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A Quantitative Survey To Analyze The Impact Of Safety Gears To Prevent Lower Limb Injuries Among Taekwondo Trainees In Karachi, Pakistan

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ABSTRACT

Background: *Taekwondo is a high-intensity martial art in which rapid kicking techniques and contact-based training expose young athletes to a substantial burden of lower-limb injuries, while routine use of protective equipment remains variable.* ***Objective****: To determine the prevalence and patterns of lower-limb injuries among taekwondo trainees in Karachi, Pakistan, and to evaluate safety gear use and its association with perceived injury prevention.* ***Methods****: A descriptive cross-sectional survey was conducted across five taekwondo academies in Karachi among trainees aged 12–20 years with 6–12 months of training experience. Data were collected using a structured injury reporting questionnaire capturing demographics, 12-month training-related lower-limb injuries (site, type, mechanism), 3-month muscle cramps, and routine protective equipment use. Data were analyzed in IBM SPSS version 24 using descriptive statistics and Fisher's exact test.* ***Results****: Among 120 trainees (59.2% male), 52.5% reported at least one lower-limb injury in the past year. The most commonly injured sites were the foot (12.5%), lower leg (11.6%), and ankle (8.3). Bruises were most frequent (21.7%), followed by contusions and sprains (13.3% each); attack kicks (24.2%) and kick-blocking (15.8%) were leading mechanisms, while 44.2% reported no identifiable mechanism. Painful cramps occurred in 50.8% over the prior three months. Routine protective equipment use was reported by 43.3%. Protective equipment use was significantly associated with belief in injury-preventive benefit (p = 0.025).* ***Conclusion****: Lower-limb injuries and painful cramps are common among adolescent taekwondo trainees in Karachi, with injuries predominantly affecting distal lower extremity regions and arising from contact-based actions. Safety gear use was suboptimal but associated with stronger perceptions of preventive benefit, supporting the need for consistent protective practices and injury-prevention-focused training.*

Keywords
Taekwondo; Lower Limb Injuries; Protective Equipment; Musculoskeletal Injury; Injury Mechanism; Muscle Cramps; Injury Surveillance

INTRODUCTION

Taekwondo is a high-intensity Olympic combat sport characterized by rapid kicking combinations, dynamic footwork, and frequent contact through offensive and defensive lower-limb techniques, which collectively create substantial exposure to musculoskeletal injury risk during both training and competition (1). Epidemiological research consistently indicates that the lower extremity bears the greatest injury burden in taekwondo, reflecting the sport's biomechanics and the predominance of kicking-based actions that concentrate impact and torsional loads across the foot, ankle, and lower leg (2). Across amateur and elite contexts, commonly reported injury phenotypes include contusions, bruises, sprains, and strains, with injury occurrence often linked to sparring exchanges and contact events such as attacking kicks and blocking maneuvers (3,4). Importantly, adolescents represent a particularly relevant population because growth-related changes in strength, flexibility, coordination, and load tolerance may interact with training exposure to amplify vulnerability to lower-limb injury patterns that can impair participation continuity, performance development, and long-term athletic trajectories (5,6).

Protective equipment is widely promoted in taekwondo to mitigate contact forces and reduce injury frequency and severity, typically encompassing shin guards, instep/foot protectors, ankle supports, and other padding intended to attenuate direct blows during striking and blocking actions (7). However, despite the intuitive rationale and broad acceptance of protective gear within combat-sport safety frameworks, real-world effectiveness during routine training remains insufficiently characterized in many settings, particularly in low- and middle-income contexts where coaching practices, enforcement norms, gear quality, and access may differ from those described in high-resource or elite competition-focused studies (2,8). Existing literature has largely emphasized competition surveillance or elite cohorts, whereas training environments—where repeated exposures, fatigue accumulation, and variable adherence to protective practices are common—may drive a substantial proportion of injuries and constitute a modifiable prevention target (2,6). Additionally, evidence suggests that injury patterns can vary by age and sex, yet findings are not always consistent across cohorts, underscoring the need for context-specific surveillance that links injury occurrence to modifiable extrinsic factors such as protective equipment use while accounting for heterogeneity in trainee characteristics (4,5).

