Construction and Effectiveness Evaluation of Shantou's Medical Talent Training System Driven by the Asian Youth Games

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ABSTRACT The Third Asian Youth Games is a major international sports event hosted by Shantou. This paper clarifies the competency dimensions of core medical talents required for the event, designs a three-pillar training system integrating college education, on-the-job training, and event drills, and introduces a practical model of promoting training through competitions. Using the analytic hierarchy process, with 12 experts in sports medicine, emergency medicine, and public health participating in weight determination and a consistency ratio of 0.07, and the fuzzy comprehensive evaluation method, an effectiveness evaluation index system is established from three dimensions: talent competency improvement, medical service quality, and urban medical development. The effectiveness of the training system is verified using empirical data from test events and simulated drills. The results show that the event-driven medical talent training system significantly improves professional quality and emergency-response capabilities. Medical-security satisfaction during the event reaches 98.7%. In an engineering-health extension, the framework can incorporate wearable monitoring, wireless communication, and electromagnetic-compatible protective equipment for medical staff, strengthening the city's public-health emergency framework and occupational health support for the post-event period. The system provides a quantifiable model for medical talent cultivation and large-scale event security.

INDEX TERMS medical talent training, Asian Youth Games, effectiveness evaluation, wireless health monitoring, electromagnetic-compatible protection

I. INTRODUCTION

A. RESEARCH BACKGROUND

THE Asian Youth Games (AYG) is the largest comprehensive youth sports event in Asia. Its scale, participant composition, and international influence impose far higher standards on the host city's public service support — especially medical security capabilities—than those required for daily operations [1, 2]. In 2021, Shantou officially secured the right to host the 3rd AYG (later postponed due to the pandemic). During the event, it was expected to receive over 100,000 athletes, coaches, officials, and spectators, with more than 20 competition events taking place. Potential risks such as sports injuries, sudden illnesses, and public health incidents posed severe challenges to the quantity, structure, and professional capabilities of Shantou's existing medical talent team [3].

When hosting large-scale international events, the host city typically establishes a government-led health and medical security institution that integrates regional industrial strengths, such as utilizing Shantou's advanced technologies to provide high-performance protective gear and antimicrobial materials for medical staff. This specialized synergy ensures comprehensive support for health security work throughout the event while showcasing the practical application of local manufacturing in public health [4]. From the perspective of Shantou's current medical talent situation, the number of licensed (assistant) physicians per 1,000 people in Shantou was 4.63 in 2021 (the baseline data for this study); by 2024, after the implementation of the training system, this number has increased to 5.89, with a growth rate of 27.2% in core medical talent fields (emergency rescue, sports medicine, infectious disease control). This figure is is lower than the average level in Guangdong Province (6.9) [5]; the emergency coordination and international communication capabilities of existing talents also need improvement [6]. Whether it is competitive athletes, spectators, or the event's logistics support staff, unavoidable health issues such as sports injuries, public health emergencies, and disease outbreaks may occur during their participation. Therefore, it is necessary to establish a scientific and efficient medical

service system to provide protection for participants [7].

B. DOMESTIC AND INTERNATIONAL RESEARCH STATUS

Internationally, the role of large-scale sports events in promoting medical talent development has attracted widespread attention [8-11]. Taking the 2012 London Olympics as an example, during training and competitions, the incidence of injuries and illnesses varied significantly across different sports and genders [12, 13], thus requiring medical talents from various specialties to participate in medical security work. Meanwhile, the London authorities provided a monitoring system for tracking public health risks, including infectious diseases, chemical, radiological, and environmental hazards. To address the unique challenges posed by the COVID-19 pandemic, the Tokyo Olympic Organizing Committee established a dedicated medical command center to coordinate and supervise medical security work across all venues, covering competition venues, the Athletes' Village, and event-related medical service systems [14-16].

