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## The impact of climate change on some aspects of public health and sustainable development, sports tourism, and green economy for the sports sector in the Eastern Province of the Kingdom of Saudi Arabia

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### Abstract

The research evaluated the effects of climate change on public health, together with sustainable development components, alongside sports tourism and the green economy elements of the sports sector throughout the Eastern Province of the Kingdom of Saudi Arabia. The researcher selected the descriptive approach along with the descriptive survey approach to fulfill the study objectives because these approaches matched the methodology requirements. A total of 1,512 participants were chosen from different sections of the study population. The data analysis revealed that climate change stands in direct connection with public health, together with the green economy and the sports sector's climate impact mitigation efforts. Results from the data collection process establish that Saudi sports institutions actively implement climate change solutions along with green protocols to demonstrate their dedication to environmental sustainability. Conclusion: The study documents substantial proof that shows how climate-related decisions support public health benefits while helping the green economy and climate mitigation efforts produce positive results. The experimental findings demonstrate that sports-focused green economic initiatives assist in fighting global warming. The incorporation of renewable energy technologies along with sustainable materials in sports infrastructure both lowers ecological harm and helps achieve the economic objectives detailed in Vision 2030.

**Keywords:** Climate Change, Public Health, Sustainable Development, Sports Tourism.

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**Transparency:** The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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## **1. Introduction**

The Saudi Arabia faces severe environmental threats because of climate change, which affects natural systems together with local economies and public health outcomes. Urban development combined with outdoor sports addiction increases these environmental concerns. Temperature increases and heightened weather volatility create biodiversity disruptions that affect agriculture alongside human health while generating food scarcity and spreading vector-borne diseases, according to the IPCC [1, 2]. Sports tourism presents a significant economic opportunity, although heat-related conditions that affect both competitors and fans threaten this revenue stream, potentially disrupting future growth [3]. The solution to these problems requires implementing both smart technology systems and sustainable operational methods for developing resilient structures. Future-proof adaptation approaches through improved public health infrastructure and environmentally sustainable land management help communities combat health risks caused by climate change while strengthening their resistance to such threats [4, 5]. Public health in the province is increasingly threatened by climate change, particularly through extreme heat and deteriorating air quality. High temperatures, often surpassing 50°C, elevate the risk of heat-related illnesses, such as heatstroke, especially during outdoor sports events, necessitating adaptive measures like shaded venues and hydration protocols [6, 7]. Additionally, air pollution from industrial activities exacerbates respiratory conditions, disproportionately affecting vulnerable populations, including athletes and outdoor workers [8, 9]. The interplay of these factors underscores the urgent need for climate-informed public health policies that integrate early warning systems, enhance healthcare infrastructure, and promote community-based adaptation strategies [6, 10]. Such comprehensive approaches are essential to mitigate the adverse health impacts of climate change and safeguard community resilience against future challenges [7, 9].

The sports industry of Saudi Arabia requires focused climate action because it faces coastal erosion alongside weather pattern inconsistencies [11]. Sports infrastructure should embrace eco-friendly designs with renewable energy sources and water-efficient systems for Saudi Vision 2030 because these sustainability features enhance eco-friendliness and attract environmentally-minded tourists and investors [12, 13]. The application of green materials in sports infrastructure development serves ecological preservation together with enhanced biomechanical functionality to keep athletes safe while performing [12]. The sports industry can achieve its transformation into a sustainable system through recent study-suggested community-oriented low-impact approaches that will unlock shared resources alongside accessible sports services and climate change solutions Szathmári [14]. Sudarmanto, et al. [15]; and Mohammad, et al. [16] demonstrate that these strategies emphasize sustainable practices for developing a robust sports tourism sector that serves environmental objectives alongside economic benefits for local communities.

The incorporation of smart technologies within the green economy serves as an essential element for sports facility sustainability by maximizing resources alongside economic development. The sector benefits from IoT-enabled energy management systems along with AI-driven waste reduction tools to achieve substantial operational improvements and better environmental oversight [17, 18]. Solar-powered sports facilities with smart irrigation platforms not only decrease facility energy usage and water depletion but also support sustainability objectives by generating green employment opportunities and promoting community economic expansion [19, 20]. AI applications for resource management combined with waste reduction lead to increased energy efficiency and reduced environmental impacts, supporting the path toward a sustainable economy [21]. Sports industry growth becomes possible through these technologies, which present solutions for tackling climate issues.

The sports industry produces substantial carbon emissions during massive athletic events, according to research findings, and needs better management methods that both improve energy utilization and cut environmental impacts [7, 22]. The sports event planning sector increasingly implements climate adaptation methods, although few planners effectively address the complete set of climate change difficulties [23]. The sector requires systemic reorganization through community-based low-impact practices to solve these difficulties, according to Szathmári [14]. The implementation of artificial intelligence enables predictions of sports event emissions to create specialized carbon-neutral strategies, according to Zhang [24]. The sports sector requires a strategic integration of policies that utilize technological advancements to address its dual challenges of climate change and economic development [24, 25].

