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SPORT Fans' Learning Process in Relation to Sport Rules and Future Consumption of Sport Products

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Abstract

Purpose: *The purpose of the study is to conceptualize and test the relationship to determine the influence sport rules acquisition has on sport consumption behaviors. Specially, this study aims to provide more practical evidence regarding the relationship between the processes associated with learning sport rules and intentions regarding future consumption. Consequently, by examining sport rules as they relate to sport fans' behaviors, this study is to recognize the significance of sport rules and the value they have with regard to marketing practitioners who will be in the position to design more effective marketing strategies.*

Method: *A total of 260 usable responses were collected via QUALTRICS, one of external online survey providers. Rule recognition process was comprised of four subscales and sport consumption behaviors were measured with four subscales. Confirmatory factor analysis(CFA) was conducted based on the procedures. Structural equation modeling was used to examine the structural relationship among variables and the reliability(Cronbach's alpha) of each subscale was checked. The average variance extracted(AVE) values were also evaluated, as they indicated whether each item contributes to the basic construct of the scales.*

Results: *Confirmatory Factor Analysis(CFA) showed the measurement of the model and structural model had reasonable fit. The structural model provides a good basis for testing the nature of each individual relationship based on the regression weights, standard error, and critical ratio. The results also showed that statistically significant differences existed between how learning of rules occurred and future consumption pathways.*

Conclusion: *A core product of sport management is the game itself and understanding sport rules is a prerequisite to enjoy the core product. Therefore, it is suggested that the role of understanding sport rules should be considered an important factor for understanding and predicting the sport fan development process and future behaviors.Learning rules via media consumption lends to future consumption of media consumption. Regarding the learning by way of playing sport pathway, it is demonstrated to have a meaningful influence in respect to purchasing sporting goods and attending sporting events.*

[Keywords] ***Sport Fans, Sport Rules, Sport Rules Learning, Sport Product, Consumption Behavior***

1. Introduction

By being exposed to a sport, people are able to know and recognize the sport, team, league, and players[1]. Several studies have suggested that knowledge regarding sport is measured by a fan's knowledge of team history, information of player/coach, team records(e.g., statistics), game strategy, skillset pertinent to the sport, and general information about the game and related personalities[2][3].

In general, knowledge is defined as the information stored within memory[4]. Knowledge, in this context, has to do primarily with information pertinent to sport teams, coaches, players, team history, etc. Based on the definition of a general rule, sport rules define a variety of as-

pects surrounding the actual play of the game, including what can and cannot be done and by whom. Prensky(2001) described sport as a kind of play organized by rules, making the game fair and exciting, and without rules, it could not be considered as a sport game[5].

Despite the importance of learning rules of play, it has been researched entirely within the concept of sport knowledge(i.e., existence of sports and teams, different levels of play, distinguishing sport and teams) and little attention has been focused on rule knowledge as a contributing factor in the fan development process[1]. Further, no research has examined the relationship between the pathway of learning sport rules and influence over future behavior of sport fans.

The purpose of the current study is to conceptualize and test the relationship to determine the influence sport rules acquisition has on sports consumption behaviors. Specially, the current study aims to provide more practical evidence regarding the relationship between the processes associated with learning sport rules and intentions regarding future consumption. Consequently, by examining sport rules as they relate to sport fans' behaviors, this study is to recognize the significance of sport rules and the value they have with regard to marketing practitioners who will be in the position to design more effective marketing strategies.

2. Literature Review

There has been a myriad of research done on various sport fan behavioral factors[1][2][6][7], and most of the research focuses on the loyal or highly identified fan[8]. Among those factors, knowledge has been considered significant with regard to its ability to influence consumption behaviors. Previous literatures regarding knowledge have indicated that knowledge, in this context, primarily has to do with information pertinent to sport teams, coaches, players, team history, etc. However, the importance of sport rules as a core factor of knowledge motivation has largely been ignored even though knowledge itself is a key motivating factor for sport fans[9][10]. Previous studies have suggested that knowledge was measured in terms of a fan's knowledge of team history, player/coach information, team records(e.g., statistics), game strategy, skillset pertinent to sport, and general information about the game and related personalities[2][3].

Various previous studies suggested that consumer's information and knowledge were important with regard to the consumer's future consumption habits and knowledge influences the initiation of behaviors[11][12][13][14]. Park and Lessig(1981) explained the relationship between consumers' decision-making processes and product familiarity, which was based on past experiences with a certain product[15][16]. Kwak(2009) asserted that sport knowledge predicts attitudes and behavioral intentions toward sport[13]. His findings indicated that when people perceive they were more knowledgeable about a sport, they had more favorable attitudes towards related sport consumption and felt more comfortable[13][17]. Per Hirt and Clarkson(2011), knowledge of sport rules is the most basic and significant element awareness stage of sport with regard to participation in and distinguishing between different teams and sports[1][18].

In the sport management field, various consumption behaviors(i.e., purchasing sporting goods, attending and watching sport games at stadiums or arenas; media consumption via television, radio, and internet; video game or movie consumption, and participating in sport via fitness clubs and the like) exist. Generally, most studies on sport consumption have focused on overall motivation of sport fans and consumers. Those efforts have failed to consider the core factor of sport management, the sport itself. Therefore, more in-depth efforts to find a core factor which influences sport consumption behaviors are necessary[19].

3. Research Methods

3.1. Sample

The target population of the current study was people 18 years of age or older who were interested in sport-related consumption activities in the United States. A total of 260 usable responses were collected via QUALTRICS which was one of external online survey providers.

3.2. Measures

Rule recognition process was comprised of four subscales with twelve items. The items were developed and revised from Funk, Ridinger, and Moorman(2003) and Kremer-Sadlik and Kim(2007)[20][21]. Respondents rated how much each type of rule recognition influenced their understanding of the rules of their favorite sport using a five-point Likert scale. The four types of recognition types are 'by playing their favorite sports,' 'by attending their favorite sporting event', 'by watching/listening their favorite sport through TV/radio', and 'by enjoying their favorite sport through video game play'.

Sport consumption behaviors were measured with four subscales(i.e., purchasing sporting goods, purchasing/attending sporting event, media consumption, purchasing sports video game) with twelve items from Voss, Spangenberg, and Grohmann(2003)[22].

General demographic information was investigated after modification based on the items of Williams(2010)[23]. Participants were asked to answer their age, gender, ethnicity, household incomes, education levels, and marital status.

3.3. Analysis

Confirmatory factor analysis(CFA) was conducted based on the procedures outlined in Byrne(2006) and Hatcher(1994)[24][25]. The χ^2 and df, the comparative fit index(CFI), the root-mean-square error of approximation(RMSEA), and standard root-mean-squared residual(SRMR) were checked to assess the overall model fit. Structural equation modeling was used to examine the structural relationship among variables. The reliability(Cronbach's alpha) of each subscale was checked. The validity of each construct was determinedbased on the correlation result.

The average variance extracted(AVE) values were evaluated, as they indicated whether each item contributes to the basic construct of the scales. Based on the result of above analysis, the final items and factors were determined.

4. Results

The means of the sport rule learning process items ranged from 3.32 to 4.02 and the standard deviations ranged from 0.77 to 1.07. The item 'attending at a stadium or arena' had the highest mean and the item 'playing video game' had the lowest mean among sport rules learning process types. The means of the intention of sport consumption items ranged from 2.84 to 4.25 and the standard deviations ranged from 0.71 to 1.35. 'Media consumption' had the highest mean and 'purchasing video game' had the lowest mean among intention of sport consumptions. As shown in the following <Table 1>.

Table 1. The summary results for measurement model.

Factors and items	λ	α	AVE
Playing Sports		.791	.573
- Playing my favorite sport helps me to understand the rules of my favorite sport game.	.838		
- It is hard to say that one way that I could learn the rules of my favorite sport is byplaying the sport.	.571		
- I feel that playing my favorite sport adds to my understanding of the sport rules.	.860		

Attending		.928	.831
- Attending my favorite sport at an arena or stadium helps me to understand the rules of my favorite sports game.	.896		
- One way that I could learn the rules of my favorite sport is by attending games at an arena or stadium associated with my favorite sport.	.916		
- I feel that attending my favorite sports at an arena or stadium adds to my understanding of the rules of my favorite sport.	.893		
Watching		.825	.651
- It is hard to say that watching my favorite sport helps me to understand the rules of my favorite sport game.	.782		
- One way that I could learn the rules of my favorite sports is by watching my favorite sport.	.695		
- I can't feel that watching my favorite sport adds to my understanding of the rules of my favorite sport.	.873		
Video Game		.936	.819
- Playing a video game related to my favorite sport helps me to understand the rules of my favorite sport.	.861		
- One way that I could learn the rules of my favorite sport is by enjoying and playing video games related to my favorite sport.	.954		
- I feel that playing video games related to my favorite sport adds to my understanding of the rules of my favorite sport.	.922		
Sporting Good Consumption		.835	.588
- I am likely to purchase my favorite sport's sporting goods to enjoy in the future.	.873		
- In the future, purchasing my favorite sport's sporting goods is something I plan to do.	.932		
- In the future, I don't intend to purchase my favorite sport's sporting goods.	.603		
Spectating		.870	.664
- I intend to attend my favorite sport's game(s).	.853		
- The likelihood that I attend my favorite sport's game(s) in the future is high.	.984		
- I won't attend my favorite sport's game(s) in the future	.683		
Media Consumption		.800	.695
- I will track news regarding my favorite sports game through the media(e.g., TV, Internet, Radio, etc.).	.695		
- I will watch or listen to my favorite sports game through the media(e.g., TV, Internet, Radio, etc.).	.866		
- I will support my favorite sport by watching or listening to game(s) through the media (e.g., TV, Internet, Radio, etc.)	.738		
Playing Video Game		.856	.576
- I am likely to purchase video games related to my favorite sport in the future.	.956		
- In the future, purchasing video games related to my favorite sport is something I plan to do	.930		
- In the future, I intend to purchase video games related to my favorite sport.	.594		

The component model was tested to find the direct relationship between learning types of sport rules and future intention of consumption behavior. Confirmatory Factor Analysis(CFA) results showed the measurement of the model had reasonable fit(X^2/df = 571.549/224 = 2.55, RMSEA = .07, CFI = .92, SRMR = .05). Also, the structural model indicated reasonable fit(X^2/df = 278.886/214 = 1.30, RMSEA = .03, CFI = .91, SRMR = .06).

