Athens Journal of Sports

Quarterly Academic Periodical,
Volume 11, Issue 4, December 2024
URL: https://www.athensjournals.gr/ajspo
Email: journals@atiner.gr
e-ISSN: 2241-7915 DOI: 10.30958/ajspo

Front Pages

Athens Journal of Sports

Published by the Athens Institute for Education and Research (ATINER)

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The ***Athens Journal of Sports (AJSPO)*** is an Open Access quarterly double-blind peer reviewed journal and considers papers from all areas of sports and related sciences. Many of the papers published in this journal have been presented at the various conferences sponsored by the Sport, Exercise, & Kinesiology Unit of the **Athens Institute for Education and Research (ATINER)** & the Panhellenic Association of Sports Economists and Managers (PASEM). All papers are subject to ATINER's Publication Ethical Policy and Statement.

The Athens Journal of Sports

ISSN NUMBER: 2241-7915 - DOI: 10.30958/ajspo

Volume 11, Issue 4, December 2024

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The current issue is the fourth of the eleventh volume of the *Athens Journal of Sports,* published by the Sport, Exercise, & Kinesiology Unit of the ATINER under the aegis of the Panhellenic Association of Sports Economists and Managers (PASEM).

Gregory T. Papanikos, President, ATINER.

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- Acceptance of Abstract: 4 Weeks after Submission
- Submission of Paper: **14 April 2025**

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Dr. Maria Konstantaki, Academic Member, ATINER & Senior Lecturer, Buckinghamshire New University, UK.

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Health and the 2004 Olympic Games

By Zoe Boutsioli[*]

Athens hosted the 2004 Olympic Games. As part of the event, it was necessary to develop a strategic and operational health program to address various contingencies. This paper reviews that program and compares it with the health programs implemented in Atlanta and Sydney. An ex-post analysis of the operational program shows that the planning was effectively executed, as Athens 2004 did not encounter major health risks.

Keywords: *Olympic Games, Health, Athens, Structural funds, Atlanta, Syndey, Operational Program*

Introduction

In 2004, Greece took on the challenge of organizing the Olympic Games. This undertaking involved risks but also offered numerous benefits for Greece, including economic, social, and cultural advantages. However, successfully hosting the Games required significant effort, and Greece worked intensively to ensure everything was ready for the Opening Ceremony. The successful execution of the Games earned Greece worldwide recognition.[1]

A successful organization requires, among other things, effective coverage of health service needs to help Greece meet the demands of the Olympic and Paralympic Games. This paper examines the preparation involved in meeting these health service needs.

The Ministry of Health and Welfare developed an operational plan for the health sector, organized around five priority areas: hospital care, primary care, emergency medicine, public health and hygiene, and organization and administration.

Within this framework, a series of measures were introduced to support the strategic objectives of the program. These measures are designed with a unified approach, focusing on operational and organizational effectiveness, infrastructure suitability, and the effective use of human resources across all priority areas (Table 1).

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[1]There are many studies that evaluated the economic, social and cultural effects of Olympic Games; see among many others Bakkenbüll & Dilger (2020), Cabralis et al. (2018), Clayton (2024), Costas (2017), Magee & Weese (2023), Máté (2018), Nicoliello (2021), Ortiz et al (2020), Papanikos (2024, 2022, 2020), Stefani R (2022), Zare & Géczi (2022), and Ziakas & Boukas (2014).

Table 1. *Structure of the Operations Program Olympic Games 2004 - Health*

Axes	**Measures/ Initiatives**			
	1	2	3	4
Hospital Care	Support for the operation of hospital care units.	Support for the organization of the hospital care network.	Support and equipment of specialized hospital care units for emergencies and special needs.	Human resources for hospital care units.
Primary Health Care	Support for the operation of primary health care production units.	Support for the organization of primary health care networks.	Support and equipment of primary health care units with medical, telecommunication, and telemedicine infrastructure.	Human resources for primary health care units.
Emergency Medicine	Support for the emergency care patient handling units.	Support for the organization of emergency medical units.	Support and equipment of emergency medical units with necessary facilities and telemedicine systems.	Human resources for emergency medicine units.
Public Health and Hygiene	Support for the operation of public health and hygiene units.	Support for the organization of public health and hygiene network units.	Support and equipment of public health and hygiene units with telecommunication and telemedicine facilities.	Human resources for public health and hygiene network units.
Organization and Administration	Support for the operation and coordination of bodies for the completion of Olympic Games health tasks.		Support and equipment for Olympic administration with medical infrastructure.	Human resources for Olympic administration and health network staffing.

This article aims to present the initiatives promoted through the "Olympic Games 2004 - Health" Operational Plan and to compare Greece's approach with the experiences of Atlanta and Sydney in the 1996 and 2000 Olympics, respectively. As shown in Table 1 below, the five focus areas of the "Olympic Games 2004 - Health" plan are funded with 367 million euros. Of this amount, 28.8% (€106 million) is allocated to Axis 1: Hospital Care; 17.6% (€65 million) to Axis 2: Primary Care; 36.8% (€135 million) to Axis 3: Emergency Medicine; 14.4% (€53 million) to Axis 4: Public Health and Hygiene; and 2.4% (€8.8 million) to Axis 5: Organization and Administration (see Table 2 below).

This work is organized into five parts, beginning with this introduction. The second part provides a detailed overview of the program's priority axes and sixteen measures. The third and fourth parts describe the experiences of Atlanta and Sydney, specifically regarding the organization and provision of medical services during the Games. Finally, the fifth part presents the conclusions, highlighting the most significant actions of the Operational Program.

Priority Axes

The Ministry of Health and Welfare had planned a series of measures focused on operational and organizational improvements, infrastructure development, and the strengthening and effective utilization of human resources at Olympic hospitals. As noted above, these measures were designed with a unified approach, adapting as needed to align with each specific priority axis and specific finance (Table 2)

Table 2. *Funding of Operational Program (OP) Olympic Games 2004 - Health*

Axis	Regular Budget (R.B.)	Public Investment Program (PIP)		Financial Weight of OP
		National Resources	Community Resources	
Axis 1: Hospital Care	€ 30814380	€ 32868672	€ 41966251	28.8%
Axis 2: Primary Care	€ 19075569	€ 24944974	€ 20542920	17.6%
Axis 3: Emergency Medicine	€ 74834923	€ 30961115	€ 29200294	36.8%
Axis 4: Public Health and Hygiene	€ 24651504	€ 20542920	€ 7630227	14.4%
Axis 5: Organization and Administration	€ 8804109	—	—	2.4%
Subtotal	€ 158180485	€ 109317681	€ 99339692	100%
Total (R.B., National, & Community Resources)				**€366,837,858**

Source: Ministry of Health (2001).

Axis "Hospital Care"

The first operational measure under the Hospital Care Axis involved designating the Olympic hospitals and ensuring their readiness and quality through specific actions. Ensuring comprehensive hospital care services required integrating hospital units into a network of hierarchically organized, complementary functions. This network's development aligned with the zoning of sports venues and parks, as well as the locations of planned cultural events.

The second organizational measure aimed to systematically organize the Olympic hospitals through interdepartmental cooperation among all health sector units and departments to fully and promptly meet urgent needs. The telecommunication and telemedicine networks connecting Olympic hospitals, along with the resources and mechanisms of EKAB, played a crucial role in supporting this measure.

The third measure addressed the adequacy of infrastructure—buildings, medical networks, and equipment—at Olympic hospitals. Implementing this measure required ensuring the effective operation of network infrastructure to support access to hospital care units.

The fourth measure focused on strengthening and effectively utilizing human resources within the Olympic hospitals. Through this measure, the Ministry of

Health and Welfare aimed to secure the necessary number of specialized staff across all hospital departments (diagnostic, therapeutic, and nursing). Volunteer involvement contributed significantly to achieving this goal.

The timeline for implementing the measures under the Hospital Care Axis began in the first quarter of 2001 and concluded in the third quarter of 2004. Activities related to hospital care were projected to peak between the fourth quarter of 2001 and the fourth quarter of 2003.

Axis "Primary Health Care"

Primary Health Care was provided through Service Networks based on both the geography of competition and accommodation sites, as well as existing units within the Primary Care Network of the NHS. These Networks included established health centers, urban-type health centers, and new health units (such as first aid stations and EKAB "unit" stations) created at sports and cultural venues, along with surrounding zones.

Among the new health units established was a Polyclinic in Olympic Village, covering approximately 2,700 sq.m., which was designed to provide 24-hour emergency health services and other medical services from 8:00 a.m. to 10:00 p.m. This initiative was funded with €7.3 million.

The first operational measure focused on ensuring the full functionality of primary health care units and hospital outpatient clinics. This measure also aimed to enhance the quality of services provided, based on medical protocol standards and referral process guidelines within primary health care units.

The second measure under the Primary Health Care Axis promoted the interconnection of Primary Health Care Network units, Olympic hospitals, and EKAB stations. It also included actions to ensure the network's preparedness for providing emergency medical care and transport to designated Olympic hospitals.

The third measure ensured the adequacy of the infrastructure within the Primary Health Care Networks. This involved improvements and upgrades to Health Center facilities, such as regional clinics, insurance fund clinics, and some private clinics.

The fourth measure focused on training and utilizing human resources by implementing actions to increase the specialization and experience of primary health care unit staff. It also facilitated staff interconnection and operational mobility to ensure full functionality of emergency medical departments.

The peak of the planned actions occurred in the third and fourth quarters of 2001, and throughout 2003, marking the final stages of implementing the second Axis.

Axis of Emergency Medicine

The upgrade of emergency medicine services during the 2004 Olympic Games in Athens was achieved through the facilitation of the use of the Ambulance Service and the enhancement of its services, as well as the development of an emergency response plan.

The first operational measure focused on actions that aimed at improving the quality and comprehensive provision of emergency pre-hospital medical care, while also ensuring its availability through the competent departments of hospitals and Health Centers, as well as through the "units," "mechanisms," and "resources" of EKAB.

The actions outlined in the second organizational measure of the emergency medicine system were aimed at fostering interdepartmental organization and cooperation among all departments and units responsible for emergency pre-hospital care across the Olympic hospitals, Health Centers, and EKAB. Particular emphasis was placed on organizing First Aid Stations at the venues of the Games.

The third measure focused on the adequacy of the infrastructure of the Emergency Medicine Units. Specifically, actions were taken to ensure the availability of certified emergency medical equipment, both for mobile and permanent units, as well as telemedicine and telecommunication network infrastructure.

The fourth measure addressed the strengthening and utilization of human resources within the emergency medicine system. This measure aimed at securing the necessary staff, both in terms of numbers and expertise, for the emergency medicine units across the entire healthcare network—emergency medicine units, hospitals, Health Centers, etc.

The implementation of the actions within the third Axis of Emergency Medicine began in the second quarter of 2001 and was completed in the third quarter of 2004. The intensity of the actions increased in the first quarter of 2002, became more focused in the first, second, and third quarters of 2003, and gradually decreased as the date of the Games approached.

Axis "Public Health and Hygiene"

The strategic objective of the fourth axis focused on epidemiological surveillance and the coordination of services and organizations responsible for ensuring compliance with hygiene standards in food, water, public places, and locations providing services to the public.

The first operational measure aimed at ensuring completeness and quality in public health and hygiene services. The full provision of these services was guaranteed through the network coverage of areas hosting the Olympic Games in Athens, the Olympic cities, tourist and archaeological sites, and the country's entry points.

The second organizational measure focused on the systematic organization of all aspects of public health and hygiene (information, laboratory investigation, data collection and analysis, preventive measures, surveillance, and implementation), as well as the equipping of units with the necessary tools for epidemiological and sanitary surveillance.

The actions under the third measure addressed the adequacy of infrastructure in the Health and Hygiene Network Units. This aimed to ensure that the units had the appropriate infrastructure to develop operational standards for medical protocols and meet the needs of the public health and hygiene protection system in all risk zones.