### *1.1. The Significance of the Research*

Saudi Arabia faces major public health risks combined with limitations in sustainable development, ecological economy, and sports tourism advancement because of climate change. Higher temperatures and unusual weather combine, creating more sports-related medical problems for athletes destroying active sports tourism, and stressing energy systems, leading away from sustainable development achievements. Smart technologies, including IoT, AI, and renewable energy systems, function as the main tools to combat these effects through improved resource management together with decreased carbon emissions and climate resilience. Predictive analytics functions as a protective measure for public health through heatwave prediction, while smart infrastructure promotes sustainable sports tourism through diminished environmental damage. Interdisciplinary collaboration is necessary to confront climate threats based on this research. Intelligent technology deployment, coupled with environmentally friendly financing and public participation, will make the Eastern Province a leader in sports facility adaptation to climate change. These initiatives will both facilitate progress toward Saudi Vision 2030 objectives and demonstrate to the world how to build sustainable sports development programs. This research under Saudi Vision 2030 highlights the critical need to implement smart technology solutions that tackle climate-caused problems in Eastern Province sports infrastructure as a method of achieving sustainability between environmental protection, economic development, and social welfare.

### 1.2. Research Questions

The research functioned based on these research objectives to explore these specific questions:

Q1: What is the reality of climate change in the Eastern Province of Saudi Arabia?

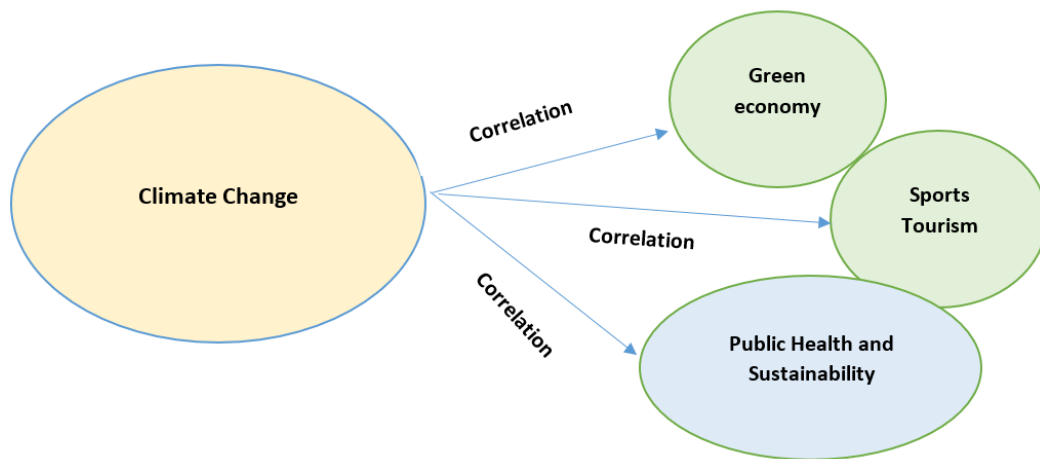
Q2: What is the impact of climate change on public health, sustainable development, sports tourism, and the green economy of the Saudi sports sector?

Q3: Is there a correlation between climate change, public health, sustainable development, sports tourism, and the green economy of the Saudi sports sector?

## 2. Materials and Methods

### 2.1. Participants

This study employed a descriptive survey approach to investigate the impact of climate change on public health, sports tourism, and the green economy in Saudi Arabia's sports sector, aligning with the research objectives. A purposive sample of 1,512 employees from sports clubs, federations, tourism companies, and institutions across the Kingdom participated voluntarily, with no financial incentives to ensure unbiased responses. Data were collected via a bilingual (Arabic and English) self-administered questionnaire divided into two sections: demographic details (gender, experience) in Table 1. The questionnaire utilized validated measures from prior studies, while a novel statistical method—unprecedented in Saudi research—was applied to analyze correlations and interpret climate-resilience strategies in sports infrastructure. This approach enabled a robust examination of how smart technologies and green economy practices can mitigate climate challenges in the Eastern Province's sports sector, as outlined in Figure 1.