The structural equation model provides a good basis for testing the nature of each individual relationship based on the regression weights, standard error, and critical ratio(t-value). Analysis was performed and results showed that statistically significant differences existed, at the .05 level, between how learning of rules occurred and future consumption pathways. Results are summarized in <Table 2>.

Table 2. Regression weights, standard errors, critical ratio(t-value), and p-value of the relationship between types of learning sport rules and future consumption intention of structural model.

	Standardized regression weight	Unstandardized regression weight	S.E.	C.R.	P	Results
By playing						
→ Sporting goods	.238	.223	.067	3.324	.001	Supported
→ Spectating	.196	.190	.069	2.745	.006	Supported
→ Media consumption	.145	.094	.051	1.869	.062	Not supported
→ Video game	-.066	-.065	.060	-1.079	.280	Not supported

By attending						
→Sporting goods	.120	.130	.093	1.397	.162	Not supported
→Spectating	.351	.396	.105	3.772	.001	Supported
→Media consumption	.046	.034	.076	.456	.648	Not supported
→Video game	-.113	-.129	.093	-1.385	.166	Not supported
By watching						
→Sporting goods	.021	.019	.073	.264	.792	Not supported
→Spectating	.060	.058	.079	.735	.463	Not supported
→Media consumption	.381	.248	.062	4.024	.001	Supported
→Video game	.136	.133	.074	1.805	.071	Not supported
By playing video games						
→Sporting goods	.397	.344	.061	5.679	.001	Supported
→Spectating	.140	.126	.062	2.021	.043	Supported
→Media consumption	.015	.009	.048	.186	.853	Not supported
→Video game	.724	.655	.076	8.594	.001	Supported

5. Discussions and Applications

A core product of sport management is the game itself and understanding sport rules is a prerequisite to enjoy the core product. Therefore, it is suggested that the role of understanding sport rules should be considered an important factor for understanding and predicting the sport fan development process and future behaviors. Practitioners or managers of sport-related organizations can utilize this information in order to build efficient marketing strategies based on the results of this study. The process of rule acquisition and future consumption behavior are interconnected and illustrated by positive relationships within the model. It was hypothesized that each path of learning would have a relationship with future consumption behaviors that was positive in nature. All hypotheses were at least partially supported. Learning by way of playing, attending games, watching sports, and playing video games influenced the likelihood of future consumption by way of attending games, purchasing sporting goods or video games or consuming media in various formats such as television and radio(See <Table 2> for results).

This study reveals useful information that translates into practical application. Regarding the learning by way of playing sport pathway, it is demonstrated to have a meaningful influence in respect to purchasing sporting goods and attending sporting events. Sport involvement itself influences commitment level and understanding sports including technique and knowledge of rule in turn relates to the purchase intention of sporting goods[26]. In application, this study reveals the value of inserting promotions, trivia, and educational sessions into all sport leagues as it leads to future sport consumption.

The relationship between rule recognition by attending games has a direct relationship with future attendance of games. Zhang et al.(1996) claimed that educating people about sport itself, which included rules of play might be one of key elements in game promotion of teams and confirmed that knowledge of sport rules critically influenced attendance and ticket consumption[10]. This study illustrates learning by attending sporting events lends to attending more games in the future. Promoting learning of rules to those in attendance will encourage those in attendance to return. Trivia and contests can be held within games in order to encourage rule acquisition to those in attendance. Another possible suggestion would be hosting events catering to international or foreign potential football fans residing or visiting the United States. During the off season, teams could host a 'rule information session' detailing the rules of football for people from other countries and cultures not familiar with football and

they could expect to secure additional potential fans group that each team has not been recognized as 'blue ocean' so far[27].

Learning rules via media consumption lends to future consumption of media consumption[28]. Raney & Depalma(2006) that explained the three different motivations(i.e., emotional, cognitive, and behavioral motivation) regarding watching sports on television. Among those three motivations, cognitive motivation supports this result. Many people who enjoy sports, appreciate opportunity in which to share their abundance of sports knowledge and participant in trivia as walking sport encyclopedias, making it possible to continuous learn about sports including team, players, history, and rules[28]. Targeting media audiences with rules-based information will influence the likelihood of future consumption. Audiences of sport media can be exposed to rules-based information in various formats such as on-screen rule explanation and rules-based trivia questions[29].

Perhaps the most profound was the relationship rule acquisition based on playing video games with respect to future behavioral intentions. Learning sport rules by way of playing videos elucidates relationships with three out of four future consumption behaviors. Specific to playing video games, it represents an appropriate way to apply sport related knowledge(players, teams, rules, strategies of game) and transfers easily to playing sports in person, which thereby coincides with purchasing sporting goods merchandise and equipment. Inserting rules-based knowledge into video games in a direct and deliberate way would increase rule acquisition and based on this study produce increased consumption rates. This relationship implies that if practitioners can increase sport-based rule knowledge for consumers of video game products, one can expect to see increases in future consumption patterns outside of purchasing additional video games[30].

6. Limitations and Recommendations

It is important to consider the overall sample for future implications. This study reveals the importance of learning rules while playing video game however this pathway also indicated the lowest overall mean within learning pathways for rule acquisition. Further research should be done within the video gaming community to investigate the full weight of these relationships. This study also did not consider demographic characteristics although previous studies[31][32]indicated that there were differences between males and females regarding their efforts to gain sport-related knowledge. Fans' preference of sports(i.e., football, baseball, basketball), type of sports(i.e., team sports, individual sports, combat sports), and preferred league levels(i.e., collegiate level, professional level), may also impact the results.

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8. Appendix

8.1. Authors contribution

	Initial name	Contribution
Lead Author	WC	-Set of concepts☑ -Design ☑ -Getting results ☑ -Analysis ☑
Corresponding Author*	HS	-Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑
Co-Author	NL	-Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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Application of Functional Training for Improving the Performance of Male High School Freestyle WRESTLER

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Abstract

Purpose: *This study is a case study that analyzes the effects after planning and applying a functional training program to improve the performance of high school male freestyle wrestler.*

Methods: *The subject of this study was one elite athlete in freestyle wrestling at K High School in D Metropolitan City. The contents of the applied functional training program consisted of 5 items related to flexibility, 5 items related to dynamic stabilization, 8 items related to muscular endurance, and 8 items related to muscle power improvement in consideration of the wrestling competition situation. After applying the functional training program twice a week at a frequency of 120 minutes per day for 5 weeks(10 times), changes in body composition, basic physical strength, maximal exercise load test, anaerobic exercise capacity, knee joint isokinetic strength and muscle power were analyzed.*

Results**:** *Body composition, basic physical fitness, maximal exercise load test, anaerobic exercise capacity, isokinetic muscle strength and muscle power were measured before and after the application of functional training, and most of the measurement items showed positive changes after application of the program. In particular, a positive change in exercise duration and maximal oxygen intake as a result of the graded maximal exercise test indicates an improvement in cardiopulmonary endurance, and a decrease in peak drop among the anaerobic exercise capacity measurement items increases tolerance to fatigue. In addition, positive changes in knee joint isokinetic muscle strength and muscle power are very important physical factors for improving the wrestler's performance, and it is judged that the effect of the functional training program applied in this study is appropriately reflected.*

Conclusions: *In summarizing the results of this study, the planning of the optimal functional training program taking into account the physical characteristics of the sport and individual athletes showed more developmental changes than the previous physical fitness training which depended on the intensity of training and the amount of training. This training method was considered to show the possibility of being fully utilized for the future improvement of elite athletes' performance.*

[Keywords] ***Wrestling, Functional Training, Graded Exercise Testing, Anaerobic Exercise Performance, Knee Joint Isokinetic Muscular Function***

1. Introduction

Wrestling is the longest-running sport in the history of mankind, in which the opponent's shoulders touch the floor at the same time in a 9m amphitheater, or the judge decides the game[1]. Domestic wrestling began in 1936 at the Jongno YMCA wrestling department[2]. Chang-seon Jang won the gold medal in the freestyle at the 1966 World Championships in USA, and Jeongmo Yang won the first gold medal in the freestyle at the Montreal Olympics in 1976[3].

In particular, Kwon-ho Shim is Korea's first wrestler to win consecutive gold medals in the Atlanta and Sydney Olympics. Wrestling competitions can be divided into freestyle games that use all parts of the human body and Greco-Roman games that can only use the upper body above the waist[4][5], and there are differences in skill types and required physical fitness factors for each sport[6][7][8]. The amateur wrestling competition is a high-intensity exercise held in 3 minutes and 3 rotations, and the maximum aerobic exercise capacity and the ability to resist fatigue and recovery from the process of anaerobic energy metabolism affect the performance(Kyung-Ryeol Lee, Won Shin, 2013).