The fourth measure, which focused on strengthening and utilizing human resources, was designed to ensure the proper functioning of the services and units within the Public Health and Hygiene Network. This was achieved by securing the required staff, both in terms of numbers and specialization/experience, in the fields of public health and in coordination services outside the health sector (e.g., police, municipalities, communities, environmental services).

According to the Ministry of Health and Welfare's schedule, the implementation of actions within the fourth Public Health and Hygiene Axis began in the second quarter of 2004.

Between 2002 and 2004, significant efforts were made to implement actions ensuring public health and hygiene across both sports and non-sports infrastructures for the 2004 Athens Games.

Axis "Organization and Management"

The administrative coordination of the health sector was the main priority of the fifth priority axis, with special emphasis on the effective management of emergencies.

The first measure of the Organization and Administration of the Health Sector Axis was operational in nature and aimed at defining the organizational structure necessary for the rational administration and coordination of the health sector during the 2004 Olympic Games (establishment of the Coordinating Body of the Health Sector – SOTY).

The second organizational measure aimed at optimizing the organization of the SOTY and ensuring its effective integration with Primary Care agencies, Olympic hospitals, "Athens 2004," services of the Ministry of Health and Welfare, relevant public health bodies, and EKAB. As part of the organizational actions, provisions were made for medical announcements throughout the Games.

Medical interpretation during the 2004 Olympic Games was provided in English, French, Russian, Mandarin, German, Arabic, and Swahili. The Ministry of Health and Welfare was responsible for interpreting medical information, offering services from the Ministry's premises, the Olympic Village Polyclinic, and the Special Center for Medical Information.

In terms of organizational actions, the importation of medicinal substances followed specific criteria. The Organizing Committee requested that National Olympic Committees submit a list of medicines they would bring into the country. These lists were subsequently reviewed by the National Medicines Agency to prevent the importation of substances banned by the International Olympic Committee.

Regarding the suitability of SOTY's infrastructure and the support systems for its operation, the third measure of the axis focused on ensuring the adequacy of building infrastructure, management and operational equipment, certified information systems (hardware), and certified health sector data collection and management software, all originating from the health sector sub-systems.

The fourth measure, aimed at strengthening and utilizing human resources for the Organization and Administration of the health sector, focused on sourcing

personnel for the staffing of SOTY. This was achieved through recruitment from health sector subsystems, the open labor market, or the selection of volunteers to support the SOTY project.

The actions of the fifth priority axis—Organization and Management of the Health Sector—began in the second quarter of 2001 and concluded in the third quarter of 2004. Implementation actions were intensified between the first quarter of 2002 and the fourth quarter of 2003.

The Atlanta 1996 Experience

During the 1996 Atlanta Olympic Games, a comprehensive system was developed to monitor and provide medical services to all participants (Wetterhall et al., 1988). On one hand, the Atlanta Olympic Committee was solely responsible for providing medical services to both residents and visitors of the Games. On the other hand, the Centers for Disease Control and Prevention (CDC) developed a health surveillance system that monitored the health and safety of the participants on a daily basis.

Medical services included the provision of first aid in emergency situations to athletes, spectators, staff, and volunteers. These services were available at the Polyclinic in the Olympic Village, at 24 sports venues, including the Olympic Stadiums, and at 11 non-sports venues, such as the Olympic Park and the central Press Offices.

In case of emergencies, medical care for participants and athletes was provided by a mobile first aid unit for every 20,000 spectators. For comprehensive medical coverage, one ambulance was stationed for every 20,000 spectators, ensuring immediate transport to nearby hospitals. Nineteen hospitals in the metropolitan Atlanta area and eight in remote areas formed the Olympic hospital network.

The cost of installing and operating the medical services system was $4.36 million. Medical services at the Polyclinic and at the sports and medical service stations for spectators were provided free of charge.

Finally, to ensure the efficient operation of the medical care delivery system, a Health Information System was developed. The purpose of this system was to monitor the health status of athletes, staff, and spectators, as well as to investigate any diseases or injuries that occurred.

The Sydney 2000 Experience

Six years before the Olympic Games were held in Sydney, Australia, planning for the provision of Olympic health services began, with the assistance of the Australian Department of Health, the Organizing Committee of the Sydney Olympic Games, the Organizing Committee of the Paralympic Games, and the Principle of Olympic Coordination (Visotina & Hills, 2000).

At the Olympic health planning stage, the Ministry of Health was responsible for: a) hospital care, b) medical care for interpreters, c) public health provision, d)

emergency services (ambulance transport), and e) coordination and management of general disasters.

On the other hand, the Olympic Organizing Committee was responsible for: a) providing medical care to athletes and spectators at competition and training venues, b) doping control, and c) confirming the gender of the athletes.

During the implementation phase of the Olympic health program, the Olympic Health Coordination Center of the Ministry of Health took on the role of overseeing the program. The main responsibility of this center was to make strategic decisions in emergency situations during the Olympic Games.

The direct health surveillance system operated with the goal of providing comprehensive information regarding the health status of participants in the Sydney Olympic Games. A key responsibility of the Health Surveillance Department was to issue a daily report, which included a summary of health-related events from the previous 24 hours, the recording of health data, and the identification of significant diseases.

Regarding hospital care at the Sydney Olympics, a network of hospitals was established to ensure the provision of medical care. In total, 13 hospitals were included in the network, three of which were Olympic hospitals, while the remaining ten provided supportive medical services. The main Olympic hospitals in the network also met the needs of the Paralympic athletes.

Significant efforts were made by the Australian Ministry of Health regarding environmental health and hygiene. In collaboration with Public Health units and local agencies, the ministry developed and implemented public health and hygiene programs in both competition and non-competition areas. Inspections were also conducted on ships providing health services, focusing on food storage temperatures, ensuring potable water, and maintaining hygiene in the ships' swimming pools.

Of paramount importance was the medical interpretation service for non-English-speaking participants in the Games. A department was created to serve the medical needs of these individuals at the Polyclinic in the Olympic Village. Medical information was available by phone in 55 languages, with the most frequently used languages, according to Table 3, being Arabic, French, Chinese, Russian, and Spanish. A total of 6,227 people required medical services in languages other than English during the Olympic and Paralympic Games.

Table 3. *More Frequent Use of Medical Interpretation Service in Olympic and Paralympic Games (Sydney)*

	Language	Usage (Olympic Games)	% of Total Usage (Olympic)	Usage (Paralympic Games)	% of Total Usage (Paralympic)
1	Arabic	554	15.06%	850	33.30%
2	French	763	20.74%	111	4.39%
3	Chinese	74	2.01%	336	13.18%
4	Russian	1,181	32.31%	690	27.08%
5	Spanish	979	26.61%	452	17.74%
Total		**3,551**	**96.52%**	**2,439**	**95.69%**

Source: Visotina & Hills (2000)

Conclusions

The Operational Program Olympic Games 2004 – Health placed special emphasis on Axis 3, Emergency Medicine, and Axis 4, Public Health and Hygiene, due to the unique needs of the Olympic Games. To address these needs, the program focused on upgrading health units and training human resources in public health and hygiene services, with the completion of interventions occurring on schedule.

The first axis, Hospital Care - Olympic Hospitals, directed its efforts toward improving the infrastructure of the Emergency Departments (EDs), creating new departmental infrastructures, upgrading existing departments, completing medical and other equipment, and modernizing beds.

Within the Primary Health Care Axis, the development of primary health services was planned, including the Polyclinic of the Olympic Village, the operation of urban health centers, and the creation of first aid stations. Post-Olympics, the Polyclinic would be repurposed as an urban health center and model diagnostic center to serve the broader community.

The third axis, Emergency Medicine, focused on creating appropriate infrastructure for the EKAB Operational Centers, installing disinfection systems for biological, toxic, and chemical substances in Olympic hospitals, renewing and reinforcing the EKAB mobile units, and staffing and training EMS workers and volunteers in emergency medicine.

The fourth axis, Public Health and Hygiene, aimed at organizational and operational interventions to improve the quality of public health services. These included creating public health networks, expanding and completing equipment for public health laboratories, supplying mobile personnel and biological material transport units, establishing electronic interconnectivity for public health units, staffing with permanent personnel, training staff, and preparing and implementing a plan to address bioterrorism.

In summary, we conclude that the Operational Program "Olympic Games 2004 – Health" was a comprehensive initiative designed to meet the health needs during the 2004 Olympic Games. It provided a set of actions that spanned a wide range of health services, both in the capital region and in the other Olympic cities.

Acknowledgments

An early version of this paper—published before the 2004 Olympics—appeared in the Greek periodical *Oikonomia & Athlitismos*. This is an updated, post-Olympic version of that paper.

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Psychological Empowerment Scale for Physical Education and Sports Teachers in the Chamchamal District, Directorate of Education

*By Hemn Hoshyar Karim**

This research examines psychological empowerment among physical education teachers in the Chamchamal region, where it is regarded as a fundamental component for enhancing individuals' sense of control and capacity to influence their lives. The study conceptualizes psychological empowerment as a dynamic process shaped by multiple factors that contribute to improved well-being and performance. A descriptive approach, using a field survey method, was adopted for the study, targeting a sample of teachers. A specific instrument for measuring psychological empowerment was utilized, following rigorous scientific procedures. The study aimed to assess the current state of psychological empowerment among teachers and explore its impact on professional performance. Findings revealed that psychological empowerment among physical education teachers results from the interaction of cultural, social, institutional, and educational factors. The research recommends fostering an educational and sports environment that supports psychological empowerment by promoting collaboration and coordination among sports supervisors, school administrators, and teachers. It emphasizes the importance of sharing information and expertise in physical education and strengthening communication between all parties involved in school physical education and sports programs.

Keywords: *Psychological Empowerment, Physical Education, Sports Teachers, Policy Recommendations,*

Introduction

Psychological empowerment is a significant topic in modern psychology, recognized for its ability to enhance an individual's sense of control and capacity to influence both personal and professional aspects of life. This empowerment helps individuals engage positively with the challenges and opportunities they encounter. It is considered essential in psychological and social research, as it aims to improve individual well-being and increase the capacity for personal and professional success.

Psychological empowerment is defined as a feeling of control, self-efficacy, self-confidence, and the ability to influence important decisions in one's life. This definition highlights that psychological empowerment is a dynamic process shaped by both internal and external factors affecting the individual (Granville and Brown, 2023).

Some believe that psychological empowerment has far-reaching effects on both individuals and communities. It can be defined as the process that enables

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a person to gain psychological and moral support to improve their quality of life and achieve personal and professional goals. This definition enhances our understanding of psychological empowerment as a crucial means of improving individual well-being and equipping people to face diverse challenges (Kamal, 2022).

Others view psychological empowerment as a significant factor in enhancing individuals' performance at work by boosting their self-confidence and decision-making abilities. This perspective illustrates how psychological empowerment can positively influence one's professional life, contributing to improved performance and productivity (Al-Khateeb, 2022).

Currently, educational institutions face considerable challenges due to rapid global changes. To adapt, schools must reevaluate their strategies and practices. With technological advancements, globalization, and intense competition, it has become essential to develop new management and educational approaches that can keep pace with these transformations.

In this context, teachers play a crucial role in education and development. They are no longer simply transmitters of knowledge; instead, they act as facilitators of the learning process and catalysts for creativity. To perform these roles effectively, teachers need both psychological and professional empowerment.

In the field of physical education, in particular, psychological empowerment is especially important. Physical education teachers play a vital role in shaping students' personalities and enhancing their physical and mental health. By empowering these teachers psychologically, they can become leaders of positive change, better equipped to face contemporary challenges and meet students' needs.

Therefore, it is essential to focus on enhancing teachers' capabilities, especially those of physical education teachers, by providing psychological empowerment and motivation to raise the quality of education. Through this research, we aim to contribute to the development of a more adaptable and effective educational system that can keep up with global changes.

