

Play and Pay: Clustering Sports by Income-related Participation Profiles in Abu Dhabi

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Abstract

Sport participation is not equally accessible and often reflects underlying social and economic stratification. This study examines whether types of sport in Abu Dhabi are segmented according to income-related participation patterns. Data were drawn from the fifth cycle of the Abu Dhabi Quality of Life Survey, covering 25 sport types evaluated across four income-related indicators: income satisfaction, perceived ability to make ends meet, subjective income class and income compared to others. A two-stage clustering procedure was applied, combining Ward's hierarchical clustering with K-means refinement to enhance cluster stability. Cluster validity was assessed using the silhouette coefficient and between-cluster mean comparisons. A two-cluster structure was identified, distinguishing income-intensive sports from more economically accessible sports. Activities such as golf, tennis and gymnastics were associated with higher income profiles, whereas walking, football and athletics demonstrated broader socioeconomic accessibility. Additional analyses indicated gender disparities within several income-intensive sports, with male participants reporting higher perceived income positioning. The findings indicate that sport participation in Abu Dhabi is structured along both socioeconomic and gender dimensions. By clustering sports rather than individuals, a structural perspective on participation inequality is introduced. These results provide empirical evidence to inform equitable sport policy design, resource allocation strategies and public health initiatives aimed at reducing access disparities in rapidly developing urban settings.

Keywords: Abu Dhabi, Cluster Analysis, Gender Differences, Income Inequality, Sport Participation.

Introduction

Sport has long been recognized as a contributor to public health, social cohesion and individual well-being. Yet participation in sport is not evenly distributed across populations. A substantial body of international research indicates that sport engagement is strongly patterned by socioeconomic status (SES), with certain activities—such as tennis, golf and swimming—being disproportionately practiced by individuals from higher-income and more educated backgrounds (1). In contrast, more accessible and lower-cost activities, including football, walking and athletics, tend to attract broader demographic participation, particularly among individuals from modest economic backgrounds (2). For example, in Geneva, participation in tennis and badminton was reported to be more than four times higher among high-income households compared to low-income households, whereas football participation showed no comparable disparity (3). Such patterns reflect broader structural inequalities and the role

of economic and cultural capital in shaping access to recreational physical activity (4).

These disparities extend beyond Europe. In the United States, children from households earning over US\$100,000 have been found to be nearly three times more likely to participate in organized sports than those from low-income families (5). Evidence from Australia and China similarly indicates that financial costs—including equipment, coaching and travel—constitute significant barriers for lower-income households, even where infrastructure is available (6). Collectively, this literature confirms that sport participation is influenced not only by personal motivation but also by affordability, access and broader social positioning.

Within the United Arab Emirates (UAE) and particularly in Abu Dhabi, this issue is especially salient. Despite substantial investment in sports infrastructure and promotional initiatives, national data indicate that only 26% of adults in the UAE

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meet the World Health Organization's (WHO) recommended levels of physical activity (7). While policy efforts have aimed to increase participation, existing assessments typically aggregate physical activity measures without differentiating between sport types or income profiles. As a result, limited empirical evidence is available regarding the extent to which specific sports are socially stratified within the Emirate.

Previous research has also linked sport participation to broader well-being outcomes and social positioning (8-10). Different sport types have been associated with variations in subjective health, psychological well-being and social interaction, reflecting lifestyle segmentation across socioeconomic groups (2, 11). Participation in particular sports has been interpreted as a marker of social distinction and embedded cultural capital, suggesting that leisure choices are structured by economic and social resources rather than individual preference alone (4, 12). These findings align with theoretical perspectives emphasizing that recreational practices are socially structured and reflect differential access to both financial and symbolic resources.

Despite strong evidence documenting socioeconomic inequalities in sport participation across Europe, North America and Australia, much of the literature has focused on individual-level determinants or aggregate participation rates (13). Less attention has been given to examining how sport types themselves are structured according to perceived financial positioning. A structural perspective that clusters sport types based on income-related participation indicators offers an alternative analytical lens through which participation inequality can be understood. By shifting the unit of analysis from individuals to sports, it becomes possible to identify patterns of segmentation embedded within sport ecosystems (14).

Gender further shapes sport participation patterns across contexts. Women have been shown to encounter structural and sociocultural barriers in accessing organized or resource-intensive sports (8, 9). Significant gender differences in sport type and access have been documented across settings (15-20), while compounded financial and cultural barriers have been reported among lower-income women (15, 16). Gender-specific sport preferences have also been identified independently of income

(21) and early sport attitudes have been linked to parental education, employment status and later income trajectories (22, 23). These patterns suggest that sport participation reflects not only economic positioning but also gendered access to resources and opportunities.

In response to persistent inequalities, evidence-based models for targeted sport funding have been proposed. For instance, a study in Austria demonstrated that allocating subsidies based on regional need and club capacity increased youth participation significantly compared to uniform distribution strategies (13). However, programs designed to offset participation costs, such as voucher schemes, have demonstrated limited effectiveness in substantially increasing engagement among low-income groups (6). These findings challenge the assumption that mass sport initiatives are inherently equitable and underscore the importance of understanding structural segmentation within sport systems.

Beyond participation disparities, sport engagement has also been linked to subsequent income trajectories (24) and cluster-based approaches have illustrated how resource configurations shape athletic and vocational outcomes (25). While clustering techniques have been widely applied in sport and health research to classify individuals based on shared characteristics (11, 26) and behavioral profiles (27, 28), relatively few studies have clustered sport types themselves according to income-related participation indicators. This analytical shift responds to calls for examining recreational activities within their broader social and structural contexts.