In addition, the frequency of use of side rolls for Greco-Roman type players and tackle and side rolls for freestyle players is high, and the success rate of this technique is an important factor in winning and losing[9]. Factors that affect the performance of elite athletes can be classified into physique, physical fitness, skill, and mental capacity, and physical fitness is important for the efficient application of game skills, and mental capacity plays a very important role in exerting the maximum ability of physical fitness and skill[9][10]. As important physical factors of wrestling performance, muscle power, muscular endurance, and agility[11][12][13][14][15] are emphasized. Because in order to win the championship, 4-6 matches per day must be performed, the recovery capacity is also evaluated as an important factor in performance [16]. Looking at the previous studies related to the wrestler's performance, the previous studies on the difference between the wrestler's gender, isokinetic muscle strength, and aerobic and anaerobic exercise capacity[17][18][19][20][21][22].

In recent, 'Whole-Body Mechanics of Double-Leg Attack in Elite and Non-elite Male Freestyle Wrestlers [23]', 'Injuries and rapid weight loss in elite Korean wrestlers: an epidemiological study[24]', and 'Effects of gradual weight loss on strength levels and body composition in wrestlers athletes [25]' have been reported. Most of the previous studies have simply compared the difference between the type of injury, gender, sport, and weight, and studies that analyzed the application effect of the training program taking into account the actual sport, athlete's physique and physical fitness level are very inadequate and insufficient.

Therefore, this study planned and applied the optimal functional training program in consideration of the characteristics of freestyle wrestling matches and individual physical fitness characteristics, and analyzed its effects.

2. Methods

2.1. Subject

The subject of this study was one freestyle wrestler at K high school in D Metropolitan City, and the physical characteristics are as shown in <Table 1>.

Table 1. Physical characteristics of subject(n=1).

Age(yr)	Height(cm)	Body weight(kg)	Fat(%)	FFM(㎏)	BMI(㎝/㎡)
17	181.2	89.1	12.7	77.3	27.1

2.2. Measurement items

Body composition test, back muscle strength, grip strength, sit-ups, push-ups, visual perception response(coordination), repetitive jump, jump in place, sergeant jump, sound/light reaction, side step test, one foot standing with eyes closed, full body and posterior flexion, lung capacity, maximal exercise load test, anaerobic exercise capacity, knee joint isokinetic muscle strength and muscle power were measured according to the measurement manual at the regional sports science center.

2.3. The functional training program

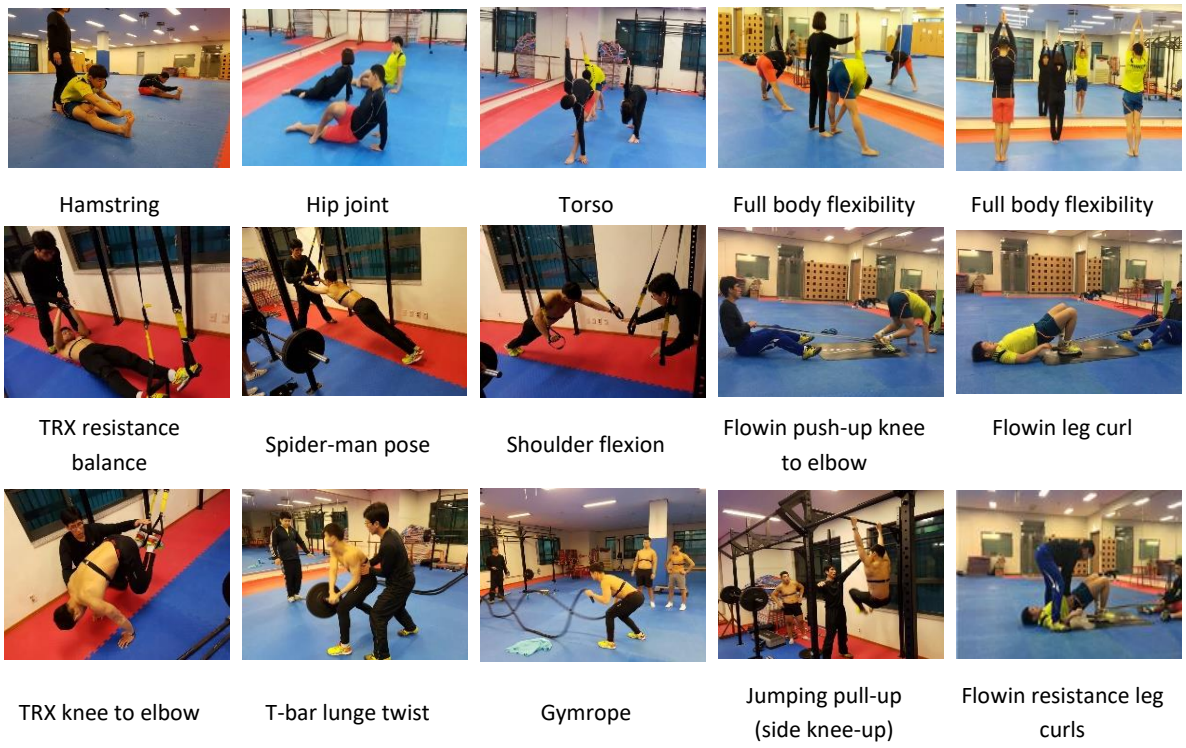
The functional training program of this study consisted of 5 flexibility-related events, 5 dynamic stabilization-related events, 8 muscle endurance-related events, and 8 muscle power enhancement training events taking into account the wrestling competition situation. The application of the functional training program was conducted for 5 weeks(10 times) excluding the before and after measurement days, and was conducted twice a week, at 120 minutes per day. Warm-up and cool-down were not included in the exercise time.

There was a difference in exercise intensity depending on the training stage(HRR 80%-100%), and the total calories consumed per exercise was applied to consume 750-800 calories based on Apple Watch(Apple Co., LosAngeles, CA., USA). The detail contents of training program were shown in <Table 2> and <Figure 1>.

Table 2. The detail contents of functional training program.

Item	Exercise events	Duration
Flexibility & dynamic stabilization	Hamstring, hip joint, torso, full body flexibility(5 events) Dynamic stabilization of the trunk(5 events)	20 min (15 frequency × 15second × 3set, individually)
Endurance training (cardiopulmonary function & muscular endurance)	400m run, 500m rowing, gymrope, TRX resistance balance, TRX knee to elbow, t-bar lunge twist, flowin push-up knee to elbow, flowin leg curl(8 events)	60 min (cardiopulmonary function 5 set, muscular endurance 20 frequency × 3 set)
Muscle power training (wrestling related functional training)	Jumping pull-up, jumping pull-up & side knee-up, t-bar lunge twist, t-bar one arm split push press, power clean, clean & jerk, split jumping up & down, reaction time training(8 events)	40 min (3 sets * 8 events, Incremental load as stage, 1 min challenge in last stage)

Figure 1. Images of functional training program.



Clean & Jerk

T-bar resistance one arm push

T-bar one arm split push press

Split Jumping up & down

Reaction Time Training

2.4. Data analysis processing

In the data analysis processing of this study, the measured values before and after the functional training were applied were compared and analyzed, and no separate statistical processing was performed.

3. Results

3.1. Physical characteristics

The changes in physical characteristics of subject before and after applying the functional training are as shown in <Table 3>.

Table 3. Changes of physical characteristics.

Weight(kg)		Fat(%)		FFM(kg)		BMI(㎝/㎡)	
Pre	Post	Pre	Post	Pre	Post	Pre	Post
85.6	89.1	15.9	12.7	71.99	77.78	26.07	27.13

3.2. Results of physical fitness

The changes in basic physical fitness before and after applying the functional training are as shown in <Table 4>.

Table 4. Changes of physical fitness.

Items		Pre	Post
Back muscular strength(kg)		160.5	164.0
Grip strength(kg)	Left	50.0	54.7
	Right	49.0	54.9
Sit-up(frequency)		53	61
Push-up(frequency)		30	43
Coordination of hand and eye	Total time(sec)	72.726	43.659
	Error frequency	12	6
Repeated jump(frequency)		35	45
Standing long jump(cm)		203.2	245.6
Sarjent jump(cm)		41	61
Audio reaction time(sec)		0.321	0.231
Video reaction time(sec)		0.372	0.260
Side-step(frequency)		38	44

One-foot standing with closed eye(sec)		15.97	16.60
Sit & reach(cm)		25.5	26.4
Backward flexion(cm)		58.1	57.4
Pulmonary function	FVC(L)	5.19	5.95
	FEV 1.0(L)	4.64	4.18
	FEV% 1.0(%)	89.6	70.3

3.3. Results of graded maximal exercise test

The results of the graded maximal exercise test before and after applying the functional training are as shown in <Table 5>. Exercise duration was changed from 18 minutes 05 seconds to 19 minutes 12 seconds, and maximal oxygen uptake was changed from 53.24 ㎖/kg/min to 56.92 ㎖/kg/min. Resting heart rate was changed from 65 to 63 beats/minute, and maximal heart rate was changed from 196 times/minute to 199 times/minute. Therefore, it showed positive changes after applying functional training in all measurement items.

Table 5. Results of graded maximal exercise test.

Items	Pre	Post
All-out time(min)	18.05	19.12
VO2max(ml/kg/min)	53.24	56.92
HRrest(beats/min)	65	63
HRmax(beats/min)	196	199

3.4. Results of anaerobic exercise capacity

Changes in anaerobic exercise capacity before and after applying functional training are shown in <Table 6>. In the measurement result of anaerobic exercise capacity, the peak power was changed from 632.24 W to 655.96 W, and the average power was changed from 441.58 W to 499.87 W. The average power per body weight was changed from 5.16 W/kg to 5.61 W/kg, and the total energy output was changed from 12170 J to 14674 J. As a result, the peak drop was changed from 68.92 % to 53.19 %, and a most of the measurement items showed a positive change after applying functional training.