Physical education teachers face significant challenges in achieving the necessary level of psychological empowerment due to a gap between the urgent need to improve their performance and the obstacles they currently encounter. They struggle to adapt to increasing professional pressures and to achieve the required level of efficiency in their work, largely because of a lack of specialized studies on psychological empowerment specifically within the field of physical education. Insufficient involvement in decision-making processes and the limited effectiveness of current strategies for fostering their psychological empowerment further hinder their ability to overcome challenges and enhance educational quality.

Therefore, it is crucial to study and understand how to enhance psychological empowerment for physical education teachers so they can improve their performance and better respond to the demands of today's educational landscape. The research problem can be defined through three key questions:

1. What is the current level of psychological empowerment among physical education teachers, and what are the primary factors affecting it given

contemporary challenges?
2. How does psychological empowerment impact the professional performance of physical education teachers and the overall quality of education in physical education?
3. What effective strategies can enhance psychological empowerment among physical education teachers, and how can these be implemented within the current educational context?

The importance of this study lies in its focus on a critical topic related to educational quality and teachers' effectiveness in addressing contemporary challenges. Theoretically, this research helps bridge a knowledge gap concerning the psychological empowerment of physical education teachers, enriching educational literature and offering a comprehensive framework for understanding this phenomenon.

On a practical level, the findings of this research will aid in developing effective strategies to enhance teachers' psychological empowerment, which will positively impact their professional performance. Additionally, understanding the factors that influence psychological empowerment will support decision-makers in designing policies and training programs that meet teachers' needs and build their capacities.

At the student level, empowering teachers psychologically will contribute to higher-quality education and improve learning outcomes in physical education. Finally, this research highlights the essential role of physical education teachers within the educational system, supporting broader efforts for comprehensive educational development and reform.

The objectives of this study are to construct and apply a psychological empowerment scale for 180 physical education teachers in the district of Chamchamal and to assess the current level of psychological empowerment among these teachers. This research is limited to physical education teachers at public schools in the district of Chamchamal, Kurdistan Region of Iraq, during the period from January 5, 2024, to April 5, 2024.

This paper is organized in five sections including this introduction. The second section discusses the concept of psychological empowerment. The third section is the research methodology. In addition, the empirical findings of this study are reported. The fourth section provides a number of recommendations based on the discussion and the findings of this paper. The last section concludes.

Psychological Empowerment

According to Young (2020), psychological empowerment is a multidimensional concept that reflects an employee's positive psychological state toward their work. It manifests in their perception of the importance of their role, confidence in their abilities, independence in decision-making, and influence over work outcomes. This state enhances the employee's intrinsic motivation, encouraging them to take initiative and persevere in the face of organizational challenges.

Psychological empowerment involves enhancing the capabilities of those

working in the field of education through both psychological and moral support, aiming to equip them to efficiently overcome modern challenges. This support focuses on strengthening self-confidence and decision-making abilities, which in turn improves performance and helps educational institutions adapt to global and technological transformations.

The final score obtained by a respondent on the psychological empowerment scale serves as an indicator of how well their responses align with their actual state of empowerment. This is implemented in this study.

Research Methodology and Findings

This study uses a descriptive style method based on primary data collected by a questionnaire. The research sample included 140 physical education teachers in the district of Chamchamal, representing 77.8% of the total population. The sample consisted of the following subgroups: the construction sample (74), the exploratory experiment (6), those excluded for various reasons (10), the reliability sample (20), and the application sample (30).

The exploratory experiment aimed to assess the clarity of the statements and scale instructions, calculate the time taken to respond to the questionnaire, address any inquiries, and prepare the final version of the statements before statistical analysis.

For this purpose, the researcher distributed the questionnaire to a sample of 6 physical education teachers who were later excluded from the main sample. These teachers were asked to read the instructions and statements, raise any questions about unclear points, and indicate any difficulties they encountered during the response process. The time required to complete the questionnaire ranged from 20 to 22 minutes, with an average of 21 minutes per teacher.

To measure the variable of psychological empowerment, the researcher developed a tool to assess this variable, following a set of scientific steps for constructing reliable scales.

The theoretical foundations were based on an international literature review.

The theoretical foundations were defined as follows:

- Relevant theories were used to define key concepts, using the principle of analyzing and breaking down these theories into basic elements. Each element was considered a specific area or reference framework from which statements were derived. The relative importance of each area in measurement was determined, which guided the preparation of statements for each area.
- The scale construction relied on the common method of using declarative statements, following the identification of the theoretical foundations and basic concepts of the current study.

To ensure the validity of these areas and their representation of the scale, the researcher presented them to a group of specialized experts for evaluation. The

experts assessed the validity and coverage of the concept of psychological empowerment.

To verify the level of agreement among the experts' opinions, the Chi-square goodness of fit test was applied. The researcher set an agreement threshold of 75% or higher, using the Chi-square critical value of 3.84, with degrees of freedom (2-1) = 1, and a significance level of 0.05. Table 1 reports the results of the Chi-square test and the percentage of experts' opinions on the validity of the domains of the Psychological Empowerment Scale.

Table 1. *Experts' Opinions*

	Areas Psychological Empowerment	#	#		#		#	χ^2
			A	%	D	%	Merging or changing the field	
1	Organizational support	23	23	100	0	0	-	23
2	Competency Area	23	22	96	1	4	Domain2, Domain4	19
3	freehand, discretion	23	22	96	1	4	Domain3 Domain5	19
4	Impact Group	23	21	91	2	9	Domain4 Domain2	16
5	Self-determining domain	23	20	87	3	13	Domain5 Domain3	13
6	Meaning domain	23	19	83	4	17	-	10

#: Number of Experts; A: Agree; D: Disagree

In Table 1, after merging and modifying the domains, we observed a shift from the "competence and qualification" domain to the "competence and impact" domain, while the "discretion and self-determination" domain became part of "autonomy." The final scale consists of four domains, as shown in Table 2.

Table 2. *Domains of Psychological Empowerment*

	Areas
1	Organizational support
2	Area of Competence and Influence
3	Autonomy (freedom of action and self-determination)
4	Meaning domain

Table 3 shows the arithmetic mean, relative importance, and the number of items for each dimension of psychological empowerment.

Table 3. *Mean and Phrases*

	Areas Psychological Empowerment	**Mean**	**Domains**	**Mean**	**Phrases**
1	Organizational support	3.03	25	(3.03x25) / 100 = 0.75	0.75 x 2 =15
2	Area of Competence and Influence	2.87	25	(2.87x25)/100 = 0.71	71 x 2 =14
3	Autonomy (freedom of action and self-determination)	2.63	25	(2.63 x25) / 100 = 0.65	2 x 0.65=13
4	Meaning domain	2.56	25	(2.56 x 25) / 100 = 0.64	2 x 0.64=13
5	Total	mean for each domain	100 / 4 = 25 per area	(mean per area x 25) /100	55 Primary Phrases

The process of drafting initial statements is a crucial step in developing psychological and pedagogical scales. This process aims to create a set of statements that accurately reflect the attribute or phenomenon to be measured while ensuring validity and reliability (DeVellis and Thorpe 2022). The statements were prepared in their initial form through several steps:

1. Some statements were derived from analyzing responses to an open questionnaire distributed to a random sample of six teachers of physical and sports education in Chamchamal district, who were excluded from the study sample. They were asked to write statements for each dimension of the scale.
2. Additional statements were derived from the theoretical framework, definitions, and existing measures addressing the concept of psychological empowerment, with adaptations to suit the context of this study. The researcher also formulated new statements, structuring them as declarative statements to which respondents select one of five options: Always Applies, Often Applies, Occasionally Applies, Slightly Applies, Never Applies.

During the statement preparation, several key points were emphasized:

1. Avoid lengthy statements to prevent response fatigue.
2. Ensure each statement is clear, understandable, and interpretable in a single way.
3. Make statements comprehensive to encompass all aspects of the evaluation.
4. Use simple and straightforward language for ease of understanding.
5. Avoid hints or wording that might bias the respondent, and refrain from using negatives like "no."
6. Avoid statements containing multiple ideas.

Logical analysis is essential at the outset of statement preparation to assess whether each statement accurately represents the intended attribute. This step is a preliminary measure to verify the scale's validity, as the scale can be considered valid if it is reviewed by subject-matter experts. Experts provided feedback on the

statements' validity and their suitability for each dimension, suggesting modifications where necessary.

Apparent validity is a foundational form of validity in the construction of psychological and educational standards. It refers to the extent to which the scale appears to measure its intended attribute, based on an examination of the content and structure (Al-Zamili et al. 2023). Apparent validity is often confirmed by presenting the scale to a panel of experts to evaluate the clarity and relevance of each statement. Researchers note that apparent validity can enhance respondents' motivation to complete the scale, thereby improving reliability (Al- Subaie 2023).

It is important to note that apparent validity does not replace other forms of validity but serves as an initial step toward more precise validation methods, such as content and construct validity (Hammouri and Abdul Jawad 2024). A tool is considered valid if its structure and content align with the behavior it intends to measure. The statements were reviewed by a panel of experts, who evaluated their validity. The chi-square test for goodness of fit was applied to assess the level of agreement among experts, with a minimum agreement threshold of 75%, a chi-square value of 3.84 (for a degree of freedom of 1), and a 0.05 error level. Results indicated that all statements met the criteria for measuring their intended constructs. Table 4 presents the chi-square results and the percentage of expert agreement on the validity of the psychological empowerment statements.

Table 4 confirms the validity of 44 statements across four dimensions. Statements in Table 4 were reviewed by experts to assess the directionality (positive or negative) of each statement. The researcher incorporated expert guidance, and the statements were then organized according to the structure outlined above.

Table 4. *Chi-square and Expert opinions*

	Areas	Phrases	#	#		#		χ^2
				A	%	D	%	
1	Organizational support	8,10,11,13	23	23	100	0	0	23
		1 ,2 ,5,12,15	23	21	91	2	9	16
		3,4	23	18	78	5	22	7
		6, 7, 9,14	23	<16		>7		5
2	Efficiency and Impact	17,21,22	23	22	96	1	4	19
		16,20,23,26	23	21	91	2	9	16
		18,19,24,27	23	20	87	3	13	13
		25,28,29	23	<16		>7		4
3	Independence	34,35,41	23	22	96	1	4	19
		31,33,36,42	23	20	87	3	13	13
		32,37,39,40	23	18	78	5	22	7
		30-38	23	<16		>7		4
4	Meaning	44,49,51	23	23	100	0	0	23
		53,54	23	20	87	3	13	13
		43,46,50,55	23	19	83	4	17	10
		45-52	23	18	78	5	22	7
		47,48	23	<16		>7		4

#: Number of Experts; A: Agree; D: Disagree

Table 5 presents the distribution of positive and negative statements by dimension.

Table 5. *Numbers of Positive and Negative Statements*

Sr	Areas Psychological Empowerment	Positive Phrase Numbers	Negative Phrase Numbers
1	Organizational support	2, 4, 8, 10, 11, 12, 13, 15	1, 3, 5
2	Efficiency and Impact	16, 17, 18, 19, 20, 21, 22	23, 24, 26, 27
3	Autonomy (freedom of action and self-determination)	31, 32, 34, 35, 39, 42	33, 36, 37, 40, 41
4	Meaning	43, 46 ,51, 52, 53, 54, 55	44, 45, 49, 50
5	Total	28	16

After administering the questionnaire to a sample of 74 physical education teachers, the responses were analyzed to determine the discriminative power of each statement. The total scores from the responses were ranked from highest to lowest, with the two extreme groups representing the top and bottom 27% of scores, respectively. Each group consisted of approximately 20 participants after rounding.

To assess differences in scores between these groups for each statement, an independent-samples t-test was used, with the calculated t-value representing the statement's discriminative power. The t-values ranged from a minimum of 0.36 to a maximum of 6.34. Four statements were removed because their t-values did not reach the critical value at the 95% confidence level, indicating insufficient discriminative power.