Domestically, the successful hosting of the Beijing Winter Olympics has provided valuable experiences in medical security models and talent team development that deserve summary and reflection [17, 18]. These experiences include the scientific formulation of public health emergency plans, training on public health knowledge, and drills for preventing and controlling public health incidents and imported epidemics. Additionally, the Beijing Winter Olympics featured several notable practices worth promoting in areas such as teleconsultation and collaboration among medical institutions. To provide adequate medical security for the Games, over 1,300 medical backbones—mainly from designated support hospitals and pre-hospital emergency institutions—undertook venue-based medical security tasks. During the security period, the team organized and participated in more than 150 seminars on operational prevention and control, prepared 45 technical response letters, and conducted 12 sessions of epidemic prevention training, benefiting a total of 2,000 participants. Despite existing discussions on short-term training programs for events [19, 20], there is a lack of research on the construction of long-term mechanisms for talent training systems and scientific evaluation indicators. In particular, there is a shortage of targeted system construction for small and medium-sized cities (such as Shantou), which face weaknesses in medical talent foundations and limited resources.

C. RESEARCH SIGNIFICANCE

This paper aims to construct a theoretical framework of "event-driven—system construction—effectiveness evaluation". On the one hand, it ensures the smooth implementation of medical security work for the event; on the other hand, it designs a quantifiable evaluation index system. The results of this study can be applied to medical talent training for the Shantou AYG, ensuring healthcare professionals are proficient in utilizing local smart applications and advanced protective materials to provide sophisticated support for event security. This integrated training approach ensures that medical personnel can leverage the city's unique industrial advantages to enhance the overall safety and response capabilities during the games. Furthermore, it can serve as a reference for medical talent training and medical security in future large-scale sports events.

II. MEDICAL TALENT DEMANDS OF THE ASIAN YOUTH GAMES FOR SHANTOU

A. ANALYSIS OF MEDICAL SECURITY DEMANDS FOR THE EVENT

As a youth-oriented sports event, the Asian Youth Games (AYG) has participants aged mainly between 14 and 18, whose physical functions differ from those of adults. Moreover, the event covers high-intensity sports such as track and field, swimming, and basketball, leading to a relatively high incidence of sports injuries (e.g., fractures, muscle strains, joint dislocations) and sudden illnesses (e.g., asthma, arrhythmia). At the same time, the large population flow and high concentration of people during the event result in a relatively high risk of infectious disease transmission (e.g., influenza) [1, 21]. Based on this, the AYG's demands for medical talents mainly focus on the following fields:

(1) Emergency Rescue Talents: They need to have the ability to quickly handle sports injuries and cardiovascular/cerebrovascular emergencies, master skills such as Cardiopulmonary Resuscitation (CPR), defibrillation, and trauma hemostasis and bandaging, and be able to carry out emergency rescue work efficiently in the complex environment of competition venues.

(2) Sports Medicine Talents: They need to be familiar with the injury characteristics of various sports events, accurately diagnose sports-related diseases, and formulate scientific treatment and rehabilitation plans.

(3) Infectious Disease Prevention and Control Talents: They need to have the capabilities of infectious disease monitoring, early warning, and disposal, be able to quickly identify infectious disease cases, and conduct epidemiological investigations and implement prevention and control measures.

(4) Critical Care Talents: They need to have the ability to treat critically ill patients (e.g., severe trauma, shock) and skillfully operate equipment such as ventilators and monitors.

(5) International Communication Talents: They need to have good English communication skills, be able to conduct smooth medical information exchanges with international athletes and coaches, and understand international medical service standards.

B. CONSTRUCTION OF COMPETENCY DIMENSIONS FOR AYG MEDICAL TALENTS

Combining the event's demands and the current status of Shantou's medical talents, a competency dimension system for AYG medical talents is constructed, as detailed in the table below:

TABLE 1. Competency Dimension System of Medical Talents for the Asian Youth Games

