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Sustainable School Menus, Sustainable Future: A Case Study from the Turkish School Lunch Menu

Sürdürülebilir Okul Menüleri, Sürdürülebilir Gelecek: Türk Okulu Öğle Yemeği Üzerine Bir Vaka Çalışması

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ABSTRACT Objective: Schools and school menus are among the most effective settings to address healthy and sustainable nutrition. This study aims to examine the carbon footprint (CF) and water footprint (WF) of the lunch menu in a private school in İstanbul, Türkiye. **Material and Methods:** The study examined 56 different foods and beverages included in a 21-day fall semester lunch menu for 275 students. The carbon and WF values of the foods in the meals were computed according to data obtained by literature review, and the relevant values per person were interpreted monthly, weekly, and daily. **Results:** As a result, the 21-day lunch menu had a total CF of 18.9 kg CO_2 eq/person/month, with a mean of 0.90±0.54 kg CO_2 eq/person/day; the total WF of the menu was 16,026 L/kg food/month, with a mean of 763.2±330.2 L/kg food/person/day. When the day with the highest carbon and WF was examined, it was observed that the menu consisted of vegetable soup, meatballs with potatoes, piyaz (bean salad), semolina halva with raisins, and salad bar (1.6 kg CO_2 eq/person/day, 988.5 L/kg food/person/day). **Conclusion:** Comparing the values in the current results with school menu studies conducted in different countries, the values in our study are at a moderate level for CF and higher for water footprint. This study is expected to pioneer school sustainability studies in our country, and further studies are warranted. The relationship between nutrition and sustainability should be more part of dietary guidelines, and awareness should be raised.

Keywords: Carbon footprint; sustainable development; menu planning; schools

ÖZET Amaç: Okullar ve okul menüleri, sağlıklı ve sürdürülebilir beslenmenin ele alındığı en etkili ortamlar arasında yer almaktadır. Bu çalışma, İstanbul'da bulunan özel bir okulun öğle yemeği menüsünün karbon ayak izi ve su ayak izini incelemeyi amaçlamaktadır. **Gereç ve Yöntemler:** Araştırmada, 275 öğrencinin 21 günlük güz yarıyılı öğle yemeği menüsünde yer alan 56 farklı yiyecek ve içecek incelenmiştir. Yemeklerde yer alan besinlerin karbon ve su ayak izi değerleri literatür taraması sonucunda elde edilen verilere göre hesaplanmış ve kişi başına ilgili değerler aylık, haftalık ve günlük olarak yorumlanmıştır. **Bulgular:** 21 günlük öğle yemeği menüsünün toplam karbon ayak izi 18,9 kg CO_2 eşdeğeri/kişi/ay, ortalama 0,90±0,54 kg CO_2 eşdeğeri/kişi/gün; menünün toplam su ayak izi ise 16,026 L/kg besin/ay, ortalama 763,2±330,2 L/kg besin/kişi/gündü. Karbon ve su ayak izinin en yüksek olduğu gün incelendiğinde menünün sebze çorbası, patatesli köfte, piyaz (fasulye salatası), kuru üzümlü irmik helvası ve salata barından oluştuğu görülmüştür (1,6 kg CO_2 eşdeğeri/kişi/gün, 988,5 L/kg besin/kişi/gün). **Sonuç:** Mevcut sonuçlardaki değerler farklı ülkelerde yapılan okul menüsü çalışmaları ile karşılaştırıldığında, çalışmamızda değerlerin karbon ayak izi açısından orta düzeyde, su ayak izi açısından ise daha yüksek olduğu gösterilmiştir. Bu çalışmanın ülkemizdeki okul sürdürülebilirliği çalışmalarına öncülük etmesi beklenmekte ve daha fazla çalışmaya ihtiyaç duyulmaktadır. Beslenme ve sürdürülebilirlik arasındaki ilişki beslenme rehberlerinde daha fazla yer almalı ve farkındalık artırılmalıdır.