**Figure 1.**  
Research framework.

**Table 1.**  
Demographic characteristics.

Characteristic	Profile	N	Percentage
Gender	Male	920	60.85%
	Female	587	38.82%
Experience	Less than 5 year	320	21.16%
	5-15 year	589	38.96%
	16-25 year	603	39.88%

### 2.2. Instruments

We used two questionnaires. The first section, consisting of 27 items, examined the climate change conditions in Saudi Arabia's Eastern Province as detailed in Appendix A. The second questionnaire consisted of 40 items to study how

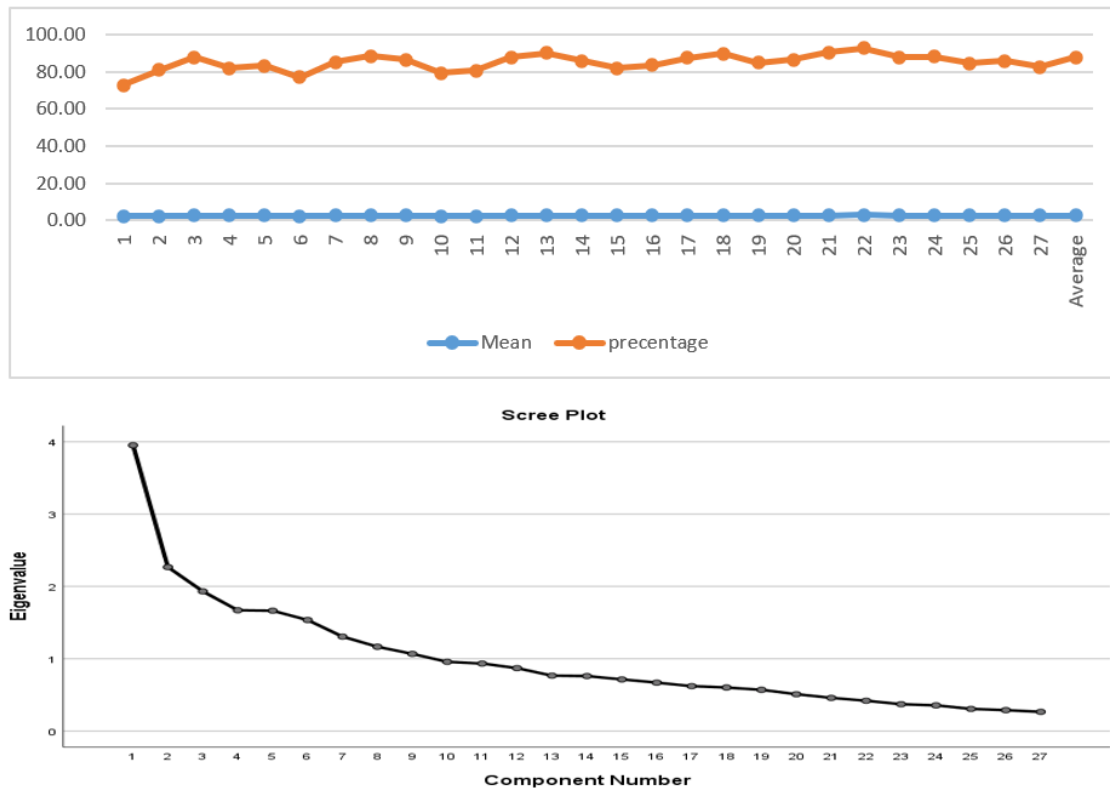
Climate change affects public health, sustainable development, and sports tourism operations, in addition to the green economy in the sports sector. The assessment tool incorporated the Public Health (PH), Sustainable Development (SD), Sports Tourism (ST), and Green Economy in the Sports Sector (GEISS) dimensions, with the specifications listed in Appendix B. The assessment of questionnaire responses depended on a three-point Likert scale that provided "yes" worth 3 points, "somewhat" worth 2 points, and "no" worth 1 point. The three-point Likert scale offers an effective method to acquire well-rounded participant feedback on question items. This approach provided a straightforward technique to obtain participant feedback. The researchers measured questionnaire validity together with reliability through Cronbach's alpha coefficient to determine the consistency between items. The first questionnaire obtained an overall reliability coefficient of 0.83, while the second questionnaire reached 0.85. The calculated coefficients demonstrate good accuracy for research of this kind. The primary research lasted from November 6, 2023, until January 10, 2024.

### 2.3. Statistical Analysis

This research used an analysis of relationships through Pearson's  $r$  correlation coefficient, while Cronbach's alpha tested the measurement tool's reliability. A combination of Chi-Square tests with percentage calculations, standard deviation, and arithmetic mean enabled the determination of randomness. The analysis used the Kaiser-Meyer-Olkin (KMO) coefficient to evaluate the appropriateness of the data for factor analysis. IBM Corporation, headquartered in Armonk, New York, released the research software IBM SPSS version 26 for data analysis. A  $p$ -value of less than 0.05 served as the threshold to reject null hypotheses, which enhanced the validity of research results that applied directly to this investigation.

### 3. Results

Figure 2, 3 demonstrates an analysis of factors along with average data and response frequency regarding climate change measurement realities within the Saudi sports industry.



**Figure 2.**  
Scree plot response to the questionnaire.

Table 3 shows the response and  $X^2$  to the questionnaire responses to the fact of Climate Change in the Eastern Province of Saudi Arabia. The percentage responses for all statements within the survey reached (72.75%-92.81%) while axis measurements (2.18-2.63) and the questionnaire showed and percentage response score of (87.85%).