First-Level Competency Dimension	Second-Level Competency Dimension	Specific Requirements
Professional Skills	Emergency Treatment Capability	Able to complete trauma assessment and preliminary treatment within 3 minutes (aligned with the emergency departure time requirement), and proficiently master skills such as CPR and defibrillation, meeting the international athletic medical service standards for large-scale sports events.
Professional Skills	Sports Injury Diagnosis & Treatment Capability	Able to accurately diagnose common sports injuries and formulate personalized treatment and rehabilitation plans.
Professional Skills	Infectious Disease Prevention & Control Capability	Able to quickly identify infectious disease cases, and conduct sampling, submission for testing, and implementation of prevention and control measures.
Professional Skills	Critical Care Capability	Able to proficiently operate equipment such as ventilators and monitors, and provide precise treatment for critically ill patients.
Collaboration Capability	Cross-Department Collaboration Capability	Able to communicate efficiently with the Event Organizing Committee, public security, fire-fighting, and other departments to collaboratively handle emergencies.
Collaboration Capability	Teamwork Capability	Able to achieve information sharing and division of labor within the medical team to improve treatment efficiency.
International Literacy	English Communication Capability	Able to proficiently use medical English for medical history collection and condition notification, and communicate smoothly with international personnel.
International Literacy	Awareness of International Medical Standards	Understand and integrate international medical service standards for sports events (e.g., IOC Medical Guidelines) into the entire training and practice process of the Three-pillar training framework, including curriculum design of college education, skill training of on-the-job training and scenario drills of event drills.
Emergency Capability	Emergency Response Capability	Able to depart within 3 minutes after receiving an emergency order and quickly reach the incident site.
Emergency Capability	Emergency Situation Handling Capability	Able to quickly formulate treatment plans and respond to various emergencies in complex and uncertain venue environments.

III. CONSTRUCTION OF SHANTOU'S MEDICAL TALENT TRAINING SYSTEM DRIVEN BY THE ASIAN YOUTH GAMES

A. PRINCIPLES FOR CONSTRUCTING THE TRAINING SYSTEM

(1) Demand-Oriented Principle: Centering on the medical security needs of the Asian Youth Games (AYG), this principle focuses on core fields such as emergency rescue and sports medicine, and designs targeted training content to ensure that the training outcomes can be directly applied to event security.

(2) Practical-Oriented Principle: By introducing simulated event scenarios and adopting methods such as practical drills and case-based teaching, this principle aims to improve talents' emergency response capabilities and practical operation skills, avoiding the theoretical-practical disconnect.

(3) Collaboration Principle: This principle integrates resources from multiple parties, including Shantou University Medical College, designated hospitals, the Event Organizing Committee, and international medical institutions, to build a four-party collaborative training mechanism involving "colleges - hospitals - events - international institutions".

(4) Long-Term Sustainability Principle: Combining event-specific training with daily talent development, this principle designs post-event talent development paths and promotes the regular operation of the training system, avoiding the situation where "training ends when the event concludes".

B. FRAMEWORK OF THE "TRINITY" TRAINING SYSTEM

Based on the above principles, a Three-pillar training system integrating "college education - on-the-job training - event drills" is constructed, with the specific framework as follows:

1) College Education: Consolidating Theoretical Foundations

In collaboration with Shantou University Medical College, a "Specialized Course on AYG Medical Security" is offered. The curriculum covers core content such as sports medicine, emergency medicine, infectious disease studies, and international medical English. A blended teaching model combining "online + offline" approaches is adopted: online theoretical teaching is conducted via the medical college's MOOC platform, while offline activities include expert lectures and case discussions. Meanwhile, outstanding medical students are selected to participate in AYG medical security internships, allowing them to familiarize themselves with the medical procedures of the event in advance and serve as a reserve force for the talent team.

2) On-the-Job Training: Enhancing Professional Skills

On-the-job training sets up special training sessions for international medical standards, and uses the IOC Medical Guidelines as the benchmark to formulate skill assessment standards for medical staff in various specialties. Specialized on-the-job training is carried out in AYG-designated hospitals. The training content is divided into two categories: "general skills" and "professional skills".

General skills include emergency response procedures, cross-departmental collaboration mechanisms, and the operation of common medical equipment.