Anahtar Kelimeler: Karbon ayak izi; sürdürülebilir gelişme; menü planlama; okullar

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The world's population is growing each day, and it is projected to reach 9,7 billion by 2050. The need for more cultivated areas to supply the food demands of a growing population leads to more deforestation, and if this trend persists, it seems unlikely that the current food system will be able to guarantee sufficient food production for future generations despite all interventions.[1] Moreover, climate change is one of the most critical challenges that humanity must urgently confront, and greenhouse gas emissions (GHGEs) released into the atmosphere induce natural disasters, disrupt the food chain, decrease biodiversity, and threaten our world and every living thing. Food systems, which are responsible for 20-35% of GHGEs in the environment, play a pivotal role in the sustainability of our planet, increasing the environmental burden and causing irreversible ecological impacts daily. Also, these systems use approximately 70% freshwater for agriculture and cause water pollution.[2] A shift to sustainable and nutritious diets is urgently necessary in the framework of the United Nations Sustainable Development Goal 2 (SDG 2) on food security and SDG 6 on water security.[1]

Sustainability is a comprehensive concept that includes many disciplines, from ecology to the environment, nutrition to agriculture, clean air and water to accessible natural resources, daily life to technology. It focuses on the conscientious use of today's resources, such as the environment, water, air, and food, to transfer them to future generations.[3,4] However, the cultivation of crops, manufacturing processes, packaging, refrigeration, transport, cooking, and waste management cause significant environmental damage and industrial activities.[5] The environmental impact of the food from field to fork causes each food to have a different carbon footprint (CF) and water footprint (WF).[6] The CF of foods refers to the GHGEs generated directly or indirectly during food production, processing, distribution, and end life. The amount of water consumed and polluted in every stage of food production is called WF.[7] Recent studies have demonstrated that animal-based diets, which include meat from livestock, milk, and dairy products, have a more profound impact on the environment than plant-based diets, which include vegetables, fruits, and grains.[8,9] Also, studies documented that preferring meat with a lower GHGEs impact instead of ruminant meat or decreasing the consumption of meat and dairy and increasing plant-based products reduce the total amount of CF in a diet by 20% to 40%.[10,11] The Intergovernmental Panel on Climate Change (IPCC) recognized that "Consumption of healthy and sustainable diets presents major opportunities for reducing GHGEs from food systems and improving health outcomes".[12]

Increasing individual awareness of food preferences is the key to mitigating the environmental impact of food.[13] Dietary habits are first shaped at an early age under the influence of family, environment, education, and culture. School is an effective learning environment where many habits, behaviors, and lifestyles are formed, and children acquire an ecological awareness. The concept of sustainability is closely related to the nutrition menus implemented in schools. Sustainable nutrition studies were conducted in European countries, mainly Sweden, Spain, Italy, and the United Kingdom (UK).[9,14,15] Groups of school-age children were selected as samples in these studies, and it was observed that GHGEs could be reduced at a high rate by implementing sustainable school menus.

Although more studies have been conducted on sustainable school menus in other countries, according to the authors' knowledge, no study has been conducted on the nutrition and sustainability of school menus in Türkiye. Therefore, this study aimed to calculate the CF and WF of the private school menu and compare the results with those of other countries.

MATERIAL AND METHODS

This study was conducted in the fall semester of the 2023-2024 academic year to calculate the CF and WF of the lunch menu served to 275 people in the cafeteria of a pilot school in İstanbul, Türkiye, and evaluate the environmental impacts of school menus. The food menus of preschool and school-age children (kindergarten, primary school, middle school, and high school groups) in a pilot school were considered the sample.

This study did not require ethical committee approval as it did not involve human or animal participants, personal data, or any intervention. Therefore, informed consent was not required. The principles outlined in the Declaration of Helsinki were not required to be followed due to the nature of the study.

SCHOOL LUNCH MENU DATA SET

The winter menu, designated as a pilot school in İstanbul, was obtained from the school authorities. The ingredients in the menu were controlled by standard recipes and by expert researchers who visited the school kitchen during production. Details related to the menu were demonstrated in Appendix 1.

