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Assessment of Prehospital Emergency Personnel's Knowledge in Pediatric Anaphylaxis Management: A Cross-sectional Study

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ABSTRACT

Anaphylaxis is a severe, rapidly progressing, and potentially life-threatening emergency requiring prompt, evidence-based intervention. This study assessed pre-hospital emergency healthcare professionals' knowledge of anaphylaxis diagnosis, acute management, and treatment protocols in line with current clinical guidelines.

A descriptive cross-sectional study was conducted between February and April 2025 among physicians, paramedics, and emergency medical technicians (EMTs) working in Emergency Medical Services (EMS) stations. Data were collected via a 21-item Google Forms survey covering demographics and key knowledge domains based on established pediatric anaphylaxis guidelines.

A total of 322 professionals participated: paramedics (n = 214, 66.5%), EMTs (n = 73, 22.7%), and physicians (n = 35, 10.9%). Although most reported prior anaphylaxis training (90.0%) and clinical encounters (87.6%), only 52.2% correctly identified all three diagnostic criteria. Regarding pharmacologic management, 81.7% recognized epinephrine as first-line treatment, with physicians performing best (94.3%) compared to paramedics (81.8%) and EMTs (75.3%). Similarly, 81.1% correctly identified the intramuscular route, with physicians again demonstrating superior knowledge (95.5%). However, major deficiencies were noted in appropriate patient positioning (52.2%) and epinephrine auto-injector use (50.6%), with significant inter-professional differences across both domains.

Substantial knowledge gaps exist among pre-hospital emergency providers regarding anaphylaxis diagnosis, patient positioning, and auto-injector administration. Targeted training and standardized protocols are urgently needed to enhance competency and improve patient safety in pre-hospital anaphylaxis management. 90 (242) 249 44 62

Keywords: Anaphylaxis; Emergency medical services; Knowledge; Management

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INTRODUCTION

Anaphylaxis is a severe, rapidly progressing, and potentially life-threatening medical emergency that necessitates all healthcare professionals to have a

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thorough understanding of its clinical presentation and evidence-based management strategies.[1] Despite the critical importance of timely and appropriate intervention, numerous studies suggest that healthcare providers often display suboptimal knowledge of anaphylaxis and demonstrate poor adherence to established clinical guidelines. Significant knowledge gaps have been observed in various aspects of anaphylaxis management, including accurate diagnosis, timely administration of epinephrine-the first-line treatment-and effective patient education. These deficiencies can lead to delayed symptom recognition and substandard care delivery.[2–6]

Such findings underscore the urgent need for targeted educational initiatives aimed at physicians and allied healthcare professionals to improve their competence in managing anaphylaxis effectively. While there has been substantial research assessing anaphylaxis management in hospital settings, particularly among emergency department physicians, there is a notable lack of focus on pre-hospital emergency medical services (EMS) personnel.[2,7] However, the limited available evidence highlights concerning trends in pre-hospital care. For example, studies from Canada and the United States reveal that paramedics often fail to administer epinephrine when clinically indicated or struggle to recognize and manage atypical presentations of anaphylaxis.[8,9]

Globally, pre-hospital emergency medical services operate based on two primary models: the French “Stay and Play” approach and the Anglo-American “Scoop and Run” model. Türkiye utilizes a hybrid system that incorporates elements of both. These services are delivered by ambulances dispatched through centralized Command Control Centers, accessible via the national emergency number 112. Depending on the ambulance type, teams may include physicians, emergency medical technicians (EMTs), and paramedics. Emergency medical ambulances are equipped with the necessary tools and supplies to provide on-scene care and patient stabilization during transport. To ensure appropriate medical intervention, each ambulance crew must include at least one physician or paramedic.[10,11]

While numerous studies have explored the knowledge and clinical approaches of hospital-based personnel in managing anaphylaxis, there is a notable lack of research focusing on pre-hospital emergency service providers in Türkiye.[2–6] This represents a significant gap in the current literature. Therefore, the aim of this study is twofold: to assess the knowledge levels of pre-hospital emergency medical services (EMS) personnel regarding the recognition and management of anaphylaxis, and to strengthen the capacity of the pre-hospital EMS system by developing targeted training programs to address identified gaps in knowledge and clinical competency.

