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THE CARBON FOOTPRINT OF SPORTS EVENTS: AN EVALUATION OF THE TOURNAMENTS ORGANIZED BY THE TURKISH UNIVERSITY SPORTS FEDERATION IN TERMS OF SUSTAINABILITY

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Abstract: This study evaluates the environmental sustainability of four interuniversity tournaments (football, volleyball, basketball, and futsal) organized by the Turkish University Sports Federation (TUSF) in the 2024–2025 season by calculating their carbon footprints. Data from 415 participants representing 24 universities were compiled from tournament records, including travel distances, overnight stays, and meal consumption. Emissions were estimated using coefficients recommended by the IPCC and the UK Department for Energy Security and Net Zero (DESNZ) for transportation (0.089 kg CO₂e per person-km), accommodation (6.8 kg CO₂e per person-night), and food (2.5 kg CO₂e per meal). Total emissions ranged from 3,584.4 kg CO₂e (volleyball) to 9,774 kg CO₂e (futsal), with travel distance and accommodation duration being the main drivers. Overall, the results indicate that sustainability-oriented planning in university sports tournaments should prioritize reducing travel-related emissions and managing accommodation demand, because these two components largely explain the differences between low- and high-emission events.

Keywords: Carbon footprint, environmental sustainability, greenhouse gas emissions, sports organizations, university sports tournaments

SPOR ETKİNLİKLERİNİN KARBON AYAK İZİ: TÜRKİYE ÜNİVERSİTE SPORLARI FEDERASYONU TARAFINDAN DÜZENLENEN TURNUVALARIN SÜRDÜRÜLEBİLİRLİK AÇISINDAN DEĞERLENDİRİLMESİ

Öz: Bu çalışma, Türkiye Üniversite Sporları Federasyonu (TÜSF) tarafından 2024–2025 sezonunda düzenlenen futbol, voleybol, basketbol ve futsal turnuvalarının çevresel sürdürülebilirliğini karbon ayak izi hesaplamaları üzerinden değerlendirmeyi amaçlamaktadır. Araştırma verileri, 24 üniversiteden 415 katılımcıya ilişkin turnuva kayıtlarından; ulaşım mesafeleri, konaklama gece sayıları ve yemek tüketimi değişkenleri dikkate alınarak derlenmiştir. Emisyonlar, IPCC ve UK Department for Energy Security and Net Zero (DESNZ) tarafından önerilen katsayılar kullanılarak hesaplanmıştır. Ulaşım için 0,089 kg CO₂e/kişi-km, konaklama için 6,8 kg CO₂e/kişi-gece ve yemek için 2,5 kg CO₂e/öğün katsayıları esas alınmıştır. Toplam emisyon değerleri voleybolda 3.584,4 kg CO₂e ile en düşük, futsalda 9.774 kg CO₂e ile en yüksek düzeyde bulunmuştur. Bulgular, üniversite spor turnuvalarında karbon emisyonlarının azaltılması için ulaşım planlaması, konaklama süresi ve yemek hizmetlerinin sürdürülebilirlik odaklı düzenlenmesi gerektiğini göstermektedir.

Anahtar Kelimeler: Karbon ayak izi, sera gazı emisyonları, spor organizasyonları, sürdürülebilirlik, üniversite spor turnuvaları



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INTRODUCTION

Global climate change is creating transformations not only in environmental aspects but also in social, economic, and cultural domains. This change has become more pronounced due to the increase in greenhouse gas emissions resulting from human activities. The carbon footprint is an important indicator that represents the amount of greenhouse gases emitted into the atmosphere by individuals and institutions (IPCC, 2021). Today, this indicator is recognized as an indispensable measure for achieving sustainable development goals (UNEP, 2022).

Sports organizations have significant environmental impacts due to high participant numbers, intensive transportation activities, energy consumption, and accommodation needs. Especially in large-scale tournaments, carbon emissions can reach substantial levels (Collins & Cooper, 2017; Pereira et al., 2020). Therefore, analyzing the carbon footprint of sporting events is of great importance for the development of sustainable sports policies. In the sport sector, environmental sustainability has increasingly been addressed through event management, logistics, reporting, and organizational planning; however, quantitative carbon footprint studies focusing specifically on university sports tournaments remain limited (Daddi et al., 2022; McCullough et al., 2023).