LIFE CYCLE ASSESSMENT

Life Cycle Assessment (LCA) is a continuously developed technique for assessing and reporting the environmental impacts of a product at every stage of its life cycle, starting from raw materials.[16] This technique, frequently used in sustainability studies in the literature, is considered one of the crucial parameters in determining the CF and WF of each food on the school menu. Since there is no database on the CF and WF of foods specific to Türkiye, "Su-EATABLE LIFE (SEL)", a database created by Petersson et al. based on peer-reviewed articles and literature, where the CF and WF values of foodstuffs are brought together, taking into account the LCA data, was used in

APPENDIX 1: School lunch menu

Monday	Tuesday	Wednesday	Thursday	Friday
		1st week		
				Anatolian soup
				Dry bean with meat
				Rice pilaf
				Pickle
				Salad bar 1
Lentil soup	Tarhana soup	Vermicelli soup	Creamy broccoli soup	Ezogelin soup
Cauliflower gratin	İzmir meatball	Boiled chicken drumstick	Meatless chickpea dish	Hamburger
Plain pasta	Rice pilaf	Bulgur pilaf with vegetables	Rice pilaf	Baked spicy potato
Seasonal Fruit	Pumpkin Dessert	Buttermilk	Pickle	Lemonade
Salad bar 2	Salad bar 1	Salad bar 2	Salad bar 1	Salad bar 2
		2nd week		
Yoghurt noodle soup	Ezogelin soup	Tomato soup	Lentil soup	Winter soup
Dry bean with meat	Green lentils with meat	Baked potatoes with minced meats	Crispy chicken -potatoes	Turkish ravioli
Rice pilaf	Pasta with tomato sauce	Rice pilaf	Plain pasta	Yogurt with sauce
Pickle	Revani	Buttermilk	Tarator	Seasonal Fruit
Salad bar 1	Salad bar 2	Salad bar 1	Salad bar 2	Salad bar 1
		3rd week		
Ezogelin soup	Yayla soup	Tarhana soup	Vegetable soup	Lentil soup
Meatless vegetable dish	Meatless chickpea dish	Peas with chicken	Meatball with potatoes	Chicken döner
Noodle	Meyhane pilaf	Rice pilaf with vermicelli	White bean onion salad vinaigrette	Rice pilaf
Seasonal fruit	Pickle	Tsatsiki	Semolina halva with raisins	Buttermilk
Salad bar 2	Salad bar 1	Salad bar 2	Salad bar 1	Salad bar 2
		4th week		
Vermicelli soup	Ayranaşı soup	Ezogelin soup	Lentil soup	Tomato soup with vermicelli
Chicken Saute	Dry bean with meat	Cheese-potato pastry	Turkish pepper-zucchini dolma with minced meat	Pizza
Bulgur pilaf with vegetables	Rice Pilaf	Turkish tabbouleh	Yoghurt	Baked spicy potato
Yoghurt	Pickle	Turkish chicken breast pudding	Seasonal fruit	Buttermilk
Salad bar 1	Salad bar 2	Salad bar 1	Salad bar 2	Salad bar 1

The table provides a comprehensive list of the dishes that are included in the 4-week lunch menu. Salad bar 1: carrot, cabbage, and lettuce, salad bar 2: tomato and cucumber.

the calculations.[7] This database provides statistical data on the CF and WF of each food (SEL CF ITEMS STAT, SEL WF ITEMS STAT). In this study, data entry was made by considering the mean in the CF and WF evaluation of the food items. For foods not included in the SEL database, meta-analysis studies in the literature and websites based on scientific data were used to calculate the CF and WF of foods.[17-21]

Among the ingredients in the meals tarhana, vermicelli, noodles, pomegranate syrup, phyllo pastry and sausage since they do not have food-specific CF factors: salt, pickles, breadcrumbs, tarhana, vermicelli, noodles, semolina, vanilla, mayonnaise, Turkish ravioli, pomegranate syrup, pepper paste, phyllo pastry and sausage as they do not have food-specific WF factors are not included in the calculation.

The CF and WF values of the foods were calculated in kg CO_2 equivalents and liters/kg for each food, respectively, and the data obtained were converted into g/product and adapted to 275 children for lunch. As a result of the calculations, the CF and WF of the meals in the menus for 1 month were averaged, and comparisons were made between days and weeks.

To be consistent with the literature and ensure significance in comparisons, the 1-month lunch menu, which included 56 different food and beverages, was analyzed in 3 categories: 1st course, 2nd course, and side dish. The 1st course includes soup, pasta, pilaf, Turkish tabboule, pastry (pizza and cheese-potato pastry), meatless vegetable dish, meatless legume dish, and potato (n=27). The 2nd course includes legume dishes with meat, vegetable dishes with meat, Turkish dolma, red meat dishes, and chicken dishes (n=13). Lastly, side dishes include beverages, fruit, dessert, yogurt, tzatziki, salad, and pickles (n=16). When the frequency of the courses is examined, the most repeated dishes in the 1st courses, 2nd courses, and side dishes were found to be soups (n=21), legumes with meat (n=5), and salads (n=23), respectively (Table 1).