Despite strong international evidence linking income to sport access and selection, localized and sport-specific analyses remain limited in rapidly developing and culturally distinct contexts such as Abu Dhabi. Given the Emirate's economically diverse population, understanding how particular sports attract participants with differing income profiles is critical for informing policies aimed at improving equitable access, participation and population well-being.

The present study addresses this gap by applying hierarchical and K-means clustering to identify income-related participation typologies across 25 sport types in Abu Dhabi. Using four income-related well-being indicators—income satisfac-

tion, ability to make ends meet, perceived income class and income compared to others—the study classifies sports into clusters associated with higher-income or more inclusive participation patterns. In addition, it examines gender differences across these clusters to assess whether financial self-perceptions within each sport differ between males and females. By uncovering the socioeconomic and gendered structuring of sport types in Abu Dhabi, the findings provide policy-relevant insights for promoting equitable participation and well-being across diverse population segments.

Methodology

Data Source and Variables

Data were drawn from the fifth cycle of the Abu Dhabi Quality of Life Survey (QoL-5), a large-scale instrument administered across the Emirate to assess well-being, socioeconomic status and demographic characteristics. For the present analysis, four income-related indicators were selected to construct sport-specific financial participation profiles:

- (a) Income satisfaction – measured on a 1–5 scale ranging from “Very dissatisfied” [1] to “Very satisfied” [5];
- (b) Perceived ability to make ends meet – rated from “Very difficult” [1] to “Very easy” [5], reflecting perceived financial strain or stability;
- (c) Subjective income class – categorized on a four-level scale: [1] Less than 10,000 AED; [2] 10,001–24,999 AED; [3] 25,000–50,000 AED; [4] More than 50,000 AED;
- (d) Income compared to others – assessed on a 1–5 scale from “Much worse than others” [1] to “Much better than others” [5], capturing relative economic positioning.

Mean values for each indicator were calculated at the sport level and standardized using z-scores to ensure comparability across measures with differing scales.

The selection of these indicators reflects a multidimensional conceptualization of economic positioning. Income satisfaction captures subjective evaluation of financial adequacy; perceived ability to make ends meet reflects short-term economic strain; subjective income class represents social comparison within broader socioeconomic hierarchies; and income compared to others captures relative economic standing.

Together, these measures extend beyond objective income reporting to capture perceived economic security and social stratification, both of which are particularly relevant for discretionary activities such as sport participation. The use of multiple complementary indicators reduces reliance on a single financial measure and strengthens construct validity in profiling participation patterns.

Although clustering was performed at the sport level, subsequent analyses examined gender-based differences within clusters to explore intersectional patterns.

Analytic Strategy

To identify latent participation patterns across sport types based on income-related characteristics, a two-stage cluster analysis was implemented. Cluster analysis is an unsupervised classification technique that identifies natural groupings within data where predefined categories are absent (29).

In the first stage, hierarchical clustering using Ward’s minimum-variance method was conducted to explore potential cluster structures and generate a dendrogram. Ward’s method was selected because it minimizes within-cluster variance and is widely recommended for producing compact and relatively homogeneous clusters in social science research (30). The dendrogram provided an initial indication of the appropriate number of clusters.

In the second stage, K-means clustering was applied using the cluster centers suggested by the hierarchical solution as initial seeds. This two-step approach enhances robustness by combining the exploratory advantages of hierarchical clustering with the partition optimization properties of K-means. Cluster validity was assessed using multiple criteria. The silhouette coefficient was computed to evaluate cohesion within clusters and separation between clusters (31). The average silhouette coefficient peaked at two clusters (0.47), indicating moderate and interpretable separation. In addition, between-cluster mean differences across the four income-related indicators were examined using analysis of variance (ANOVA), all of which were statistically significant, further supporting the stability of the two-cluster solution. Although the income-related indicators were measured on ordinal scales, they were treated as continuous variables during clustering. This approach is consistent with established

methodological practice in social and behavioral research when Likert-type variables contain multiple ordered categories and approximate interval properties (32). Standardization using z-scores was performed prior to clustering to ensure comparability across indicators with differing scales.

K-means clustering was conducted using the cluster centers derived from the hierarchical solution as initial seeds. This two-stage approach combines the structural detection strengths of hierarchical methods with the partition optimization properties of K-means, thereby enhancing cluster stability, interpretability and internal homogeneity.

Cluster validity was assessed using multiple criteria. The silhouette coefficient was calculated to evaluate cohesion within clusters and separation between clusters (31). The average silhouette coefficient peaked at two clusters (0.47), indicating moderate yet meaningful separation. In addition, between-cluster mean differences across the four income-related indicators were examined using analysis of variance (ANOVA), with all differences reaching statistical significance, further supporting the robustness of the two-cluster solution.

Although the income-related indicators were measured on ordinal scales, they were treated as continuous variables during clustering. This approach is consistent with established methodological practice in social and behavioral research when Likert-type variables contain multiple ordered categories and approximate interval properties (32, 33). Prior to clustering, all indicators were standardized using z-scores to ensure comparability across differing measurement scales.

Cases with missing values on any of the income-related indicators were excluded using listwise deletion. The proportion of missing data was minimal and did not materially reduce the analytical sample. No systematic pattern of missingness was observed across the core income-related variables and given the large overall sample size, the potential impact of missingness on cluster stability is expected to be limited.