MATERIALS AND METHODS

Study Design and Setting

This descriptive, cross-sectional study invited 990 EMS professionals (60 physicians, 412 paramedics, and 518 emergency medical technicians) to participate. The sample size was calculated using OpenEpi software (Version 3.01), assuming a 50% prevalence (to maximize the required sample size in the absence of prior studies), a 95% confidence level (α=0.05), and 80% power. The minimum required sample size was determined to be 197 participants. Ultimately, 322 professionals (35 physicians, 214 paramedics, and 73 EMTs) completed the survey, exceeding the required sample size and thereby strengthening the statistical validity of the study despite a 32.5% response rate.

Ethical Considerations

The study received ethical approval from the relevant institutional ethics committee. The study adhered to the ethical principles of the Declaration of Helsinki and received official approval for survey distribution from the relevant national EMS authorities. All participants provided electronic informed consent after being fully briefed on the study’s purpose and the confidentiality of their responses. As this was a descriptive, cross-sectional study not involving an intervention, clinical trial registration was not applicable.

Study Protocol

Data were collected through a structured online survey administered via Google Forms (Google LLC, Mountain View, CA, USA) for descriptive purposes. The survey content was developed based on current pediatric anaphylaxis management guidelines, specifically incorporating recommendations from the US National Institute of Allergy and Infectious Diseases/Food Allergy and Anaphylaxis Network (NIAID/FAAN)[1] and the European Academy of Allergy and Clinical Immunology (EAACI) guidelines.[12]

The questionnaire comprised 21 structured questions organized into two main sections. The first section included 10 items on demographic and professional background (e.g., age, gender, clinical experience, training history). The second section consisted of 11 items presenting common clinical scenarios to assess guideline-based knowledge of pediatric anaphylaxis, covering diagnostic criteria, pharmacologic interventions, epinephrine administration, and emergency response protocols. The full questionnaire is available as supplemental material.

Anaphylaxis Diagnostic Criteria and Classification

This study applied the diagnostic criteria for anaphylaxis based on the 2017 and 2021 EAACI Anaphylaxis Guidelines,[12,13] which were the primary references in clinical practice and educational resources at the time of the study's design. The NIAID/FAAN guidelines[1] were also incorporated, given their widespread use in both clinical and training settings. Although the World Allergy Organization (WAO) 2020 guidance[14] provides an updated framework, the fundamental principles for recognizing and managing anaphylaxis-particularly the key clinical signs, symptoms, and the central role of epinephrine-remain consistent across all major international guidelines.

Anaphylaxis was considered highly probable if at least one of the following three clinical criteria was met:

1. Acute onset of illness: Rapid onset (minutes to hours) with skin/mucosal symptoms plus either respiratory compromise or reduced blood pressure with end-organ dysfunction.

2. Two or more symptoms after allergen exposure: Rapid onset of two or more of the following after likely allergen exposure: skin/mucosal involvement, respiratory compromise, reduced blood pressure/end-organ dysfunction, or persistent gastrointestinal symptoms.

3. Hypotension after known allergen exposure: Significant reduction in systolic blood pressure (<90 mmHg or>30% decrease from baseline) following exposure to a known allergen.

Participants' knowledge of these criteria was assessed using a binary classification system: complete knowledge (accurate identification of all three criteria) or incomplete knowledge (correct identification of two or fewer). This system aimed to evaluate the adequacy of theoretical knowledge and to identify specific educational gaps.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics, version 23.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed through both visual methods (histograms, probability plots) and analytical tests (Kolmogorov-Smirnov and Shapiro-Wilk). None of the continuous variables followed a normal distribution. Descriptive statistics are presented as frequencies and percentages for categorical variables and as median (interquartile range, IQR) for continuous variables. Given the non-normal distribution, non-parametric tests were applied for inferential analyses. The Mann-Whitney U test was used to compare two independent groups, while the Kruskal-Wallis test was applied for comparisons involving more than two groups. Categorical variables were analyzed using the Chi-square test of independence. A p value<0.05 was considered statistically significant.