RESULTS

This study examined a 1-month winter lunch menu of a private school in İstanbul, and comparisons were performed on CF and WF. Relevant data were detailed based on weeks, days, courses, and meals. In total 21 school days were analysed; the 1st week included 6 school days; weekends were not included in the calculations.

THE CF OF THE SCHOOL LUNCH MENU

The total CF of the lunch menu was 18.9 kg CO_2eq/person/monthly, and the mean was found to be 0.90±0.54 kg CO_2 eq/person/daily. The highest CF among the weeks was reported in 1st week with 1.0 kgCO_2eq/person, followed by the 4th week with 0.96, 3rd week with 0.85, and 2nd week with 0.78. When compared between days, the 15th day had the highest CF with 2.02 kg CO_2 eq/person, while the 5th had the lowest CF with 0.23 kg CO_2 eq/person (Figure 1).

Since soups have a special place and importance in Turkish culture and are often preferred before the main course at lunch and dinner, in this study, the soups in the 1st course were examined separately, and their CF and WF were compared. 13 types of soups were analyzed, and the mean CF was found to be 0.06 kg CO_2 eq/person. Among these, yayla soup (yogurt with boiled rice) had the highest CF of 0.09, while tarhana soup had the lowest CF with 0.01 kg CO_2 eq/person. After tarhana soup, lentil and ezogelin soup (lentil with rice) had the lowest CF with 0.03 kg CO_2 eq/person. It has been shown that the soups with the highest CF after yayla soup are Anatolian soup and yogurt noodle soup with 0.08 kg CO_2 eq/person (Table 1).

The mean CF of the 1st course dishes was 0.17 kg CO_2 eq/person, and the lowest CF was calculated for baked spicy potato with 0.03 kg CO_2 eq/person, followed by noodles with 0.056 kg CO_2 eq/person. The highest CF was found for Turkish ravioli, which had 0.49 kg CO_2 eq/person, followed by cheese potato pastry, which had 0.44 kg CO_2 eq/person. The mean CF of the second-course dishes was 0.77 kg CO_2 eq/person, and the lowest CF was calculated for peas with chicken with 0.12 kg CO_2 eq/person. At the same time, the highest was found for a meatball with potatoes with 1.6 kg CO_2 eq/person. The mean CF side dishes was found to be 0.12 kg CO_2 eq/person, and the lowest CF was calculated for salad bar 1 with 0.01 kg CO_2 eq/person due to its

TABLE 1: CF and WF of foods according to different food groups

Name of food on the lunch menu*		
	CF	WF
First course (n=14)	(kg/CO_2 eq/person)	(L/kg food/person)
Turkish ravioli (Mantı)	0.49	
Cheese-potato pastry	0.44	345.81
Pizza	0.31	358.44
Meatless vegetable dish	0.22	110.30
Bulgur pilaf with vegetables	0.19	150.49
Rice pilaf	0.14	110.07
Rice pilaf with vermicelli	0.14	110.07
Meyhane pilaf	0.11	152.40
Turkish tabbouleh	0.08	124.67
Meatless chickpea dish	0.06	159.85
Pasta with tomato sauce	0.06	83.80
Plain pasta	0.06	80.69
Noodle	0.056	80.69
Baked spicy potato	0.03	82.16
	CF	WF
First course (Soup) (n=13)	(kg/CO_2 eq/person)	(L/kg food/person)
Yayla soup (yogurt with rice)	0.09	125.48
Yogurt noodle soup	0.08	121.64
Anatolian soup (lentils with bulgur)	0.08	157.58
Vermicelli soup	0.07	68.82
Tomato soup	0.07	85.99
Tomato soup with vermicelli	0.07	110.07
Creamy broccoli soup	0.07	53.57
Ayranaşı soup (yogurt with chickpea and wheat)	0.07	142.30
Vegetable soup	0.06	103.91
Winter soup	0.05	102.69
Ezogelin soup (red lentil with rice)	0.03	164.71
Lentil soup	0.03	159.09
Tarhana soup	0.01	65.05
	CF	WF
Second course (n=13)	(kg/CO_2 eq/person)	(L/kg food/person)
Meatball with potatoes	1.6	988.53
İzmir meatball	1.57	906.37
Hamburger	1.57	887.74
Turkish pepper-zucchini dolma with minced meat	1.48	730.83
Baked potatoes with minced meat	0.83	498.97
Crispy chicken potatoes	0.55	802.22
Dry bean with meat	0.48	416.70
Cauliflower gratin	0.47	319.92
Green lentils with minced meat	0.44	431.79
Chicken doner	0.39	444.36
Chicken saute	0.31	339.65
Boiled chicken drumstick with vegetables	0.18	194.21
Peas with chicken	0.12	166.19