Gender Analysis

Gender was not included in the clustering algorithm because it is a categorical variable and not directly compatible with distance-based clustering procedures applied to continuous

standardized indicators. Including gender in the clustering stage would have altered the distance matrix and potentially obscured the structural segmentation of sports based solely on income-related characteristics.

Instead, gender was incorporated in a post hoc descriptive analysis. The gender composition of participants within each sport type was calculated and compared across the identified clusters. This approach allowed for examination of how gender patterns intersect with income-based sport segmentation while preserving the methodological integrity of the clustering procedure. By separating cluster formation from gender-based interpretation, structural income typologies could be identified independently and subsequently interpreted through a gender-sensitive lens.

Theoretical Framework

This study is conceptually grounded in social stratification theory and the Social Determinants of Health (SDH) framework. These perspectives emphasize that access to resources—including sport and leisure—is shaped by structural factors such as income, education and gender (4, 10). Sport participation is therefore viewed not as a neutral individual choice, but as an outcome structured by broader socioeconomic positioning. Beyond material resources alone, sport engagement is also embedded within forms of social and cultural capital. Theories of capital suggest that individuals' networks, relational ties and status affiliations influence access to leisure spaces and culturally valued activities. In higher-income segments, sport participation may function not only as physical activity but also as a mechanism for social networking and status signaling. Conversely, participation among lower-income groups may be more strongly influenced by affordability constraints and community-level accessibility patterns. Integrating economic and social capital perspectives thus allows for a multidimensional understanding of how income-related participation profiles emerge across sport types.

The framework further draws on Bourdieu's theory of practice, particularly the interrelated concepts of cultural capital, habitus and field (4). Within this perspective, sports represent socially structured fields in which participation patterns reflect accumulated resources and embedded dispositions. Engagement in sports such as golf,

tennis, or swimming may signal alignment with elite cultural capital, whereas more accessible sports such as football or walking may reflect lower material entry barriers and broader inclusivity across socioeconomic groups.

Gendered participation patterns are similarly understood as part of the reproduction of social inequalities. Norms surrounding “appropriate” sports for men and women, combined with differential institutional access, contribute to structured participation disparities. By applying cluster analysis to classify sports according to income-related indicators and subsequently examining gender composition within clusters, the study operationalizes these theoretical perspectives in a data-driven manner. This approach aligns

with the SDH framework by demonstrating how structured socioeconomic inequalities may be reflected in everyday recreational practices.

Results

Respondents for Each Sport

Table 1 presents the gender distribution of respondents across the 25 sport types, including total participation and the proportion of male and female participants within each activity. Walking recorded the highest participation ($n = 43,669$), with 54.78% male and 45.22% female respondents. Jogging ($n = 12,885$) and running ($n = 11,297$) also showed substantial participation, with male representation exceeding two-thirds in both activities.

Table 1: Gender Distribution of Respondents Across 25 Sport Types

Type of Sport	Total	Male	Percent	Female	Percent
Walking	43669	23923	54.78%	19746	45.22%
Jogging	12885	8631	66.98%	4254	33.02%
Running	11297	7625	67.50%	3672	32.50%
Football	6292	5279	83.90%	1013	16.10%
Rugby	343	195	56.85%	148	43.15%
Cricket	1791	1612	90.01%	179	9.99%
Tennis	1545	897	58.06%	648	41.94%
Swimming	8260	5184	62.76%	3076	37.24%
Jiu-Jitsu/Martial Art	1580	1097	69.43%	483	30.57%
Volleyball	2053	1318	64.20%	735	35.80%
Basketball	2228	1113	49.96%	1115	50.04%
Fencing	284	153	53.87%	131	46.13%
Handball	755	346	45.83%	409	54.17%
American football	281	149	53.02%	132	46.98%
Golf	585	374	63.93%	211	36.07%
Badminton	2377	1168	49.14%	1209	50.86%
Cycling	5291	3480	65.77%	1811	34.23%
Athletics (TAF)	1866	1292	69.24%	574	30.76%
Gymnastics	1436	866	60.31%	570	39.69%
Dance	4008	446	11.13%	3562	88.87%
Netball	328	161	49.09%	167	50.91%
Hockey	275	142	51.64%	133	48.36%
Boxing	1241	718	57.86%	523	42.14%
Squash	835	369	44.19%	466	55.81%
CrossFit	9763	5606	57.42%	4157	42.58%

Team-based sports such as football ($n = 6,292$) and cricket ($n = 1,791$) demonstrated pronounced male dominance, with 83.90% and 90.01% male participants, respectively. Moderate male predominance was observed in sports including swimming, cycling, athletics and Martial Art. In contrast, dance (88.87% female) showed a strong female majority, while squash and netball exhibited slightly higher female participation. Several sports, including basketball, badminton,

fencing and hockey, displayed near parity between male and female respondents.

Overall, the distribution highlights marked gender variation across sport types within the fifth cycle of the Abu Dhabi Quality of Life Survey.

Cluster Analysis of Sports by Income-related Indicators

To identify patterns in sport participation based on income-related indicators, a two-stage cluster

analysis was conducted using IBM SPSS (Version 30) and Python 3.10. The analysis included 25 sport types and four income-related variables: perceived income class (INC1), perceived ability to make ends meet (INC2), income compared to others (INC3) and satisfaction with income (INC4). All variables were standardized to z-scores prior to analysis to ensure scale comparability.

Hierarchical clustering using Ward's method was first performed to explore the underlying structure of the data and determine the appropriate number of clusters (Figure 1). Ward's method minimizes within-cluster variance and is commonly applied in exploratory segmentation analysis (29, 30).