**Table 2.**

The questionnaire data on the reality of Climate Change in the Eastern Province of Saudi Arabia.

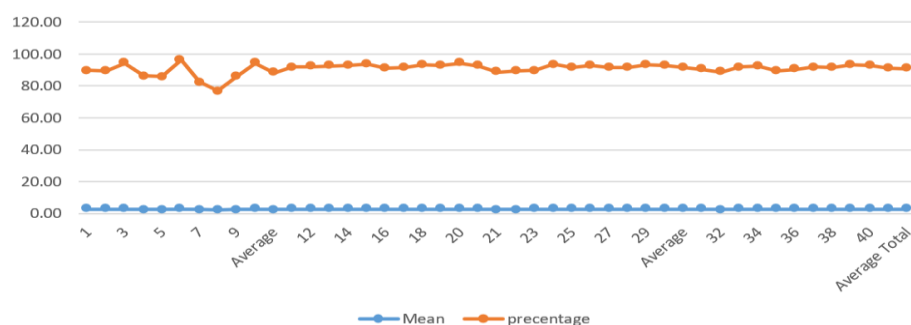
No.	Phrase	Mean	Std.	$X^2$	p- value	Imp. percentage
1-	I feel that climate change is increasingly affecting the environment in the Eastern Province.	2.18	0.63	474.25	0.001	72.75%
2-	I believe that rising temperatures in the Eastern Province have been noticeable in recent years.	2.43	0.64	449.43	0.001	80.97%
3-	I see that the seasons in the Eastern Province have become irregular compared to the past.	2.63	0.50	911.92	0.001	87.79%
4-	I believe that there is an increase in the intensity of rainfall in the Eastern Province.	2.46	0.51	742.92	0.001	81.92%
5-	I feel that climate change is affecting agriculture in the Eastern Province.	2.50	0.52	719.17	0.001	83.36%
6-	I notice the impact of climate change on biodiversity and plant life in the Eastern Province.	2.31	0.65	362.11	0.001	76.94%
7-	I think urban areas in the Eastern Province are suffering more from climate change effects than rural areas.	2.55	0.58	699.72	0.001	85.14%

No.	Phrase	Mean	Std.	X <sup>2</sup>	p- value	Imp. percentage
8-	I believe that the Saudi government is making sufficient efforts to address climate change.	2.65	0.53	976.80	0.001	88.43%
9-	I see a need to increase awareness of climate change in local communities.	2.59	0.52	806.54	0.001	86.33%
10-	I believe that there is greater importance in adopting better environmental policies in the Eastern Province.	2.38	0.60	494.68	0.001	79.17%
11-	I consider that climate change affects public health in the Eastern Province.	2.42	0.59	542.87	0.001	80.62%
12-	I feel that issues such as desertification have become more prominent due to climate change.	2.63	0.51	908.94	0.001	87.76%
13-	I believe that technological solutions can help in facing climate change.	2.70	0.48	1123.48	0.001	89.95%
14-	I believe educational institutions should enhance teaching about climate change and its impacts.	2.58	0.50	800.67	0.001	85.93%

Continued.

No.	Phrase	Mean	Std.	X <sup>2</sup>	p- value	Imp. percentage
15-	I see that water authorities in the Eastern Province are focusing efforts on addressing climate change.	2.46	0.60	545.19	0.001	81.90%
16-	I believe that private companies should take more responsibility in addressing climate change.	2.51	0.55	658.17	0.001	83.62%
17-	I personally feel more prepared to participate in efforts to adapt to climate change.	2.62	0.50	875.44	0.001	87.30%
18-	I see that climate change may affect the local economy in the near future.	2.69	0.48	1101.78	0.001	89.77%
19-	I believe that there is a greater need for the development of renewable energy projects in the Eastern Province.	2.54	0.51	747.77	0.001	84.77%
20-	I consider that investing in climate-resilient infrastructure is necessary.	2.60	0.49	58.73	0.001	86.62%
21-	I think that citizens should play a larger role in managing the risks of climate change.	2.71	0.47	1182.33	0.001	90.48%
22-	I feel that the media highlights climate change sufficiently.	2.78	0.41	1491.86	0.001	92.81%
23-	I see that encouraging environmental activities has a positive impact on awareness of climate change.	2.63	0.48	918.96	0.001	87.81%
24-	I believe that regional and international cooperation is important for addressing climate threats.	2.64	0.49	938.25	0.001	88.10%
25-	I feel that climate change affects daily life patterns in the Eastern Province.	2.53	0.52	732.40	0.001	84.35%
26-	I see a necessity to enhance partnerships between the public and private sectors in the field of climate change.	2.58	0.50	801.11	0.001	85.91%
27-	I consider that sustainable development is key to addressing climate change in the Eastern Province.	2.48	0.50	758.00	0.001	82.52%
	Average	2.64	0.18	907.96	0.001	87.85%

The statistical X2 values presented in Table 2 achieve levels of significance when set at 0.05 for both questionnaire data and Eastern Province climate change reality measurements in the Kingdom of Saudi Arabia. The questionnaire achieved a suitable Knowledge Modulus value of 0.658, and Bartlett's sphericity test indicated significant results. All questionnaire item means fall within the range of 2.18 to 2.63, and the complete scale shows an average of 2.64 (p = 0.001).