TABLE 1: CF and WF of foods according to different food groups *(contunied).*

	CF	WF
Side dishes (n=16)	(kg/CO_2 eq/person)	(L/kg food/person)
Turkish chicken breast pudding	0.3	251.25
Semolina halva with raisins	0.27	202.72
Tsatsiki (diced cucumber garlic and mint in yogurt)	0.23	117.89
Tarator (carrot salad with yogurt)	0.16	119.47
Yogurt with sauce	0.16	138.88
Salad bar 2 (tomato and cucumber)	0.15	8.93
Yogurt	0.15	116.73
Ayran	0.13	96.30
Revani (semolina cake soaked in light syrup)	0.12	181.66
Pumpkin dessert	0.11	277.13
White bean onion salad vinaigrette	0.07	126.48
Seasonal fruit	0.04	81.60
Pickle	0.03	0.00
Tangerine	0.03	51.68
Lemonade	0.03	67.16
Salad bar 1 (carrot, cabbage, and lettuce)	0.01	7.16

*Foods are listed by CF from largest to smallest within each group. CF: Carbon footprint; WF: Water footprint

fresh vegetable content, while the highest CF was found for Turkish chicken breast pudding with 0.3 kg CO_2 eq/person (Table 1).

THE WF OF THE SCHOOL LUNCH MENU

The WF of a 1-month menu was 763.15 L/kg food/person. The highest WF among the weeks was seen in the 4th week with 796.3 L/kg food/person, followed by the 1st week with 789.6, the 2nd week with 765.1, and the 3rd week with 701.6 Except for the 3rd week, the WF of the other 3 weeks were closer to each other (Figure 2).

When comparing days, the 15th day had the highest WF with 1,428.81 L/kg food/person, similar to the CF. The day with the lowest WF was the 11th, with 330.34 L/kg food/person. The meatball with potatoes on the menu on the 15th day had the highest WF calculated in the 1-month menu, which caused this day to have a high WF. As mentioned, the dishes also caused the highest CF on the 15th day.

The mean WF of the soups was found to be 112.4 L/kg food/person, among which ezogelin soup