RESULTS

Participant Demographics and Professional Characteristics

A total of 322 pre-hospital emergency medical service professionals participated in the study, comprising 214 paramedics (66.5%), 73 emergency medical technicians (EMTs) (22.7%), and 35 physicians (10.9%). The median age of participants was 33 years (IQR: 29.0–38.0), and the majority were female (n = 201, 62.4%). Overall, participants had a median of 12 years (IQR: 6.0–15.0) of professional experience, with physicians having significantly greater clinical experience compared with paramedics and EMTs (p < 0.001). Most participants reported prior training in anaphylaxis management (n = 290, 90.0%) and previous clinical exposure to anaphylactic cases (n = 282, 87.6%). The most commonly identified triggers were medications (45.7%), stinging insect venom (35.0%), and food allergens (6.9%). Regarding theoretical knowledge of anaphylaxis diagnostic criteria, 168 participants (52.2%) correctly identified all three criteria ("complete knowledge"), whereas 154 participants (47.8%) demonstrated "incomplete knowledge" by identifying two or fewer criteria. Complete demographic and professional characteristics are summarized in Table 1.

Table 1. Demographic characteristics and anaphylaxis-related factors of participants

Characteristics	Total (n=322)	Physicians (n=35)	Paramedics (n=214)	EMTs (n=73)	*p*
Gender, n (%)					0.004[a]
Male	121 (37.6)	22 (62.9)	76 (35.5)	23 (31.5)	
Female	201 (62.4)	13 (37.1)	138 (64.5)	50 (68.5)	
Age, y, median (IQR)	33.0 (29.0-38.0)	44.0 (28.0-54.0)	32.0 (28.0-35.3)	34.0 (32.0-40.0)	<0.001[b]
Duration of professional experience, y, median (IQR)	12.0 (6.0-15.0)	5.0 (2.0-25.0)	10.0 (6.0-14.3)	14.0 (12.0-17.0)	<0.001[b]
Received Anaphylaxis Training, n (%)					0.095[a]
Yes	292 (90.7)	34 (97.1)	195 (91.2)	63 (86.3)	
Does not know	19 (5.9)	1 (5.3)	14 (6.5)	4 (5.5)	
No	11 (3.4)	0	5 (2.3)	6 (8.2)	
Time elapsed since training (n=292), n (%)					0.808[a]
< 2 years	55 (18.8)	8 (23.5)	38 (19.5)	9 (14.3)	
2–5 years	162 (55.5)	17 (50.0)	107 (54.9)	38 (60.3)	
> 5 years	75 (25.7)	9 (26.5)	50 (25.6)	16 (25.4)	
Experience with anaphylaxis cases, n (%)					0.219[a]
Yes	282 (87.6)	28 (80.0)	187 (87.4)	67 (91.8)	
No	40 (12.4)	7 (20.0)	27 (12.6)	6 (8.2)	
Identified anaphylaxis trigger (among those with experience), n (%)					0.047[a]
Venom	113 (35.1)	5 (17.9)	81 (43.3)	27 (40.3)	
Foods	22 (6.8)	3 (10.7)	17 (9.1)	2 (3.0)	
Medication	147 (45.7)	20 (71.4)	89 (47.6)	38 (56.7)	
Recognition of anaphylaxis diagnostic criteria (EMS professionals only), n (%)					0.038
Correctly identified all criteria	168 (52.2)	24 (68.6)	113 (52.8)	31 (42.5)	
Partially correct	154 (47.8)	11 (31.4)	101 (47.2)	42 (57.5)	

p values were calculated using Chi-square test.

Data are presented as median (interquartile range) and *p* values were calculated using Kruskal-Wallis test.

[c]EMS: emergency medical services; EMTs: emergency medical technicians; F: female; IQR: interquartile range; M: male.