Professional skills are delivered through targeted training based on different specialties. For example, emer gency rescue talents participate in simulated trauma emergency drills, while sports medicine talents receive focused training on the diagnosis, treatment, and rehabilitation planning of sports injuries.

The training combines "theoretical lectures + practical operation training" and invites renowned domestic experts to provide on-site guidance and teaching.

3) Event Drills: Strengthening Practical Capabilities

Event drills are designed in strict accordance with IOC Medical Guidelines, and international medical service standards are used to evaluate the drill effect and optimize the medical security process. A three-level progressive drill system of "simulated drills - test event drills - official event security" is established:

(1) Simulated Drills: VR technology is used to construct common AYG scenarios (e.g., an athlete suffering a fracture in a track-and-field venue, an athlete drowning in a swimming venue). Medical teams are organized to conduct immersive drills to improve proficiency in emergency response.

(2) Test Event Drills: During the AYG test events, medical teams are organized to participate in full-process practical security work, simulating the entire medical response process of official events. The focus is on testing the collaboration efficiency of multiple departments and the operation effect of emergency mechanisms, identifying problems in a timely manner, and optimizing procedures.

(3) Official Event Security: Medical talents who have undergone systematic training are integrated into the official AYG security team. Clear job responsibilities and collaboration mechanisms are defined to comprehensively enhance their comprehensive response and teamwork capabilities in a real event environment.

C. IMPLEMENTATION GUARANTEES FOR THE TRAINING SYSTEM

1) Organizational Guarantee

A "Leading Group for Shantou's AYG Medical Talent Training Work" is established. The Director of Shantou Municipal Health Commission serves as the group leader, while relevant principals from Shantou University Medical College, designated hospitals, and the Event Organizing Committee act as deputy leaders. The group is responsible for overall coordination of the training work, formulating training plans, supervising training progress, and resolving problems encountered during the training process.

2) Resource Guarantee

(1) Funding Guarantee: Shantou Municipal Finance Bureau sets up a special training fund, which is used for curriculum development, expert recruitment, equipment procurement (e.g., VR simulation training equipment, emergency rescue equipment), internship subsidies, and other expenses to ensure the smooth implementation of the training work.

(2) Teaching Staff Guarantee: A "dual-qualification teaching team" consisting of "domestic and international experts + local backbones" is formed. Domestic experts are responsible for teaching core courses and providing skill guidance; local backbones take charge of daily teaching and management. Meanwhile, international medical experts (e.g., experts who have served as medical consultants for the Olympic Games) are invited to conduct training on international medical standards and communication skills.

(3) Equipment Guarantee: Designated hospitals are equipped with emergency rescue equipment, monitoring equipment, infectious disease testing equipment, and other devices required for AYG medical security. This ensures consistency between the equipment used in training and actual practice, improving medical talents' proficiency in equipment operation.

3) Institutional Guarantee

The Administrative Measures for Shantou's AYG Medical Talent Training is formulated, which clarifies the selection criteria for training participants, training assessment requirements, and reward and punishment mechanisms. A linked mechanism of "training - assessment - appointment" is established, where training assessment results are linked to professional title promotion, selection of outstanding individuals, and appointment to medical security positions for the event. This aims to stimulate the enthusiasm of medical talents to participate in the training.

IV. EVALUATION OF THE EFFICIENCY OF SHANTOU'S MEDICAL TALENT TRAINING SYSTEM

A. CONSTRUCTION OF THE EFFICIENCY EVALUATION INDEX SYSTEM

Based on the Analytic Hierarchy Process (AHP) (12 experts in the fields of sports medicine, emergency medicine, public health management and medical education were invited to form an expert panel to determine the indicator weights; the consistency test was conducted on the judgment matrix, and the consistency ratio CR was 0.07, which is less than 0.1, indicating that the judgment matrix has satisfactory consistency and the weight setting is scientifically valid), an efficiency evaluation index system is constructed from three primary dimensions: "Talent Ability Improvement", "Medical Service Quality", and "Urban Medical Development". The specific indicators and weights are shown in the following table:

TABLE 2. Efficiency Evaluation Index System

First-Level Indicator	Weight	Second-Level Indicator	Weight	Third-Level Indicator	Weight
Talent Capacity Improvement	0.45	Professional Skill Improvement	0.5	Qualification Rate of Emergency Treatment	0.3
Talent Capacity Improvement	0.45	Professional Skill Improvement	0.5	Accuracy Rate of Sports Injury Diagnosis	0.25
Talent Capacity Improvement	0.45	Professional Skill Improvement	0.5	Recognition Rate of Infectious Diseases	0.25
Talent Capacity Improvement	0.45	Professional Skill Improvement	0.5	Proficiency in Operating Critical Care Equipment	0.2
Talent Capacity Improvement	0.45	Collaboration Capacity Improvement	0.3	Cross-Department Collaboration Response Time	0.5
Talent Capacity Improvement	0.45	Collaboration Capacity Improvement	0.3	Team Collaboration Satisfaction	0.5
Talent Capacity Improvement	0.45	International Literacy Improvement	0.2	Qualification Rate of English Communication	0.6
Talent Capacity Improvement	0.45	International Literacy Improvement	0.2	Awareness of International Medical Standards	0.4
Medical Service Quality	0.30	Event Medical Support Quality	0.6	Medical Service Response Time	0.4
Medical Service Quality	0.30	Event Medical Support Quality	0.6	Medical Support Satisfaction (Athletes/Officials)	0.3
Medical Service Quality	0.30	Event Medical Support Quality	0.6	Incidence Rate of Medical Disputes	0.3
Medical Service Quality	0.30	Routine Medical Service Quality	0.4	Outpatient Satisfaction	0.5
Medical Service Quality	0.30	Routine Medical Service Quality	0.4	Cure Rate of Inpatients	0.5
Urban Medical Development	0.25	Talent Team Construction	0.5	Growth Rate of Talent Quantity in Core Fields	0.6
Urban Medical Development	0.25	Talent Team Construction	0.5	Optimization Rate of Talent Structure	0.4
Urban Medical Development	0.25	Improvement of Public Health Emergency System	0.5	Handling Time of Public Health Emergencies	0.5
Urban Medical Development	0.25	Improvement of Public Health Emergency System	0.5	Sufficiency Rate of Public Health Emergency Supplies	0.5

B. COLLECTION AND PROCESSING OF EFFECTIVENESS EVALUATION DATA

All evaluation data in this study are derived from AYG test events held in Shantou from 2023 to 2024 and large-scale simulated event drills, including 8 test events and 23 simulated drills, with a total of 3,200 participants involved in the medical security evaluation. This study was approved by the Ethics Committee of the Second Affiliated Hospital of Shantou University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

1) Data Collection

(1) Questionnaire Survey: Surveys are conducted among medical professionals participating in the training program, athletes and officials of the Asian Youth Games, as well as outpatient and inpatient patients to collect subjective evaluation data such as satisfaction and awareness levels. The questionnaires are designed using a 5-point Likert scale (1 = Very Dissatisfied/Unskilled, 5 = Very Satisfied/Skilled). After testing, the overall Cronbach's α coefficient of the questionnaire is 0.87, indicating good reliability and validity.
(2) On-site Inspection: Experts are organized to conduct on-site assessments of medical professionals' professional skills (e.g., emergency treatment procedures, medical equipment operation), and record objective performance indicators such as the qualification rate of emergency treatment and the accuracy rate of sports injury diagnosis. Meanwhile, process-related data including medical service response time and cross-department collaboration response time are monitored in real time through the event support command system.
(3) Data Statistics: Relevant statistical data before and after the training program are obtained from authoritative institutions such as the Shantou Municipal Health Commission and designated hospitals, including the number of talents in core fields, the cure rate of inpatients, and the reserve volume of public health emergency supplies, so as to ensure the authority and accuracy of the data.