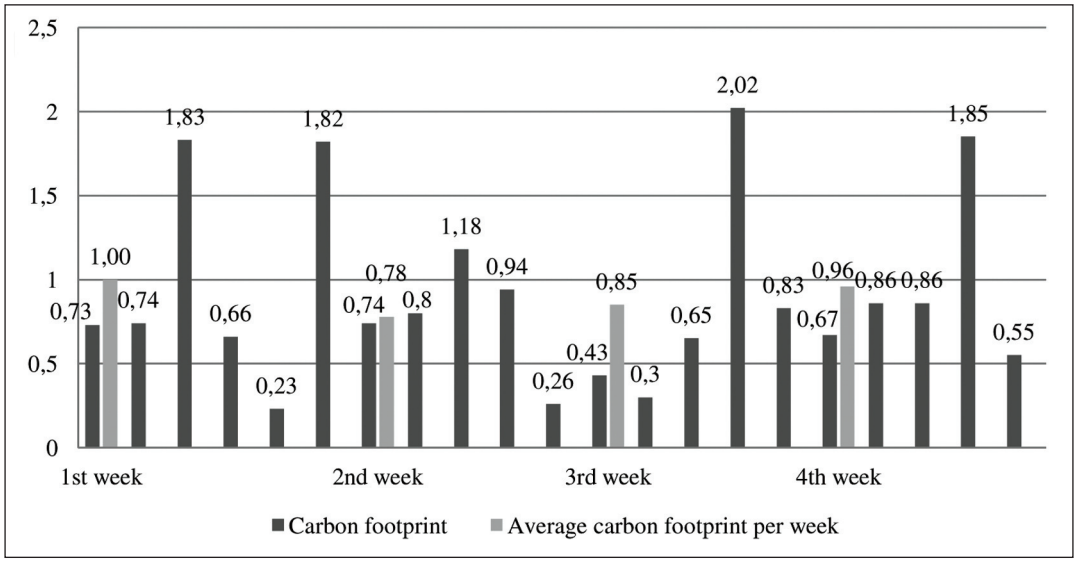

FIGURE 1: The CF of the lunch menu on a weekly basis

The mean CF of the lunch menu for each week were as follows: 1st week (1.0 kg CO_2 eq/person), 2nd week (0.78 kg CO_2 eq/person), 3rd week (0.85 kg CO_2 eq/person), and 4th week (0.96 kg CO_2 eq/person).

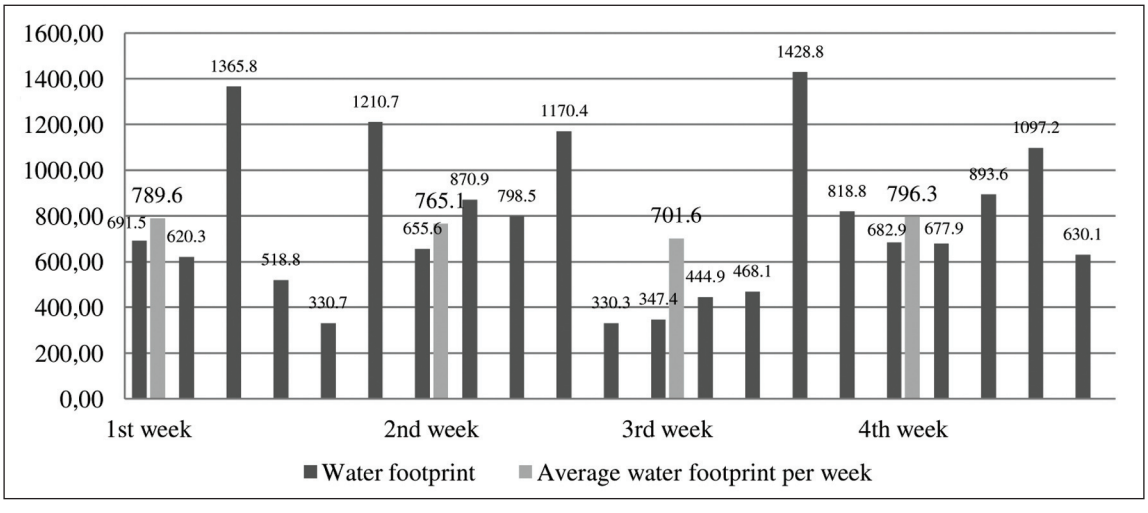

FIGURE 2: The WF of the lunch menu on a weekly basis

The mean WF of the lunch menu for each week were as follows: 1st week (789.6 L/kg food/person), 2nd week (765.1 L/kg food/person), 3rd week (701.6 L/kg food/person), and 4th week (796.3 L/kg food/person).

(lentil with rice) had the highest WF with 164.7 L/kg food/person, while creamy broccoli soup had the lowest WF with 53.57 L/kg food/person. The mean WF of the 1st course dishes was found to be 144.65 L/kg food/person. The lowest WF was calculated for plain pasta at 80.69 L/kg food/person, followed by baked spicy potato at 82.16 L/kg food/person. The highest WF was calculated for pizza, with 358.44 L/kg food/person, followed by cheese-potato pastry, with 345.81 L/kg food/person (Table 1).

The mean WF of the 2nd-course dishes was 548.3 L/kg food/person. For 2nd-course meals, the lowest and highest WF was the same as the CF, with 166.19 L/kg food/person for peas with chicken and 988.53

L/kg food/person for meatballs with potatoes. The mean WF of the side dishes was found to be 123 L/kg food/person. The lowest WF was calculated for salad bar 1 as in CF with 7.16, and the highest for pumpkin dessert with 277.13 L/kg food/person. Since the WF of pickles could not be found in the literature, it was not included in the comparisons of side dishes. The group with the highest mean WF was again the 2nd course, with 548.3 L/kg food/person, while the lowest was the side dishes, with 123 L/kg food/person (Table 1).