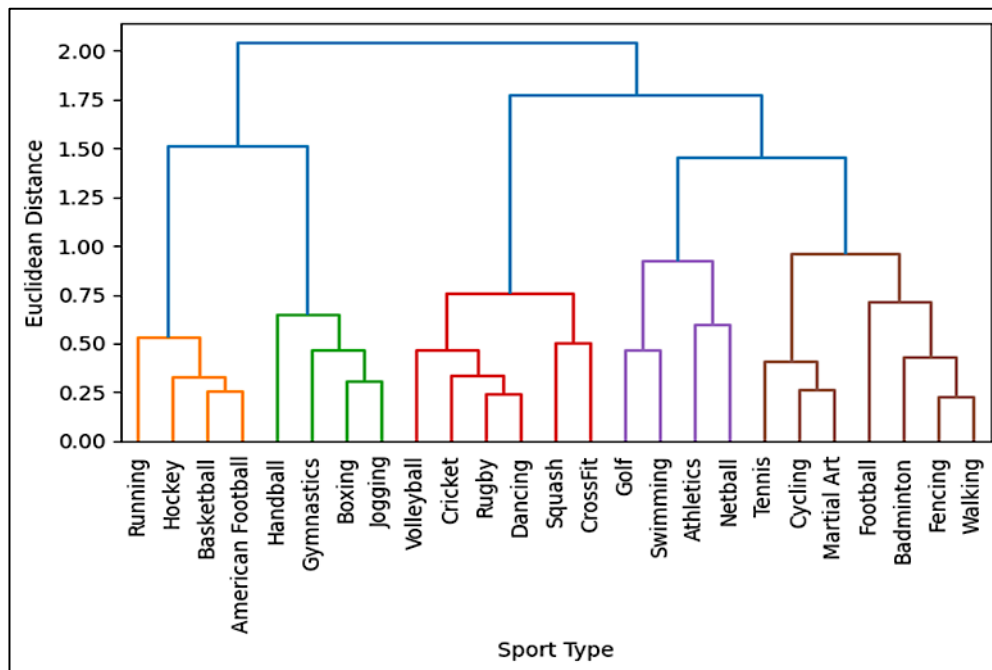


Figure 1: Dendrogram of Hierarchical Clustering (Dendrogram of Sports by Income-related Variables)

Clustered Sports with Income Indicators

Table 2 presents the 25 sport types included in the analysis, along with their mean scores on the four income-related indicators and their corresponding cluster membership. The indicators reflect the aggregated income profile of participants engaged in each sport. Cluster assignments were derived from the two-stage clustering procedure described earlier.

The results reveal a clear differentiation between two income-based sport groupings. Cluster 0 comprises sports characterized by comparatively higher mean scores across the income indicators, suggesting participation by individuals reporting higher perceived income class, stronger ability to make ends meet, more favorable income compari-

son and greater income satisfaction. Sports such as golf and tennis exhibit consistently elevated values across these dimensions.

Cluster 1 includes sports with comparatively lower mean income profiles across the four indicators. Activities such as walking, football, athletics and several team-based sports fall within this cluster, indicating broader participation across more diverse income strata. The cluster separation reflects systematic variation across all four income-related measures rather than differences in a single indicator, reinforcing the multidimensional nature of income-based sport stratification in Abu Dhabi. For interpretive clarity, Cluster 0 is hereafter referred to as “Income-Intensive Sports,” and Cluster 1 as “More Economically Accessible Sports.”

Table 2: Cluster Profiles (Mean Income Indicators)

Sport	INC1 (Income class)	INC2 (Ability to make ends meet)	INC3 (Income compared)	INC4 (Income satisfaction)	Cluster
Rugby	3.152	2.696	2.696	3.014	0.000
Cricket	2.535	2.812	2.676	3.190	0.000
Tennis	3.188	2.917	2.811	3.163	0.000
Gymnastics	2.923	2.913	2.774	3.183	0.000
Cycling	2.965	2.771	2.680	3.048	0.000
Badminton	2.773	2.890	2.719	3.160	0.000
Golf	3.438	3.264	3.016	3.324	0.000
Walking	2.834	2.628	2.544	2.978	1.000
Boxing	3.032	2.589	2.600	2.886	1.000
Hockey	2.814	2.547	2.519	2.670	1.000
Netball	3.067	2.512	2.552	2.856	1.000
Dancing	2.826	2.562	2.492	2.839	1.000
Athletics	2.795	2.502	2.445	2.804	1.000
Handball	2.838	2.559	2.575	2.878	1.000
Squash	3.021	2.577	2.528	2.869	1.000
Fencing	2.581	2.533	2.478	2.933	1.000
Basketball	2.828	2.645	2.639	2.966	1.000
Volleyball	2.889	2.544	2.477	2.943	1.000
Martial Art	3.003	2.548	2.498	2.819	1.000
Swimming	3.009	2.724	2.634	3.027	1.000
Football	2.746	2.593	2.546	3.007	1.000
Running	2.875	2.646	2.557	2.994	1.000
Jogging	2.840	2.668	2.563	2.986	1.000
American Football	2.809	2.684	2.674	3.042	1.000
CrossFit	2.958	2.591	2.537	2.917	1.000

Table 3 reports the mean values of the four income-related indicators for each cluster derived from the K-means solution. The comparison highlights systematic differences in the aggregated income profiles of the two sport clusters.

Cluster 0 demonstrates higher mean values across all four indicators, including subjective income class (INC1 = 2.996), perceived ability to make ends meet (INC2 = 2.895), income compared to others (INC3 = 2.767) and income satisfaction (INC4 = 3.155). In contrast, Cluster 1 shows comparatively lower averages on each dimension (INC1 = 2.876; INC2 = 2.592; INC3 = 2.548; INC4 = 2.912).