**Figure 3.**  
Scree plot response to the questionnaire.

Table 3 shows the responses and X2 to the survey on the impact of climate change on public health, sustainable development, and sports tourism operations, as well as the green economy in the sports sector. A total of 76.90% to 96.23% of respondents in the public health (PH) category answered the survey, while sustainable development (SD) received answers between 91.31% and 94.20%. Sports tourism (ST) reached values of 91.56% to 93.61%, and the green economy in the sports sector (GEISS) attracted 88.67% to 92.84% of participants.

**Table 3.**

The questionnaire data on the impact of climate change on public health, sustainable development, and sports tourism operations, as well as the green economy in the sports sector.

No.	Phrase	Mean	Std.	X <sup>2</sup>	p-value	Imp. percentage
	Effects of Climate Change on Public Health					
1-	I believe that climate change negatively affects the health of athletes in the region.	2.69	0.46	222.49	0.001	89.73
2-	I feel that increasing temperatures lead to a higher incidence of heat-related illnesses among athletes.	2.69	0.46	208.89	0.001	89.53
3-	I think that climate change contributes to the spread of infectious diseases in sports activities.	2.83	0.38	653.46	0.001	94.29
4-	I see that adapting to climate changes affects athletes' performance in competitions.	2.59	0.49	49.65	0.001	86.35
5-	I feel that climate change impacts the mental well-being of athletes.	2.57	0.49	33.185a	0.001	85.80
6-	I believe that extreme weather conditions limit outdoor sports activities.	2.89	0.32	905.36	0.001	96.23
7-	I think that climate change affects the quality of food available to athletes.	2.47	0.50	4.23	0.001	82.45
8-	I feel that health authorities should ensure the protection of athletes from the impacts of climate change.	2.31	0.46	225.57	0.001	76.90
9-	I believe that climate change may increase the prevalence of allergies among athletes.	2.58	0.49	42.67	0.001	86.13
10-	I think that there is a need for regular health screenings for athletes given changing climatic conditions.	2.83	0.38	653.46	0.001	94.29
	Average	2.65	0.19	2264.23	0.001	88.17
	Effects of Climate Change on Sustainable Development					
11-	I believe that climate change restricts the development of sustainable sports in the community.	2.76	0.43	398.27	0.001	91.89
12-	I see that new sports investments have been affected by climate change.	2.76	0.43	419.06	0.001	92.11
13-	I think that climate change negatively impacts sports infrastructure.	2.78	0.42	468.89	0.001	92.61
14-	I believe that adapting to climate change should be part of sports development strategies.	2.78	0.41	484.61	0.001	92.77
15-	I believe that effective environmental management can enhance the sustainability of sports activities.	2.82	0.39	604.46	0.001	93.87
16-	I feel that climate change hinders efforts to develop sustainable sports events.	2.74	0.44	346.68	0.001	91.31
17-	I see the importance of education about climate change in promoting sustainable development in sports.	2.75	0.44	368.07	0.001	91.56
18-	I believe that collaboration between sports and environmental organizations is essential for sustainability.	2.80	0.40	538.10	0.001	93.28
19-	I believe that sustainability practices should be integrated into sports programs.	2.79	0.41	491.43	0.001	92.84
20-	I feel that awareness programs on climate change could help in achieving sustainability in sports development.	2.83	0.38	642.99	0.001	94.20
	Average	2.78	0.22	1604.20	0.001	92.64
	Effects of Climate Change on Sports Tourism					
21-	I believe that climate change negatively impacts sports tourism destinations.	2.66	0.47	157.50	0.001	88.71
22-	I feel that changing weather patterns affect the attraction of tourists to sports events.	2.68	0.47	194.29	0.001	89.31
23-	I see that climate change is leading to shorter sports tourism seasons.	2.69	0.46	219.43	0.001	89.68

No.	Phrase	Mean	Std.	X <sup>2</sup>	p-value	Imp. percentage
24-	I think that aquatic sports events are particularly affected by climate change.	2.81	0.39	574.49	0.001	93.61
25-	I consider that reduced snowfall affects winter sports activities in the area.	2.75	0.43	376.00	0.001	91.64
26-	I believe that climate change may alter the pricing of tickets for sports events.	2.78	0.41	475.60	0.001	92.68
27-	I see that sports tourism needs to respond to climate challenges for sustainability.	2.75	0.44	368.07	0.001	91.56
28-	I believe that eco-friendly sports events will attract more tourists in the future.	2.75	0.44	368.07	0.001	91.56
29-	I believe that the promotion of local sports tourism can mitigate climate change effects.	2.80	0.40	538.10	0.001	93.28
30-	I feel that partnerships between local businesses and sports organizations can enhance the sustainability of sports tourism.	2.79	0.41	491.43	0.001	92.84
	Average	2.74	0.25	1378.29	0.001	91.49

Continued.