In Karachi, Pakistan, taekwondo participation among adolescents has expanded through academies and youth programs, yet locally generated injury surveillance data remain limited, constraining the ability of coaches, clinicians, and sports institutions to implement evidence-based safety strategies tailored to this population. From a PICO perspective, the population of interest is adolescent taekwondo trainees engaged in routine academy training; the exposure is the use of lower-limb protective equipment; the comparator is non-use or inconsistent use; and the outcomes are the 12-month prevalence, anatomical distribution, and type/mechanism of lower-limb injuries, alongside the association between protective equipment use and injury occurrence. Accordingly, this study was designed to quantify common lower-limb injury patterns among taekwondo trainees aged 12–20 years in Karachi and to evaluate whether routine use of protective gear is associated with lower injury occurrence during training. We hypothesized that trainees who routinely use lower-limb protective equipment experience a lower prevalence of self-reported lower-limb injuries over the preceding 12 months compared with trainees who do not routinely use such equipment.

MATERIAL AND METHODS

This study employed a cross-sectional observational design, selected to estimate the prevalence and patterns of lower-limb injuries and to examine their association with protective equipment use within a defined trainee population at a single time point, consistent with international recommendations for sports injury surveillance in youth athletes (9). The study was conducted across five established taekwondo academies located in Karachi, Pakistan, representing organized urban training settings with structured coaching and regular practice schedules. Data collection was carried out over a continuous 6–8-month period following institutional approval, ensuring adequate coverage of trainees enrolled during routine training cycles.

The target population comprised male and female taekwondo trainees aged 12–20 years who had been actively training for a minimum of 6 months and no longer than 12 months at the time of recruitment. This age and experience window was selected to capture adolescent athletes with sufficient exposure to taekwondo-specific training loads while minimizing heterogeneity related to long-term elite participation or early attrition (10). Trainees were excluded if they had retired from active practice, reported pre-existing lower-limb injuries attributable to non-taekwondo trauma, or fell outside the predefined age range. Participants were selected from academy rosters using a simple random selection approach within each academy to reduce selection bias and enhance representativeness of the active trainee population.

Recruitment was conducted on-site during scheduled training sessions. Eligible trainees and, where applicable, their parents or legal guardians were informed verbally and in writing about the study objectives, procedures, potential risks, and confidentiality safeguards. Written informed consent was obtained from all participants, with parental consent secured for minors, prior to data collection. Participation was voluntary, and trainees were informed of their right to withdraw at any stage without academic or training-related consequences, in accordance with ethical standards for research involving human participants (11).

Data were collected using a structured taekwondo injury reporting questionnaire administered in person. The instrument captured demographic characteristics (age, sex), training exposure variables (duration of taekwondo participation), history of lower-limb injuries sustained during training over the preceding 12 months, anatomical site of injury, type of injury, and perceived injury mechanism. Injury was operationally defined as any self-reported musculoskeletal complaint affecting the lower extremity (foot, ankle, lower leg, knee, thigh, hip, or related structures) that occurred during taekwondo training and resulted in pain, discomfort, or functional limitation, irrespective of time loss or medical consultation, aligning with inclusive definitions commonly used in youth sports injury epidemiology (12). The questionnaire also assessed the routine use of lower-limb protective equipment during training, including shin guards, foot or instep protectors, and ankle supports, categorized dichotomously as routine use versus non-use. Muscle cramps experienced during the preceding three months were additionally recorded to capture training-related neuromuscular symptoms that may influence injury susceptibility (13).

To reduce information bias, questionnaires were completed under researcher supervision, with standardized explanations provided for key terms such as injury type, anatomical location, and protective equipment. Recall bias was addressed by restricting injury reporting to a defined 12-month period and cramps to a 3-month period, consistent with recommended recall windows for self-reported sports injury data (9). Potential confounding related to age and sex was anticipated and accounted for in the analytical plan through stratified and adjusted analyses.

The sample size of 120 trainees was determined a priori using a standard prevalence-based calculation approach, assuming an anticipated lower-limb injury prevalence of approximately 50% among adolescent taekwondo trainees, a 95% confidence level, and a 5% margin of error, which yields adequate precision for cross-sectional estimates in sports epidemiology studies (14). This sample size also provided sufficient cell counts to permit exact statistical testing for categorical associations.