The largest absolute difference between clusters is observed for income satisfaction ($\Delta = 0.243$), followed by perceived ability to make ends meet ($\Delta = 0.303$). Although the numerical gaps appear modest, they are consistent across all four indicators, reinforcing the internal coherence of the clustering solution. The uniform direction of these differences supports the interpretation of Cluster 0 as representing income-intensive sports and Cluster 1 as reflecting more economically accessible sports.

Independent-samples ANOVA tests confirmed that between-cluster differences were statistically significant across all four income indicators ($p < 0.05$).

Table 3: Mean Scores of Income-related Indicators for the Two Clusters

Cluster	INC1	INC2	INC3	INC4
0	2.996	2.895	2.767	3.155
1	2.876	2.592	2.548	2.912

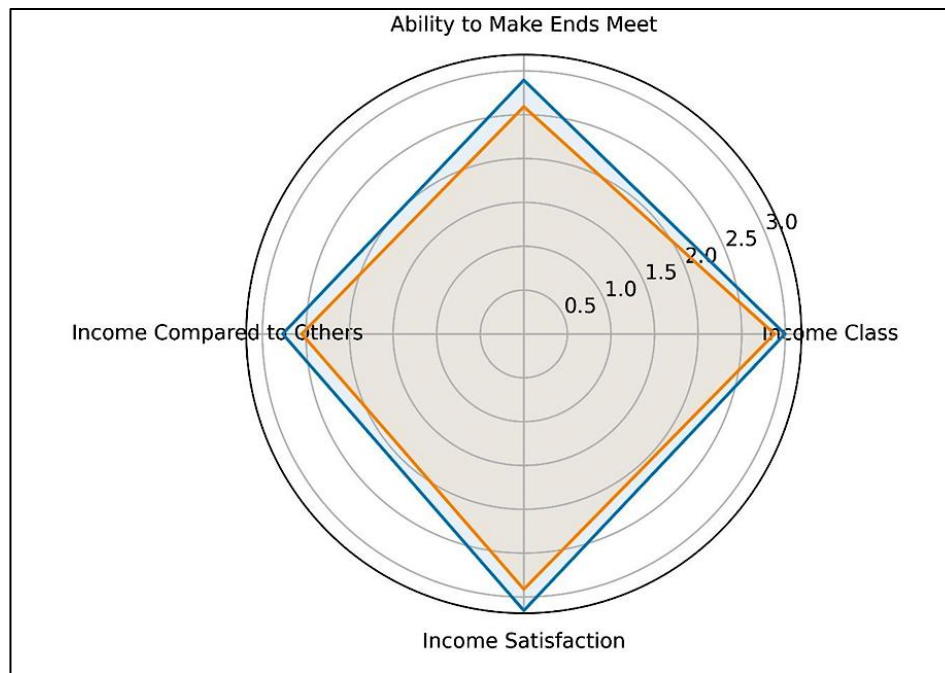


Figure 2: Radar Plot of Income Indicators by Cluster

Radar Plot of Income Indicators by Cluster

Figure 2 displays a radar chart comparing the mean values of the four income-related indicators across the two clusters. The visualization provides a multidimensional representation of the cluster profiles and facilitates comparison of their relative magnitudes across indicators.

Cluster 0 demonstrates higher mean values on all four income dimensions—subjective income class, perceived ability to make ends meet, income compared to others and income satisfaction—relative to Cluster 1. The consistent outward extension of Cluster 0's polygon across all axes reflects a systematically higher income-related profile. In contrast, Cluster 1 exhibits comparatively lower values across each dimension, resulting in a more contracted polygon.

The graphical separation between the two cluster shapes visually corroborates the numerical differences reported in Table 3 and supports the interpretation of a clear socioeconomic distinction between income-intensive and more economically accessible sports. The radar chart is based on standardized (z-score) values to ensure comparability across indicators.

Expanded Interpretation of Cluster Analysis Results

The K-means clustering procedure classified the 25 sports into two distinct groups based on their

income-related participation profiles. This segmentation indicates systematic variation in the socioeconomic characteristics associated with different sport types in Abu Dhabi.

Cluster 0 comprises sports such as golf, tennis, gymnastics, cycling, rugby, cricket and badminton. These sports exhibited consistently higher mean values across the four income-related indicators. The mean income satisfaction score (INC4) for Cluster 0 was 3.15, compared to 2.91 for Cluster 1. Similarly, perceived income class (INC1) averaged 2.996 in Cluster 0 versus 2.876 in Cluster 1. Golf demonstrated the highest observed values across several indicators (e.g., income class = 3.44; income satisfaction = 3.32), reinforcing its association with comparatively higher income profiles.

Cluster 1 includes sports such as walking, football, athletics, basketball, handball, Martial Art and running. These sports displayed lower mean values across the income-related indicators, suggesting comparatively broader socioeconomic participation. For example, walking and football recorded income class means of 2.83 and 2.75 respectively, alongside moderate-income satisfaction levels near 3.00.

Alternative clustering solutions involving three- and four-cluster configurations were explored during preliminary analysis. Although these models increased structural complexity, they produced smaller and less stable subgroups,

greater overlap in income profiles and reduced interpretability. The two-cluster solution demonstrated clearer separation, stronger between cluster variance across income indicators and greater conceptual coherence with established theories of sport stratification. From both statistical and theoretical standpoints, the two-cluster model provided the most parsimonious and interpretable structure.