No.	Phrase	Mean	Std.	X <sup>2</sup>	p-value	Imp. percentage
	Effects of Climate Change on the Green Economy in the Sports Sector					
31-	I believe climate change enhances the need for investments in the green economy in sports.	2.71	0.45	277.71	0.001	90.48
32-	I feel that sports activities can benefit from sustainable technologies to address climate change.	2.66	0.47	154.93	0.001	88.67
33-	I think that using renewable resources is important to improve the environmental performance of sports events.	2.76	0.43	402.38	0.001	91.93
34-	I consider that developing low-emission sports facilities is an effective response to climate change.	2.77	0.42	438.225a	0.001	92.31
35-	I believe encouraging sports companies to use eco-friendly materials should be a priority.	2.68	0.47	200.07	0.001	89.40
36-	I feel that the green economy contributes to supporting sustainable and effective sports.	2.71	0.45	265.84	0.001	90.32
37-	I see the importance of providing incentives to sports companies that adopt environmentally friendly practices.	2.76	0.43	394.17	0.001	91.84
38-	I think that environmental education should be part of sports development programs to promote the green economy.	2.75	0.44	368.07	0.001	91.56
39-	I believe that adopting green practices in sports can lead to cost savings for organizations.	2.80	0.40	538.10	0.001	93.28
40-	I believe that collaboration between government and sports organizations is essential for promoting the green economy.	2.79	0.41	491.43	0.001	92.84
	Average	2.74	0.25	1029.53	0.001	91.26
	Average total	2.73	0.16	744.03	0.001	90.89

The X<sup>2</sup> values within Table 3 exceed the level of significance at 0.05 for the questionnaire data gathered. The accepted KMO value (0.741) accompanied the questionnaire axes' values (public health (PH), sustainable development (SD), sports tourism (ST), green economy in the sports sector (GEISS) with 0.793, 0.727, 0.831, and 0.631) respectively.

Table 4 shows the correlation coefficients between climate change and public health, sustainable development, and sports tourism operations, as well as the green economy in the sports sector.

**Table 4.**  
Correlation coefficients.

		PH	SD	ST	GEISS
CM	<b>Pearson Correlation</b>	.162**	-0.015	0.027	.120**
	<b>Sig.</b>	0.000	0.554	0.296	0.000
	<b>N</b>	1512	1512	1512	1512

Note: \*\*Correlation is significant at the 0.01 level

\*Correlation is significant at the 0.05 level

The correlation analysis reveals significant trends regarding public health and the green economy in the context of climate change. However, it suggests a lack of significant correlation with sustainable development and sports tourism,

necessitating targeted studies to understand these dynamics further. Stakeholders across these sectors should recognize the impacts of climate change seriously and incorporate this awareness into their strategies for improved outcomes in public health, sustainable practices, and responsive sports tourism planning.

#### **4. Discussion**

The results reveal that Eastern Province sports institutions in Saudi Arabia have adopted sustainable environmental practices to address climate change problems. These institutions maintain substantial dedication to green approaches that help build fundamental elements of a green economy while supporting environmental preservation efforts. According to the study, the institutions implement sustainable green approaches through policy declarations and functional practices that operate under complete environmental oversight. The research shows that the development of a green economy in sports requires three essential components, including per capita income, information technology, and human capital, to enable sustainability projects in sports and other sectors. The support that governments provide to sports activities helps minimize community-wide carbon emissions, thus advancing sustainable green growth throughout all parts of society. The Eastern Province sports institutions of Saudi Arabia demonstrate environmental sustainability through their dedication to Vision 2030 goals, which include sustainable development and environmental governance [26, 27]. The institutions follow whole-system green practices through extensive oversight procedures that support fundamental green economy components [26]. A green economy in sports depends on fundamental factors of per capita income, together with information technology and human capital, to achieve successful sustainability projects [28]. The support of governments toward sports activities leads to significant carbon reduction, which creates sustainable growth throughout society [27, 28].