2) Data Processing

The fuzzy comprehensive evaluation method is adopted to process the collected data, with the steps as follows:
(1) Determine Evaluation Grades: The evaluation results are divided into four grades, namely "Excellent (90-100 points)", "Good (80-89 points)", "Qualified (70-79 points)" and "Unqualified (<70 points)".
(2) Construct Fuzzy Relation Matrix: Based on the data collection results, calculate the membership degree of each indicator under different evaluation grades to form the fuzzy relation matrix R. Taking the "Qualification Rate of Emergency Treatment" as an example, if 85% of medical professionals meet the "Excellent" standard and 15% meet the "Good" standard, the membership vector of this indicator is [0.85, 0.15, 0, 0].
(3) Calculate Comprehensive Evaluation Results: Perform matrix multiplication between the indicator weight vector W and the fuzzy relation matrix R to obtain the comprehensive evaluation result vector $B = W \times R$, and determine the final evaluation grade according to the maximum membership degree principle.

C. EFFECTIVENESS EVALUATION RESULTS

Based on the above evaluation method, the comprehensive effectiveness of Shantou's medical talent training system is calculated, and the evaluation results are shown in the table below:

TABLE 3. Comprehensive Efficiency Evaluation of the Medical Talent Training System in Shantou City

First-Level Indicator	Weight	Comprehensive Score	Evaluation Grade	Key Contributing Indicators
Talent Capacity Improvement	0.45	89.2	Good	Qualification Rate of Emergency Treatment (92.5 pts), Qualification Rate of English Communication (88.3 pts)
Medical Service Quality	0.30	91.5	Excellent	Medical Support Satisfaction (98.7 pts), Outpatient Satisfaction (90.2 pts)
Urban Medical Development	0.25	85.8	Good	Growth Rate of Talent Quantity in Core Fields (87.6%), Sufficiency Rate of Emergency Supplies Reserve (92.0%)
Overall System Effectiveness	1.0	89.6	Good	-

Data shows that the total score of Shantou's medical talent training system construction effect is 89.6 points, reaching the "Good" level, which indicates that the system construction and implementation have achieved certain results. Among them, the medical support satisfaction in AYG test events and simulated drills is 98.7%, far exceeding the expected target of 90%. This shows that the construction of the medical talent training system has played a beneficial guarantee role in the implementation of the event medical support tasks.

V. CONCLUSION

Based on the practical needs of the Asian Youth Games event support, this paper constructs Shantou's medical talent training system by incorporating specialized modules on medical innovations and conducts an empirical evaluation of its effectiveness in real-world scenarios. This comprehensive framework ensures that medical personnel are uniquely equipped to utilize local advanced material technologies for enhanced emergency response and athlete care. "college education - on-the-job training - event drill" Three-pillar training model constructed in this study has significantly improved the professional quality and comprehensive response capabilities of medical talents through the organic combination of theoretical teaching, skill training and practical drills. The medical support satisfaction in AYG test events and simulated drills reached as high as 98.7%, which strongly verifies the feasibility and effectiveness of the system in practical application. In addition, the effectiveness evaluation system constructed based on the Analytic Hierarchy Process (AHP) (with scientific weight setting through expert panel judgment and consistency test) and the fuzzy comprehensive evaluation method systematically quantifies the training effect from three dimensions: talent capacity improvement, medical service quality and urban medical development. The indicator system is optimized to clarify the causal relationship between talent capacity improvement and medical service quality, eliminating the covariance problem of overlapping indicators. The evaluation results show that the overall

system effectiveness score is 89.6 points, reaching the "Good" level, which provides a scientific basis and data support for the continuous optimization of the system and its promotion in similar cities.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Ethics Committee of the Second Affiliated Hospital of Shantou University, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

AUTHOR CONTRIBUTIONS

Conceptualization –Juanjuan Zhang and Shengsheng Yin; methodology – Juanjuan Zhang and Shengsheng Yin; investigation – Juanjuan Zhang and Shengsheng Yin; writing-original draft preparation – Juanjuan Zhang and Shengsheng Yin. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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