Knowledge of First-line Pharmacological Intervention

Participants' knowledge of first-line pharmacological intervention for anaphylaxis was evaluated. Overall, 81.7% (n=263) correctly identified epinephrine as the primary treatment, with significant differences across professional groups (p=0.043): physicians demonstrated the highest accuracy (94.3%, n=33), followed by paramedics (81.8%, n=175) and EMTs (75.3%, n=55). Regarding correct dosing (1:1000 solution, 0.01 mg/kg, maximum adult dose 0.5 mg, pediatric dose maximum 0.3 mg), 76.7% (n=247) responded correctly, while 10.9% (n=35) selected "1:100 solution," 6.2% (n=20) chose "1:10000 solution," and 6.2% (n = 20) indicated "I do not know," reflecting critical knowledge gaps in this life-threatening

emergency scenario. For the appropriate route of administration, 81.1% (n=261) identified the intramuscular route correctly, with significant differences across groups (p<0.001): physicians achieved the highest accuracy (95.5%, n=33), followed by paramedics (86.4%, n=185) and EMTs (63.0%, n=46). Knowledge regarding epinephrine auto-injector devices was less comprehensive, with only 50.6% (n=163) demonstrating adequate understanding of proper use. Significant inter-professional differences were again observed (p=0.019): physicians scored highest (81.4%, n=28), followed by EMTs (53.4%, n=39) and paramedics (46.3%, n=99). Detailed findings on first-line pharmacological intervention knowledge are presented in Table 2.

Knowledge of Comprehensive Anaphylaxis Management Protocols

Participants demonstrated strong knowledge of key anaphylaxis management principles. High accuracy rates were recorded for allergen source elimination, oxygen therapy, intravenous fluid administration, and the use of antihistamines and corticosteroids as adjunctive therapies. The critical importance of prompt epinephrine administration was also widely recognized, with 91.9% (n = 296) answering correctly. Physicians achieved perfect accuracy (100%, n = 35), followed by paramedics (92.5%, n = 198) and EMTs (86.3%, n=63), representing a statistically significant difference (p=0.043). In contrast, knowledge regarding appropriate patient positioning during anaphylaxis was suboptimal. Only 52.2% (n=168) correctly identified the recommended supine position with lower extremity elevation. Inter-professional differences were significant (p=0.002), with physicians demonstrating the highest accuracy (80.0%, n=28), while paramedics (49.0%, n=105) and EMTs (47.9%, n=35) scored notably lower. Effect size analyses using Cramér's V indicated small effects for significant chi-square associations, (V=0.131–0.185). Detailed results for comprehensive management knowledge are presented in Table 3.

Table 2. Participants' knowledge of first-line epinephrine treatment for anaphylaxis

Characteristics	Total (n=322)	Physicians (n=35)	Paramedics (n=214)	EMTs (n=73)	*p*
Knowledge of First-Line Anaphylaxis Treatment, n (%)	263 (81.7)	33 (94.3)	175 (81.8)	55 (75.3)	0.043[a]
Knowledge of Correct Epinephrine Administration Route, n (%)	261 (81.1)	30 (85.7)	185 (86.4)	46 (63.0)	<0.001[a]
Knowledge of Correct Epinephrine Dose for Anaphylaxis, n (%)	247 (76.7)	27 (77.1)	167 (78.0)	53 (72.6)	0.426
Awareness of Epinephrine Auto-Injector (EAI), n (%)					0.019[a]
Yes	163 (50.6)	25 (71.4)	99 (46.3)	39 (53.4)	
No	159 (49.4)	10 (28.6)	115 (53.7)	34 (46.6)	
Prior EAI Administration, n (%)					0.060
Yes	27 (8.4)	6 (17.1)	13 (6.1)	8 (11.0)	
No	295 (91.6)	29 (82.9)	201 (93.9)	65 (89.0)	

Chi-square test. EAI: epinephrine auto-injector; EMT: emergency medical technician.