In this context, calculation methods based on conversion factors provided by organizations such as the Intergovernmental Panel on Climate Change (IPCC) and the UK Department for Energy Security and Net Zero (DESNZ) allow for a more objective assessment of the environmental impacts of sports events. The aim of this study is to calculate the carbon footprint generated by transportation, accommodation, and food consumption during interuniversity sports events held in Turkey, to compare the results with international examples, and to develop recommendations that contribute to sustainability.

Previous studies show that the carbon footprint of sports organizations is largely shaped by participant mobility, team travel, accommodation, food services, and event duration. Dolf and Teehan (2015) reported that transportation constituted the dominant source of emissions in university sport events, while Pereira et al. (2020) emphasized that accommodation and sport-related tourism can considerably increase total carbon emissions in large-scale events. Piccerillo, Misiti, and Digennaro (2023) similarly demonstrated that university sport events can be evaluated through measurable sustainability indicators when participant numbers, travel distances, and service consumption are systematically recorded. In Turkey, the environmental sustainability of sports organizations has mostly been discussed conceptually or through participants' perceptions. Quantitative studies calculating emissions from transportation, accommodation, and meals in university sport tournaments remain limited. Therefore, this study addresses an important empirical gap by converting tournament-level logistical data into carbon dioxide equivalent (CO₂e) values and by presenting comparable evidence for sustainable university sport management.

The primary aim of this study is to calculate the carbon footprint generated by transportation, accommodation, and food consumption during interuniversity sports tournaments organized by the Turkish University Sports Federation in the 2024–2025 season. Within this aim, the study compares football, volleyball, basketball, and futsal tournaments according to total emissions, emission components, and per capita carbon footprint values. The significance of the study lies in providing one of the first data-based carbon footprint assessments for university sports tournaments in Turkey. By producing numerical evidence, the research can support the Turkish University Sports Federation, universities, event organizers, and policy makers in planning low-

carbon transportation, accommodation, catering, and carbon-offset strategies. In this respect, the study contributes both to the academic literature on sport sustainability and to practical decision-making in university sport organizations.

Theoretical Framework

The Concept of Climate Change and Carbon Footprint

The carbon footprint refers to the total amount of greenhouse gas emissions directly or indirectly caused by individuals, institutions, or organizations. This concept enables the assessment of environmental impact and the planning of sustainability policies (IPCC, 2021; Binboğa & Ünal, 2018). It is typically measured through analyses conducted in areas such as transportation, energy use, food consumption, and waste generation (DESNZ, 2023).

The carbon footprint lies at the core of environmental sustainability efforts and has been integrated into corporate responsibility strategies in many countries. Studies conducted in Turkey have generally examined institutional carbon footprint calculations and carbon footprint awareness in university contexts (Binboğa & Ünal, 2018; Gökçek et al., 2019). However, it has been observed that such analyses remain limited in multidimensional and large-scale organizations such as sporting events.

Environmental Impacts of Sports Organizations

Sports events represent not only competition but also intensive resource consumption in areas such as transportation, accommodation, energy, and food. This results in significant carbon emissions. Especially at the university level, tournaments can cause substantial environmental impacts due to regional mobility (Collins & Cooper, 2017; Dolf & Teehan, 2015).

The projections by Pereira et al. (2020) for the FIFA 2030 World Cup clearly reveal the impact of sports tourism and accommodation services on the carbon footprint. Dolf and Teehan's (2015) study on university sports events in Canada shows that transportation-related emissions can account for up to 70% of the total footprint.

Previous research on sport-event sustainability has generally emphasized environmental management practices, sustainability reporting, and the development of measurement tools for event organizers (Daddi et al., 2022; Hugaerts et al., 2021). However, research that quantitatively assesses the carbon emissions of university sports organizations is still limited. Addressing this gap is important for developing more sustainable sports policies (Ünal & Bağcı, 2017).

METHOD

Research Design

This study was designed as a quantitative descriptive/documentary analysis based on carbon footprint calculation. The unit of analysis was each interuniversity tournament and the team delegations participating in these tournaments. The study did not involve an experimental intervention or psychological measurement; instead, it transformed measurable organizational data into carbon dioxide equivalent (CO₂e) values by using internationally accepted emission coefficients.

Study Group and Scope

The study covered four regional interuniversity sports tournaments organized under the Turkish University Sports Federation during the 2024–2025 season, within the December 2024–April

2025 tournament period. The tournaments included football hosted by Kafkas University (Kars), volleyball hosted by Artvin Çoruh University (Artvin), basketball hosted by Sivas Cumhuriyet University (Sivas), and futsal hosted by Atatürk University (Erzurum).

