Journal of Sports and Physical Education Studies
ISSN: 2788-788X
DOI: 10.32996/jspes
Journal Homepage: www.al-kindipublisher.com/index.php/jspes

JSPES
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

| RESEARCH ARTICLE

Lower Extremity Injury Prevention in Taekwondo Poomsae Athletes: An Educational Intervention

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| ABSTRACT
Poomsae is a non-contact form of taekwondo that involves physical exertion, technique, skills, and art. It combines kicks, blocks, stances, strikes, and punches demonstrated with an imaginary opponent. It is practice for self-defense, belt promotion, and action preparation for contact sparring. Chronic Overuse injuries are common in taekwondo Poomsae athletes as they participate in repetitive stress to attain mastery of forms used in competitions. The goal is to provide deep understanding and knowledge essential for training and optimal performance in sports to athletes and coaches. Educational intervention is deployed as a free webinar session consisting of 221 participants attended. The data are collected through a qualitative reflective feedback form consisting of questions targeting knowledge acquired and application of the information towards their practice as a coach and athlete. The result showed common reflective feedback towards the injury prevention strategy in Poomsae from the webinar: 1) Discovering strength and weakness, 2) Reason for strength and conditioning, 3) Prevention and management of injury.

| KEYWORDS

Taekwondo; Poomsae; Injury prevention; Lower Extremity; Sports Education; Martial Arts

| ARTICLE DOI: 10.32996/jspes.2022.2.1.1

1. Introduction

Recently, Poomsae has been a broad interest as a competitive sport in various competitions in local and international games. Poomsae was established in the year 2000 by the World Taekwondo Federation and is now being practiced by many practitioners in different competitions such as in Worlds, Asian Championship, SEA Games, and many international games. In the Philippines, the Philippines Taekwondo Association has established at least 15 national and regional Poomsae competitions annually to help develop the athletes' experience and skills. Poomsae is a non-contact form of taekwondo that involves physical exertion, technique, skills, and art. It combines movements such as kicks, blocks, stances, strikes, and punches demonstrated with an imaginary opponent. It is practice for self-defense, belt promotion, and action preparation for contact sparring (Kazemi M. et al., 2016). A Poomsae practitioner's average training is six days a week, with a maximum of four hours and 40 minutes per exercise per day (Koh, J.O & Kwak J.H., 2011). The type of training involved mastery informs through repetition and strength training. Thus, it is not surprising that overuse injuries in Poomsae are common among athletes, and acute injuries are rare (Koh, J.O & Kwak J.H., 2011) due to the repetitive movement involved during training. Although there is a considerable amount of research on the prevalence of lower extremity injuries among sparring taekwondo, few studies are present in Taekwondo Poomsae (Park, S., 2019; Kazemi, M. al., 2016).

Chronic Overuse Injuries (COI) are defined as injuries in the bones, muscles, joints, and tendons due to stress, trauma, and repetitive use of the muscle group involved without providing an adequate amount of time for healing (Yang et al., 2012). Observations by Koh (2017) found that COI is higher in Poomsae than Sparring in South Korean taekwondo athletes. Another study conducted in Canadian Poomsae athletes stated that the prevalence rate of COI in Poomsae elevated by 73% (Kazemi M. et al., 2016).

Strength and conditioning provide athletes with the physical prerequisite in preparation in a competitive environment (Jukic I. et al., 2020). One of the crucial roles of strength and conditioning is to ensure the prevention and reduction of the severity of sports injuries (Talpey and Siesma, 2017; O'Brien et al., 2019). Although deep understanding and knowledgeable coaches are essential to achieve safety and optimal performance in sports, the athletes need to become aware of their bodies and help themselves acquire knowledge and education from a strength and conditioning coach.