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Table 3. Participants' knowledge of acute anaphylaxis treatment

In the treatment of acute anaphylaxis	Total (n=322)	Physicians (n=35)	Paramedics (n=214)	EMTs (n=73)	*p*
Any existing contact with the antigen must be terminated promptly, and the causative agent should be eliminated before initiating therapy, n (%)					0.618[a]
Correct	320 (99.4)	35 (100.0)	213 (99.5)	72 (98.6)	
Not correct	2 (0.6)	0	1 (0.5)	1 (1.4)	
Epinephrine must be administered urgently, n (%)					0.043[a]
Correct	296 (91.9)	35 (100.0)	198 (92.5)	63 (86.3)	
Not correct	26 (8.1)	0	16 (7.5)	10 (13.7)	
The patient should be placed in supine position with the lower extremities elevated, n (%)					0.002[a]
Correct	168 (52.2)	28 (80.0)	105 (49.1)	35 (47.9)	
Not correct	154 (47.8)	7 (20.0)	109 (50.9)	38 (52.1)	
Oxygen therapy should be administered, n (%)					0.776[a]
Correct	321 (99.7)	35 (100.0)	213 (99.5)	73 (100.0)	
Not correct	1 (0.3)	0	1 (0.5)	0	
Intravenous fluid therapy should be administered early, n (%)					0.563
Correct	304 (94.4)	32 (91.4)	204 (95.3)	68 (93.2)	
Not correct	18 (5.6)	3 (8.6)	10 (4.7)	5 (6.8)	
H1 antihistamines can be administered via oral, intramuscular (IM), or intravenous (IV) routes, n (%)					0.679
Correct	292 (90.7)	31 (88.6)	193 (90.2)	68 (93.2)	
Not correct	30 (9.3)	4 (11.4)	21 (9.8)	5 (6.8)	
Steroids can be administered via oral, intramuscular (IM), or intravenous (IV) routes, n (%)					0.721
Correct	260 (80.7)	30 (85.7)	172 (80.4)	58 (79.5)	
Not correct	62 (19.3)	5 (14.3)	42 (19.6)	15 (20.5)	
Salbutamol via nebulizer is required for bronchospasm (indicated by wheezing), and epinephrine nebulizer is indicated for stridor, n (%)					0.450
Correct	295 (91.6)	34 (97.1)	195 (91.1)	66 (90.4)	
Not correct	27 (8.4)	1 (2.9)	19 (8.9)	7 (9.6)	

Chi-square test. EMT: Emergency Medical Technician; IM: Intramuscular; IV: Intravenous.

Factors Associated with Anaphylaxis Diagnostic Knowledge

This study evaluated whether demographic, professional, and educational factors influenced participants' ability to correctly identify all three anaphylaxis diagnostic criteria. Variables including age, gender, professional experience, workplace protocols, training history, and recency of training showed no

significant associations with diagnostic knowledge (all $p>0.05$) (Table 4).

Similarly, no significant differences were observed between participants who correctly identified all three diagnostic criteria and those who did not when stratified by age, gender, experience, workplace protocols, or training history (all $p>0.05$). Although female participants demonstrated slightly lower awareness of epinephrine auto-injector (EAI) use compared with males (46.3% vs. 57.9%), this difference did not reach statistical significance ($p=0.058$) (Table 5).

Key knowledge deficiencies across professional groups (physicians, paramedics, EMTs) are visually summarized in Figure 1, illustrating the primary areas requiring targeted educational interventions.

Table 4. Comparison of demographic characteristics by knowledge of anaphylaxis diagnostic criteria