Data were coded and entered into IBM SPSS Statistics version 24 (IBM Corp., Armonk, NY, USA) using double-entry verification procedures to ensure data integrity. Descriptive statistics were computed for all variables, with categorical data summarized as frequencies and percentages. The primary analytical comparison examined the association between routine use of protective equipment and the occurrence of lower-limb injury (yes/no) using Fisher's exact test, selected due to small expected frequencies in contingency table cells. Effect sizes were estimated using odds ratios with corresponding 95% confidence intervals to quantify the strength and direction of associations. Secondary analyses explored associations between injury characteristics, demographic variables, and muscle cramps. Missing data were minimal and were handled using complete-case analysis. Statistical significance was defined a priori as a two-tailed p-value <0.05 (15).

Ethical approval for the study was obtained from the relevant institutional ethics review body prior to commencement. All procedures conformed to the principles of the Declaration of Helsinki. Participant confidentiality was maintained through anonymized data coding and secure data storage, with access restricted to the research team. To support reproducibility, standardized data collection procedures, predefined variable definitions, and transparent statistical methods were applied consistently across all participating academies.

RESULTS

A total of 120 taekwondo trainees were included in the final analysis. The demographic characteristics of the study population are summarized in Table 1. Most participants were adolescents aged 12–16 years (75.0%), with males comprising 59.2% of the sample. This distribution reflects the predominance of early adolescent engagement in organized taekwondo training within the participating academies. The prevalence and anatomical distribution of lower-limb injuries sustained during training within the preceding 12 months are presented in Table 2. Overall, 63 trainees (52.5%) reported experiencing at least one lower-limb injury, while 57 (47.5%) reported no injury. Among injured trainees, the most frequently affected

anatomical sites were the foot (12.5%), lower leg (11.6%), and ankle (8.3%). Injuries involving the knee (5.0%) and hamstrings (4.1%) were less common, while other lower-extremity regions—including the pelvis, heel/Achilles, buttock, groin, and toe—were infrequently affected. The distribution of injury types and reported mechanisms is shown in Table 3. Bruises were the most commonly reported injury type (21.7%), followed by contusions (13.3%) and sprains (13.3%). Strains were less frequently observed (6.7%). Regarding mechanisms, attacking kicks accounted for nearly one-quarter of all reported injuries (24.2%), followed by blocking a kick (15.8%). Drill-related activities (8.3%) and falls (7.5%) were less frequent contributors. A substantial proportion of participants (44.2%) were unable to identify a specific mechanism, consistent with the multifactorial and dynamic nature of taekwondo training exposures. Painful muscle cramps experienced during the preceding three months were reported by 61 trainees (50.8%), as detailed in Table 4. Among those affected, cramps most commonly occurred 1–3 times per month (18.3%), followed by less than once per month (16.7%) and more than once per week (14.2%). Daily cramps were rare (1.7%). In terms of perceived severity, most trainees described cramps as painful (40.8%), while smaller proportions reported very painful (7.5%) or less painful (2.5%) episodes, indicating substantial inter-individual variability in neuromuscular symptom burden. Routine use of lower-limb protective equipment during training was reported by 52 trainees (43.3%), whereas 68 trainees (56.7%) indicated non-use. The association between protective equipment use and trainees' belief in its effectiveness for injury prevention is presented in Table 5.

Table 1. Demographic Characteristics of Taekwondo Trainees (n = 120)

Variable	Category	n	%
Age Group (years)	12–16	90	75.0
	>16	30	25.0
Sex	Male	71	59.2
	Female	49	40.8

Table 2. Prevalence and Anatomical Distribution of Lower-Limb Injuries in the Past 12 Months (n = 120)

Injury Status / Body Region	n	%
Any Injury		
Yes	63	52.5
No	57	47.5
Principal Body Part Injured		
None	57	47.5
Foot	15	12.5
Lower leg	14	11.6
Ankle	10	8.3
Knee	6	5.0
Hamstrings	5	4.1
Upper leg	3	2.5
Pelvis	3	2.5
Heel/Achilles	2	1.6
Buttock	2	1.6
Groin	2	1.6
Toe	1	0.8

Table 3. Types of Injuries and Mechanisms of Injury among Trainees (n = 120)

Injury Type	n	%	Injury Mechanism	n	%
Bruises	26	21.7	Attack kick	29	24.2
Contusion	16	13.3	Blocking a kick	19	15.8
Sprain	16	13.3	Drills	10	8.3
Strain	8	6.7	Fall	9	7.5
None	54	45.0	None identified	53	44.2
Total	120	100	Total	120	100