Table 6. Results of anaerobic exercise capacity.

Items	Pre	Post
Peak power(W)	632.24	655.96
Peak power(W/kg)	7.39	7.36
Average power(W)	441.58	499.87
Average power(W/kg)	5.16	5.61
Total energy(J)	12170	14674
Peak drop(%)	68.92	53.19

3.5. Results of isokinetic muscle function of the knee joint

The measurement results of isokinetic muscle function of the knee joint before and after applying the functional training are as shown in <Table 7> and <Table 8>. In the case of knee joint isokinetic strength measured at an angular velocity of 60°/sec, after functional training was applied in most of the measurement items, positive results were shown, but positive

changes were not found in the case of the left and right flexors. In the case of the isokinetic muscle power of the knee joint measured at an angular velocity of 180°/sec, a positive change was shown in all measurement items after applying the functional training.

Table 7. Results of isokinetic muscular strength of the knee joint(60°/sec).

Items	Pre	Post
Right extensors(Nm)	199	254
Left extensors(Nm)	210	251
Right extensors(%BW)	232	283
Left extensors(%BW)	244	280
Right flexors(Nm)	121	126
Left flexors(Nm)	126	127
Right flexors(%BW)	140	140
Left flexors(%BW)	146	143
Ratio of flexors to extensors in left	60	51
Ratio of flexors to extensors in right	61	50

Table 8. Results of isokinetic muscular power of the knee joint(180°/sec).

Items	Pre	Post
Right extensors(Nm)	176	183
Left extensors(Nm)	170	194
Right extensors(%BW)	197	206
Left extensors(%BW)	199	218
Right flexors(Nm)	95	100
Left flexors(Nm)	110	114
Right flexors(%BW)	109	113
Left flexors(%BW)	121	128

4. Discussion

This study analyzed the application effect of functional training to improve athletic performance for one elite freestyle wrestler in high school. Based on the results of various previous studies[16][26][27][28][29][30][31][32], a functional training program was constructed to improve the physical fitness factors related to the wrestler's performance. As a result of interviewing with the instructor before applying the functional training, the study subjects said that they need to gain body weight now and that they need to compensate for their lack of concentration in the latter half of the game. In the physical fitness measurement results, the peak drop of the muscular endurance and result of Wingate test was high, so the interview result of the instructor and the physical fitness measurement result were consistent.

The functional training program was constructed in consideration of improvement of movement that can use efficient exercise chain along with physical fitness improvement. As a result of examining changes in physical characteristics and physical fitness after applying func-

tional training, muscle mass and weight increased, but body fat percentage decreased, and positive changes were found in all measurement items except balance, flexibility, and lung capacity. In particular, body weight gain, push-ups and sit-ups, etc. through reduction of body fat and increase in muscle mass are thought to have greatly improved to satisfy the needs of instructor. The results of a preceding study[33] comparing the physical fitness difference between freestyle and Greco-Roman type junior wrestlers show that the Greco-Roman type wrestler, whose center of the lower limb is important, has higher grip and back muscular strength than the freestyle wrestlers who mainly attacks the lower body using the upper body.

Although reported, there was also a result of a previous study[34] that did not confirm the difference between sports in the case of back muscular strength considering weight, so muscular strength is regarded as an important physical fitness factor for wrestlers regardless of the sports event. In the results of the preceding study[34], the abdominal muscular strength considering the weight of freestyle wrestlers of the same age group was 1.89±0.79kg/BW, which was almost the same as the physical fitness measurement result(1.84kg/BW) of the subject. In the results of the graded maximal exercise load test, positive changes in exercise duration and maximal oxygen uptake after functional training were applied indicate that cardiopulmonary function was improved. The subjects of this study increased from 53.24ml/kg/min before applying functional training to 56.92ml/kg/min after applying functional training.

These results are almost in line with the measured values(54.43ml/kg/min) suggested in the previous study[35] that reported changes in maximal oxygen uptake and isokinetic muscle function after applying resistance training in 27 wrestling freestyle athletes. Long-term training of 3 months or longer is required to improve cardiorespiratory function. In this view, as the functional training program applied in this study includes fast-tempo muscle power training that requires muscle strength of 15 RM or more, in spite of relatively short training, cardiorespiratory function showed the improvement of 7% range. In the measurement results of anaerobic exercise capacity, positive changes were found in all measured items except peak power per 1 kg of body weight.

In particular, the peak drop decreased significantly from 68.92% to 53.19%, resulting in improved resistance to exercise-induced fatigue. According to the results of a previous study that the anaerobic exercise conducted by Kyung-Ryeol Lee and Won Shin(2013)[16] affects the fatigue substances and basic physical fitness of wrestlers by career, aerobic power training for senior wrestlers and anaerobic power training for junior wrestlers. These previous suggestions are considered to support the results of this study by emphasizing it as more important. Another previous studies[36][37] also reported the importance of training to increase tolerance to fatigue in order to maximize athletic performance and demonstrate effective skills.

Finally, the isokinetic muscular strength measured at an angular velocity of 60°/sec as a result of analyzing the knee joint isokinetic muscle function was found to be positive in the items of the left and right extensors and the extensors considering body weight, and the angular velocity 180°/sec was also shown the similar result. These results were consistent with the results of previous studies by Jeong and Jin-Won(2001)[38], which reported that extension and muscle power are important for wrestlers. A scientific and systematic physical fitness training program taking into account the sport and physical characteristics of wrestlers has been required in the training field for a long time[39], but it is inadequate to meet the demands of athletes and instructors.

Therefore, athletes and instructors of various sports events are urgently demanding the optimal training method[40][41] to improve the exercise performance. This study is a case study in which a functional training program focused on physical fitness factors identified through physical fitness measurement and evaluation of elite high school freestyle wrestler was constructed and applied, and the effects were analyzed. Therefore, these results suggest a possibility that can be applied for the improvement of physical fitness in wrestler‘s actual exercise training.

5. Conclusions

The purpose of this study was to analyze the effect of a functional training program applied to a freestyle wrestler at K high school in D city to improve their athletic performance. As a result of comparing body composition, basic physical fitness, graded maximal exercise load test, anaerobic exercise capacity, isokinetic muscular strength and power before and after applying functional training, a most of the measurement items showed positive changes after training.

In summarizing the results of this study, applying the optimal functional training program in consideration of the sport and the individual physical fitness characteristics of wrestler can be suggested as a way to get out of the limitations of the traditional physical fitness training that depended only on the training intensity and amount of training. In addition, it is expected to have a high possibility of helping wrestlers improve their performance.

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7. Appendix

7.1. Authors contribution

	Initial name	Contribution
Lead Author	JP	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑ -Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑
Corresponding Author*	KK	

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Comparative Analysis of OFFENSIVE SKILLS According to Gender and Grade of Judo Athletes in Middle, High, and University

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Abstract

Purpose: *The purpose of this study is one,and-intended to provide a basis for performance improvement compared to the difference of the attack techniques according to sex and grade of the University of inducing the player.*

Method: *In this study, a questionnaire survey was conducted on 198middle,high,andcollege judo athletes,andthe collected data were analyzed using the SPSS 26.0 Statistical Program.Frequency analysis was performed to understand the general characteristics of the study subjects, and Cronbach'sαcoefficient was calculated toverify the reliability of the questionnaire.A t-test was conducted to find out differences in attack techniques according to gender, and One Way ANOVA was conducted to find out differences in attack techniques according to grades.*

Results: *It did not show the difference statistically significant attack skills according to gender. in the case of the attack techniques of the grade hand techniques and foot techniques of college students showed highly significant statistically than high school. On back technology of middle school students, it was significantly higher than high school students and college students.*

Conclusion: *Syntehsizing this study, these results, in the case of hand techniques and foot techniques, according to the grade of, compared to high school with high frequency utilization of college players, it should be taken into account that as identified in prior studies, on the training program plan of high school elite athletes, therefore, it is necessary to find a plan for physical strength and skill training to increase the scoring rate of hand skills and foot skills.*

[Keywords] ***Judo Players, Gender, Grade Level, Attack Skill, Score Rate***

1.Introduction

Judo is a sport with the sentiment of the East, and it is practiced at various ages globally beyond Japan, the country of origin[1]. It is one of sports that have positive effects on character and training body and soul, including strengthening of physical strength and whether to win or lose the game[2][3][4][5]. Several previous studies also suggested that judo training has an effect on self-confidence[6] and interpersonal relationships[7], which has a positive effect on self-efficacy and social support[8]. All sports, including judo, have physical strength, skill, body composition, and psychological factors as factors that affect performance depending on the sport, and among them, physical strength and skill factors are evaluated as the most important factors[9]. Judo match is a high-intensity sport in which the opponent's center must be defeated and a goal must be scored, and it requires a considerable level of professional physical strength because the technique must be applied at the correct timing[10][11]. Look-

ing at the judo match of the recent international competition[12], the match performance of Japan, the successor, is not overwhelmingly high, but it is generally leveled. These results are thought to have been influenced by the development of game technology through scientific analysis using smart devices and big data, and a professional physical training program taking into account the characteristics of judo games[13]. Judo match technology analysis can collect a variety of information on individual attack types, strategy analysis and game management of opponents, and this is known to have a great influence on the improvement of judo players' performance[14]. Looking at the results of previous studies related to the analysis of the judo players' game skills, a study on the solidifying techniques and development process of elite female judo players[15] and a study on scoring techniques for the 2012 London Olympic judo national team[16], differences in skill patterns and tactics of judo players according to gender and age[17][18], judo match rules[19][20], attack system[21], catch technique[22], training effect[23]. A study on the relationship between the winning career and the experience of selecting a representative player[24] has been conducted. In particular, Kang(2014)[16] reported that the frequency of using the leg technique of female athletes was significantly higher than that of male athletes in the results of a prior study that analyzed the scoring technique for the 2012 London Olympic judo national athletes.