2. Literature Review

Poomsae is a non-contact sport consisting of 13 defined patterns of movement for the blackbelt Senior 1 Category ages 30 under commonly used in the World Taekwondo Poomsae Championship, Asian Taekwondo Poomsae Championship, Southeast Asian Games, and most international games. In the Philippines, there are at least 1,500 practitioners (The Philippine Star, 2018; World Taekwon Media, 2019) competes in the Poomsae championship locally, and the Philippine national team has been dominating in various international games (Dela Cruz, B., 2020; Dioquino, D., 2018; ABS-CBN News, 2019). The study of Lee, S.B., & Lee, T.S. (2010) analyzes the energy expenditure of taeguek Poomsae, which are forms used in competitions using an accelerometer recording a total of 323 motions with 156 leg action and 165 arm action from taeguek 1 to taeguek eight excluding blackbelt forms for Senior 1 category for collegiate Poomsae. The duration of eight taeguek forms will take 25-31 minutes, depending on the athlete's accuracy, skills, and efficiency of movements. In Poomsae competition, the category is divided into three groups: individual, mixed pair, and team, which can be a group of men or women. Rhythm practice for the team to move the same, the more synchronized, the better, and the higher the score. Movements are repeated to gain mastery, and actions such as kicks, punches, blocks, and stances are practiced to perfection to get high accuracy. Average training is six days a week and a maximum of four hours and 40 minutes of practice per day. As a result, the probability of injuries is high in the lower extremity, as it is the taekwondo's inherent nature that focuses mostly on kicking techniques that involve repetitive micro stresses around the knee joint (Koh, J.O., 2017). That is why injuries in Poomsae are developed through time and repetitions.

Chronic Overuse injuries are repetitive loading of the muscles, tendons, bones, and ligaments while having an insufficient recovery time (De Bleecker et al., 2020; Roos, K. et al., 2015; Yang, J. et al., 2012; Leppänen, M. et al., 2017; Clarsen, B. et al., 2013). According to Kazemi et al. (2016), the prevalence rate of chronic overuse injuries is more typical to Poomsae taekwondo athletes than in Sparring taekwondo. The study of Altarriba-Bartes (2014) reveals that the highest injury site was located on the lower extremity for both male and female athletes, which is vital to taekwondo as a kicking sport; that is why injuries are common in that area. There are some cases where injuries occur during competition but are very rare. According to Park (2019), Most participants suffered injuries during training, such as kicking and repeated movements of forms to achieve perfection while overworking their bodies. On the study of Minghelli et al. (2020), 30.6% of Poomsae athletes in Portugal responded that lower extremity injuries (84.6%) as the familiar site of injury, having foot and fingers (18.9%) as the highest, followed by the ankle (15.3%), leg (15.3%), thigh (15.3%), knee (11.7%) and pelvis (8.1%). A systematic review of Thomas et al. (2017) mentioned that both gender experience injury mostly on the lower extremities and head/neck. The average lower extremity in men for all ages is 2.7% percent, and for women, it is 26.6.%.

Most recently, sports training has rapidly evolved, in large part, as a consequence of science-led advances (Renshaw, 2019). As a result, the literature is replete with studies about sports injury prevention. However, implementing effective preventive interventions on a large-scale in real-world sports settings is still a major challenge (Tee et al., 2020; Vriend, 2017). To prevent actual injury in daily practice, large-scale adoption and the correct use of evidence-based preventive interventions by the target population are required (Tee et al., 2020). The available evidence on sports injury prevention to reduce the risk of injuries centered mostly on implementing measures that require a behavioral change of individual athletes, use of personal protective equipment, as well as specific training and educational programs (Ryu et al., 2021; Ryu, 2020; Seo et al., 2020, Verhagen et al., 2019). Additionally, implementing intervention strategies that predominantly target behavioral modifications in individuals is considered most daunting and found to be less effective in injury prevention than those based on contextual modifications, such as regulations, enforcement methods, and environmental and product modifications (Boiling et al., 2018). Therefore, a range of potentially relevant strategies should be considered to support and strengthen sports injury prevention efforts.

Kirkpatrick's Model of Training evaluation (Kirkparticks, 1996) consists of four levels 1) Reaction, 2) Learning, 3) Behavior, 4) Results. The first level of evaluation – reaction, evaluates the participant's response after the program's intervention. The objective is to gather the thought of the participant. The second level of evaluation – Learning, refers to assessing the participant's acquired knowledge throughout the program's implementation. The objective is to determine the learning developed that aids their field of expertise. The third level of evaluation – transfer, refers to the application of the learning experience of the participants to its professional field. Assessing change helps in examining the improvement of the participants whether the program taught is used. And lastly, the fourth level of evaluation – results, evaluates if the program's primary goal is applied. The positive effect corresponds to the success of the program implemented.