Characteristics	Partially Correct (n=154)	Correctly Identified All Criteria (n=168)	*p*
Gender, n (%)			0.176[a]
Male	52 (33.8)	69 (41.1)	
Female	102 (66.2)	99 (58.9)	
Age, y, median (IQR)	32.0 (28.0–37.0)	33.0 (29.3–39.0)	0.219[b]
Duration of Professional Experience, y, median (IQR)	10.0 (5.0–15.0)	12.0 (7.0–15.8)	0.172[b]
Implementation of anaphylaxis action plans in occupational settings, n (%)			0.358[a]
Does not know	10 (6.5)	18 (10.7)	
Yes	92 (59.7)	100 (59.5)	
No	52 (33.8)	50 (29.8)	
Received anaphylaxis training			0.814[a]
Does not know, n (%)	6 (3.9)	5 (3.0)	
Yes	138 (89.6)	154 (91.7)	
No	10 (3.9)	9 (5.4)	
Time elapsed after training, n (%)			0.801[a]
< 2 years	27 (19.6)	28 (18.2)	
2–5 years	78 (56.5)	84 (54.5)	
> 5 years	33 (23.9)	42 (27.3)	
Experience with anaphylaxis cases, n (%)			0.332[a]
Yes	132 (85.7)	150 (89.3)	
No	22 (14.3)	18 (10.7)	

Chi-square test. Mann Whitney *U* test. F: female; IQR: interquartile range; M: male.

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Table 5. Participant knowledge of anaphylaxis by gender

Characteristics	Male (n=121)	Female (n=201)	*p*[a]
Recognition of anaphylaxis diagnostic criteria (EMS professionals only)			0.176
Correctly identified all criteria	69 (57.0)	99 (49.3)	
Partially correct	52 (43.0)	102 (50.7)	
Knowledge of first-line anaphylaxis treatment	102 (84.3)	161 (80.1)	0.427
Knowledge of correct epinephrine administration route	98 (81.0)	163 (81.1)	1.000
Knowledge of correct epinephrine dose for anaphylaxis	92 (76.0)	155 (77.1)	0.824
Awareness of EAI			0.058
Yes	70 (57.9)	93 (46.3)	
No	51 (42.1)	108 (53.7)	
Prior EAI Administration			0.328
Yes	13 (10.7)	14 (7.0)	
No	108 (89.3)	187 (93.0)	

[a]Chi-square test. [b]EAI: Epinephrine Auto-Injector.

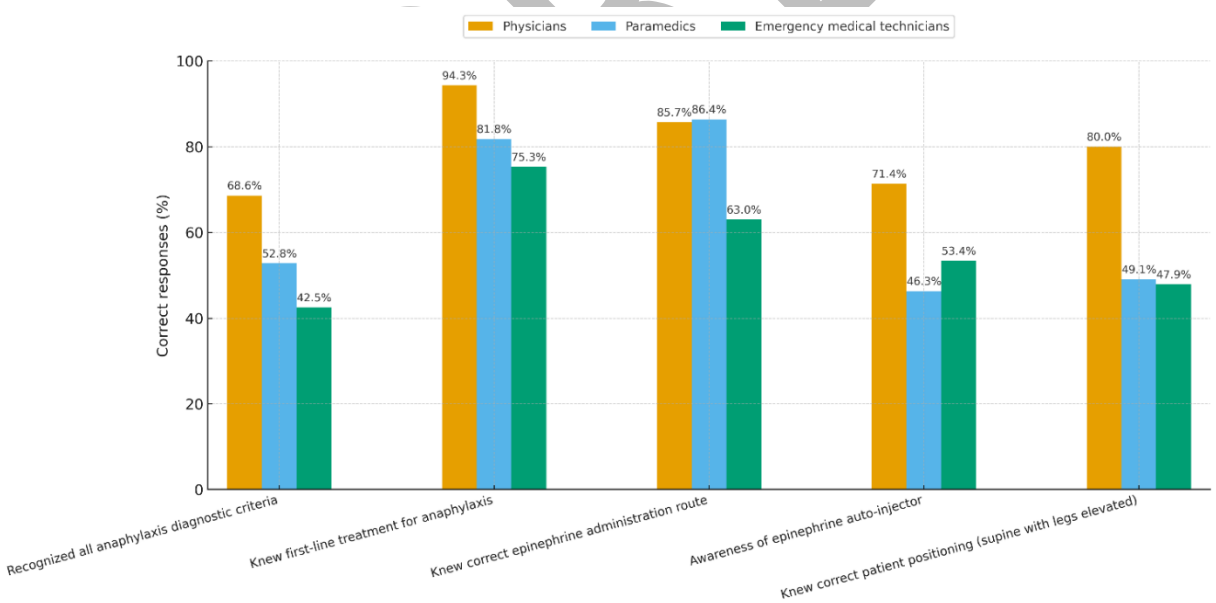

Figure 1. Knowledge across professional groups regarding recognition of anaphylaxis diagnostic criteria, first-line treatment, correct epinephrine administration route, awareness of epinephrine auto-injectors, and correct patient positioning. Bars display the percentage of participants answering correctly in each group (Physicians, Paramedics, EMTs).