Judo techniques can be divided into strangulation performed while standing and solidification performed while lying down. There are hand, waist, foot techniques, and lie down strangulation. This study aims to provide useful information for training plans to improve performance by comparing and analyzing differences in attack techniques according to gender and age(grade) of domestic middle, high, and university judo players.

2. Research Method

2.1. Research subject and sampling method

In this study, a questionnaire survey was conducted using the self-administration method of 200 subjects by Convenience sampling using the 2020 Daegu-Gyeongbuk area judo athletes as a population. Among the questionnaires, 198 questionnaires were taken as valid samples, excluding data whose responses were poor or part of the survey content was omitted.

Table 1. General characteristics of the research subject.

	Division	N(%)	System
Gender	Man	119(60.1)	198
	Woman	79(39.9)	
Grade	Junior high school 1st grade	18(9.1)	198
	Junior 2nd grades	20(10.1)	
	3rd grade junior high school	22(11.1)	
	First grade in high school	17(8.6)	
	Second grade in high school	24(12.1)	
	High school 3rd grade	22(11.1)	
	University first year	19(9.6)	
	University 2nd year	13(6.6)	
	University 3rd year	27(13.6)	
	University 4th grade	16(8.1)	
Career	2 years or less	52(26.3)	198

	3 years or more - 5 years or less	48(24.2)	
	More than 6 years	98(49.5)	
Whether or not to have the winning experience	Have	148(74.7)	198
	None	50(25.3)	
Representative experience	Have	118(59.6)	198
	None	80(40.4)	

2.2. Contents of the questionnaire

A questionnaire was used as a survey tool to achieve the purpose of this study, and a draft of the questionnaire was prepared based on the judo competition rules and revised after discussing it with the leaders and athletes. It was supplemented.

2.3. Validity and reliability of the questionnaire

The validity of the content of this study was secured through consultations with experts in related research fields in order to adopt a questionnaire that fits the research purpose. Reliability is the degree to which an individual's score appears consistently when repeated tests of the same or homogeneous test are performed. The reliability was verified based on the result of the questionnaire and the reliability was analyzed using Cronbach's α coefficient.

2.4. Data processing

In the data processing of this study, after collecting the distributed questionnaire, data that were judged to be inadequate or unreliable were excluded from the study subject, and data that could be analyzed were individually entered into a computer and analyzed using the SPSS 26.0 Program. Frequency analysis was performed to understand the general characteristics of the study subjects, and Cronbach'sαcoefficient was calculated to verify the reliability of the questionnaire. A t-test was conducted to find out differences in attack techniques according to gender, and One Way ANOVA was conducted to find out differences in attack techniques according to grades.

3. Research Results

3.1. Differences in attack techniques by gender

Differences in attack techniques according to gender are shown in <Table 2>.

Table 2. Differences in attack techniques by gender.

Technology		Gender	Average (M)	Standard deviation (SD)	t-value	Sig
Hand technology	Using both arms throwing down	Male	3.5210	1.44298	.421	.674
		Female	3.4304	1.54159		
	With a single arm throwing down	Male	3.7647	1.64526	-.136	.892
		Female	3.7975	1.68233		

	Tai-otoshi	Male	1.7311	1.29338	-.152	.880
		Female	1.7595	1.28318		
	Using shoulder tachil-waza	Male	1.6218	1.37157	.071	.943
		Female	1.6076	1.39061		
	A chip grabbing the collar	Male	1.7731	1.41683	.444	.657
		Female	1.6835	1.34493		
Waist technology	Waist chip	Male	1.9496	1.52854	-.728	.467
		Female	2.1139	1.59315		
	Ukigoshi	Male	1.8067	1.12202	-1.163	.246
		Female	2.0127	1.35395		
	O-goshi	Male	1.5546	.89913	-.201	.841
		Female	1.5823	1.02040		
	Hip throw	Male	1.5210	1.08024	-1.024	.307
		Female	1.6962	1.31417		
	Hip throw with sash grabbing	Male	1.3025	.87870	-.383	.702
		Female	1.3544	1.01322		
Foot technique	Uchi-mata	Male	2.2521	1.01027	-.007	.994
		Female	2.2532	1.07975		

	Okuri-barai	Male	1.4118	.92436	1.602	.111
		Female	1.2152	.71020		
	Kouchi-gari	Male	1.9076	1.33399	-.214	.831
		Female	1.9494	1.36719		
	Weigh-in	Male	1.3782	.90190	-.657	.512
		Female	1.4684	1.01065		
	Chip	Male	1.6134	1.14321	.591	.555
		Female	1.5190	1.03603		

3.2. Differences in attack skills by grade

Differences in attack techniques according to grades are as shown in <Table 3>, <Table 4>, and <Table 5>.

Table 3. Differences in attack hand techniques by grade.

		N	M	SD	F	sig	post hot
Throwing down using both arms	Junior high school 1st grade	18	3.6667	1.64496	1.274	.253	
	Junior 2nd grades	20	4.0000	1.37649			
	3rd grade junior high school	22	3.7727	1.60154			
	1st grade in high school	17	3.9412	1.39062			
	Second grade in high school	24	3.0000	1.28537			
	High school third grade	22	3.0909	1.15095			
	University first year	19	3.3158	1.45498			
	University 2nd year	13	3.0769	1.80100			
	University 3rd year	27	3.6667	1.38675			
	University 4th grade	16	3.2500	1.77012			
With a single arm throw-ing down	Junior high school 1st grade	18	3.7222	1.77584	.628	.773	
	Junior 2nd grades	20	4.0500	1.60509			
	3rd grade junior high school	22	3.6818	1.72892			
	1st grade in high school	17	4.0588	1.51948			
	Second grade in high school	24	3.7083	1.80529			
	High school third grade	22	3.5909	1.76363			
	University first year	19	3.6316	1.77045			
	University 2nd year	13	3.2308	1.58923			
	University 3rd year	27	4.2593	1.34715			
	University 4th grade	16	3.5000	1.78885			
Tai-otoshi	Junior high school 1st grade	18	1.0556	.23570	3.674	.000	I>A, I>B, I>D
	Junior 2nd grades	20	1.1000	.30779			
	3rd grade junior high school	22	1.4545	.96250			

	1st grade in high school	17	1.1765	.39295			
	Second grade in high school	24	1.7500	1.18872			
	High school third grade	22	1.8182	1.22032			
	University first year	19	2.3158	1.56534			
	University 2nd year	13	1.7692	1.48064			
	University 3rd year	27	2.4074	1.59950			
	University 4th grade	16	2.3750	1.85742			
Using shoul-der Tachil-waza	Junior high school 1st grade	18	1.0000	.00000	8.634	.000	H>A,B,C,D,E I>A,B,C,D,E,F,G J>A,B,C,D,E
	Junior 2nd grades	20	1.0000	.00000			
	3rd grade junior high school	22	1.0000	.00000			
	1st grade in high school	17	1.0000	.00000			
	Second grade in high school	24	1.0000	.00000			
	High school third grade	22	1.5455	1.40500			
	University first year	19	1.6842	1.37649			
	University 2nd year	13	2.6154	1.85016			
	University 3rd year	27	2.8519	1.87501			
	University 4th grade	16	2.6250	1.92787			
Chip grab-bing collar	Junior high school 1st grade	18	1.0000	.00000	13.874	.000	H>A,B,C,D,E I>A,B,C,D,E,F,G J>A,B,C,D,E,F,G
	Junior 2nd grades	20	1.0000	.00000			
	3rd grade junior high school	22	1.0000	.00000			
	1st grade in high school	17	1.0000	.00000			
	Second grade in high school	24	1.2917	.99909			
	High school third grade	22	1.6364	1.43246			
	University first year	19	1.5263	1.30675			
	University 2nd year	13	2.6923	1.70219			
	University 3rd year	27	2.9259	1.54237			
	University 4th grade	16	3.5625	1.50416			

Note: A: Middle 1, B: Middle 2, C: Middle 3, D: High 1, E: High 2, F: High 3, G: Large 1, H: Large 2, I: Large 3, J: Large 4.

Table 4. Differences in attack waist techniques by grade.