The study group consisted of 415 participants from 24 universities, including athletes, coaches, drivers, and administrative staff who were directly involved in the relevant tournaments. Since the analysis was conducted at the team delegation and tournament level, no personal identification data were used.

Data Sources and Data Collection Process

Data were obtained from tournament records, written information provided by the relevant university representatives and organizing committees, and researcher-prepared tournament data forms. For each team delegation, the following variables were recorded: number of participants, type of transportation, round-trip travel distance in kilometres, number of accommodation nights, and number of meals consumed during the tournament period.

To ensure comparability across tournaments, all data were organized in the same format. Distances were checked using the departure and host city information, accommodation was calculated as person-nights, and meal consumption was calculated according to the number of participants and meals served during the tournament days.

Data Collection Tool

The main data collection tool was the Carbon Footprint Data Entry Form developed by the researcher. The form included fields for tournament name, host university, participating university, participant number, travel distance, accommodation nights, meal number, and notes about data source or estimation. This form functioned as a standardized measurement and recording instrument for calculating carbon footprint indicators.

Carbon Footprint Calculation Method and Standards

The carbon footprint refers to the total amount of greenhouse gases released as a result of an activity and is expressed in carbon dioxide equivalent (CO₂e). In this study, calculations were based on the methodological framework of IPCC (2021), DESNZ (2023), ISO 14064-1:2018 (International Organization for Standardization [ISO], 2018), and the Greenhouse Gas Protocol (World Resources Institute & World Business Council for Sustainable Development [WRI & WBCSD], 2004). IPCC and DESNZ provide internationally comparable emission factors, while ISO 14064 and the GHG Protocol offer guidance for organizational-level greenhouse gas quantification and reporting.

Transportation emissions were calculated as: Number of participants × round-trip distance (km) × 0.089 kg CO₂e/person-km. In this study, all intercity team travel was assumed to be carried out by road-based group transportation (bus/minibus), because the official tournament records did not provide vehicle-specific distinctions such as fuel type, exact vehicle model, or occupancy rate. Therefore, the coefficient of 0.089 kg CO₂e/person-km was used as an average road-transport emission factor for all transportation calculations. Accommodation emissions were calculated as: Number of participants × number of nights × 6.8 kg CO₂e/person-night.

Meal emissions were calculated as: Number of participants × number of meals × 2.5 kg CO₂e/meal. Because the meal records did not distinguish menu types such as meat-based, vegetarian, or plant-based meals, food-related emissions were calculated using a general average meal coefficient. Thus, the value of 2.5 kg CO₂e/meal should be interpreted as an approximate average emission factor rather than a menu-specific measurement.

For each tournament, transportation, accommodation, and meal emissions were first calculated separately. Then, these component values were summed to obtain the total carbon footprint. Per capita carbon footprint was calculated by dividing the total emission value of each tournament by the number of participants.

Data Analysis

The data were entered into Microsoft Excel and analysed using descriptive calculations. The analysis included total carbon emissions, component-based emission distribution, number of participants, total travel distance, accommodation duration, and per capita carbon footprint. Results were presented through tables and figures in order to compare the environmental impact of the four tournaments.

Ethics Committee Approval

This study was based solely on aggregate and anonymized tournament-level records. No direct data were collected from human participants, and no identifiable personal data, surveys, interviews, or experimental procedures were used. Therefore, ethics committee approval was not required for this documentary/secondary data analysis.

RESULTS

All findings presented in this section refer to the 2024–2025 Turkish University Sports Federation tournament season and the December 2024–April 2025 data collection period.

General Data on the Tournaments (Participants, Distance, Days)

During the 2024–2025 season and the December 2024–April 2025 tournament period, the four tournaments were compared according to participant numbers, total travel distances, and accommodation days. The highest number of participants and the greatest total travel distance were observed in the futsal tournament, indicating that this event created the greatest logistical mobility among the tournaments.