DISCUSSION

To our knowledge, this is the 1st study to address the ecological effects of school menus by calculating their CF and WF values in Türkiye. Although there is no study on school menus in Türkiye, there are several studies on CF and/or WF in different areas, such as omnivorous, vegetarian, and vegan diets and national diets based on Turkish cuisine, hospital menus, and university refectory.[22-26]

The primary motivator for examining sustainability in the school menu is that the school years are one of the most crucial periods for environmental awareness after the family. Raising awareness at an early age can contribute to the development of healthy and sustainable eating habits in society in the long term. In line with this approach, Höijer et al. revealed that hospitals and schools are the most effective areas for promoting the perception of sustainability.[27]

Turkish cuisine encompasses a wide range of dishes that have been preserved over the years due to its vast geography, intercultural interaction, climate and environmental advantages, and hosting of different cultures over the years. Despite its notoriety as a meat-based cuisine, Turkish cuisine encompasses various foods, from pastries to kebabs, from elaborate vegetable dishes to various dairy products.[28] The foods included in the school menus are designed to reflect the Turkish culinary culture and meet the children's daily energy and nutritional needs. Compared to different studies evaluating the environmental impact of school menus, as shown in Figure 3, the CF of our menu (0.9 kg CO_2-eq/day) is lower than in some countries, such as the United Kingdom (1.02 kg CO_2-eq/day), Italy (1.2 kg CO_2-eq/day), Brazilian (1.95 kg CO_2-eq/day), France (2.1 kg CO_2-eq/day).[29-32] On the other hand, according to studies performed in different countries such as England (0.72 kg CO_2-eq/day), Sweden (0.82 kg CO_2-eq/day), and France (0.9 kg CO_2-eq/day).[9,15,32] The primary reason can be attributed to the repetition of meat dishes in 76% of the 21-day menu in the current study. In addition, the frequency of milk and dairy products is another factor

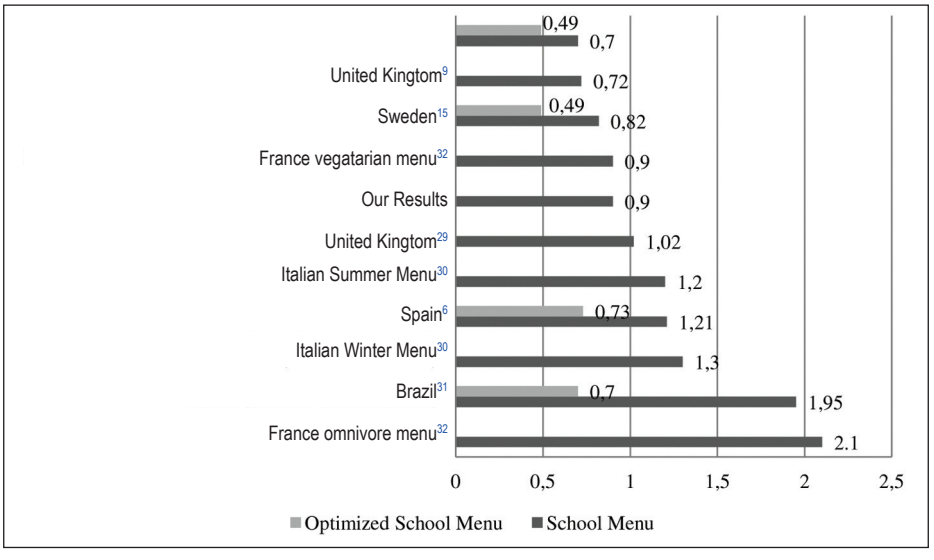

FIGURE 3: Comparison of our study with the CF (kg CO_2 eq/person/day) of other countries

that causes a high CF. However, according to the IPCC report data, the World Wildlife Fund has limited CF to 0.5 kg CO_2-eq/day per lunch.[15] From this perspective, it was determined that our menu is very close to this value and is amenable to improvement.