		N	M	SD	F	sig	post hot
Waist chip	Junior high school 1st grade	18	1.8889	1.60473	2.310	.017	Not coming out
	Junior 2nd grades	20	1.4500	1.09904			
	3rd grade junior high school	22	1.5000	1.30018			
	1st grade in high school	17	1.7059	1.44761			
	Second grade in high school	24	1.7083	1.51741			
	High school third grade	22	2.5909	1.79043			
	University first year	19	2.6842	1.66842			
	University 2nd year	13	2.9231	2.01914			
	University 3rd year	27	1.7778	1.33973			
	University 4th grade	16	2.4375	1.31498			
O-goshi	Junior high school 1st grade	18	1.9444	1.47418	.272	.981	
	Junior 2nd grades	20	1.6000	1.09545			
	3rd grade junior high school	22	1.8636	1.24577			
	1st grade in high school	17	1.9412	1.24853			
	Second grade in high school	24	1.9167	1.28255			
	High school third grade	22	2.0455	1.52682			
	University first year	19	1.9474	1.43270			
	University 2nd year	13	2.1538	1.21423			
	University 3rd year	27	1.8148	.78628			
	University 4th grade	16	1.7500	1.00000			
waist techniques	Junior high school 1st grade	18	1.9444	1.58938	1.928	.050	Not coming out
	Junior 2nd grades	20	1.6000	1.09545			

	3rd grade junior high school	22	1.8636	1.24577			
	1st grade in high school	17	2.0588	1.47778			
	Second grade in high school	24	1.4167	.50361			
	High school third grade	22	1.4091	.50324			
	University first year	19	1.3158	.47757			
	University 2nd year	13	1.6923	.63043			
	University 3rd year	27	1.2222	.42366			
	University 4th grade	16	1.3750	.50000			
A hip throw grabbing the belt	Junior high school 1st grade	18	2.0000	1.45521	2.256	.020	Not coming out
	Junior 2nd grades	20	1.6000	1.09545			
	3rd grade junior high school	22	1.9091	1.23091			
	1st grade in high school	17	2.0000	1.50000			
	Second grade in high school	24	1.4167	.88055			
	High school third grade	22	1.9545	1.61768			
	University first year	19	1.7368	1.48482			
	University 2nd year	13	1.0000	.00000			
	University 3rd year	27	1.1852	.55726			
	University 4th grade	16	1.0000	.00000			
Sash grabbing	Junior high school 1st grade	18	1.9444	1.58938	3.605	.000	A>F, A>I, D>I
	Junior 2nd grades	20	1.4500	1.09904			
	3rd grade junior high school	22	1.7273	1.27920			
	1st grade in high school	17	1.8824	1.53632			
	Second grade in high school	24	1.1667	.38069			
	High school third grade	22	1.0455	.21320			
	University first year	19	1.1053	.45883			
	University 2nd year	13	1.0000	.00000			
	University 3rd year	27	1.0000	.00000			
	University 4th grade	16	1.0000	.00000			

Note: A: Middle 1, B: Middle 2, C: Middle 3, D: High 1, E: High 2, F: High 3, G: Large 1, H: Large 2, I: Large 3, J: Large 4.

Table 5. Differences in attack skill according to grade.

		N	M	SD	F	sig	post hot
uchi-mata	Junior high school 1st grade	18	1.6667	.48507	4.214	.000	F>A,I,J G>A,J
	Junior 2nd grades	20	2.4500	.82558			
	3rd grade junior high school	22	2.4545	.96250			
	1st grade in high school	17	2.0588	.96635			
	Second grade in high school	24	2.1667	.63702			
	High school third grade	22	2.9091	.97145			
	University first year	19	2.8421	1.25889			
	University 2nd year	13	2.3846	1.19293			
	University 3rd year	27	1.9259	1.10683			
	University 4th grade	16	1.5625	1.09354			
Okuri-barai	Junior high school 1st grade	18	1.5000	.85749	3.239	.001	H>D,E,F,G
	Junior 2nd grades	20	1.7500	1.06992			
	3rd grade junior high school	22	1.2727	.70250			
	1st grade in high school	17	1.0000	.00000			

	Second grade in high school	24	1.0000	.00000			
	High school third grade	22	1.1818	.66450			
	University first year	19	1.0526	.22942			
	University 2nd year	13	2.0769	1.38212			
	University 3rd year	27	1.5185	1.18874			
	University 4th grade	16	1.1875	.75000			
Kouchi-gari	Junior high school 1st grade	18	1.5000	.85749	1.495	.152	
	Junior 2nd grades	20	1.3500	.74516			
	3rd grade junior high school	22	1.8636	1.12527			
	1st grade in high school	17	2.0000	1.36931			
	Second grade in high school	24	1.7500	1.18872			
	High school third grade	22	1.8182	1.22032			
	University first year	19	2.3158	1.56534			
	University 2nd year	13	1.7692	1.48064			
	University 3rd year	27	2.4074	1.59950			
	University 4th grade	16	2.3750	1.85742			
Weigh-in	Junior high school 1st grade	18	1.1667	.38348	4.892	.000	I>A,B,C,D,E,F
	Junior 2nd grades	20	1.2000	.41039			
	3rd grade junior high school	22	1.0455	.21320			
	1st grade in high school	17	1.1176	.33211			
	Second grade in high school	24	1.0833	.28233			
	High school third grade	22	1.1818	.39477			
	University first year	19	1.4737	1.12390			
	University 2nd year	13	1.6923	1.10940			
	University 3rd year	27	2.2222	1.52753			
	University 4th grade	16	1.9375	1.43614			
Chip	Junior high school 1st grade	18	1.1111	.32338	10.338	.000	H>A,B,C,D,E I>A,B,C,D,E,F,G J>A,B,C,D,E,F,G,H
	Junior 2nd grades	20	1.1000	.30779			
	3rd grade junior high school	22	1.0909	.29424			
	1st grade in high school	17	1.0000	.00000			
	Second grade in high school	24	1.1667	.63702			
	High school third grade	22	1.5000	1.22474			
	University first year	19	1.3684	1.01163			
	University 2nd year	13	2.2308	1.36344			
	University 3rd year	27	2.4815	1.28214			
	University 4th grade	16	2.8750	1.40831			

Note: A: Middle 1, B: Middle 2, C: Middle 3, D: High 1, E: High 2, F: High 3, G: College 1, H: college 2, I: college 3, J: college 4

4. Discussion

The study discusses the results of comparative analysis differences of attack techniques by gender and grade of the University of inducing the player.

As a result of comparing and analyzing the difference in attack techniques according to gender, no statistically significant difference in attack techniques according to sex was found. However, in the hand technique, men showed higher average values than women in both arms using both hands throwing down, using shoulder throwing down, and chip grabbing the collar, and women showed higher average values than men in using a single arm throwing down, and Tai-otoshi. In the waist technique, women showed higher average values than men in the Harai-goshi, Uki-goshi, O-goshi, a hip throw and a hip throw grabbing the belt. In the foot technique, men showed higher average values than women in Uchi-mataKouchi-gari, and Weigh-in. Women showed higher average values than men in Uchi-mata, Kouchi-gari and Weigh-in. In the results of previous studies that analyzed the association between world judo skill types and athletic performance, judo techniques may differ according to gender[26][27], and scoring techniques for the 2012 London Olympic judo national team were analyzed[16]. It is reported that the frequency of use of the leg technique of female athletes is significantly higher than that of male athletes, but in another previous study[28], both male and female use high frequency of hand technique, and that of female leg technique and waist technique. It was reported that the frequency of use was relatively low, and it could be confirmed that there is a difference according to the characteristics of the study subjects. In the results of this study, there was no statistically significant difference according to gender, and among the foot techniques, the average values of Uchi-mata, Kouchi-gari, and Weigh-in were higher in female athletes, which was somewhat different from the previous study results. The use of judo techniques differs according to gender[29][30][31], and the frequency of use of hand and foot techniques also differs according to gender[32]. It is believed that a follow-up study is needed to compare the differences according to gender, taking into account the level of performance and the size of the competition.

As a result of comparing and analyzing the difference in attack hand techniques according to grades, 3rd graders of college showed statistically significant higher than those of the 1st and 2nd grades of middle school and the 1st grader of high school. Using shoulder Throwing down was statistically significantly higher in college 2nd year than in middle 1st, 2nd, 3rd grade, high school 1st, 2nd grade, and 3rd grade college 1st, 2nd, 3rd grade, high school 1st, 2nd, 3rd grade It was statistically significantly higher than that of the first grade and the first year of college, and the fourth year of college was statistically significantly higher than that of the first, second, and third year of middle school, and the first and second year of high school. In summary, it was found that the 3rd graders of the university showed the most frequent using shoulder throwing down attack technique, and that the college students used it more frequently than the middle and high school students.

In the case of the waist technique, the first grade of middle school was statistically significantly higher than that of the third grade of high school and the third grade of university in the belt grabbing hip throw attack technique, and the first grade of high school was statistically significantly higher than that of the third grade of university.

In the case of foot technique, high school 3rd graders were statistically significantly higher than middle school 1st graders, college 3rd and 4th graders in thigh-hanging attack technique, and university 1st graders were statistically significantly higher than middle school 1st graders and university 4th graders. appear. It was found that college players had higher attack skills than those of high school and middle school players in the attack skills of all-hanging, battery-freeing, and under-freeing.These results are from the results of previous studies[33] that college 4th grade athletes have higher competitive strength and sports confidence than college 1st, 2nd, and 3rd grade athletes[33], and the higher the athletic experience, the more the fighting spirit, self-confidence, and athletic performance influence the exertion of judo attack skills. Considering the results of previous studies[34] that may be insane, it is judged to support the results of this study.

Among the judo attack techniques, the skeletal muscle striking and the thigh hang require strong muscle function, which suggests that there is a difference between college athletes with relatively completed skeletal muscle development and middle and high school athletes in progress[35]. In ad-

dition, it is reported that there is a difference in the incidence of knee and back pain in the physical examination results by age[36] for judo athletes, indicating that exercise experience and exercise continuation can cause frequent injuries. These results have been reported not only in judo but also in previous studies[37][38][39][40][41] targeting elite athletes in various sports, supporting the differences according to gender and age.

5. Conclusion

This study aims to provide basic data for improving performance by comparing and analyzing differences in attack skills according to gender and grade for 198middle,high,anduniversity judo players.

Did not show the difference statistically significant in this study attack techniques according to gender, in the case of the attack techniques of the grade hand techniques and foot techniques are college students in,it showed highly significant statistically than high school, back technology junior high school and It was statistically significantly higher than that of college students.