It should be noted that certain sports occupy intermediate positions within the income distribution. For example, cricket and badminton demonstrate relatively higher values on income satisfaction and comparative income, while remaining accessible in certain contexts. These patterns suggest that sport-level socioeconomic positioning may vary depending on institutional setting, cost structures and participant composition. While cluster assignment provides a structural categorization, individual sports may exhibit internal heterogeneity.

Overall, the findings indicate that sport participation in Abu Dhabi is patterned along socioeconomic gradients. Sports grouped within Cluster 0 are associated with comparatively higher income-related profiles, whereas Cluster 1 sports demonstrate broader participation across income levels. This distinction contributes to understanding how recreational engagement may reflect underlying socioeconomic positioning within rapidly developing urban environments.

Validation

To further assess the adequacy of the clustering structure, the Calinski–Harabasz (CH) Index was calculated. The CH index evaluates the ratio of between-cluster dispersion to within-cluster dispersion, with higher values indicating greater separation between clusters relative to internal cohesion (33).

For the two-cluster configuration, the CH value

was 21.31. When compared with alternative three- and four-cluster solutions examined during exploratory analysis, the two-cluster solution yielded a comparatively higher and more stable CH score. This pattern supports the selection of the two-cluster structure as the most parsimonious and interpretable segmentation of sports based on income-related indicators.

The convergence of multiple validation criteria—including dendrogram inspection, silhouette coefficient analysis, between-cluster mean differences and the Calinski–Harabasz Index—strengthens confidence in the stability and coherence of the identified clusters.

Gender Differences

Gender differences in income-related indicators across sport types are presented in Table 4. The analysis revealed statistically significant gender differences in several sports, although the magnitude and consistency of these differences varied by activity.

Rugby demonstrated significant gender differences across all four income-related indicators— income comparison, ability to make ends meet, income satisfaction and perceived income class ($p < 0.001$). In each case, male participants reported higher mean scores than female participants. Similar patterns were observed in Squash and American Football, where males reported significantly higher values on selected income-related indicators, particularly income satisfaction and income comparison.

In Swimming, males reported higher mean scores than females on income comparison, ability to make ends meet and income satisfaction, with statistically significant differences ($p < 0.01$). CrossFit also exhibited gender gaps in income comparison and ability to make ends meet, with males reporting more favourable financial perceptions.

Table 4: Means and ANOVA Results for Each Type of Sport/Income Related Wellbeing According to Gender

Sports	Income compared to others				Ability to make ends meet				Income satisfaction				Perceived Income class			
	Male	Female	F-value	Significance	Male	Female	F-value	Significance	Male	Female	F-value	Significance	Male	Female	F-value	Significance
Rugby	2.574	2.469	74.979	0.001	2.669	2.525	88.450	0.001	3.032	2.843	152.95	0.001	2.815	2.881	152.95	0.001
Cricket	2.693	2.561	16.706	0.001	3.018	2.848	27.330	0.001	2.835	2.864	0.334	0.563	2.693	2.561	16.706	0.001
Tennis	2.577	2.457	14.646	0.001	2.666	2.540	10.459	0.001	3.020	2.859	16.948	0.000	2.885	2.820	1.151	0.283
Gymnastics	2.544	2.583	0.249	0.618	2.592	2.628	0.142	0.707	3.009	2.975	0.113	0.736	2.733	3.082	3.847	0.050
Cycling	2.783	2.522	2.132	0.147	2.739	2.609	0.388	0.534	3.087	2.870	1.243	0.267	3.163	3.125	0.014	0.906
Badminton	2.685	2.553	1.146	0.285	2.822	2.681	0.872	0.351	3.211	2.915	4.664	0.031	2.513	2.944	2.173	0.141
Golf	2.846	2.689	3.908	0.048	2.941	2.833	1.339	0.248	3.213	2.994	5.765	0.017	3.199	3.150	0.124	0.725
Walking	2.649	2.582	4.807	0.028	2.744	2.657	5.184	0.023	3.072	2.870	29.189	0.001	2.997	3.051	1.028	0.311
Boxing	2.492	2.557	0.301	0.583	2.539	2.629	0.386	0.535	2.830	2.710	0.658	0.418	2.996	3.087	0.153	0.696
Hockey	2.483	2.444	0.189	0.663	2.553	2.496	0.283	0.595	2.987	2.701	6.864	0.009	2.897	2.843	0.090	0.765
Netball	2.673	2.511	3.857	0.050	2.662	2.581	0.680	0.410	2.984	2.897	0.784	0.376	2.819	2.878	0.098	0.755
Dancing	2.500	2.429	0.085	0.772	2.548	2.500	0.030	0.863	2.968	2.857	0.158	0.692	2.667	2.400	0.297	0.590
Athletics	2.676	2.392	3.791	0.053	2.601	2.481	0.544	0.461	2.930	2.785	0.791	0.375	2.714	3.056	1.764	0.187
Handball	2.841	2.344	4.903	0.029	2.794	2.469	1.464	0.229	3.175	2.781	2.762	0.100	2.967	2.417	1.732	0.196
Squash	3.123	2.606	18.485	0.001	3.353	2.924	7.833	0.005	3.429	2.924	13.373	0.001	3.507	3.125	4.978	0.027
Fencing	2.760	2.576	8.692	0.003	2.950	2.685	10.226	0.001	3.232	2.918	16.208	0.001	2.779	2.750	0.046	0.829
Basketball	2.678	2.688	0.053	0.818	2.766	2.793	0.256	0.613	3.056	3.012	0.719	0.396	2.955	3.009	0.425	0.515
Volleyball	2.460	2.368	1.332	0.249	2.516	2.428	0.874	0.350	2.831	2.658	2.987	0.084	2.748	3.083	4.268	0.039
Martial Art	2.796	2.701	1.473	0.225	2.935	2.838	0.893	0.345	3.213	3.078	2.042	0.153	2.906	2.986	0.269	0.604
Swimming	2.657	2.454	12.073	0.001	2.780	2.513	13.595	0.000	3.094	2.781	18.444	0.001	2.684	2.861	2.366	0.124
Football	2.618	2.449	0.974	0.326	2.553	2.449	0.236	0.628	2.908	2.776	0.420	0.518	3.160	2.950	0.338	0.564
Running	2.677	2.268	3.630	0.059	2.754	2.220	4.814	0.030	2.877	2.341	5.669	0.019	2.966	2.500	1.191	0.282
Jogging	2.624	2.548	0.556	0.456	2.574	2.622	0.169	0.681	2.898	2.859	0.107	0.743	2.987	3.153	0.836	0.362
US Football	2.692	2.290	18.993	0.001	2.732	2.352	11.280	0.001	3.051	2.605	15.445	0.001	3.149	2.840	4.030	0.046
CrossFit	2.621	2.507	12.774	0.001	2.966	2.782	30.692	0.001	2.943	3.000	1.385	0.239	2.621	2.507	12.774	0.001