Table 4. Prevalence, Frequency, and Intensity of Painful Muscle Cramps (n = 120)

Variable	Category	n	%
Painful cramps (past 3 months)	Yes	61	50.8
	No	59	49.2
Frequency of cramps (n = 61)			
	1–3 times/month	22	18.3
	<1 time/month	20	16.7
	>1 time/week (not daily)	17	14.2
	Daily	2	1.7
Pain intensity (n = 61)			
	Painful	49	40.8
	Very painful	9	7.5
	Less painful	3	2.5

Table 5. Association between Protective Equipment Use and Belief in Injury Prevention (n = 120)

Protective Equipment Use	Believe It Helps n (%)	Believe It Does Not Help n (%)	Odds Ratio (95% CI)	p-value
Yes (n = 99*)	90 (90.9)	9 (9.1)	4.00 (1.18–13.55)	0.025
No (n = 21*)	15 (71.4)	6 (28.6)	Reference	
Total	105	15		

A significantly higher proportion of trainees who routinely wore protective equipment believed it to be effective compared with those who did not (Fisher's exact p = 0.025). The estimated odds of perceiving protective gear as beneficial were approximately four times higher among users than non-users (odds ratio 4.00; 95% CI 1.18–13.55). Collectively, these findings demonstrate that lower-limb injuries are common among adolescent taekwondo trainees, with more than half reporting at least one injury within a 12-month period, predominantly affecting the foot, lower leg, and ankle. Injury mechanisms were largely contact-related, particularly during attacking and blocking kicks. Muscle cramps were also prevalent and frequently painful, suggesting an additional neuromuscular burden during training. Although fewer than half of trainees routinely used protective equipment, those who did were significantly more likely to perceive it as effective for injury prevention, highlighting a meaningful relationship between safety practices and injury-related perceptions that may influence behavior and compliance.

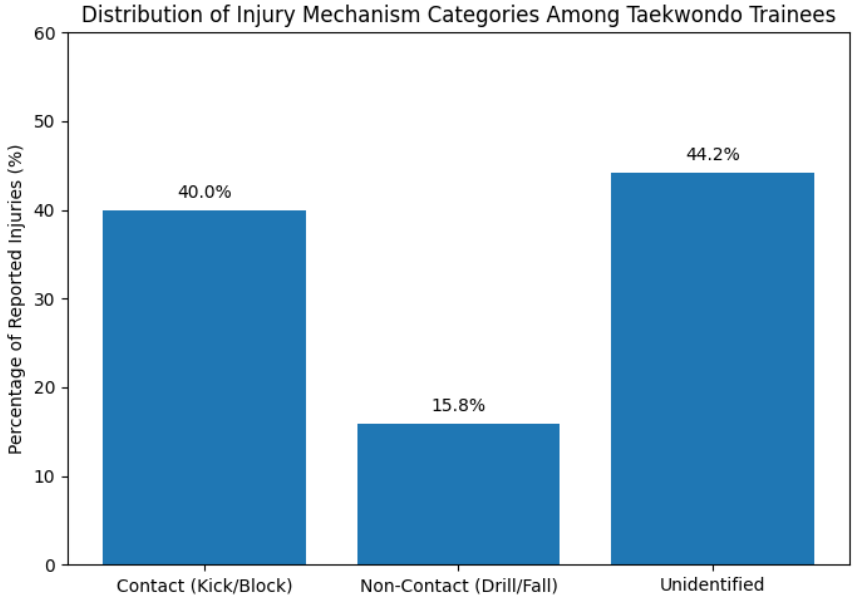

Figure 1 Distribution of Injury Mechanism Categories among Taekwondo Trainees

Figure 1 illustrates the proportional distribution of aggregated injury mechanism categories among taekwondo trainees based on reported injury mechanisms over the preceding 12 months. Contact-related mechanisms, comprising attacking kicks and blocking actions, accounted for 40.0% of reported injuries, underscoring the dominant role of direct lower-limb contact inherent to taekwondo training. Non-contact mechanisms, including drills and falls, represented a smaller proportion at 15.8%, suggesting that structured training activities and accidental events contribute less frequently to injury occurrence. Notably, a substantial proportion of injuries (44.2%) were classified as having unidentified mechanisms, highlighting the complex, multifactorial nature of injury causation in dynamic martial arts environments and the potential influence of cumulative microtrauma, fatigue, or recall limitations. Clinically, this distribution emphasizes the need for targeted preventive strategies addressing high-impact contact actions while also improving injury awareness and reporting accuracy to better inform injury surveillance and risk mitigation efforts.