Experts in measurement, evaluation, and psychometrics emphasize the importance of validity in the items of measurement scales, as the validity of the overall scale largely depends on the validity of its individual items (Al-Sharifain and Abu Zaytoun 2020). While certain statements may initially seem suitable for measuring a particular trait, empirical validity—how each statement correlates with the scale's overall score—provides a more accurate assessment. This is because empirical validity reveals each statement's capacity to measure the same concept as the scale as a whole, ensuring item homogeneity (Al-Khatib and Al- Hadidi 2019).

To assess the discriminatory power of the statements, the internal consistency coefficient was calculated to ensure a homogeneous scale in which each statement reflects the same behavioral dimension as the scale overall, highlighting inter-item correlations (Murad and Abdulaziz 2019).

When a statement is correlated with an internal or external criterion, this relationship indicates its validity. In the absence of an external criterion, the respondent's total score is considered the best internal criterion. After removing non-significant items, the validity of each statement was calculated using Pearson's correlation coefficient with the overall score (Suleiman and Abdulsalam, 2021). The correlation coefficients (r) ranged from 0.19 to 0.72, and all statements were statistically significant, with coefficients above the critical value at a 0.05 significance level—except for four statements, which were excluded because their correlation

coefficients fell below the critical threshold. The final scale thus includes 36 statements.

Correlation values between each dimension's total score and the overall scale score were also calculated, as these correlations are fundamental indicators of homogeneity and help define the behavioral dimension measured. Results showed that the subscale correlation coefficients were statistically significant, exceeding the critical correlation value at a 0.05 significance level.

Reliability is a key criterion in evaluating psychological and educational tools, as it reflects the stability of measurement results over time and across conditions. In this study, the split-half method was used to estimate reliability, a time- and resource-efficient approach that requires administering the test only once. This method involves dividing the items into two halves—odd-numbered items in one half and even-numbered items in the other.

Following scale administration, the Pearson correlation coefficient was calculated for the split halves. Since this value reflects the reliability of only half of the test, correction methods were applied to estimate the overall reliability. Specifically, the researcher used the Spearman-Brown and Guttman formulas for correction, along with Cronbach's alpha, which is suitable for this scale's structure (Al-Ansari 2022).

Results from the three methods showed a Spearman-Brown reliability coefficient of 0.924 for the psychological empowerment scale, a Guttman-corrected reliability coefficient of 0.926, and a Cronbach's alpha of 0.923. These values meet the study's reliability standards, indicating a high degree of reliability for the psychological empowerment scale.

The final version of the scale was administered to a sample of 30 physical education teachers and instructors in the Chamchamal district. Respondents were given the psychological empowerment questionnaire with instructions on how to respond to each item. Confidentiality and the scientific use of responses were emphasized. The final administration period ran from June 9, 2024, to June 25, 2024, with a response time of 20-22 minutes. The results, which will be presented and discussed according to the study's objectives, were derived from these analyses. To ensure methodological rigor, statistical analyses were conducted to examine the distribution of data obtained from the measurement tool. This analysis provides insight into the data's distribution characteristics, aiding in the selection of appropriate statistical tests and enhancing the reliability of study findings.

Based on the data presented in Tables 6 and 7 and Figures 1 and 2 give the scores for the research sample show a moderate distribution. Therefore, parametric inferential statistical methods are appropriate for analyzing the data. After administering the scale to the application sample, teachers' responses were analyzed based on the provided answer choices. The results showed an arithmetic mean of 120 with a standard deviation of 13.6. When compared with the hypothetical mean of 108 using a one-sample t-test, the calculated t-value of 4.9 exceeded the critical t-value of 2.04 at a 0.05 significance level, with a degree of freedom of 29. This indicates a statistically significant difference between the two means, suggesting that teachers have a high level of mood. Table 8 presents these results.

The results of this study align with Abdullah's (2022) findings that organizational support significantly enhances professional performance by fostering a work environment that encourages innovation and development. Such support encourages the adoption of effective new teaching and training methods, thereby raising creativity and independence in the workplace.

Moreover, institutions that provide ongoing organizational support contribute to greater job satisfaction among teachers, which positively impacts overall performance. Organizational support also expands opportunities for professional development and peer interaction, helping to create an integrated learning environment aimed at excellence in teaching and sports training.

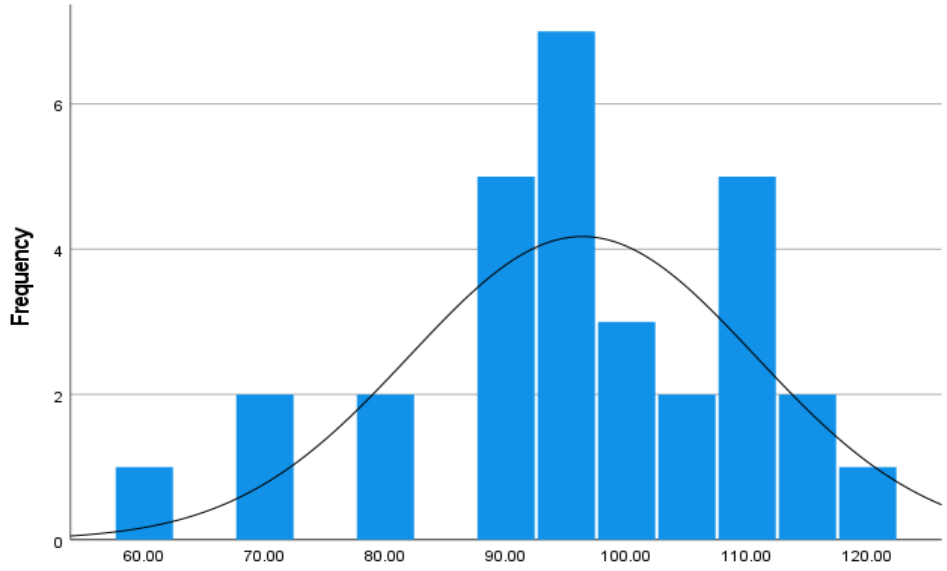
Table 6. *Summary Statistics*

Statistic	Value
Mean	96.3
Standard Deviation	14.3
Range	59
Skewness	-0.573
Kurtosis	0.222
Minimum	60
Maximum	119

Table 7. *Test of Normality*

Kolmogorov-Smirnova			**Shapiro-Wilk**		
Statistical	**df**	**Sig**	**Statistical**	**df**	**sig**
0.115	30	200	0.960	30	0312

Figure 1. *Psychological Empowerment Scale*



Al-Qahtani (2023) also emphasizes that investing in skill and competency development enhances teachers' effectiveness and their capacity for innovation

within the work environment, improving educational and training outcomes and the quality of educational outputs. This development fosters a generation of teachers capable of leading change within their fields.

Based on these results, it can be concluded that the professionalism of teachers and physical education instructors plays a vital role in enhancing the quality of the educational and training process. Institutional support and continuous professional development strengthen self-efficacy, enabling teachers to confront challenges and implement innovative, effective teaching strategies. Enhanced proficiency also increases teachers' confidence in their ability to positively impact students, both cognitively and physically, and improves job satisfaction.

Figure 2. *Psychological Empowerment*

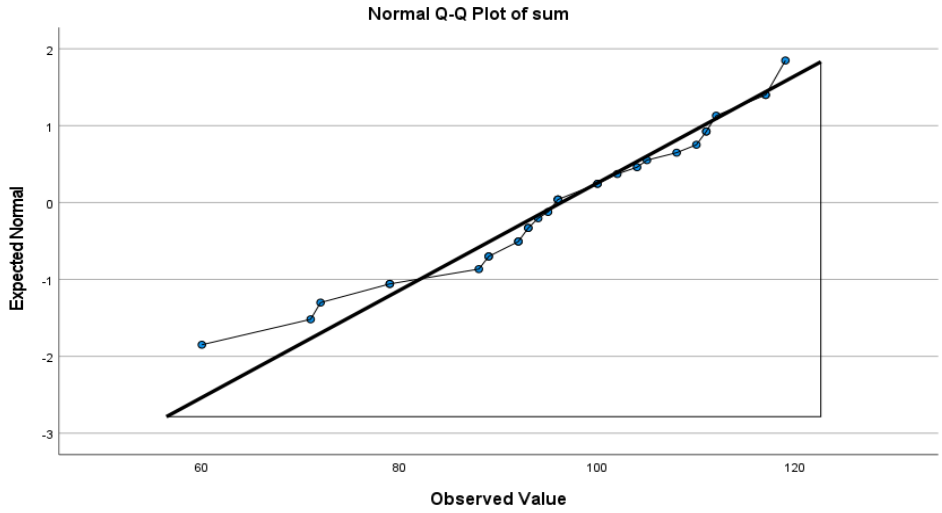


Table 8. *T-test Results for the difference between the means*

	M	SD	Expected	T value		N	df
				Estimated	Critical		
Psychosocial Empowerment	120	13.57	108	4.92	2.04	30	29

This study's results are also consistent with those of Samir and Laila (2023), who found that a stimulating educational climate fosters creativity and independence in educational and sports practices. This aligns with self-determination theory, which highlights the importance of autonomy and competence in motivating and psychologically empowering individuals, leading to improved teaching methods and sports training by teachers and physical education instructors.

In light of these findings, it is evident that the psychological empowerment of teachers and physical education instructors in the Chamchamal district results from a complex interplay of cultural, social, institutional, and educational factors. These findings underscore the importance of a holistic approach to fostering psychological empowerment, emphasizing the need for a supportive environment,

opportunities for professional development, and meaningful participation in educational and sports decision-making. Such measures contribute to enhancing the quality of both education and sports training in the region.

Recommendations

Based on the discussion and empirical findings of this paper, the following recommendations are proposed:

1. **Establishing a Supportive School Environment for Psychological Empowerment:** Schools should foster an environment that supports the psychological empowerment of physical education teachers by:

    a. Enhancing collaboration between sports supervisors, school administrators, and physical education teachers.
    b. Promoting the exchange of information and expertise in sports and physical education.
    c. Improving communication among all stakeholders involved in school physical education and sports.

2. **Developing Awareness of Teachers' Abilities and Skills:** Increase physical education teachers' awareness of their sports and educational skills by:

    a. Allowing them greater autonomy in planning and implementing sports activities and lessons.
    b. Encouraging innovative solutions to challenges encountered in teaching and organizing sports events.

3. **Organizing Seminars and Training on Psychological Empowerment:** Provide newly appointed physical education teachers with seminars and training focused on:

    a. Spreading awareness of psychological empowerment among professionals in physical education and school sports.
    b. Making psychological empowerment a core component of the school's physical education culture.

4. **Addressing Educational and Administrative Challenges:** Support physical education teachers in overcoming challenges by:

    a. Removing barriers to implementing sports activities and practical lessons.
    b. Emphasizing the importance of psychological empowerment within physical education.
    c. Strengthening teachers' sense of purpose, competence, and independence.
    d. Enabling teachers to positively impact the school's sports environment.

5. **Developing Programs to Foster Psychological Empowerment:** Conduct research to create programs that enhance psychological empowerment in physical education and sports science teachers, focusing on:

    a. Building self-confidence, physical abilities, and teaching skills.
    b. Developing sports leadership abilities and effective management of sports classes and teams.

Conclusion

The psychological empowerment of physical education and sports science teachers results from a complex interaction of cultural, social, institutional, and educational factors, highlighting the need for a holistic approach to fostering such empowerment. According to self-determination theory, creating a stimulating learning environment that promotes creativity and autonomy in physical education and sports science practices is essential.

The findings of this paper suggest that opportunities for professional development and involvement in decision-making within physical education and sports science enhance the competence of teachers and specialists in this field.

This aligns with other studies indicating that societal appreciation for physical education and sports science strengthens teachers' and specialists' sense of value and purpose, as suggested by social exchange theory.