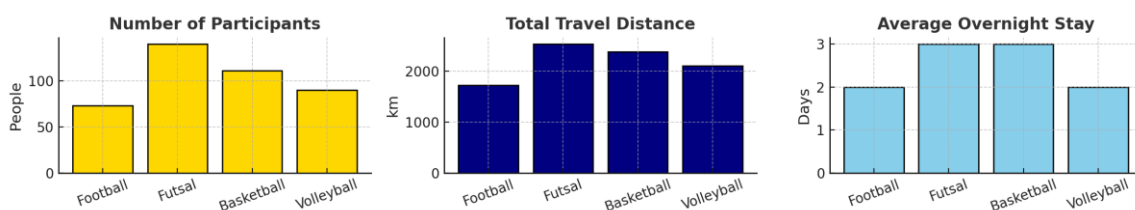


Figure 1. Comparison of general data on interuniversity tournaments

When examining Figure 1 for the 2024–2025 season, the Futsal Tournament had the highest number of participants (140), whereas the Football Tournament had the lowest number of participants (73). The total travel distance was also highest in futsal (2,540 km). In terms of accommodation duration, the Basketball and Futsal tournaments stood out with three-day event structures. These findings show that events combining high participation, long-distance travel, and multi-day accommodation produced greater carbon footprint potential.

Total Carbon Footprint of the Tournaments (kg CO₂e)

For the 2024–2025 tournament period, the Futsal Tournament produced the highest carbon footprint with 9,774 kg CO₂e, whereas the Volleyball Tournament produced the lowest carbon footprint with 3,584.4 kg CO₂e. The 6,189.6 kg CO₂e difference between these two tournaments demonstrates that travel distance and accommodation duration are decisive factors in total emission levels.

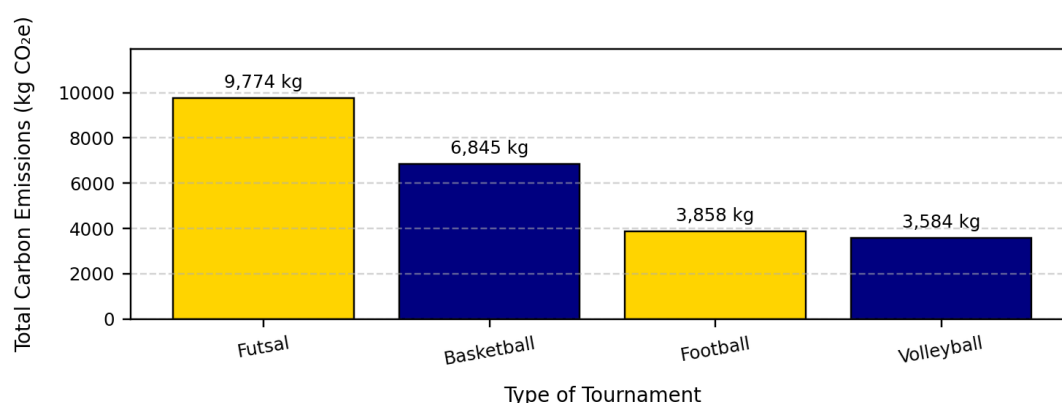


Figure 2. Comparison of the carbon footprints of interuniversity sports tournaments (kg CO₂e)

When Figure 2 is examined, the carbon footprint values of the four tournaments organized during the 2024–2025 season are presented comparatively. The Futsal Tournament recorded the highest emission value (9,774 kg CO₂e), followed by the Basketball Tournament (6,844.9 kg CO₂e), Football Tournament (3,857.5 kg CO₂e), and Volleyball Tournament (3,584.4 kg CO₂e). This ranking indicates that the environmental impact of university sports tournaments is shaped not only by the number of participants but also by travel distance, accommodation needs, and event duration.

Carbon Footprint Distribution by Emission Components

During the December 2024–April 2025 analysis period, the component-based results showed that transportation and accommodation were the most influential emission sources. This finding highlights the importance of route planning, regional grouping, shared transportation, and accommodation policies in reducing the environmental burden of university sports tournaments.

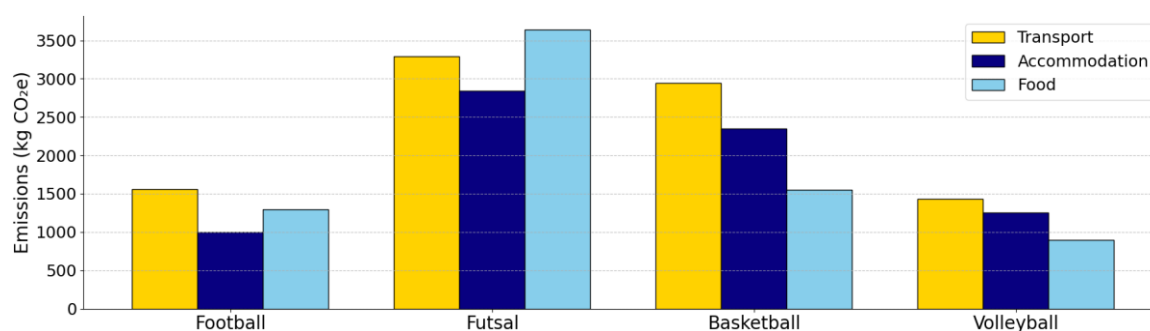


Figure 3. Distribution of emission components by tournaments (kg CO₂e)