The research conducted by Paliienko and Diachenko [29], together with Jaroensombut, et al. [30], shows that green economy performance indicators serve as critical tools for financial tracking alongside social responsibility assessment in sports organizations. The three core elements of successful green economic development, according to Ganguly [31] and Niță, et al. [32], include per capita income, information technology, and human capital, which culminate in sustainability projects across all sports. Jaroensombut, et al. [30] stressed that corporations must integrate CSR practices to merge their business targets with environmental and social goals to achieve long-term sustainability and improve their reputation. The findings from the study indicate a strong awareness among respondents regarding the impacts of climate change on the sports sector, highlighting a consensus on the necessity for sustainable practices. The research shows that outdoor organizations are experiencing significant challenges due to climate change, with extreme weather events prompting operational adjustments [33]. Additionally, the sports industry is increasingly focusing on integrating sustainability into its practices, as evidenced by a rise in academic publications addressing environmental concerns within sports management [34]. Furthermore, specific studies have quantified the carbon footprint of sports facilities, emphasizing the urgent need for strategies to minimize environmental impacts [35]. The integration of smart technology and sustainable practices is essential for achieving these goals, as outlined in frameworks that promote stakeholder collaboration and eco-conscious marketing strategies [36].

The survey participants showed a strong interest in studying the connections between public health, sustainable development, sports tourism, and the green economy in the sports sector. Climate change creates serious health dangers, which include heat-based medical crises and vector-borne disease spread that specifically target marginal groups within the population [37]. Sports event planners actively work to identify adaptation approaches for climate impact prevention in their industry, but many of them have not established these strategies as top priorities [38]. The sports industry needs to implement sustainable practices together with community-oriented methods as fundamental elements for successful climate challenge management, according to Szathmári [14]. Responding to these findings demonstrates the immediate need for combined academic and governance partnerships that provide protection against environmental health threats and foster sustainable sports tourism advancement [39, 40].

A correlation study of public health with the green economy during climate change shows two key developments concerning the enhancement of public health alongside green low-carbon development and environmental pollution reduction. Consistent research demonstrates that Chinese low-carbon city initiatives have generated positive health outcomes by controlling environmental deterioration and climate change, yet these benefits strengthen primarily within cities, that possess both an advanced economy and established green finance systems [41]. The adoption of sustainable policies that cut pollution from renewable energy systems in Asian economies aids in reaching Sustainable Development Goals because of their effective management of resources and policy improvements [42]. Research shows that the connection between sports tourism and sustainable development continues to be obscure since sports facilities work well with ecological landscapes concerning coordination, yet they have no obvious impact on the wider sustainable development framework [43]. The integration of sports ecology and urban development under green sports faces obstacles due to inadequate policies and wrong ideas about the program, according to Huang [44] because of a necessary need for specific strategic development approaches. The urgent requirement for clean energy solutions with improved pollution regulations emerges from the climate change implications on public health that air pollution, along with African dust events [45]. Every stakeholder working across the sectors will need to grasp the significant effects of climate change before they can add climate awareness to strategic planning for public health improvements and sustainable implementation alongside sports tourism development.

#### **5. Conclusion**

This research examined climate change effects on public health, sustainable development, sports tourism, and the green economy in Saudi Arabia's Eastern Province through questionnaires for 1,512 participants. The collected data showed that Saudi sports institutions are actively working on climate change solutions alongside green practices, demonstrating their



dedication to environmental sustainability. The research produced significant evidence indicating that climate change adaptation and its connections to public health promotion and green economy support, combined with climate effects mitigation, work together positively. Research topics that deserve future investigation involve smart technology sustainability promotion mechanisms and their lasting effects on the environment, as well as implementation strategies in sustainable sports operations. The study found value in public-private sector teamwork that would advance the implementation of novel technologies. The paper identified critical digital infrastructure requirements and skills development needs of the Saudi workforce. The research unveils the necessity to develop new strategies that will help Saudi Vision 2030 reach its sports sector objectives. The examination of these factors helps develop sustainable practices while maximizing natural resource utilization for improved development.

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## Supplementary Materials

### Appendix A.

The appendix includes a questionnaire data on the reality of Climate Change in the Eastern Province of Saudi Arabia

**Table S1.**

The questionnaire data on the reality of Climate Change in the Eastern Province of Saudi Arabia.

No.	Phrase	Yes	Somewhat	No
1-	I feel that climate change is increasingly affecting the environment in the Eastern Province.			
2-	I believe that rising temperatures in the Eastern Province have been noticeable in recent years.			
3-	I see that the seasons in the Eastern Province have become irregular compared to the past.			
4-	I believe that there is an increase in the intensity of rainfall in the Eastern Province.			