In contrast, sports such as Basketball, Jogging, Dancing and Boxing showed limited or no statistically significant gender differences across the income-related indicators. The relatively similar mean values observed in these sports suggest a more balanced income profile between male and female participants within those activities.

To assess potential confounding effects, demographic characteristics were compared across clusters. Age and education levels differed modestly between clusters, whereas nationality distribution showed variation. Although demographic characteristics may partially intersect with participation patterns, the clustering solution was derived exclusively from income-related indicators and the gender comparisons were conducted within sport types rather than across clusters. This supports the interpretation that the observed patterns reflect sport-specific income segmentation rather than purely demographic sorting.

Overall, the findings indicate that gender-based differences in income-related perceptions are concentrated in selected sports rather than uniformly distributed across all activities. This uneven distribution aligns with broader evidence suggesting that sport participation intersects with both socioeconomic positioning and gendered access structures.

Discussion

This study provides empirical evidence that sport participation in Abu Dhabi is stratified according to income-related perceptions and further differentiated by gender patterns. Using hierarchical and K-means clustering applied to four income-related indicators—income satisfaction, ability to make ends meet, perceived income class and income compared to others—sports were classified into two distinct clusters. The first cluster, characterized by consistently higher mean scores across all income indicators, included sports such as golf, tennis, gymnastics and swimming. These activities typically require specialized facilities, equipment and structured engagement. The second cluster—comprising walking, football, athletics and basketball—represented more economically accessible and lower-cost forms of participation.

These findings are consistent with international evidence demonstrating socioeconomic disparities in sport access and engagement (3, 14). It has been reported that individual, elite, or racquet-based sports are more frequently practiced by individuals with higher socioeconomic profiles, whereas team-based and informal sports are more broadly distributed across income groups (3). Comparable patterns have been observed in European and North American contexts, where sport participation is closely linked to affordability, facility access and symbolic status (10, 18, 21, 22).

Beyond income segmentation, gender differences were observed in several sport types. Football, cricket and boxing were predominantly male, whereas dance, gymnastics and netball exhibited higher female participation. These distributions align with established international findings indicating persistent gendered participation patterns shaped by social norms and institutional access structures (8, 19). Evidence further suggests that women and adolescent girls from lower-income backgrounds face compounded barriers to participation in structured or competitive sport environments (15, 16).

The two-cluster solution reveals structural stratification embedded within sport participation patterns. This aligns with Bourdieu's theory of social fields, in which leisure practices reflect distributions of economic and cultural capital (4). Participation in higher-cost sports may function not only as physical engagement but also as symbolic differentiation and social positioning. The alignment between elevated income indicators and specific sports supports the interpretation that leisure choices are socially structured rather than purely preference-driven. Longitudinal evidence linking early sport participation to later economic outcomes further reinforce the reciprocal relationship between sport engagement and socioeconomic advantage (23, 24).

The clustering patterns may also reflect variations in social capital embedded within different sporting environments. High-cost sports frequently operate within exclusive institutional settings that facilitate networking and prestige accumulation, whereas community-based sports may foster broader bonding social capital across diverse socioeconomic groups.

Gender differences observed across clusters should be interpreted within broader theoretical frameworks of gender socialization and intersectionality. Participation patterns suggest that economic segmentation does not operate independently of gender norms. Certain resource-intensive sports may attract greater female participation, indicating that cultural capital and gendered expectations interact in shaping sport choices. Drawing from Bourdieu's concept of habitus, socially internalized dispositions may influence alignment with particular sports. Intersectionality theory further emphasizes that gender intersects with socioeconomic status and cultural context, producing layered participation inequalities.

Sport participation patterns in Abu Dhabi are additionally shaped by sociocultural context. The Gulf environment is characterized by strong family orientation, gendered participation norms and climatic conditions that influence accessibility. Facility-based sports associated with prestige may reflect elite leisure cultures, while community-oriented or indoor sports may demonstrate broader accessibility. Cultural expectations regarding gender roles may also influence women's participation in public or mixed-gender sport settings. These contextual dynamics likely reinforce the income-related segmentation identified in the cluster analysis.