This study These results In the case of hand techniques and foot techniques according to the grade of, compared to high school with high frequency utilization of college athletics is among the considerations that identified in previous research results,in the training program plan of high school elite athletes hand techniques And it is thought that it is necessary to find a plan for physical fitness and skill training to increase the scoring rate of foot skill.

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7. Appendix

7.1. Authors contribution

	Initial name	Contribution
Lead Author	BK	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑
Corresponding Author*	WC	-Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑
Co-Author	SJ	-Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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Reforming Tool to Measure SPORTS Ethics Consciounsness of Korean College Students

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Abstract

Purpose: *This study complements some of the shortcomings of the past developed tool for measuring sports ethics consciousness of Korean college students.*

Method: *The past tool used the basic principles developed by G. Lind of Germany. The validity was also based on the verification procedure proposed by G. Lind. To get better validation, this study got comments from 3 advisors who are very specialized in the sphere of moral education.*

Results: *This sports ethics consciousness measurement tool is generally good at verifying the order of preference for each moral development stage. The experts' reactions in 1st, 4th, and 5th stage were slightly out of the normal range. The quasi-simplex structure validation was clearly classified and guaranteed, and cognitive-emotional parallel validation also not bad. In the past researches, the 4th and 5th stages were slightly higher than the 6th stage. But the result of this study could be acceptable. To overcome the weakness the past tool, this study got interview with three domestic moral education based doctors. Mostly they commented trivial problems in the past tool which contains weakness at the stage of moral development. According to these aids, this study could change the sentences at the 4th stage.*

Conclusion: *This study showed the a little corrected tool for measuring sports ethics awareness of Korean college students that has been developed. Later the result of this study will be verified through statistical study.*

[Keywords] ***Sports Ethics Consciousness Measurement Tool, Moral Competence Test, Preference Hierarchy by Moral Development, Affective- Cognitive Parallelism Test, Simplex Structure of Inter Correlations between the Six Moral Orientations Test***

1. Introduction

Sports ethics is a sort of public value. Public value covers so many areas including sports, arts, education, culture etc.[1][2][3][4][5]. It deals with the evaluation which sports or sports person is good or bad. Sports ethics is an applied ethics in normative ethics under the ethics[6].

Most of past researches for sports ethics have tried to conduct the academic justification of sports ethics[7][8][9][10][11][12][13][14][15][16][17][18]. Some scholar showed the research of sports ethics in terms of J. Rawls' point of view of justice[19].

This study aims to reform sports ethics judgment tool. In particular, this study complements the weaknesses of the previously developed tools[20]. So, this study got the optimistic opinions from experts who are specialized at the morality measurement and moral education.

2. Overview on the Past Tool to Measure Sports Ethics Consciousness

2.1. Subject of survey

The survey for this study was conducted among 170 college students in Gyeongnam province of South Korea, from May to June 2019. Specific data can be seen as follows <Table 1>.

Table 1. Characteristics of survey targets(N=159).

Variable	Frequency	
Sex	Female (n=91, 57.2%)	Male (n=68, 42.8%)
Military experience	Yes (n=22, 32.4%)	No (n=46, 69.6%)
Major area	Humanity & social (n=56, 35.2%)	Natural science (n=103, 64.8%)
Faith	Yes (n=27, 16.9%)	No (n=132, 83.1%)
Age	20 years old (n=115, 72.3%)	More than 20 years (n=44, 27.7%)

2.2. Tool

The past survey tool followed the algorithm of Moral Judgment Competence Test(MCT) developed by Professor G. Lind. Originally, MCT exploited two moral dilemmas[21][22][23][24][25][26][27]. The past tool did not use it. But it used the MCT algorithm of 'value hierarchy' and 'weighting'.

2.3. Data processing

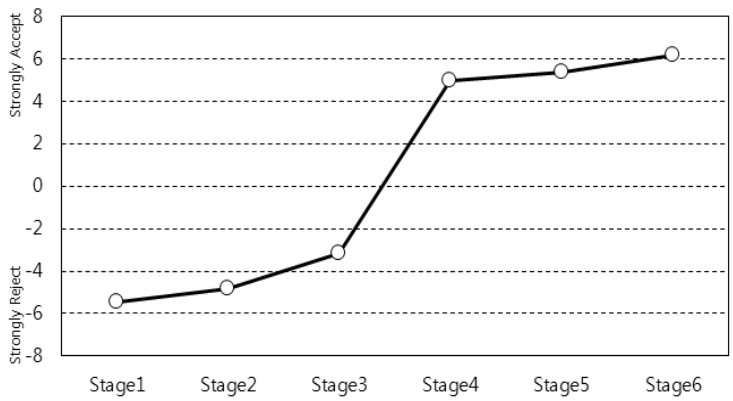
Data processing followed the C-score calculation method in MCT[27]. The processing was conducted according to the validity verification procedure created by G. Lind. For statistical analysis, this paper used the frequency comparison, mean comparison, and variance comparison. And the results of interviewing with moral education expert were quoted after transcription.

2.4. Validation process of the investigation tool

In previous studies, the validation of the tool followed the suggestions by G. Lind. Those were three validation as follows: 1)Moral development preferences' Sequence Validation, 2)Quasi-Simplex Structure of inter-correlations between the six moral orientations, 3)affective-cognitive parallelism validation.

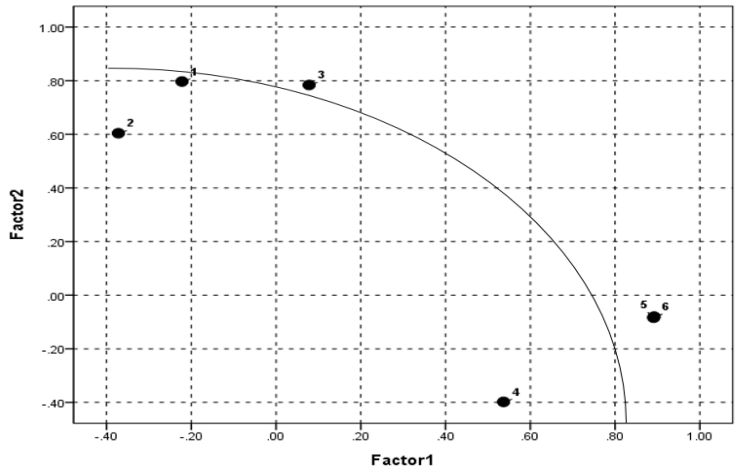
First, as a result of the verification of the order of preference, the average morality level for each stages was -5.47 for stage 1, -4.83 for stage 2, -3.14 for stage 3, 4.95 for stage 4, 5.36 for step 5, and 6.20 for stage 6. Statistically there was a significant difference for each stage($\chi 2=242.519$, $p<.001$). It was gradually increased <Figure 1>. So the validity of the order of preference is very well verified.

Figure 1. Moral development preferences' sequence validation.



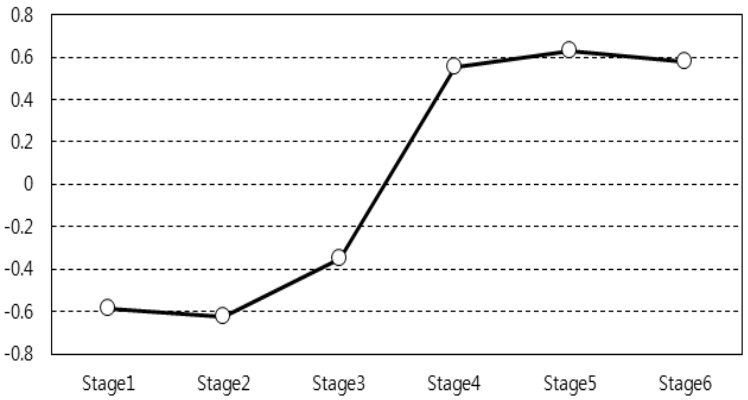
Second, as a result of examining the relationship between Kohlberg's six stages through quasi-simplex structure verification, stage 1 to 3 were grouped into one factor, and stage 4 to 6 were grouped into another factor <Figure 2>. This is a good verification of quasi-simplex structure.

Figure 2. Quasi-simplex structure of inter-correlations between the six moral orientations validation.



Third, as a result of the cognitive-emotional parallel test, it has secured some degree of validity. Except for the result of stage 1 and stage 6, rough sequence was good example to explain the validation of cognitive-emotional consistency <Figure 3>.

Figure 3. Affective-cognitive parallelism validation.



3. Improvement for the Past Sports Ethics Consciousness Measurement Tool

To improve the past sports ethics consciousness measurement tool, this research got the advised from 3 experts in the area of moral education. Their specific details are as follows <Table 2>.

Table 2. Three experts' summarized biographies.

	Institute	Specific major area	Career year
Bongje Kim	Seoul national university of education	Morality measurement	24
Hyunsoo Kim	Pusan national university	Moral education methodology	24
Intae Lee	Korea institute curriculum and evaluation	Moral psychology	18

Note: Source: Individual Communication, March, 2021.

First of all, the researchers interviewed with professor Bong-Je Kim at Seoul National University of Education was focused on developing a tool for measuring sports ethics consciousness. He commented as follows: “Sports ethics consciousness measurement tool is very broad, so it is hard to measure. I don't know why the past tool did not use a moral dilemma. It could be very provocative. But if the researcher or researchers can show the reason why the paper did skip it. I think it's very creative.”

Next, there was an interview with a professor Hyunsoo Kim at Pusan National University, who majored in moral education methodology. He maintained a critical view as follows: “G. Lind's MCT utilized two dilemmas to provide practical instruction and moral judgment. It had an advantage of being able to perform measurements and to teach at the same time. No dilemma based teaching and learning will not give weakness or limitation to the area of measurement. But it can give some difficulties to real practical classroom activities.”