As shown in Figure 3, the Futsal Tournament had the highest transportation and meal emissions, mainly due to its high number of participants and longer travel distances. The Basketball Tournament also had high transportation and accommodation emissions. In contrast, the Football and Volleyball tournaments produced lower component-based emissions. This pattern suggests that carbon reduction strategies should be tailored to the logistical characteristics of each tournament rather than applying a single uniform policy.

Note. Component-based values were calculated using the same emission coefficients described in the method section; therefore, the figure should be interpreted together with the total and per capita values reported in Table 1.

Per Capita Carbon Footprint Comparisons

When the 2024–2025 season is evaluated on a per capita basis, the highest value was observed in the Futsal Tournament (69.81 kg CO₂e per participant), while the lowest value was observed in the Volleyball Tournament (38.96 kg CO₂e per participant). The per capita difference of 30.85 kg CO₂e shows that individual environmental impact increases when long-distance travel and accommodation are combined in the same event.

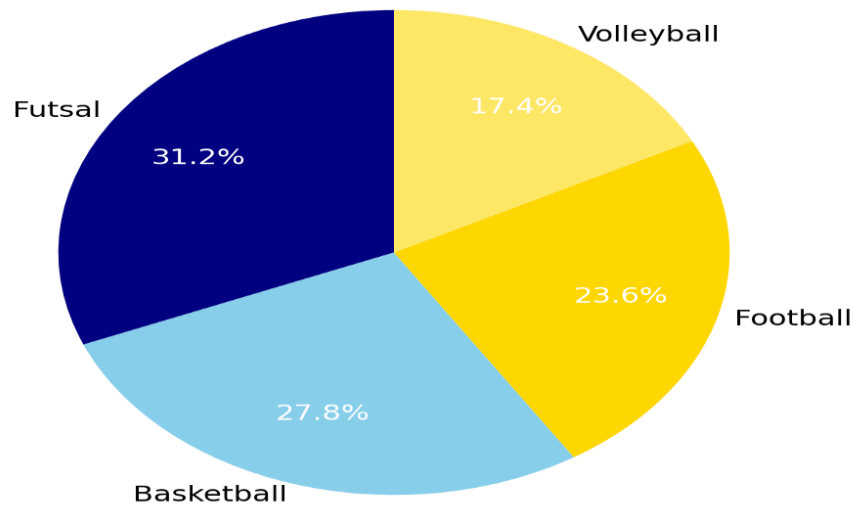


Figure 4. Per capita carbon footprint by tournaments (kg CO₂e)

The pie chart in Figure 4 illustrates the percentage distribution of per capita carbon emissions across the tournaments. The Futsal Tournament constitutes the largest segment because it has the highest per capita carbon footprint. It is followed by the Basketball and Football tournaments, while Volleyball has the lowest per capita emission value. This result confirms that per capita analysis is useful for identifying high-impact tournaments even when participant numbers differ.

Tournament-level Carbon Footprint Summary

Table 1. Total and per capita carbon footprint values by tournament

Tournament	Total Emissions (kg CO ₂ e)	Number of Participants	Per Capita Emission (kg CO ₂ e)
Football	3,857.5	73	52.84
Futsal	9,774.0	140	69.81
Basketball	6,844.9	110	62.23
Volleyball	3,584.4	92	38.96

When Table 1 is examined for the 2024–2025 season, the highest total emission value was observed in the Futsal Tournament (9,774 kg CO₂e), while the lowest value was recorded in the Volleyball Tournament (3,584.4 kg CO₂e). The Futsal Tournament also had the highest per capita emission value (69.81 kg CO₂e), whereas Volleyball had the lowest value (38.96 kg CO₂e). The overall findings indicate that interuniversity sports events generate environmental impacts through total participation, travel distance, accommodation duration, and catering needs. Therefore, sustainability-oriented planning is especially important for tournaments involving long-distance mobility and multi-day accommodation.

DISCUSSION AND CONCLUSION

This study calculated and compared the carbon footprints of four interuniversity sports tournaments organized under the Turkish University Sports Federation during the 2024–2025 season. The findings showed that the total carbon footprint of the analysed tournaments reached 24,060.8 kg CO₂e. Among the tournaments, futsal generated the highest emission value (9,774 kg CO₂e), whereas volleyball generated the lowest emission value (3,584.4 kg CO₂e). Thus, the futsal tournament produced approximately 2.7 times more emissions than the volleyball tournament.