Anchored on Kirkpatrick's Model of evaluation applied to educational intervention in Sports Medicine, the overall goal of this study is to evaluate the participants' reactions and perceived learning after undergoing an educational intervention that provided knowledge about evidence-based, data-driven injury prevention strategies to reduce sport-related injuries among taekwondo Poomsae athletes.

3. Methodology

The educational intervention was deployed as a free webinar session. Promotional activities were done through social media (e.g., Facebook, Instagram, Tiktok, Twitter). Among the 573 athletes who registered for the webinar, 221 participants (38.5%) attended on the day of the webinar. The inclusion and exclusion criteria details are shown in table 1.

Participants of the study

Inclusion	Exclusion
Taekwondo Poomsae Athletes	Taekwondo Kyorugi Athletes
8 – 31 years old and above	Less than 8 years old
Yellow belt to Blackbelt holders	White belt holder
	No experience in taekwondo

Table I. Inclusion and Exclusion criteria

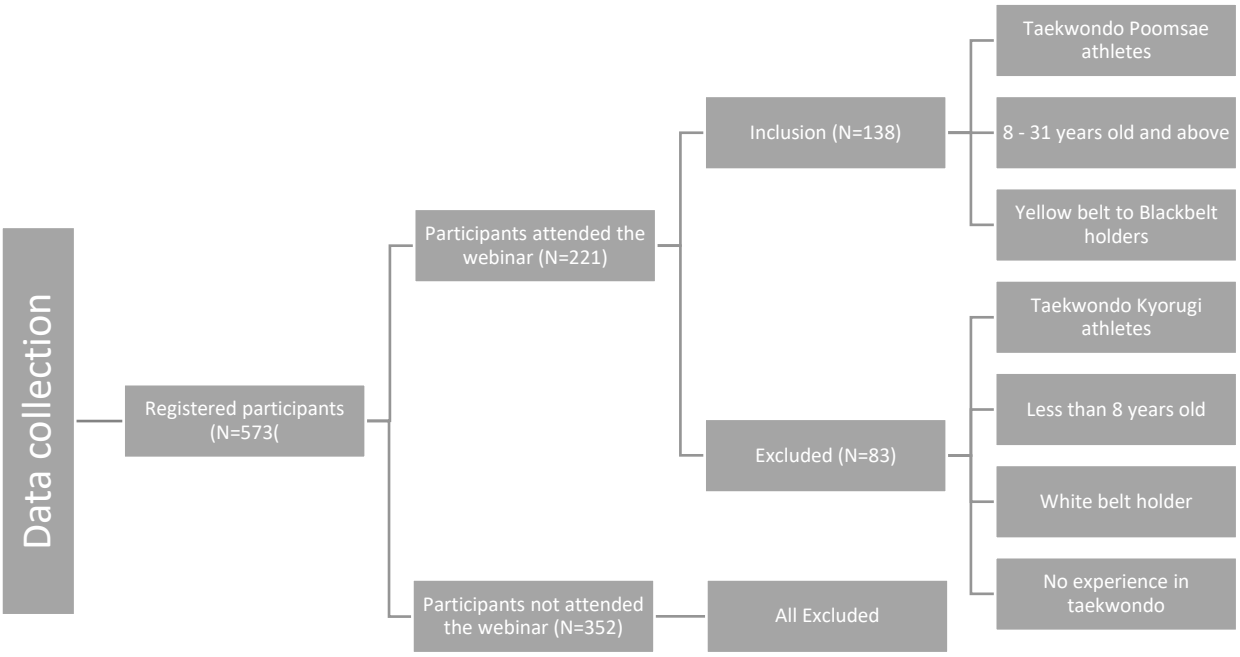

Figure 1. Process flow diagram of participant inclusion and exclusion

At the end of the webinar, the participants were expected to achieve the following learning outcomes: 1) discuss taekwondo as a sport, 2) differentiate the two taekwondo events (Poomsae and Kyorugi) in terms of scoring and how it is played, 2) describe the common site of lower extremity injury and predict its occurrence, 3) analyze the biomechanics of taekwondo kicks, and 4) create an injury prevention plan through strength and conditioning.