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Athens Journal of Sports - Volume 11, Issue 4, December 2024 – Pages 217-228

Leveraging Machine and Manual Feeding Method in Enhancing Badminton Smash Accuracy in Cagayan De Oro City

By Zofea Abellanosa Briosos[*]

This study examines the effectiveness of manual and machine shuttle feeding methods on badminton smash accuracy in novice tertiary education students over 12 weeks, using a quasi-experimental methodology. The study focused on male students enrolled in a Physical Education badminton course, evaluating their performance through pre-test and post-test assessments specifically on smash accuracy. The results showed substantial improvements in both intervention groups, with participants progressing from "less accurate" to "moderately accurate" smash performance. The manual technique exhibited a decrease in standard deviation from 1.78 to 1.56, indicating greater consistency in performance. Conversely, the machine technique resulted in a larger average increase in smash accuracy (from 3.55 to 5.47), though variability among participants increased (standard deviation rising from 2.11 to 2.43). Statistical analysis, using the Wilcoxon signed-rank test and the Mann-Whitney U test, confirmed significant improvements in smash accuracy within each group after the intervention, with no notable differences between the two methods in terms of performance gains. Both manual and machine feeding methods proved effective and comparable in enhancing badminton smash accuracy for novice players. The study underscores the importance of combining modern training tools with traditional coaching methods to meet individual learner needs and preferences. The findings provide valuable insights into badminton training, suggesting that utilizing both manual and machine feeding methods can improve outcomes by catering to different learning styles and enhancing skill development in badminton smash accuracy.

Keywords: *Badminton Smash Accuracy, Machine Shuttle-Feeding Method, Manual Shuttle-Feeding Method, Quasi-Experimental Study, Skill Enhancement in Badminton*

Introduction and Literature Review

Badminton, a racquet sport, is a mainstay in tertiary Physical Education (PE) programs due to its fast-paced, high-stakes gameplay, which demands expert technique, stamina, and control. However, research has largely focused on younger or general populations rather than tertiary-level students. This study addresses that gap (Dewi, 2021; Singh & Ambre, 2023), specifically examining how manual and machine shuttle feeding methods enhance smash accuracy among first-year college students.

The sport's minimal equipment requirements and indoor adaptability contribute to its widespread appeal. The dynamic postural adjustments required,

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such as jumps and rapid directional changes, make skilled play particularly challenging (Malwanage et al., 2022). To develop proficiency, especially in smash accuracy, players need professional training focused on biomechanics, including trunk rotation and limb coordination (Li, 2016; Zhang, 2017).

This study compares the effectiveness of manual and machine feeding methods on badminton smash accuracy under quasi-experimental conditions, addressing a notable gap in the literature. Most research has focused on overall badminton performance and fitness (Li, 2016; Phomsoupha & Laffaye, 2015), leaving a need for more studies on targeted training techniques to improve smash accuracy. The manual feeding method is a traditional approach where shuttlecocks are hand-thrown or fed with a racket, which is believed to enhance both general physical coordination and specific badminton smash skills (Alsaudi, 2020).

In contrast, technological advances have led to the development of automated shuttlecock-feeding machines, which offer a consistent, repetitive training environment. These machines are increasingly used in athletic training due to their ability to provide precise motion input while reducing the risk of injury (Smith et al., 2020; Xie et al., 2022).

This research is grounded in Vygotsky's Social Constructivism, Bruner's Theory of Scaffolding, and the Theory of Deliberate Practice. These frameworks suggest that skill development in badminton requires more than just time spent practicing—it requires social interaction and scaffolded learning to improve both mental and physical abilities (Ericsson et al., 2020; McLeod, 2019).

Conducted at a private university in Cagayan de Oro City, this quasi-experimental study aims to determine which training method is more effective in improving smash accuracy among novice players. Participants were assigned to either manual or machine-feeding interventions, with outcomes measured through pre- and post-tests using a standardized protocol. The findings are expected to offer valuable insights into current practices in tertiary badminton education and to inform training methods for higher levels of competition. In addition to improving smash technique and performance, the study aims to explore how best to integrate technology into sports training to achieve peak performance.

Methodology/Materials and Methods

This study employed a quasi-experimental methodology to evaluate the effectiveness of manual and machine shuttle feeding methods in improving smash accuracy among novice badminton players. Quasi-experimental designs are well-suited to educational contexts as they allow for controlled comparisons without random assignment (White, 2020; Gopalan et al., 2020).

Eighty male students from a beginner-level badminton PE class at a private university participated in the study. The students were pre-assigned to either the manual or machine feeding method, ensuring a balanced sample size between groups.

Two main tools were used in the study: the Health Appraisal Record, which assessed participants' fitness and ensured their safety, and the badminton smash

test (Johnson & Nelson, 1969), which evaluated smash accuracy before and after the training period for both groups. Key equipment included a standard platform, shuttlecocks, and a tightly strung badminton racket. To maintain consistency, the machine was used for shuttlecock feeding. Each participant had ten opportunities to score, with "Very Accurate" (ten hits) being the highest possible rating and "Inaccurate" (zero to two hits) being the lowest.

The study adhered to the highest ethical standards, as it was approved by the Research Ethics Committee of the host institution. Data collection spanned from August to November 2023 across 24 sessions. Ethical procedures included obtaining informed consent, ensuring strict compliance with data privacy regulations, and implementing safety measures.

The intervention was conducted in three phases over twelve weeks. In the Preliminary Phase (Weeks 1-4), participants focused on mastering form and technique while receiving immediate feedback. The Intermediate Phase (Weeks 5-8) reduced the amount of feedback to encourage independence. In the Final Phase (Weeks 9-12), participants applied their skills autonomously, culminating in a post-test to evaluate their progress. Sessions were held twice weekly for one hour each to maximize focus and minimize fatigue.

Results

Table 1 presents the result of the descriptive analysis of the badminton smash performance before and after the intervention.

Table 1. *Descriptive Analysis of Badminton Smash Performance before and after the Interventions*

Range	Description	Manual Method				Machine Method			
		Pretest		Post-test		Pretest		Post test	
		f	%	f	%	f	%	f	%
10 hits	Very accurate	0	0	1	1.67	1	1.67	2	3.33
8-9 hits	Accurate	1	1.67	2	3.33	0	0	13	21.67
5-7 hits	Moderately accurate	15	25	37	61.67	21	35	21	35
3-4 hits	Less accurate	24	40	18	30	16	26.67	17	28.33
0-2 hits	Inaccurate	20	33.33	2	3.33	22	36.67	7	11.67
Total		60	100	60	100	60	100	60	100
Mean		3.57		5.10		3.55		5.47	
Description		Less accurate		Moderately accurate		Less accurate		Moderately accurate	
SD		1.78		1.56		2.11		2.43	

The table shows that at the start of the study, both groups exhibited a "less accurate" mean score of slightly over 3.5, which reflects the skill level of beginners. However, in the post-test, the mean scores in both groups increased to over 5.0. There was a notable increase in the frequency of "moderately accurate" hits in the manual method group, rising from 25% to over 61%.

Additionally, the manual technique group's standard deviation decreased from 1.78 to 1.56, suggesting that this intervention, likely due to the individualized feedback and one-on-one interaction during training, promoted more consistent accuracy among participants. In contrast, the machine technique group's standard deviation increased from 2.11 to 2.43, indicating a wider range of results. This suggests that participant interactions with mechanical training aids may vary, potentially leading to higher peaks in performance (as indicated by the mean increase) but also greater variability in outcomes.

Moreover, the study shows that the manual method resulted in a higher frequency of hits classified as "moderately accurate" in the post-test, indicating that it helps participants focus on refining and correcting their technique. This implies that personalized coaching can lead to more consistent performance across the group. While the machine method also led to an increase in accuracy, the greater variability suggests that improvements varied more among participants. This could indicate that some players adapt more quickly to automated feeding, while others may require more time to adjust.

Table 2 presents the results of the Wilcoxon signed-rank test comparing badminton smash performance before and after the intervention.

Table 2. *Result of the Wilcoxon Signed-rank Test comparing the Badminton smash Performance be-fore and after the Intervention*

	Statistics	Manual Method	Machine Method
Badminton smash accuracy	Pre-test mean	3.57	3.55
	Post-test mean	5.10	5.47
	W	26	14.0
	p	<0.001*	<0.001*
	Effect size (RBC)	-1.00	-1.00

* Significant at 0.001 level

The table shows the results of the Wilcoxon signed-rank test for badminton smash accuracy before and after the intervention using both manual and machine methods. The Wilcoxon signed-rank test ($W = 26$, $p < 0.001$) indicates significant improvement, rejecting the null hypothesis and suggesting a meaningful difference between the pre-test and post-test scores in the manual method group. Supporting this, the Rank Biserial Correlation (RBC = -1.00) demonstrates that the post-test scores entirely surpass the pre-test scores, meaning every value in the post-test is greater than every value in the pre-test.

The study emphasizes the practical effectiveness of targeted badminton training interventions, with post-intervention scores consistently exceeding pre-intervention scores for all participants. This underscores the robustness of the training methods and the ability of structured training, whether manual or machine-based, to significantly improve the skill levels of novice players. The findings suggest that these methods could be applied to other technical aspects of badminton or even other sports, potentially leading to widespread improvements in athletic performance. The success of these interventions could promote the development of personalized and adaptive training programs.

Table 3 presents the results of the Mann-Whitney U test, which compares the effectiveness of each intervention in enhancing badminton smash accuracy. The test produced a statistic of 2050.50 with a p-value of 0.178. As a result, the null hypothesis (Ho2), which states that there is no significant difference between the two groups regarding the increase in badminton smash accuracy, cannot be rejected. Additionally, the RBC (0.139) indicates a minimal effect size. While one group achieved a slightly higher average score than the other, the difference between the manual and machine feeding methods in terms of improving badminton smash accuracy is minimal.

Table 3. *Result of the Mann-Whitney U Test to Compare the Increments of the Manual and Machine Groups in enhancing badminton Smash Accuracy*

Badminton smash accuracy	Manual Method	Machine Method	W	p	RBC
Mean	1.53	1.92	2050.50	0.178	0.139
SD	1.17	1.56			

Based on the findings, both interventions are comparably effective in helping novice players improve their badminton smash accuracy. This gives coaches more flexibility in choosing training methods that suit their players' needs, preferences, and available resources. When designing badminton training programs, it is important to consider the fundamental principles of effective training.

Discussion

Problem 1: How did the participants perform in the Badminton smash accuracy test before and after the interventions?

The study shows that in terms of badminton smash performance, the manual method led to a higher frequency of "moderately accurate" hits in the post-test, suggesting that this method helps participants refine their technique. This implies that personalized coaching fosters more consistent technique across the group. The machine method also resulted in improved accuracy, but the variation in results suggests that some participants adapted to automated feeding faster than others.

Before the pre-test, the researcher personally asked participants in the manual group about their badminton experience. Some participants mentioned playing during leisure time, while others had competed in intramural games. Participating in organized sports or leisure activities can help develop skills outside formal settings (Fuchs & Osikominu, 2016). The researcher recognized that the participants had a mix of beginner and intermediate skill levels, based on these informal conversations during the first week of the intervention.

During the intervention, the researcher noticed that many participants struggled to hit the shuttlecock when it was thrown manually, indicating poor hand-eye coordination. This suggests that participants had low neurodevelopmental readiness

for sports participation at the start of the experiment (Patel et al., 2021). They needed to learn the correct form and biomechanics for a successful badminton smash, as the shuttle's release angle and clearance height are directly affected by the player's body position. Timing, technique, and fundamental skills are essential for executing an effective smash.

In the post-test, noticeable skill improvements were observed. Targeted training programs, such as drill exercises and hand-eye coordination practices, can enhance badminton smash skills (Alsaudi, 2020). Participants developed better timing and hand-eye coordination, supported by research showing that smash skills improve through training approaches that emphasize timing and synchronization (Akbari, 2017). Studies also confirm the connection between smash power, accuracy, and body alignment, showing that participants' coordination and strength improved after the intervention (Li et al., 2023; Indora et al., 2022).