Although studies examining the CF of school menus are available in the literature, studies on WF are limited. In a study conducted in Spain, the average of 10 school lunch menus was found to be 680 L/kg food/person/lunch.[5] Another study on school lunches in the United Kingdom found the average WF to be 554 L/kg food/person/lunch.[29] These values were lower than the value we found (763.15 L/kg food/person/lunch). Although WF was higher in this study than in other countries, the country comparison study revealed that total WF values in Türkiye were lower than in other countries, and this was attributed to Türkiye being a grain-dominated society.[23,33]

When the 56 dishes of the lunch menu discussed in this study were classified into the 1st course, 2nd course, and side dishes, it was demonstrated that the highest mean CF was the second-dishes (0.77 CO_2-eq/day), including meat dishes. Parallel to our findings, in the study by Martinez et al. the dishes with the highest CF were 2nd course, ranging from 0.2 kg CO_2 eq/person to 0.41 kg CO_2 eq/person. The lowest CF was found in the side dish course (ranging from 0.012 kg CO_2 eq/person to 0.21 kg CO_2 eq/person), in parallel with our study (0.01-0.30 kg CO_2 eq/person).[34]

When studies on school menus in the literature were examined comprehensively, comparisons of menu models, primarily vegan, vegetarian, and omnivorous menus, were frequently seen. When compared with these menus, it was seen that our omnivorous menu has the same values as France's vegetarian menu (0.9 CO_2-eq/day). In another study aiming to assess the CF associated with 2-week vegan, vegetarian, and omnivorous menus for primary school lunches in Italy, the vegan menu was found to be 1.74 kg, the omnivorous menu 3.57 kg, and the vegetarian menu 4.72 kg CO_2 eq/person/weekly. This means that vegan and vegetarian menus alone are not enough to reduce pressure on the environment, and the optimal selection of dishes in menu design is the main factor in lowering GHGEs.[14] The fact that the CF of our study is similar to those of vegetarian menus in other countries may be due to reasons such as the relatively lower amount of meat used in our menus compared to other countries, recipes that differ from country to country, religious beliefs, economic conditions, and the assumptions used to calculate the CF.[35]

The strongest aspect of this study is that it is the 1st study to examine the CF and WF of the school lunch menu. In addition, standard recipes for the meals on the school menu were achieved, and on-site observations ensured the accuracy of the quantities. However, the generalizability of this study is limited due to the study being conducted in only one school in Türkiye and on a 1-month menu. Since there is no database specific to Türkiye, the utilization of databases and articles accepted in the literature may not correspond precisely to the data in our country.

CONCLUSION

In this study, the CF and WF of meals served in school lunch menus were analyzed, and the results were compared with those of the literature. The CF and WF values in the current results are at a moderate level for CF and higher for WF, according to a comparison with school menu studies in other countries. This study found that animal-based foods' CF and WF were higher than plant-based foods. In terms of menus, the frequent repetition of meals in the 1st course and side dishes and the repetition of soup, which is specific to Turkish culture in every meal, caused the lowest CF and WF, while the high CF and WF in the 2nd group was caused by meat dishes. This study is expected to pioneer sustainability studies for schools in Türkiye, and more comprehensive studies are needed. The relationship between nutrition and sustainability should be included more in the country-specific guidelines, and awareness should be raised primarily from a young age. The aim should be to plan more sustainable and healthier alternative school menus, to popularize the concept of a "Sustainable Nutrition-Friendly School", and to contribute to a sustainable future.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Gözde Dumlu Bilgin;* ***Design:*** *Gözde Dumlu Bilgin, Melis Keküllüoğlu Tan;* ***Control/Supervision:*** *Gözde Dumlu Bilgin, Melis Keküllüoğlu Tan;* ***Data Collection and/or Processing:*** *Mina Dürdane Anbaroğlu, Ecem Pirli;* ***Analysis and/or Interpretation:*** *Mina Dürdane Anbaroğlu, Ecem Pirli;* ***Literature Review:*** *Mina Dürdane Anbaroğlu, Ecem Pirli;* ***Writing the Article:*** *Mina Dürdane Anbaroğlu, Ecem Pirli, Melis Keküllüoğlu Tan, Gözde Dumlu Bilgin;* ***Critical Review:*** *Gözde Dumlu Bilgin, Melis Keküllüoğlu Tan;* ***References and Fundings:*** *Gözde Dumlu Bilgin.*

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