At the end of the webinar, the participants were given a feedback form to complete. The feedback form was divided into five (5) parts. In the first part, demographics of the participants was obtained, which included: age, classified according to categories used in competitions: kids (8-11 years old), Cadet (12-14 years old), junior (15-17 years old), senior (18-30 years old), master (31 and above); gender; current taekwondo event; years in practice; region; and belt level (Table I). In the second part, the participants were asked to rate a series of questions relating to the participant's participation and self-rating, having excellent as the highest and poor as the lowest. In the third part, the participants were asked to rate a series of questions grouped according to 1) mastery of instructor, 2) organization of the webinar, 3) content. The rating questions' content details are shown in Table II. In the fourth part, the participants were asked to write their reflections regarding their take-away learning points and were further prompted to write

whether they would apply their learnings from the webinar. Lastly, in the fifth part, the participants answered a structural question for the reflective feedback. The responses were recorded in words. The reflective feedback content details are shown in Table III.

Rating questions content
Participation
Level of effort you put into the webinar
Level of skills/knowledge at the start of the webinar
Level of skill/knowledge at the end of the webinar
Contribution of webinar to your skill/knowledge as taekwondo practitioner
Applicability of webinar to training as a taekwondo practitioner
Mastery of instructor
Instructor was an effective lecturer/demonstrator
Presentation was clear and organized
Instructor stimulated the athlete's interest
Learning objectives were clear
Organization of the webinar
Webinar content was organized and well planned
Webinar organized to allow all participants to participate fully

Table II. Rating questions content

Reflective feedback content
In your own words, reflect on your experience as a taekwondo practitioner and what this webinar can contribute to your current practice?

Table III. Reflective feedback content

4. Results

A total of 138 out of 221 participants (62.4%) who answered the post-webinar survey were included for analysis. Table 4 shows the participants' characteristics. The participants' age was highest in seniors (18-30 years old), having a frequency of 31.9%. Male showed slightly higher numbers than female participants who completed the webinar (52.9% vs. 47.1%). Most of the participants were highly experienced, with nine (9) and above years of practice (29.7%). Participants were higher in the NCR region (31.9%) and lowest in region 4-B (0%), region 10 (0%), region 11 (0%), region 12 (0%), and CARAGA (0%). Most of the participants are blackbelt holders (58%).

Category	**Frequency**	**%**
Age (years)		
Kids (8-11)	39	28.3
Cadet (12 - 14 years old)	21	15.2
Junior (15 - 17 years old)	19	13.8
Senior (18 - 30 years old)	44	31.9
Master (31 and above)	15	10.9
Gender		
Male	76	52.9
Female	62	47.1
Years in Practice		
Less than 1 year	20	14.5
1 - 2 years	14	10.2
3 – 4 years	36	26.1
5 – 6 years	17	12.3
7 – 8 years	9	6.5
9 and above	41	29.7
Region		
NCR	44	31.9
CAR	1	0.7

Region 1	11	8
Region 2	23	16.7
Region 3	5	3.6
Region 4-A	19	13.8
Region 4-B	0	0
Region 5	4	2.9
Region 6	15	10.9
Region 7	1	0.7
Region 8	3	2.2
Region 9	2	1.5
Region 10	0	0
Region 11	0	0
Region 12	0	0
CARAGA	0	0
BARMM	2	1.5
Belt Level		
Yellow	25	18.1
Blue	7	5.1
Red	7	5.1
Brown	18	13
Black	81	58.7

Table IV. Participants' demographics

Most of the participants showed effort in attending the webinar, of whom 72 (52.7%) rated their effort as excellent. Before the webinar, the skills/knowledge of participants was primarily excellent (34.8%), followed by satisfactory (33.3%). At the end of the webinar, most participants felt that it improved their level of skills/knowledge (52.7%). A total of 96 (69.6%) participants rated excellent in terms of the applicability of the webinar to their training as taekwondo practitioners.

Most of the participants strongly agreed that the instructor was an effective demonstrator/lecturer (77.5%) and stimulated athlete's interest (76%). The participants likewise were also strongly agreed that the presentation was well organized (74.6%), and the objectives were clear (74.6%).