DISCUSSION

The present study provides a comprehensive overview of lower-limb injury patterns, muscle cramp prevalence, and the role of protective equipment among adolescent taekwondo trainees in an urban Pakistani setting. The findings demonstrate that more than half of the trainees sustained at least one lower-limb injury within a 12-month period, reinforcing the notion that taekwondo training, even outside formal competition, carries a substantial injury burden for youth participants. This prevalence aligns with prior epidemiological studies conducted in amateur and youth taekwondo populations, which similarly report injury rates ranging from approximately 45% to over 60% annually, particularly during training sessions rather than competitions (8,15). Such consistency across diverse settings underscores the intrinsic injury risk associated with the sport's biomechanical demands and training structures.

Anatomically, injuries were predominantly localized to the foot, lower leg, and ankle, findings that mirror earlier reports identifying the distal lower extremity as the most vulnerable region in taekwondo athletes (3,10,15). The emphasis on rapid kicking techniques, repeated impact with opponents or protective targets, and frequent blocking maneuvers places concentrated mechanical stress on these segments, predisposing them to contusions, bruises, and ligamentous injuries. While some studies have identified the ankle or knee as the most commonly injured site, particularly in elite or older cohorts, the prominence of foot and lower-leg injuries in the current adolescent sample may reflect developmental factors such as incomplete musculoskeletal maturation, footwear characteristics, and technique refinement during early training years (4,6). These observations suggest that injury patterns may evolve with age, experience, and training intensity, highlighting the importance of age-specific injury surveillance.

In terms of injury type, bruises, contusions, and sprains constituted the majority of reported injuries, indicating that most injuries were mild to moderate in severity. This distribution is consistent with previous prospective and retrospective analyses, which describe contact-related soft tissue

injuries as the dominant injury phenotype in taekwondo (9,13). Strains were comparatively uncommon in this cohort, a finding that may be attributable to the relatively young age of participants, who typically exhibit greater muscle elasticity and recovery capacity than older athletes. The predominance of contact-related injuries is further supported by the mechanism analysis, which identified attacking kicks and blocking actions as the leading contributors. These findings corroborate biomechanical and observational studies demonstrating that sparring and contact drills generate the highest external loads and injury risk due to high-velocity limb movements and collision forces (14,16).

A notable observation in this study was the high proportion of injuries for which trainees were unable to identify a specific mechanism. Similar findings have been reported in prior research and may reflect the cumulative nature of training-related microtrauma, the rapid and complex sequence of movements in taekwondo, or limitations inherent to retrospective self-reporting over extended recall periods (8,10). This underscores the multifactorial etiology of many sports injuries and highlights the need for improved athlete education regarding injury recognition, as well as more systematic injury surveillance systems within training environments.

Beyond acute injuries, the study revealed that muscle cramps were experienced by approximately half of the trainees within the preceding three months, with a substantial proportion describing these episodes as painful or very painful. Although muscle cramps are often underreported in sports injury research, their high prevalence in this cohort suggests a meaningful neuromuscular burden associated with taekwondo training. Potential mechanisms include repetitive high-intensity lower-limb activity, neuromuscular fatigue, dehydration, and electrolyte imbalance, all of which have been implicated in cramp pathophysiology (7,27). Clinically, frequent or painful cramps may impair training quality, compromise technique, and indirectly increase injury risk, indicating that cramp prevention strategies—such as adequate hydration, conditioning, and recovery protocols—should be integrated into youth training programs.

With respect to protective equipment, fewer than half of the trainees reported routine use during training, despite widespread acknowledgment of its protective value. This finding is consistent with earlier studies documenting suboptimal compliance with protective gear in martial arts training settings, particularly outside competition contexts where enforcement may be less stringent (19,24). Importantly, trainees who routinely used protective equipment were significantly more likely to believe in its effectiveness for injury prevention. While the cross-sectional design precludes causal inference, this association suggests that attitudes and beliefs may play a critical role in shaping safety behaviors. It also points to a potential feedback loop whereby positive perceptions reinforce compliance, which may, in turn, influence injury experiences over time.