The group eventually learned the proper stroke form and biomechanics required for the smash, including racquet placement, angle at impact, and body tension (Li et al., 2023). Biomechanical analysis explains the improvements in participants' smash abilities after the intervention (Brahms, 2014). Additionally, trunk rotation, or the "X-factor," enhances power in the forehand smash by creating intense muscular contractions and increasing racquet speed (Zhang et al., 2016).

In the machine method group, participants also acknowledged limited experience in smashing before the pre-test. The machine that fed shuttlecocks was new to them, but it motivated them to learn. Research suggests that unfamiliar training tools can inspire new learners to engage in practice (Aslam et al., 2019). However, some participants still had difficulty hitting the shuttle during the experiment, further emphasizing the complexity of badminton skill development (Gogoi & Duwarah, 2017).

During the post-test, improvements in smashing accuracy were observed, with participants advancing from "less accurate" to "moderately accurate." They also became more independent, performing the skill without the instructor's guidance.

Problem 2: How do the participants in each group compare their badminton smash performance before and after the intervention?

> Ho1. The participants in each group do not significantly differ in their Badminton smash accuracy before and after the interventions.

In the comparison of badminton smash performance between the groups before and after the intervention, the researcher observed that manual shuttle feeding allowed for real-time adjustments, enabling the shuttle feeder to wait until participants were properly positioned before releasing the shuttle. This created an immediate feedback loop, allowing players to correct elements like grip, footwork, arm swing, and follow-through. The personalized attention given through manual feeding is believed to significantly enhance the accuracy of badminton smashes. Unlike automated methods, manual feeding emphasizes human interaction and judgment, reinforcing the researcher's confidence in its effectiveness.

From a Social Constructivist perspective, Vygotsky's theory suggests that learners benefit from guidance provided by more skilled individuals, which is mirrored in manual badminton instruction. In this setting, the coach plays the role of the 'more informed other,' providing real-time feedback and personal coaching that falls within the learners' Zone of Proximal Development (ZPD) (Vygotsky & Cole, 1978). By maintaining tasks that are challenging yet achievable, the manual approach fosters skill development through social interaction, adapting instruction to the individual's needs.

During training, coaches using the manual method corrected players' technique, offering a customized approach that aligns with Vygotsky's belief in the importance of direct interpersonal communication for skill acquisition (Schunk, 2012). In line with this, research (Wee et al., 2019) highlights that manual feeding has proven benefits for enhancing athletic performance, although the study did not separate manual from machine approaches. The focus on body alignment and trunk rotation during an overhead smash (Zhang, 2019) further supports the idea that manual methods provide immediate corrections that help enhance performance. However, despite these findings, there remains a lack of extensive research focusing specifically on the manual feeding approach.

In contrast, the machine approach offers consistency in practice by ensuring uniformity in shuttle speed and landing position. This stability allows players to focus on developing timing and coordination without the variability inherent in manual feeding. Over time, this repetition leads to improvements in students' motor coordination and skill consistency, demonstrating the method's effectiveness in improving smash accuracy.

Bruner's Scaffolding Theory reinforces the benefits of the machine-based approach. Scaffolding offers temporary support until learners achieve competency, allowing them to practice consistently without external variability. The machine delivers shuttles at a consistent trajectory, enabling players to master key elements of the smash. As players' skills improve, external assistance is gradually reduced, mirroring how scaffolding is removed when no longer needed. This highlights the machine's role as a scaffold, facilitating skill development through structured repetition.

The effectiveness of the machine-based approach is further demonstrated by the significant increase in post-test scores (Wilcoxon signed-rank test, Table 2), as supported by previous research (Yousif & Yeh, 2011; Xie et al., 2019; Aslam et al., 2019; Punithan et al., 2023). Technologies such as CAD, 3D printing, and AI in modern badminton training tools, like the Shuttlecock Propulsion Machine and IBTR (Intelligent Badminton Training Robot), enhance players' ability to develop consistency and precision in smashes.

The success of both interventions in improving smash accuracy depended largely on the duration (12 weeks, 24 sessions). This extended training period allowed participants to learn, practice, and refine their skills. Regular, repetitive practice strengthened key muscles and reduced performance anxiety, allowing players to focus on improving both technique and power. As a result, both groups demonstrated significant performance improvements post-intervention.

Manual feeding, with its personalized guidance, offered participants tailored feedback, improving their precision and skill through real-time corrections. On the other hand, the machine-fed group benefitted from regular, intensive practice that likely improved their timing and strength. Comparing pre- and post-intervention results revealed the effectiveness of both methods in enhancing badminton smash technique. These findings provide valuable insights into balancing human-guided practice with machine-assisted training to achieve the best outcomes in badminton training.

Problem 3: Do the two groups of participants differ significantly in their Badminton smash performance increments?

> Ho2. The two groups of participants do not significantly differ in their Badminton smash accuracy increments.

When comparing the improvements in badminton smash accuracy between the manual and machine groups, the Deliberate Practice Theory (Ericsson & Harwell, 2019) provides a relevant framework. This theory emphasizes that performance enhancements are largely driven by focused, repetitive practice combined with feedback. Both manual and machine training methods in this study offered participants ample opportunities for repetition and feedback, which likely explains why both methods were equally successful in improving smash accuracy. This perspective suggests that deliberate practice, when aimed at refining specific skills and providing immediate feedback, is effective in both manual and machine-based training approaches.

Another theoretical interpretation of the data can be drawn from Vygotsky's Zone of Proximal Development (ZPD) (Vygotsky & Cole, 1978), which proposes that optimal learning occurs when learners are supported but not entirely autonomous. Both training techniques (manual and machine) likely positioned participants in their ZPD by providing an appropriate level of challenge and support necessary for skill improvement. This framework supports the idea that both methods created a learning environment that was conducive to skill enhancement by balancing difficulty and assistance (McLeod, 2019).

The study's findings align with previous research that underscores the significance of structured, repetitive training in developing technical skills in sports. Both human and machine feeding techniques are effective in this regard (Zhang et al., 2016). Technological advancements in sports training have been found to be as effective as traditional methods, further supporting the notion that machine feeding is a viable alternative to manual feeding (Xie et al., 2019).

Moreover, research by Punithan et al. (2023) highlights the critical role that the quality of practice and feedback loops play in sports training. The study's design, which incorporated feedback from both manual and machine approaches, was likely instrumental in ensuring their effectiveness. This finding is supported by research from Alsaudi (2020), which emphasizes the importance of personalized training regimens that cater to individual skill levels and needs. This could explain the comparable improvements observed in both groups in the study.

The real-world implications of these findings for badminton training and coaching are significant. Since both human and machine feeding methods resulted in similar improvements in smash accuracy, coaches have the flexibility to choose between these approaches based on factors such as budget, personal preference, or training environment without compromising the quality of their players' skill development. These results reinforce the idea that the most critical elements in improving badminton skills are high-quality practice sessions and the integration of feedback, rather than the specific type of training equipment used. This suggests that modern training tools can complement traditional coaching methods, providing players with diverse options for skill improvement in badminton.

Conclusions

The study successfully met its objective of evaluating the effectiveness of manual and machine shuttle feeding methods in improving badminton smash accuracy among beginners. Both intervention groups exhibited significant improvements in smash accuracy, with a slight edge in effectiveness observed in the machine feeding approach. The findings underscore that both methods are highly effective in developing smash accuracy, particularly for novice players.

The study also confirmed the relevance of several key theories—Deliberate Practice Theory, Bruner's Theory of Scaffolding, and Vygotsky's Social Constructivism —in enhancing badminton smash accuracy. Regular, systematic practice, following scaffolding principles, allowed players to progressively develop their smash skills over the 12-week intervention. Training exercises were designed to provide gradual, adaptive support, which was reduced as the players became more proficient. Additionally, the social interaction and guided feedback central to Social Constructivism facilitated the acquisition of skills, demonstrating how both manual and machine feeding created structured learning environments that supported players' Zone of Proximal Development (ZPD) and skill improvement.

The study offers valuable insights for sports educators, coaches, and practitioners looking to design effective badminton training programs. It recommends integrating technology-assisted training, highlighting the benefits of machine feeding in improving smash accuracy for beginners. However, it also emphasizes the importance of manual feeding for providing personalized feedback and real-time adjustments, suggesting that combining both approaches could yield even better results. The choice of which intervention to use depends on factors such as resource availability, individual preferences, and the specific nature of the training environment.

For tertiary physical education (PE) students, the study advises discussing their preferences and training goals with their instructors to develop a personalized approach. Physical educators are encouraged to create training protocols that incorporate both manual and machine feeding methods to optimize the development of smash accuracy. Badminton coaches may tailor training sessions to focus on key aspects of the smash technique—such as timing, footwork, and

racket positioning—while ensuring access to quality equipment for both manual and machine feeding. Finally, the study suggests that future researchers explore the comparative effectiveness of various training approaches across different skill levels, sports, and populations, with an emphasis on long-term skill retention and the transferability of skills to game situations.

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Athens Journal of Sports - Volume 11, Issue 4, December 2024 – Pages 229-240

The Regional Distribution of Greek Football Clubs

By Gregory T. Papanikos[*]

Greece is divided into 13 NUTS2 regions, each with distinct area, demographics, and economic characteristics. This paper examines the regional distribution of Greek football clubs. The analysis uses the total number of football clubs in the top three divisions. The study's main conclusion is that football clubs are unevenly distributed across regions relative to population size, geographical area and economic strength.

Keywords: *Greece, Football, Clubs, Regions, NUTS2, Population, Per capita GDP, Demographics*

Introduction

The issue of regional disparities has been widely examined both at the national and the European level. The most important index of measuring regional disparities is per capita Gross Domestic Product (GDP). Policies have been implemented to increase the convergence of regions by increasing the rate of growth of per capita GDP (reducing unemployment rates) of the lagging regions relative to regions that are above the average (Papanikos, 2024a). However, less attention has been paid to the unequal distribution of sports and fitness activities. This paper examines the regional distribution of football clubs in the 13 *Nomenclature des Unités Territoriales Statistiques* (NUTS2) Greek regions.

There is a strong cultural affinity to sports because Greeks consider themselves as birthplace of the Olympic Games.[1] It was also an integral part of the ancient Greek system of education where students learned not only how to read and write but how to maintain a balance between education and sports. The Greek word gymnasium was a place where along with the gymnastics there were rooms where philosophers could meet and organize philosophical symposiums.

Today sports in Greece plays is an integral part of its economic, political, social and cultural life and their unequal distribution among the 13 regions has been debated particularly after Athens was selected in 1977 to organize the 2004 Olympic Games. Rightly many regions show that this obligation will bias the development of sports in the region of Athens called Attica which is one of the 13 NUTS2 regions in Greece.[2] It is of interest to note that football was the only sport which was organized in various regions of Greece as part of the 2004 Olympic Games. New stadiums were built and old ones were renovated. These new investments were expected to increase the development of football in Greece.

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[1]I have written extensively on the Olympic Games; see, for example, Papanikos (2020, 2022).

[2]There is extensive literature on how sports, in general, can be used to develop small regions and communities; see Burke et al. (2014) for an example of such a study.

Football clubs have their own merit for at least two reasons. First, the existence of a football club in a region provides a sense of identity and bondage between its residents. In Greece this is truer at the level of NUTS3 regions rather than NUTS2 regions. Second, regions that lag behind football may be used as a vehicle for promoting economic growth.

The literature on football is not only extensive but so diverse that it is difficult to review it within the restricted context of this study. This journal has published many papers on various issues that deal exclusively with football and, in general, with professional team sports; see Barget et al. (2017), Binjwaied (2015), Cincimino (2014), Ellapen et al. (2014), Espitia-Escuer & Garcia-Cebrian (2015), Günter & Vischer (2024), Harman (2022), Ibrahim (2014), Leela et al. (2023, 2024), Leite W (2017), Magueta et al. (2015), Maugendre (2018), Nunes & Valério (2020), Ogunsanya & Rasheed (2019), Papanikos GT (2014, 2017, 2021, 2023, 2024c), Pfeffel et al. (2016, 2017), Suominen (2019), Vannier Borges (2018), and Zambom-Ferraresi et al. (2017).