From a policy perspective, the findings underscore the need for equity-oriented sport development strategies. Despite substantial public investment in infrastructure and sport promotion, participation remains unevenly distributed across income profiles. International evidence supports data-driven allocation of sport resources based on participation disparities and regional needs (25, 26). Reducing financial barriers, expanding access for women and lower-income residents and promoting inclusive competitive opportunities may contribute to narrowing participation gaps.

Methodologically, this study introduces a structural approach by clustering sports themselves rather than individuals. Previous research has largely focused on individual-level predictors of participation; the present study classifies sport types according to income-related profiles. This sport-level typology provides a novel analytical lens and a practical framework for targeted policy intervention.

Although the analysis focused on adult participation, implications extend to youth engagement and intergenerational inequality. Socioeconomic disparities in childhood sport access have been shown to contribute to long-term health and social inequalities (16, 17). Future research should examine developmental trajectories of sport engagement and the interaction between income and gender across life stages. The findings contribute to global sport stratification research by shifting analytical emphasis from individual determinants to structural segmentation of sport types. Empirical evidence from a rapidly developing Middle Eastern context adds geographic and cultural depth to existing literature, where comparable analyses remain limited.

This study has several limitations. First, the cross-sectional design precludes causal inference and limits the ability to assess temporal changes in sport participation patterns. Longitudinal data would permit examination of how income-related segmentation evolves across economic transitions and life stages.

Second, the analysis is restricted to adult respondents and does not capture participation among children or adolescents, where inequalities may originate and persist.

Third, the income-related indicators used in clustering are perception-based measures, including income satisfaction, perceived income class and perceived ability to make ends meet. Although subjective measures may be influenced by reporting bias or cultural sensitivities regarding income disclosure, they capture perceived financial positioning, which is particularly relevant for discretionary activities such as sport participation. Future research incorporating objective income data would strengthen validation of participation segmentation.

Finally, findings were not disaggregated by nationality or ethnicity. Given the multicultural composition of Abu Dhabi, further demographic segmentation would enhance understanding of sport stratification across diverse population groups.

Conclusion

This study provides empirical evidence that sport participation in Abu Dhabi is structured along both socioeconomic and gender dimensions. By

clustering 25 sport types using four income-related indicators—income satisfaction, subjective income class, perceived ability to make ends meet and income comparison—two distinct participation profiles were identified: income-intensive sports and more economically accessible sports. Activities such as golf, tennis and gymnastics were associated with higher income-related profiles, whereas football, walking and athletics demonstrated broader socioeconomic accessibility.

The findings further indicate that economic stratification intersects with gendered participation patterns. Several income-intensive sports exhibited higher male representation, while more accessible sports showed relatively balanced or greater female participation in certain cases. These patterns suggest that financial resources and sociocultural norms operate concurrently in shaping sport engagement within the Abu Dhabi context.

From a policy standpoint, the two-cluster typology provides a structured framework for evidence-based sport development and public health planning. Targeted financial support mechanisms, equitable infrastructure distribution and culturally responsive programming may contribute to reducing income-related participation disparities. Expanding inclusive and gender-sensitive sporting environments may further enhance engagement across diverse demographic groups and support broader social inclusion and health objectives.

Methodologically, this study contributes to the literature by clustering sports themselves rather than individuals, thereby identifying structural segmentation embedded within leisure systems. The proposed framework offers a replicable analytical model for examining sport accessibility in other urban and regional contexts, particularly in rapidly developing and multicultural societies. Promoting equitable access to sport should be understood not solely as an issue of participation rates, but as a component of social cohesion, preventive health strategy and long-term community well-being.

Abbreviations

ANOVA: Analysis of Variance, CH: Calinski–Harabasz Index, INC1: Perceived Income Class, INC2: Ability to Make Ends Meet, INC3: Income Compared to Others, INC4: Income Satisfaction, QoL: Quality of Life, RII: Relative Index Inequality, SDH: Social Determinants of Health, SEP:

Socioeconomic Position, SES: Socioeconomic Status, WHO: World Health Organization.

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Author Contributions

Masood Badri: conceptualization, designed the methodology, conducted the data analysis, drafted the manuscript, interpretation of the results, reviewed, revised the manuscript, Shamis AlDhaheeri: interpretation of the results, reviewed, revised the manuscript, Hamad AlDhaheeri: interpretation of the results, reviewed, revised the manuscript, Guang Yang: conceptualization, designed the methodology, conducted the data analysis, drafted the manuscript, interpretation of the results, reviewed, revised the manuscript, Muna AlBahar: interpretation of the results, reviewed, revised the manuscript, Asma AlRashdi: interpretation of the results, reviewed, revised the manuscript. All authors contributed to the interpretation of the results, reviewed and revised the manuscript and approved the final version for submission.

Conflict of Interest

The authors declare that they have no known competing financial or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The dataset analyzed in this study is not publicly available because it contains confidential survey microdata. Aggregated results supporting the findings are available from the corresponding author upon reasonable request, subject to approval by the data custodian.

Declaration of Artificial Intelligence (AI) Assistance

During the preparation of this manuscript, the authors used generative AI tools to assist with language refinement, editing and clarity of expression. The authors reviewed, verified and edited all content to ensure accuracy, originality

and full responsibility for the final version of the manuscript.

Ethics Approval

The study used anonymized secondary data from the Abu Dhabi Quality of Life Survey, administered by the Department of Community Development. The survey was conducted in accordance with applicable ethical guidelines and informed consent was obtained from all participants at the time of data collection.

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