From a clinical and practical standpoint, these results have several implications. Coaches and trainers should prioritize injury prevention strategies that address the high-risk actions identified in this study, particularly attacking and blocking kicks. Emphasis on proper technique, progressive load management, and neuromuscular conditioning may help reduce the frequency of contact-related injuries. Additionally, fostering a safety-oriented culture that normalizes routine protective equipment use during training—not solely during competitions—could enhance compliance and potentially mitigate injury risk. Educational interventions targeting both trainees and parents may be especially valuable in adolescent populations, where perceptions and habits are still forming.

The study also possesses notable strengths, including its focus on an understudied population, the inclusion of both male and female trainees, and the comprehensive assessment of injury patterns, mechanisms, cramps, and safety practices within real-world training environments. However, several limitations warrant consideration. The cross-sectional design limits causal interpretation, and reliance on self-reported data introduces the possibility of recall and reporting bias. The sample was drawn from selected urban academies, which may limit generalizability to rural settings or different training systems. Additionally, unmeasured confounders such as training frequency, sparring intensity, belt rank, and previous injury history could have influenced the observed associations.

Future research should build on these findings through longitudinal designs that track injury incidence prospectively and evaluate the effectiveness of specific protective equipment types under controlled conditions. Incorporating objective exposure measures, biomechanical assessments, and standardized injury definitions would further enhance methodological rigor. Gender- and age-stratified analyses may also elucidate differential risk profiles and inform tailored prevention strategies. Collectively, such efforts would contribute to a more robust evidence base for safeguarding the health and performance of young taekwondo practitioners.

CONCLUSION

In conclusion, lower-limb injuries were common among taekwondo trainees aged 12–20 years in Karachi, with over half reporting at least one training-related injury in the preceding 12 months and the foot, lower leg, and ankle emerging as the most frequently affected sites, while bruises, contusions, and sprains predominated and were most often linked to contact-based actions such as attacking and blocking kicks; additionally, painful muscle cramps affected approximately half of trainees over the prior three months, indicating a relevant neuromuscular symptom burden alongside injury occurrence. Although routine protective equipment use during training was suboptimal, trainees who reported using protective gear were significantly more likely to endorse its preventive value, reinforcing the need for structured safety education, consistent enforcement of protective practices, and training interventions that emphasize technique refinement, load management, hydration, and recovery to support adolescent athlete safety and sustained participation.

REFERENCES

1. Oh H, Lim H, Jeon M. Analysis of Sports Injury in Lower Extremities of High School Taekwondo Athletes. Applied Sciences. 2021;11(24):11690.
2. Qiao Y, Zhang L, Zhang B. Rehabilitation Treatment of Muscle Strain in Athlete Training Under Intelligent Intervention. Computational and Mathematical Methods in Medicine. 2022;2022:1–9.
3. Kazemi M, Pieter W. Injuries at a Canadian National Taekwondo Championships: A Prospective Study. BMC Musculoskeletal Disorders. 2004;5:1–8.
4. Guan Y, Bredin SSD, Taunton J, Jiang Q, Wu N, Warburton DER. Predicting the Risk of Injuries Through Assessments of Asymmetric Lower Limb Functional Performance: A Prospective Study of Youth Taekwondo Athletes. Orthopaedic Journal of Sports Medicine. 2023;11(8):23259671231185586.
5. El Ashry SR, El Gamal TA, Platt SR. Atypical Chronic Ankle Instability in a Pediatric Population Secondary to Distal Fibula Avulsion Fracture Nonunion. Journal of Foot and Ankle Surgery. 2017;56(1):148–152.