DISCUSSION

Anaphylaxis is an acute, life-threatening allergic reaction requiring immediate recognition and intervention to prevent fatal outcomes.[12] Despite the availability of evidence-based management guidelines, multiple studies consistently report significant deficiencies in healthcare professionals' knowledge, training, and adherence to these recommendations.[15–17] Limited research has focused on pre-hospital emergency medical personnel, highlighting an important knowledge gap in this critical population and underscoring the need for targeted training interventions.

Our findings reveal that although EMS personnel generally recognized the clinical features of anaphylaxis, their knowledge of evidence-based management principles was insufficient. Physicians demonstrated superior knowledge compared to paramedics and emergency medical technicians (EMTs) across multiple domains, including symptom recognition, diagnostic criteria, epinephrine dosage, and administration techniques. This disparity likely reflects differences in training intensity, clinical exposure, and professional responsibilities, with physicians receiving more comprehensive medical education and broader clinical experience than paramedics or EMTs. Importantly, our results indicate that system-level interventions—rather than individual educational differences—are needed to improve diagnostic consistency and decision-making in emergency situations. Implementing standardized protocols, regular simulation training, and continuous professional development programs may bridge these knowledge gaps and ensure the effective application of theoretical knowledge in real-world settings.

Deficiencies in recognizing anaphylaxis diagnostic criteria emerged as a critical concern. Variability across guideline definitions (e.g., NIAID/FAAN vs. WAO recommendations)[1,14] and the complexity of simultaneously recalling all diagnostic components likely contributed to these gaps. Notably, participants frequently overlooked key indicators such as allergen-induced hypotension, aligning with prior studies documenting diagnostic challenges among pre-hospital providers. For example, a survey of 3,537 paramedics in the United States reported near-perfect recognition of classic anaphylaxis presentations (98.9%) but very low recognition of atypical cases (2.9%).[9] These findings underscore the need for standardized, practical training to reinforce consistent diagnostic approaches across professional groups and institutions.

Interestingly, multivariate analyses revealed no significant association between diagnostic knowledge and demographic or professional factors, such as age, gender, years of experience, training history, or time since training. It is possible that the retention and applicability of knowledge were influenced by factors including the timeliness of the training, the curriculum's quality, a dearth of practical sessions, and the infrequency of training. This situation indicates that even prior clinical exposure to anaphylaxis cases had no statistically significant effect on diagnostic accuracy. This finding suggests that current educational approaches may be fundamentally inadequate in translating theoretical knowledge into practical diagnostic skills. However, when evaluating competency regarding first-line epinephrine treatment, participants generally demonstrated an adequate understanding, including knowledge of appropriate administration routes and dosage protocols.

Regarding pharmacologic management, epinephrine was correctly identified as the first-line treatment by 81.7% of participants, with physicians performing best (94%), followed by paramedics (81%) and EMTs (75%). These findings align with prior studies reporting correct epinephrine recognition rates between 87.2% and 93.5% among healthcare professionals.[2–4] However, paramedics and EMTs demonstrated lower knowledge levels than physicians, a trend also reported internationally. For instance, in a U.S. study, only 46.2% of paramedics identified epinephrine as the first-line treatment and just 38.9% chose the intramuscular route, while Canadian studies documented epinephrine underutilization rates as high as 64% in pre-hospital settings.[8,18] These international variations likely reflect differences in training curricula, system protocols, and regulatory frameworks.