This study is part of a larger project that aims at examining sports related issues at the regional level. In a study published in the previous issue of this journal, I presented the results of an analysis of the determinants of the geographical distribution of private business exercise centers in the wider area of Athens known as Attiki (Papanikos, 2024a), which was a follow up of another study that I conducted earlier on the economic effects of physical exercise (Papanikos, 2015). In the 2024 study, I used the 58 municipalities of Attiki and the geographical distribution of 214 fitness businesses to demonstrate how wealth and population relates to the under-or oversupply of physical exercise enterprises. It was found a positive effect of both wealth and population. The population effect was linear, while the wealth effect was non-linear; an increase in wealth increases the number of gyms in an area but at a decreasing rate. The study also identified unexplored opportunities for investing in small physical exercise enterprises as well as areas of oversupply.

This study looks at the regional distribution of Greek football teams. The literature on football is huge and this journal has published many papers on football and related issues. These issues also have a regional dimension that as part of the aforementioned project will be examined and published in this journal as separate papers. On football in general, I have conducted a number of studies. In Papanikos (2017) I examined the economic, population and political determinants of the 2014 world cup match results. The economic and population determinants are also examined here in this study as being associated with the number of football clubs in the 13 regions of Greece.

At the global and local level football creates news and sends us messages that goes beyond the narrow borders of the game. In a recent study, Papanikos (2023), I examined the global media coverage of the 2022 Qatar world football cup. Countries, regions and cities bid to host such events for a number of reasons which include favorable global, national and local media coverage serving economic, political, national, and cultural purposes. I know of no study that examines this issue at the regional level especially the Greek regions.

Regional Distribution of Football Clubs

Table 1 presents the regional distribution of Greek football clubs across the 13 NUTS2 regions, while Table 2 provides summary statistics. Greek football is organized into three divisions, with a total of 103 teams competing across all divisions. The first division consists of 14 teams (14% of the total), the second division includes 20 teams (19%), and the third division has 69 teams (67%).

There are several ways to analyze the distribution of football clubs. One approach is to consider the total number of teams. Two regions have more than 20 teams: Kentriki Makedonia (23 teams) and Attiki (21 teams). The former region includes Greece's second-largest city, Thessaloniki, while the latter includes Athens, the country's largest city. Notably, Athens itself is classified as both a NUTS2 and a NUTS3 region due to its large population relative to Greece's total population and its small area, as described in the following section. The region with the third-highest number of clubs is Peloponnisos, with 11 teams. All other regions have fewer than 10 teams. Voreio Aigaio has only one team, while Dytiki Makedonia and Dytiki Ellada each have only two teams.

Another way to examine the distribution of teams across the 13 Greek regions is by division. The most prominent teams are those in the 1st Division. Six of the 13 regions do not have a team in the 1st Division. Of those six, three regions are also unrepresented in the 2nd Division. However, every region has at least one team competing in the 3rd Division.

Table 1. *Number of Football Clubs by NUTS2 Greek Region (2024-25 Season)*

Region	Name	1st Division	2nd Division	3rd Division	Total	%
1	Anatoliki Makedonia, Thraki	0	1	7	8	8
2	Kentriki Makedonia	3	5	15	23	22
3	Dytiki Makedonia	0	0	2	2	2
4	Ipeiros	0	1	3	4	4
5	Thessalia	1	2	5	8	8
6	Sterea Ellada	2	0	6	8	8
7	Ionia Nisia	0	0	3	3	3
8	Dytiki Ellada	1	0	1	2	2
9	Peloponnisos	1	4	6	11	11
10	Attiki	5	5	11	21	20
11	Voreio Aigaio	0	0	1	1	1
12	Notio Aigaio	0	1	4	5	5
13	Kriti	1	1	5	7	7
	Total	**14**	**20**	**69**	**103**	**100**
	Percent	14%	19%	67%		

Source: Author's calculations from the official websites of the three divisions.

Table 2 presents summary statistics on the number of teams. The average number of teams per region is 1.1 in the 1st Division, 1.5 in the 2nd Division, and

5.3 in the 3rd Division. Overall, the average number of teams per region is 7.9, with a standard deviation of 6.9. The distribution shows positive skewness, and the kurtosis indicates that the distribution of teams is not normal.

Table 2. *Summary Statistics of Greek Football Clubs by NUTS2 Region (2024-25 Season)*

	1st Division	2nd Division	3rd Division	Total
Mean	1.1	1.5	5.3	7.9
Standard Deviation	1.5	1.9	4.0	6.9
Kurtosis	3.2	-0.2	1.9	1.3
Skewness	1.8	1.1	1.4	1.4
Range	5	5	14	22
Minimum	0	0	1	1
Maximum	5	5	15	23
Sum	14	20	69	103

However, these unequal distributions can be partially explained by differences in regional area, population, GDP, and per capita GDP. The associations between the number of teams and these four variables are examined in the fourth section of the paper, following a brief discussion of the overall and summary statistics of these variables in the next section.

Overview of Area, Population, GDP, and GDP per Capita by Greek Regions

Tables 3 and 4 display the raw data and summary statistics, respectively, for the four variables of interest in this paper: regional area in square kilometers, population in thousands, Gross Domestic Product (GDP) in 2022 (in millions of euros), and per capita GDP in euros.

All four indicators reveal substantial differences across the 13 Greek regions. The smallest region by area is Attiki, which includes the capital city of Athens, with an area of 3,808 square kilometers (the second smallest among all regions), a population of 3.8 million (the largest of the 13 regions), a GDP of 97 billion euros (also the largest among the regions), and a per capita GDP of 25,440 euros, which is the highest of all regions.

Kentriki Makedonia, the largest region by area, covers 19,416 square kilometers. It has the second-largest population and GDP, but lags in per capita GDP at 15,826 euros, placing it in the middle of all regions by this measure.

Table 3. *Area, Population, GDP and Per Capita GDP By 13 NUTS2 Greek Regions*

Region	Area[1] (km^2)	Population[2] (2021)	GDP[3] 2022 (in mil €)	GDP[4] per capita (€)
Anatoliki Makedonia, Thraki	14157	562201	8117	14438
Kentriki Makedonia	19146	1795669	28418	15826
Dytiki Makedonia	9451	254595	4552	17879
Ipeiros	9203	319991	4432	13850
Thessalia	14036	688255	10661	15490
Sterea Ellada	15549	508254	11475	22577
Ionia Nisia	2318	204532	3343	16344
Dytiki Ellada	11336	648220	9093	14028
Peloponnisos	15490	539535	9729	18033
Attiki	3808	3814064	97030	25440
Voreio Aigaio	3836	194943	2704	13871
Notio Aigaio	5286	327820	6737	20550
Kriti	8335	624408	10331	16545
Total	**131951**	**10482487**	**206620**	**19711**

Source: [1]https://shorturl.at/4L9uR; [2]https://elstat-outsourcers.statistics.gr/Census2022_GR.pdf; [3]https://shorturl.at/wTTHx [4]GDP divided by Population.

Table 4. *Summary Statistics*

	Area (km^2)	Population (2021)	GDP 2022 (in mil €)	GDP per capita (€)
Mean	10150	806345	15894	17298
Standard Deviation	5330	992589	25229	3594
Kurtosis	-1.15	7.90	10.87	0.83
Skewness	0.03	2.75	3.23	1.21
Range	16828	3619121	94325	11590
Minimum	2318	194943	2704	13850
Maximum	19146	3814064	97030	25440

The summary statistics for variability—standard deviation, minimum, maximum, skewness, and kurtosis—demonstrate significant differences among the regions across all four indicators. These disparities may explain the variations observed in the descriptive analysis presented in previous sections. The associations between the number of football teams per region and these four regional indicators are examined in detail in the following section.

Exploring the Relationships between Regional Team Counts and Area, Population, GDP, and GDP per Capita

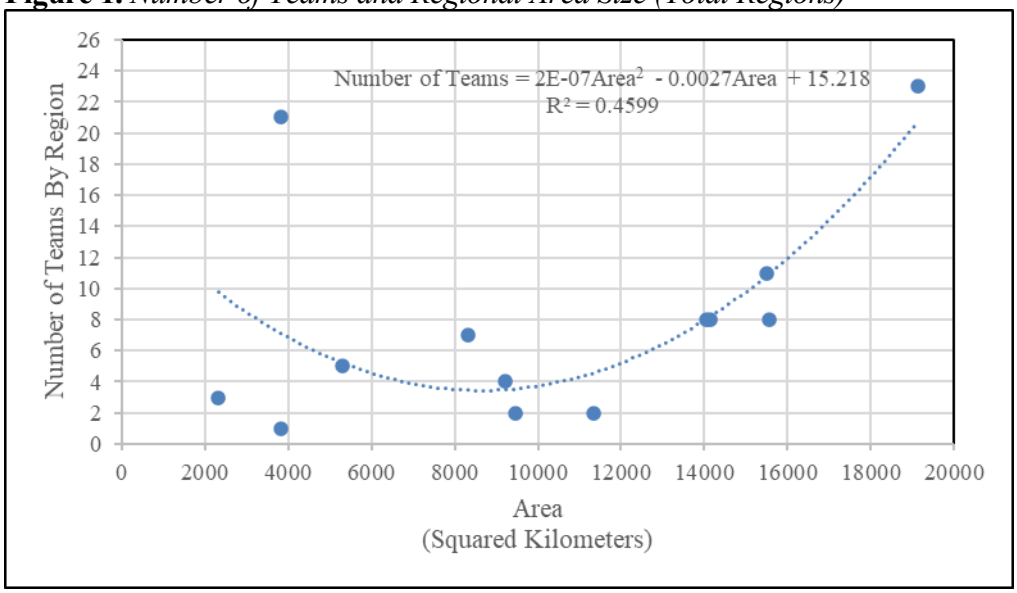
This section provides a descriptive analysis of the association between the number of football teams across the 13 Greek regions and regional characteristics such as area, population, GDP, and per capita GDP. All associations are expected to be positive at a certain range of values, meaning that an increase in any of these variables is anticipated to correspond with an increase in the total number of football teams within a region.

These relationships cannot be considered as either correlations or causal due to the limited number of observations, which restricts the ability to conduct a rigorous statistical analysis and reduces the degrees of freedom. However, the consistency of positive associations across all four variables lends support to the hypothesis of a potential cause-effect relationship, suggesting that these variables may influence the number of regional teams. In all cases, we use a second-degree polynomial alongside a scatter plot to illustrate the associations.

Number of Teams and Regional Area Size

Figure 1 illustrates the positive association between the size of a region and the number of football teams. The association is curvilinear, suggesting that as the area size increases, the number of teams initially decreases until reaching around 10,000 square kilometers, after which it begins to increase.