6. Bisson LJ, Kluczynski MA, Hagstrom LS, Marzo JM. A Prospective Study of the Association Between Bone Contusion and Intra-Articular Injuries Associated With Acute Anterior Cruciate Ligament Tear. American Journal of Sports Medicine. 2013;41(8):1801–1807.
7. Minetto MA, Holobar A, Botter A, Farina D. Origin and Development of Muscle Cramps. Exercise and Sport Sciences Reviews. 2013;41(1):3–10.
8. Lystad RP, Graham PL, Poulos RG. Epidemiology of Training Injuries in Amateur Taekwondo Athletes: A Retrospective Cohort Study. Biology of Sport. 2015;32(3):213–218.
9. Schlüter-Brust K, Leistenschneider P, Dargel J, Springorum HP, Eysel P, Michael JP. Acute Injuries in Taekwondo. International Journal of Sports Medicine. 2011;32(8):629–634.
10. Geßlein M, Rüther J, Millrose M, Bail HJ, Martin R, Schuster P. High Incidence of Hand Injuries From Blocking in Elite Taekwondo Despite the Use of Protective Gear: A 5-Year Descriptive Epidemiology Study. Orthopaedic Journal of Sports Medicine. 2021;9(1):2325967120973996.
11. Xu G, Liu H, Zhang L. Characterization of Changes in Subchondral Bone Tissue Density of the Ankle Joint in Taekwondo Players. Frontiers in Bioengineering and Biotechnology. 2022;10:872258.
12. Li WL, Shen HY, Hung JT, Shih CP. Effect of Moisture on Friction Coefficient of Fabrics Used on Taekwondo Personal Protective Equipment. Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology. 2019;233(1):87–94.
13. Ziaee V, Rahmani SH, Rostami M. Injury Rates in Iranian Taekwondo Athletes: A Prospective Study. Asian Journal of Sports Medicine. 2010;1(1):23–28.
14. Ryu S, Lee TK. Biomechanical Parameters That May Influence Lower Limb Injury During Landing in Taekwondo. Medicina. 2021;57(4):373.
15. Jeong HS, Ha S, Jeong DH, O'Sullivan DM, Lee SY. Injury and Illness in World Taekwondo Junior Athletes: An Epidemiological Study. International Journal of Environmental Research and Public Health. 2021;18(4):2134.
16. Altarriba-Bartes A, Drobnic F, Til L, Malliaropoulos N, Montoro JB, Irurtia A. Epidemiology of Injuries in Elite Taekwondo Athletes: Two Olympic Periods Cross-Sectional Retrospective Study. BMJ Open. 2014;4(2):e004605.
17. Kashefi T, Daneshjoo A, Mousavi Sadati SK. Effect of Up-Chagi and Yup-Chagi Exercises on Knee Kinematic Indices and Incidence of Genu Varum in Professional Taekwondo Practitioners. Journal of Sport Biomechanics. 2021;6(4):214–225.
18. Zarei M, Johari K, Bagherian R. Lower Extremity Risk Factors in Iranian Adolescent Taekwondo Players. Physical Treatments – Specific Physical Therapy. 2020;10(1):7–14.
19. Xiao S. Characteristics and Prevention of Sports Injuries in Taekwondo Training. Revista Brasileira de Medicina do Esporte. 2020;28(1):37–39.
20. Kushartanti W. Risk Factors and Preventive Strategies of Musculoskeletal Injury Among Hapkido Athletes: Indonesian Coaches' Perceptions and Practices. 2023;59–65.
21. Jar A. Role of Sports and Protective Gear in Preventing Dental Trauma. Journal of Oral Health Sciences. 2023;3(12):728–734.
22. Pieter W, Caine DJ, Harmer PA, Schiff MA. Taekwondo. In: Epidemiology of Injury in Olympic Sports. Oxford: Wiley-Blackwell; 2010. p. 249–259.
23. Kazemi M, Chudolinski A, Turgeon M, Simon A, Ho E, Coombe L. Nine-Year Longitudinal Retrospective Study of Taekwondo Injuries. Journal of the Canadian Chiropractic Association. 2009;53(4):272–281.
24. Park KJ, Song BB. Injuries in Female and Male Elite Taekwondo Athletes: A 10-Year Prospective Epidemiological Study of 1,466 Injuries Sustained During 250,000 Training Hours. British Journal of Sports Medicine. 2018;52:735–740.
25. Kim E, Cha J, Choi H, You J. Longitudinal Panel Study of Sports Injuries in University Elite Athletes. Korean Journal of Sports Medicine. 2020;38:43–54.
26. Kim JS. Exploration of Factors Causing Injuries in Taekwondo Demonstration. Korea Journal of Sport. 2018;16:709–717.
27. Carlson MF. The Epidemiology of Taekwondo Injuries in Youth and Adult Competitors. Grand Forks: University of North Dakota Scholarly Commons; 2013.