Despite adequate knowledge of epinephrine dosing and administration, critical deficiencies were observed in patient positioning during anaphylactic episodes. Only 52.2% of participants correctly identified the recommended supine position with lower extremity elevation, a simple yet life-saving maneuver. Physicians demonstrated the highest accuracy (80%), whereas paramedics (49%) and EMTs (47.9%) performed poorly. Similar deficits have been reported previously, with correct positioning knowledge as low as 24.3% among nurses and 42.9% among physicians.[19] Improper

positioning can precipitate catastrophic complications such as cardiovascular collapse due to impaired cerebral perfusion—a phenomenon known as "empty ventricle syndrome"—emphasizing the critical importance of correct training in this area.

Knowledge regarding epinephrine auto-injectors (EAIs) was also inadequate, with only half of participants demonstrating familiarity with proper use. Physicians again performed best, while paramedics scored lowest. Limited availability of EAIs in some emergency systems, inconsistent inclusion in national EMS protocols, and insufficient emphasis in training programs likely contribute to this knowledge gap. In Türkiye, the routine stocking of EAIs in all Emergency Medical Services (EMS) units is not a standardized national policy. While some advanced EMS protocols and regional services may include EAIs, their consistent availability is not guaranteed across all levels of care (e.g., Basic Life Support vs. Advanced Life Support) or geographical regions (urban vs. rural). International studies similarly report poor EAI knowledge among healthcare providers, with one study noting only 26.5% of pediatric emergency physicians had hands-on auto-injector experience.[20] These deficiencies highlight the urgent need for mandatory continuing medical education (CME) programs focusing on practical skills such as dosing accuracy, auto-injector use, and patient positioning.

Importantly, our study represents one of the first national investigations assessing anaphylaxis knowledge among pre-hospital EMS personnel, a population historically underrepresented in the literature. By identifying specific gaps-including diagnostic criteria knowledge, patient positioning, and EAI administration-our findings provide a foundation for targeted educational interventions to improve pre-hospital anaphylaxis care and patient safety.

Limitations

Several limitations warrant consideration. First, although the questionnaire was developed using current EAACI guidelines[12] and reviewed by pediatric allergy specialists, it was not formally validated, potentially limiting its psychometric robustness. Second, data collection relied on an online survey distributed via smartphones and email rather than face-to-face interviews, with a response rate of 32.5%. This approach may have introduced selection and response bias while limiting the depth and completeness of the information obtained. Participants with greater interest in anaphylaxis management may have been more likely to respond, and reliance on self-reported data may not accurately reflect real-world performance. Third, the cross-sectional design prevents causal inference; while associations were identified, no conclusions regarding causality can be drawn. Fourth, the study relied on self-reported data for training and experience; participants' reported confidence, knowledge, and previous training may not accurately reflect their actual skills or competence. Additionally, multiple chi-square analyses were performed without adjustment for multiple comparisons, raising the possibility of type I error. Finally, the single-center setting limits external validity, as EMS training protocols, resources, and organizational structures vary across regions and countries. Future studies should use mixed-method approaches-including simulations, interviews, and multicenter designs-to enhance generalizability, reduce response bias, and evaluate real-world clinical performance.

This study identified significant knowledge gaps among pre-hospital emergency healthcare providers regarding anaphylaxis diagnostic criteria, appropriate patient positioning, and epinephrine auto-injector administration. While physicians demonstrated superior knowledge compared to paramedics and EMTs, deficiencies were evident across all professional groups, posing potential risks to patient safety. Implementing standardized training protocols, mandatory CME programs, and regular simulation-based exercises focused on practical skills-including correct epinephrine dosing, administration route, auto-injector use, and patient positioning-is essential for optimizing pre-hospital anaphylaxis care. System-level interventions addressing these gaps could substantially improve emergency preparedness, treatment consistency, and clinical outcomes for patients experiencing anaphylaxis.

STATEMENT OF ETHICS

The study received ethical approval from the relevant institutional ethics committee.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

AI ASSISTANCE DISCLOSURE

AI tools were used only for English language editing and proofreading.

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