Regarding the webinar organization, the participants strongly agreed that the webinar content was organized and well planned (74.6%) and that it allowed the participants to participate fully (74.4%).

Questions	**Rating N (%)**				
Participation	Excellent	Very good	Satisfactory	Fair	Poor
Level of effort you put into the webinar	72 (52.7)	45(32.6)	17(12.3)	4(2.9)	0(0)
Level of skills/knowledge at the start of the webinar	48 (34.8)	34(24.6)	46(33.3)	9 (6.5)	1 (0.7)
Level of skill/knowledge at the end of the webinar	72 (52.7)	43(31.2)	18 (13)	5 (3.6)	0 (0)
Contribution of webinar to your skill/knowledge as taekwondo practitioner	75 (54.3)	35(25.4)	20 (14.5)	7 (5.1)	1 (0.7)
Applicability of webinar to training as a taekwondo practitioner	96 (69.6)	32(23.2)	10 (7.3)	0 (0)	0 (0)
Mastery of instructor	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree

Instructor was an effective lecturer/demonstrator	107 (77.5)	26(18.8)	4 (2.9)	1 (0.7)	0 (0)
Presentation was clear and organized	103 (74.6)	27(19.6)	4 (2.9)	1 (0.7)	3 (2.2)
Instructor stimulated the athlete's interest	105 (76)	23(16.7)	6 (4.3)	1 (0.7)	3 (2.2)
Learning objectives were clear	103 (74.6)	31(22.5)	1 (0.7)	0	3 (2.2)
Organization of Webinar	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
Webinar content was organized and well planned	103 (74.6)	30(21.7)	2 (1.5)	0 (0)	3 (2.2)
Webinar organized to allow all participants to participate fully	104 (75.4)	29(21)	2 (1.5)	0 (0)	3 (2.2)

Table V. Participant's rating: participation, mastery of instructor, organization of webinar.

4.1 Reflective Feedback

Reflections of the 138 participants regarding the application of knowledge acquired towards the injury prevention strategy in Poomsae centered on the following themes: 1) Discovering strength and weakness, 2) Reason for strength and conditioning, 3) Prevention and management of injury.

4.2 Discovering one's strengths and weaknesses

The participants become knowledgeable about the biomechanics of taekwondo, focusing on the skills used in competitions. Since most of the participants are black belters, they commonly discussed how the reoccurrence of their injuries affected their performance. Discovering one's weakness was the first step to injury prevention. Some of the participants discussed their weaknesses and knew this was the first step in targeting the muscle groups they needed to improve.

> "*This webinar had given me more knowledge about specific topics like what muscles we are using when we do certain kicks. Because of this, it will be easier for me to do these kicks without experiencing an injury.*"

> "*I learned How to avoid them and what muscles are used in different types of kicks, so now I know what's my weaknesses and what I need to improve.*"

> *"At this time, this seminar helps me to understand more about how to improve my condition and get to know where to work on at exact parts or the body."*

4.3 Targeting areas for strengthening and conditioning

Strength and conditioning were essential to all participants in preventing injuries in taekwondo when knowing what was good for their body and what was not.

> *"My knowledge of what is good for my body or not, especially when exercising or training for taekwondo, has not been much. But with this current webinar, I now know what I should do and what I should not do when I train or exercise. I know now too what to do if ever I do get injured during training or practice."*

Knowledge of strength and conditioning helped avoid exercises that can cause overuse injuries and exercise strategies in improving their performance. They also mentioned how strength and conditioning were an addition to help them prevent future injuries.

> *"The webinar gave me tips on how to avoid another injury by strengthening muscles that are used during training, and I would surely use it not only to prevent injuries but also to continue playing the sports I like."*

Sports biomechanics was essential to the participants, especially in knowing the muscle group working to prevent and manage injury. Some participants also mentioned that even small muscle groups have a massive role in the techniques.

"Understanding how the body functions and using that knowledge to enhance performance is essential."

"As a taekwondo practitioner, I had not enough knowledge that even small muscles of the body can have a huge role in our techniques. I sometimes do exercises incorrectly, which eventually led to injuries."

4.4 Learning how to prevent and manage injury

Participants stated that the prevention and management of an injury could help them avoid further damage to their bodies. They become quicker to judge in areas that commonly cause injury. Some of the participants also mentioned that they perform self-conditioning in their own homes without supervision. Knowing the correct exercise form can help them in completing the exercises safely.