5-	I feel that climate change is affecting agriculture in the Eastern Province.			
6-	I notice the impact of climate change on biodiversity and plant life in the Eastern Province.			
7-	I think urban areas in the Eastern Province are suffering more from climate change effects than rural areas.			
8-	I believe that the Saudi government is making sufficient efforts to address climate change.			
9-	I see a need to increase awareness of climate change in local communities.			
10-	I believe that there is greater importance in adopting better environmental policies in the Eastern Province.			
11-	I consider that climate change affects public health in the Eastern Province.			
12-	I feel that issues such as desertification have become more prominent due to climate change.			
13-	I believe that technological solutions can help in facing climate change.			
14-	I think educational institutions should enhance teaching about climate change and its impacts.			
15-	I see that water authorities in the Eastern Province are focusing efforts on addressing climate change.			
16-	I believe that private companies should take more responsibility in addressing climate change.			
17-	I personally feel more prepared to participate in efforts to adapt to climate change.			
18-	I see that climate change may affect the local economy in the near future.			
19-	I believe that there is a greater need for the development of renewable energy projects in the Eastern Province.			
20-	I consider that investing in climate-resilient infrastructure is necessary.			
21-	I think that citizens should play a larger role in managing the risks of climate change.			
22-	I feel that the media highlights climate change sufficiently.			
23-	I see that encouraging environmental activities has a positive impact on awareness of climate change.			
24-	I believe that regional and international cooperation is important to address climate threats.			
25-	I feel that climate change affects daily life patterns in the Eastern Province.			
26-	I see a necessity to enhance partnerships between the public and private sectors in the field of climate change.			
27-	I consider that sustainable development is key to addressing climate change in the Eastern Province.			

## Appendix B.

The appendix includes questionnaire data on the impact of climate change on public health, sustainable development, and sports tourism operations, as well as the green economy in the sports sector.

**Table S1.**

An applied study at questionnaire data on the impact of climate change on public health, sustainable development, and sports tourism operations, as well as the green economy in the sports sector.

No.	Phrase	Yes	Somewhat	No
	Effects of Climate Change on Public Health			
1-	I believe that climate change negatively affects the health of athletes in the region.			
2-	I feel that increasing temperatures lead to a higher incidence of heat-related illnesses among athletes.			
3-	I think that climate change contributes to the spread of infectious diseases in sports activities.			
4-	I see that adapting to climate changes affects athletes' performance in competitions.			
5-	I feel that climate change impacts the mental well-being of athletes.			
6-	I believe that extreme weather conditions limit outdoor sports activities.			
7-	I believe that climate change affects the quality of food available to athletes.			
8-	I feel that health authorities should ensure the protection of athletes from the impacts of climate change.			
9-	I believe that climate change may increase the prevalence of allergies among athletes.			
10-	I think that there is a need for regular health screenings for athletes given changing climatic conditions.			
	Effects of Climate Change on Sustainable Development			

11-	I believe that climate change restricts the development of sustainable sports in the community.			
12-	I see that new sports investments have been affected by climate change.			
13-	I think that climate change negatively impacts sports infrastructure.			
14-	I consider that adapting to climate change should be part of sports development strategies.			
15-	I believe that good environmental management can enhance the sustainability of sports activities.			
16-	I feel that climate change hinders efforts to develop sustainable sports events.			
17-	I see the importance of education about climate change in promoting sustainable development in sports.			
18-	I think that collaboration between sports and environmental organizations is essential for sustainability.			
19-	I believe that sustainability practices should be integrated into sports programs.			
20-	I feel that awareness programs on climate change could help in achieving sustainability in sports development.			
	<b>Effects of Climate Change on Sports Tourism</b>			
21-	I believe that climate change negatively impacts sports tourism destinations.			
22-	I feel that changing weather patterns affect the attraction of tourists to sports events.			
23-	I see that climate change is leading to shorter sports tourism seasons.			
24-	I think that aquatic sports events are particularly affected by climate change.			
25-	I consider that reduced snowfall affects winter sports activities in the area.			
26-	I believe that climate change may alter the pricing of tickets for sports events.			
27-	I see that sports tourism needs to respond to climate challenges for sustainability.			
28-	I think that eco-friendly sports events will attract more tourists in the future.			
29-	I believe that the promotion of local sports tourism can mitigate climate change effects.			
30-	I feel that partnerships between local businesses and sports organizations can enhance sports tourism sustainability.			

**Continued.**

No.	Phrase	Yes	Somewhat	No
	<b>Effects of Climate Change on the Green Economy in the Sports Sector</b>			
31-	I believe climate change enhances the need for investments in the green economy in sports.			
32-	I feel that sports activities can benefit from sustainable technologies to address climate change.			
33-	I think that using renewable resources is important to improve the environmental performance of sports events.			
34-	I consider that developing low-emission sports facilities is an effective response to climate change.			
35-	I believe encouraging sports companies to use eco-friendly materials should be a priority.			
36-	I feel that the green economy contributes to supporting sustainable and effective sports.			
37-	I see the importance of providing incentives to sports companies that adopt environmentally friendly practices.			
38-	I think that environmental education should be part of sports development programs to promote the green economy.			
39-	I believe that adopting green practices in sports can lead to cost savings for organizations.			
40-	I believe that collaboration between the government and sports organizations is essential for promoting the green economy.			