The results indicate that the carbon footprint of university sports events is not determined by participant number alone. Although participant numbers are important, the combination of travel distance, event duration, and accommodation need appears to be more decisive. This is particularly evident in the futsal and basketball tournaments, where longer travel distances and multi-day accommodation increased both total and per capita emissions. The per capita carbon footprint also supports this interpretation: futsal had the highest value (69.81 kg CO₂e), while volleyball had the lowest value (38.96 kg CO₂e).

These findings are consistent with previous research emphasizing the central role of mobility in sport-related emissions. Dolf and Teehan (2015) reported that transportation accounted for the largest proportion of emissions in university sport events, while Pereira et al. (2020) showed that travel and accommodation substantially increase the carbon footprint of large sport events. Similarly, Piccerillo, Misiti, and Digennaro (2023) demonstrated that university sport events can be evaluated through measurable environmental indicators. In addition, McCullough et al. (2023) underlined the importance of standardized and transparent emission reporting in sport events. The present study extends this literature by presenting a Turkey-based quantitative case from interuniversity tournaments and by emphasizing both pre-event estimation and post-event reporting.

The component-based results also provide practical implications. Transportation-related emissions can be reduced through regional grouping of competitions, preference for shared buses or rail travel where feasible, and route optimization. Accommodation-related emissions can be reduced by selecting energy-efficient facilities, shortening unnecessary overnight stays, or designing competition calendars that reduce travel and lodging requirements. Meal-related emissions, although lower than transportation in many cases, can also be managed through local sourcing, waste reduction, and lower-carbon menu options.

From a policy perspective, the Turkish University Sports Federation and universities can use these findings to integrate carbon footprint assessment into routine event planning. Pre-event carbon estimation, post-event emission reporting, and annual sustainability reports would enable institutions to monitor progress and compare tournaments over time. Such practices would also contribute to the development of carbon-neutral university sports events in Turkey.

In conclusion, the study demonstrates that interuniversity sports tournaments organized in the 2024–2025 season generated measurable carbon emissions, with a total footprint of 24,060.8 kg CO₂e across four tournaments. The highest carbon footprint was calculated for futsal (9,774 kg CO₂e; 69.81 kg CO₂e per participant), while the lowest was calculated for volleyball (3,584.4 kg CO₂e; 38.96 kg CO₂e per participant). These numerical results show that the sustainability problem in university sports tournaments is primarily related to travel distance, accommodation duration, and participant mobility. Therefore, carbon-conscious planning should be considered an essential component of university sports event management.

Recommendations

- Carbon footprint calculations should be conducted before university sports events and reported after the event.
- Tournament calendars should be organized to reduce unnecessary long-distance travel and accommodation needs.
- Environmentally friendly transportation options such as shared buses, rail travel, or electric vehicles should be encouraged where possible.
- Energy-efficient accommodation facilities and shorter stay strategies should be prioritized.
- Local, seasonal, and lower-carbon meal options should be preferred in catering services.
- The Turkish University Sports Federation could establish an interuniversity carbon-offset or sustainability fund for high-emission tournaments.
- Carbon footprint reporting should be integrated into annual sustainability reports by TUSF and participating universities.

Limitations

The carbon footprint values in this study should be interpreted as approximate estimates rather than exact measurements. The use of average emission coefficients may not fully reflect differences in vehicle type, fuel efficiency, occupancy rate, meal content, or accommodation facility characteristics. In addition, some data were based on official tournament records and organizer confirmations rather than direct real-time measurement. Nevertheless, the use of standardized coefficients increases the comparability and methodological transparency of the findings.

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Data Availability: The datasets used and/or analyzed in this study are available from the corresponding author upon reasonable request, provided that the necessary permissions are obtained from the relevant institutions.

Author Contributions: Conceptualization and study design: Tarkan Havadar. Data collection: Tarkan Havadar. Data analysis, interpretation of the findings, writing, review, and editing: Tarkan Havadar. The author has read, reviewed, and approved the final version of the manuscript.

Use of Generative Artificial Intelligence: During the preparation of this manuscript, generative artificial intelligence tools were used only for language editing, academic expression improvement, and translation checking. The scientific content, data analysis, interpretation of the findings, and final version of the manuscript were reviewed, controlled, and approved by the author.

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