"In this seminar, I have learned how to prevent injuries and what to do if I have an existing injury. These will help me prevent or manage any injuries during training."

"In my experience, this seminar has contributed to my current practice by letting me know which muscle would hurt if I do it the wrong way, and at least now I know how to prevent myself from getting hurt by doing it properly."

"It contributed to my knowledge, and especially I have my self-conditioning at home so I can do it more appropriately and safely.

Self-prevention was important to participants as well, as they are aware that coaches are having a hard time correcting everyone at once. Knowing the basics can help them take good care of their own body even if no one is watching.

"I usually have an injury, especially now that coaches cannot check and make your form right all the time, so this seminar can help me to be informed on how I can improve myself."

5. Discussion

Most of the taekwondo poomsae athletes who attended the webinar are blackbelt holders (58%) and reside in the NCR region (31.9%). The mastery of the instructor reflects the participant's interests (76%), delivery of presentation to understand the lecture (74.6%) entirely, and effectivity as a lecturer/demonstrator (77.5%). The research highlighted that educational program in strength and conditioning results in a positive result of transmitting techniques and educational insight into how the body responds to exercise (Massey, D., 2010; Elder, C. et al., 2003; Vescovi, J. et al., 2004). Massey (2010) suggests that in building influences on the athletes, a strength and conditioning coach must possess a skill necessary to build a relationship, be competent, and knows what they are talking about to convince them. A strength and conditioning coach should have three interrelated types of knowledge, professional knowledge, interpersonal knowledge, and interpersonal knowledge, to effectively teach and coach (Gilbert, D & Baldis, M., 2014). Professional knowledge includes knowing the principles and pedagogical strategies in application to its field of expertise. Interpersonal skill is the ability to connect and communicate to its target participants. Intrapersonal skill relates to the ability of self-awareness and introspection.

The participant's awareness in discovering strengths and weaknesses in their own body relates to the first step to injury prevention. For this study, participants learn about the biomechanics of taekwondo skills. Strength and conditioning helped the participants understand the relevance of physical conditioning toward the improvement of sports performance and avoidance of further bodily injuries. A strength and conditioning coach should have the ability to relay the necessary knowledge to increase the athlete's self-consciousness towards their body in avoiding injury (Gilbert, D & Baldis, M., 2014). Sports biomechanics is one of the subjects of expertise of a strength and conditioning coach. (Massey, D. 2010).

According to Plisk (2003), teaching is the most critical job of a strength and conditioning coach and is responsible for managing and monitoring students' learning. An instructional conversation is a powerful tool for teaching to engage learners and must be practiced by coaches. In preventing and managing injuries, participants learn how to prevent injuries through the knowledge acquired in the webinar and through interaction with the instructor.

6. Conclusion

The research aims to provide deep understanding and knowledge essential for training and optimal performance in sports to athletes and coaches. The key findings of the study include 1) Discovering the strength and weaknesses through the application of knowledge with introductory biomechanics of taekwondo, 2) targeting the areas of weaknesses through strength and conditioning program, and 3) learning how to prevent and manage injury through proper exercise forms targeting the correct

muscle group. The study will contribute as the first research regarding lower extremity injury prevention in Taekwondo poomsae through educational intervention in Southeast Asia.

The limitation of the study includes the application of learning through behavior and results (a continuation of Kirkpatrick's model of training evaluation) in determining if there is a positive or negative change from the educational intervention.

6.1 Recommendation

The following recommendations are proposed:

1. To address if there is an effect of educational intervention towards their practice, a continuation of Kirkpatrick's Model of Training evaluation such as the behavioral change and performance can be applied.
2. Assessment can also be included to check the learnings of the participants using Bloom's Taxonomy as a guide.

Funding: This research did not receive financial support.
Acknowledgments: Foremost, the authors would like to acknowledge the contributions of Lawrence Borres, Philippines Taekwondo Blackbelt brotherhood/sorority, Negros Taekwondo Union – Bacolod, Rafael Taekwondo Academy for their assistance with this research.
Conflicts of Interest: The authors declare no conflict of interest

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