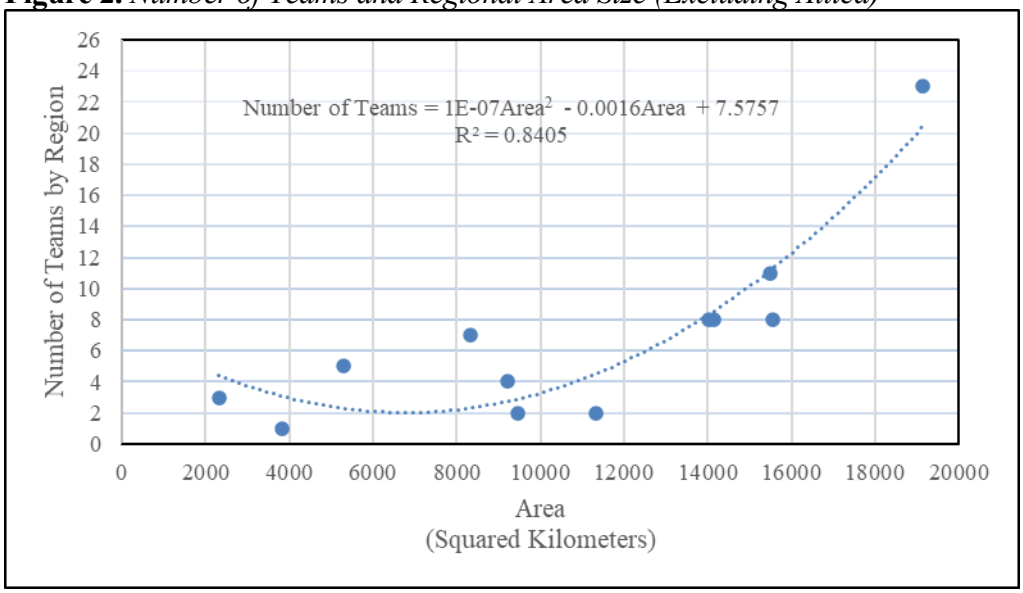
Figure 1. *Number of Teams and Regional Area Size (Total Regions)*



This observation remains consistent even if we exclude the special case (outlier) of the Attiki region, which has 21 teams and an area of approximately 3,800 square kilometers, as shown in Figure 2. Notably, the coefficient of determination nearly doubles (from 0.4599 to 0.8405) when the Attiki region is excluded. This

pattern is consistent across all associations that follow, so I have chosen not to report the graphs without Attiki. However, excluding Attiki does not alter the nature of the curvilinear relationship.

Figure 2. *Number of Teams and Regional Area Size (Excluding Attica)*



Number of Teams and Regional Population

Population plays an important role in determining the number of teams in a region due to the potential number of supporters and the resulting revenue streams that teams can attract. One might argue that a higher population, particularly among younger demographics, could be a valuable source of local talent for regional teams. However, as I discussed in a recent paper, Papanikos (2024c), Greek football is dominated by foreign players. There is a shortage of Greek players, and it is often unrealistic to expect a team to rely solely on talent from its own region.

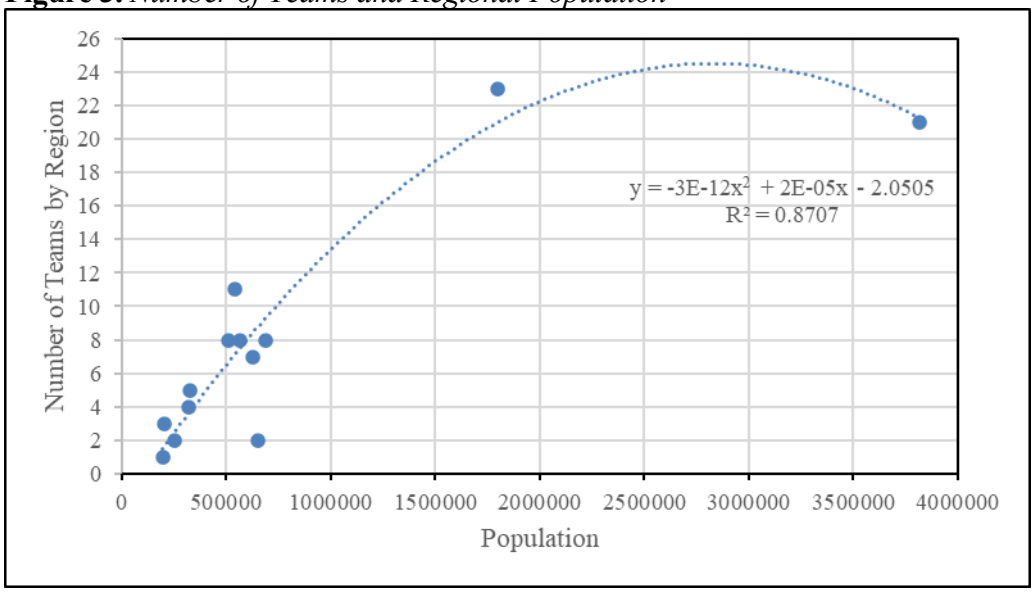
A higher population not only draws larger crowds but also boosts revenue from television rights and sponsorships. Nonetheless, a key challenge in developing strong regional teams is that most people do not support their local teams but rather favor the major Greek teams from the first division, of which there are only a few. When a prominent team plays against a local team, the visiting team often attracts more supporters than the local team.

Figure 3 illustrates the relationship between the number of teams and regional population. Excluding Attiki, the effect of population on team numbers is positive, increasing at a decreasing rate. However, when Attiki is included, as shown in Figure 3, the relationship becomes negative for population sizes above approximately 3 million.

One region stands out: based on its population, the Dytiki Ellada (Western Greece) region would be expected to have around 8 teams, yet it has only 2. This region includes Patras, the third-largest city in Greece, which lacks a team in the first division of Greek football. All other regions closely align with the fitted line,

except for Peloponnisos, which has 11 teams—more than expected based on its population. According to the model, Peloponnisos would be expected to have 7 teams. Similarly, the region of Kentriki Makedonia has 23 teams but would be expected to have 21 according to the fitted line.

Figure 3. *Number of Teams and Regional Population*



Number of Teams and Regional GDP and GDP per Capita

The most important economic variables considered here are total GDP and GDP per capita. Figures 4 and 5 display the relationship between these two economic indicators and the number of regional teams. Both associations are non-linear: one is concave (with a maximum), and the other is convex (with a minimum).

While this statistical analysis is limited by the low degrees of freedom, it nonetheless aligns well with economic reasoning. The association between total GDP and the number of teams suggests that as a region's total income rises, the optimal number of teams also increases, albeit at a decreasing rate, reaching a peak and then declining. In the graph, this peak occurs at a regional GDP of approximately 60 billion euros, at which point the number of football teams reaches 32. Notably, total GDP and the number of teams show an almost perfect fit, with a coefficient of determination of 0.913.

The analysis differs for GDP per capita. It begins with a minimum of 6 teams, corresponding to a per capita GDP of about 14,000 euros. However, for regions at this level of per capita GDP, there are significantly fewer teams than predicted by the fitted line. Furthermore, there are numerous outliers in this relationship. Kentriki Makedonia, for instance, stands out with 23 teams and a per capita GDP near 16,000 euros. The fit here is less precise than in the previous analysis, as indicated by the relatively low coefficient of determination of 0.2359.

Figure 4. *Number of Teams and Regional GDP*

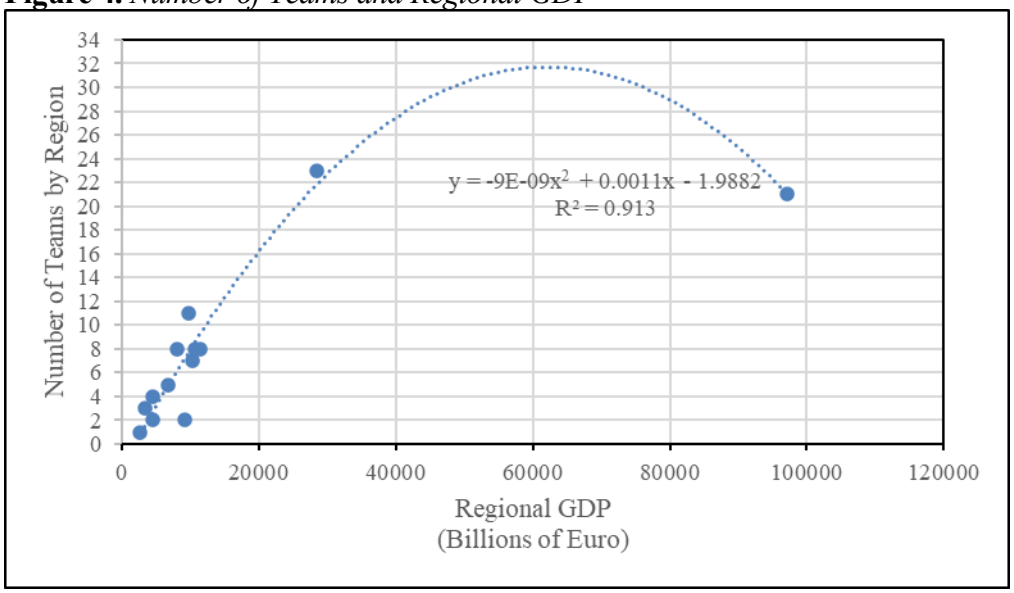
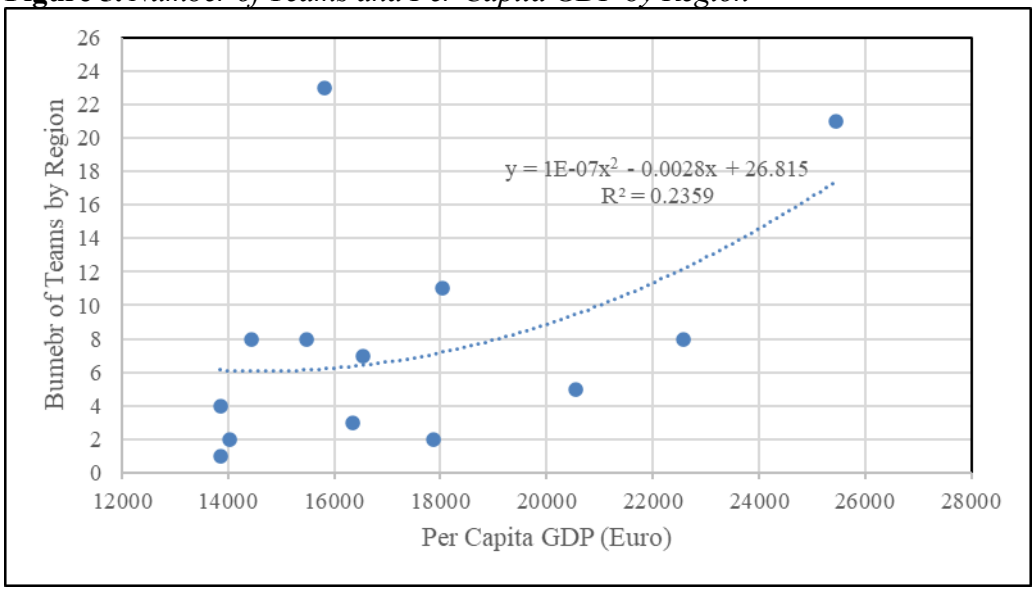


Figure 5. *Number of Teams and Per Capita GDP by Region*



If the overall fit of the curves reveals anything, it is that total GDP appears to be the most important variable, with the strongest association relative to all other variables examined here. This makes perfect economic sense, as it is something one would expect: a high GDP indicates that a region can afford to support more football teams.

Conclusions

This is not a proper statistical analysis due to the small number of observations, which limits the ability to test hypotheses and perform diagnostic tests. Thus, the aim of the study was restricted to examining scatter diagrams of the associations between the number of teams in each of the 13 NUTS2 regions of Greece and four key variables that, at least theoretically, are expected to have an effect. Other empirical studies using different datasets have shown that these variables play a statistically significant role.

Despite this limitation, the descriptive statistics on the distribution of football clubs across the 13 Greek regions reveal significant variability that cannot be explained by differences in area, population, GDP, or per capita GDP. A notable example is Dytiki Ellada (Western Greece), which, according to the fitted line, should have 8 teams but instead has only 2. This region includes Patras, Greece's third-largest city, which does not have a team in the first division.

Overall, per capita GDP—often seen as a variable that might explain variations in demand for various goods, including football matches—does not appear to account for the distribution of football teams. Future research may shed light on why this is the case. Anecdotal evidence suggests that wealthy individuals who own Greek football teams may use these teams to generate revenue from other sources, such as illegal gambling through match-fixing. However, this analysis is beyond the scope of this paper.

Acknowledgments

This paper is part of a larger research project aimed at studying sports and fitness activities across various regions of Greece. In the previous issue of this journal, an empirical paper was published examining the distribution of fitness centers in the broader Attica region. I would like to thank the two anonymous reviewers for their constructive comments and suggestions.

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