Lastly, there was an interview with In-Tae Lee, a research fellow at the Korea Institute for Curriculum and Evaluation who explored the academic background of moral psychology. He gave us significant hints as follows: “The morality could be analyzed through various moral psychological mechanism. By the way, although MCT is a simple morality measurement tool, it has tendency toward cognition. Of course, Professor G. Lind has used the dual aspect theory to minimize the gap between cognition and emotion. I think G. Lind also need to explain the more specific function or operation of the emotion. I would say that tear as noun is not as same as crying or tearing as the type of verb.”

This study aimed to improve the research tools previously developed by the researchers. Since the existing research tools have been secured to some extent, this study is a minimal task. As a result, in near future, much more empirical research needs to be continued. At this point this study would show the correction of the 4th level statements <Table 3>, <Table 4>.

Table 3. Reform the sentences at the 4th stage.

Before or after	Pro or contra	Sentences
Before	Pro	If I break the rules of the game, I break my promises with everyone.
After	Pro	The rules of an athletic event must be followed as long as the sport is in place.
Before	Contra	Taking offenses doesn't help develop a sustainable sports culture.
After	Contra	You must not commit a foul to continue the sport.

Table 4. Reformed sports ethics consciousness measurement tool.

	Statement	Disagree								Agree
Pro	1. I am afraid of punishment, so I reluctantly obey the rules of the game. (1)*	-4	-3	-2	-1	0	1	2	3	4
	2. If it doesn't hurt me directly, I can violate the rule. (2)	-4	-3	-2	-1	0	1	2	3	4
	3. I obey the rules of the game because I want to be recognized with good person by others. (3)	-4	-3	-2	-1	0	1	2	3	4
	4. The rules of an athletic event must be followed as long as the sport is in place. (4)	-4	-3	-2	-1	0	1	2	3	4
	5. When we all obey the rules of the sport and play fair, it benefits all of us. (5)	-4	-3	-2	-1	0	1	2	3	4
	6. When I play the game properly, it is the way to consider and admit that my opponent can play the game completely. (6)	-4	-3	-2	-1	0	1	2	3	4
Contra	7. I don't follow the rules unless it's because of fear of punishment. (1)	-4	-3	-2	-1	0	1	2	3	4

	8. If it is in my benefit or interest, it can violate the rules of the game. (2)	-4	-3	-2	-1	0	1	2	3	4
	9. I don't cheat because I'm afraid of what others will see. (3)	-4	-3	-2	-1	0	1	2	3	4
	10. You must not commit a foul to continue the sport. (4)	-4	-3	-2	-1	0	1	2	3	4
	11. Breaking the rules of the game created will not help the community develop. (5)	-4	-3	-2	-1	0	1	2	3	4
	12. The act of cheating is to deceive yourself and should not be done by humans. (6)	-4	-3	-2	-1	0	1	2	3	4

Note: Mark '*' means L. Kohlberg's Moral Developmental Stage. During the survey it does not show the figures to the interviewees.

4. Conclusion

This study started to revise the past tool developed to measure sports ethics consciousness of college students. The tool's algorithm was already standardized G. Lind in Germany. It's name is MCT.

The past tool got some weakness in the sentences at the 1st, 4th, and 5th stages. This study tried to redeem and revise it. To do it, this study got some significant implications through interviewing with three experts who are specialized at the moral education and moral measurement.

Finally, this study could get the satisfactory result. To make further solid result, separate empirical study needs to be supplemented in near future. This study concludes that the past tool's weakness came from not ordinary life story but more formal explanation about 4th stage which stands for order maintenance.

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6. Appendix

6.1. Authors contribution

	Initial name	Contribution
Author	GP	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑ -Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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Profiling of Team Performances based on the Official Data in SOCCER

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Abstract

Purpose: *The performance analysis of sport has utilized to distinguish level of performances in past decade. Especially, the concept of identification on important factors relevant to winning and losing performances was always considered in the field of performance analysis in sports. This study was to compare different performances between groups separated by frequencies of participant to soccer World Cup 2002, 2006, 2010, 2014, and 2018. This study was also intended to identify factor of distinguishing levels of performances instead of regional factor.*

Method: *In this study, the official data from FIFA official website was collected by Microsoft Excel version 16.0 with Visual Basic Application scripts that totally 20 variables relevant to goals and features of performances were considered. After data collection has done, all data were separated by groups basing on frequencies of participant to soccer World Cup. In addition, descriptive statistics and one-way ANOVA test with Turkey's test as post hoc comparisons were utilized to compare different performances between groups.*

Results: *As results of this study, there were significant differences found on variables relevant to goals, such as Goals, Shot attempt. Also, there were significant differences found between groups on Passes, Passes completed, Short passes, Foul sustained, % of Passes completed, % of Short passes completed and Ball possession. Those findings indicated different levels of performances between experiences on soccer World Cup that those variables also indicated different features of performances depending on the experiences.*

Conclusion: *According to results of this study, the experiences on soccer World Cup are important factors to distinguish different levels of performances considering with the official data. The variables relevant to goals and different features of performances in soccer would be utilized to identify characteristics of team performances or nations regarding to the results of this study. Further researches are required that variables relating to the levels of performances distinguished in this study would be a factor of prediction models for identification of outcome of performances in soccer.*

[Keywords] ***Soccer, Performance Analysis of Sport, Levels of Performances, Soccer Analysis, Sport Analytics***

1. Introduction

Sport science has often aimed to provide meaningful information of performances from the matches in past decade. The information usually included knowledge of physiology, psychology, physics, engineering, statistics and computer science[1]. For instance, factors relevant to performances, such as power of performance, speed of actions and frequencies of skills, were utilized to analyze performances based on the knowledge. Especially, the principle of performance analysis in sport has been explored to accept other principles in sciences that the concept of performance analysis in sport is thought as a rise of sport science nowadays[2].

The concept of performance analysis in sport is to enhance performances based on systematic observation, objective data, and even immediate feedback in a practice. That's why the

sport scientists have been tried to concerned the convergence between sport science and numeric analysis while the data gathered in a match[3]. The effort of applied science into the field of sports has often considered on the aspect of physiology or exercise science[4][5][6][7]. Among previous researches relevant to enhancement of performances, the enhancement of performance in any sport, however, would be determined within the boundary of science[8]. As Hughes & Franks[9] mentioned, the performance analysis in sport has been aided to analyze the performance with numeric features and video technology. It is important to apply the science on the process relevant to the enhancement of performances that the maintaining objectivity of any stage such as data collection, data pre-processing, and data analysis.

The ways to feedback with the analyzed performances are various[10]. Among the methods of feedback in the field of performance analysis in sport, the visualization with artificial intelligence technology[11][12] has often utilized to summary the analyzed results of performance analysis. The advantage of using the visualization with artificial intelligence technology is that the data process and computing procedures are clearly presented with graphs and figures after the analysis is done as well as the accuracy of prediction models[13][11]. Thus, the utilization of AI models intends to bring the benefit while the data is on a process of analysis. Especially, the visualization and data analysis is hardly applied when a huge amount of performance data has been gathered.

As the advantage of artificial intelligence[14][15][16], the data sources must be valid and determined with reasonable concepts based on scientific theories in order to analyze performances in sports efficiently. The consideration on combination of all variables is valid that only a variable could not distinguish different characteristics of performances in soccer. Therefore, this study was to identify consistency of different characteristics of performances in soccer basing on the profiling[17].

2. Research Method

2.1. Subjects

The subjects of this study were official data of soccer World Cup 2002, 2006, 2010, 2014 and 2018. The official data was considered separately between winning and losing performances[18]. And then all data was grouped by frequencies of participant to World Cup from 2002 to 2018. <Table 1> is shown the matches played by nations concerned.

Table 1. Frequencies of participant to World Cup by nations and number of matches played from 2002 to 2018.

Freq. of participant	N	Nations
1	17	Angola, BOSNIA AND HERZEGOVINA, China, Czech Republic, Egypt, Iceland, Ireland, Korea DPR, Morocco, NewZealand, Panama, Peru, Slovakia, Togo, Trinidad, Turkey, Ukraine
2	16	Algeria, Chile, Colombia, Greece, Honduras, Senegal, Slovenia, South Africa
3	45	Belgium, Cameroon, Cote d'Ivoire, Denmark, Ecuador, Ghana, Iran, Netherlands, Paraguay, Poland, Russia, Saudi Arabia, Serbia, Sweden, Tunisia
4	32	Australia, Costa Rica, Croatia, Italy, Nigeria, Switzerland, Uruguay, USA
5	50	Argentina, Brazil, England, France, Germany, Japan, Korea Republic, Mexico, Portugal, Spain

2.2. Research variables

Totally, 20 variables from the official data of World Cup used for this study. <Table 2> is shown the variables used to compare the performances by the frequencies of participant to World Cup.

Table 2. Variables used for this study and its explanations.

Type	Variables & explanations	Scale	Unit
Type 1	Goals-total number of goal scored and goal conceded, GS-goal scored, GC-goal conceded, SA-shot attempt, SOG-shot on goal, passes-total passes completed and missed, PC-pass completed, SP-short passes, SPC-short passes completed, LP-long passes, LPC-long passes completed, CK-corner kicks, FC-foul committed, FS-foul sustained, OFF-offsides	Continuous	Frequency
Type 2	SOGP-% shot on goal, PCP-% pass completed, SPCP-% short passes completed, LPCP-% long passes completed, BP-ball possession	Continuous	Ratio

2.3. Data collection & analysis

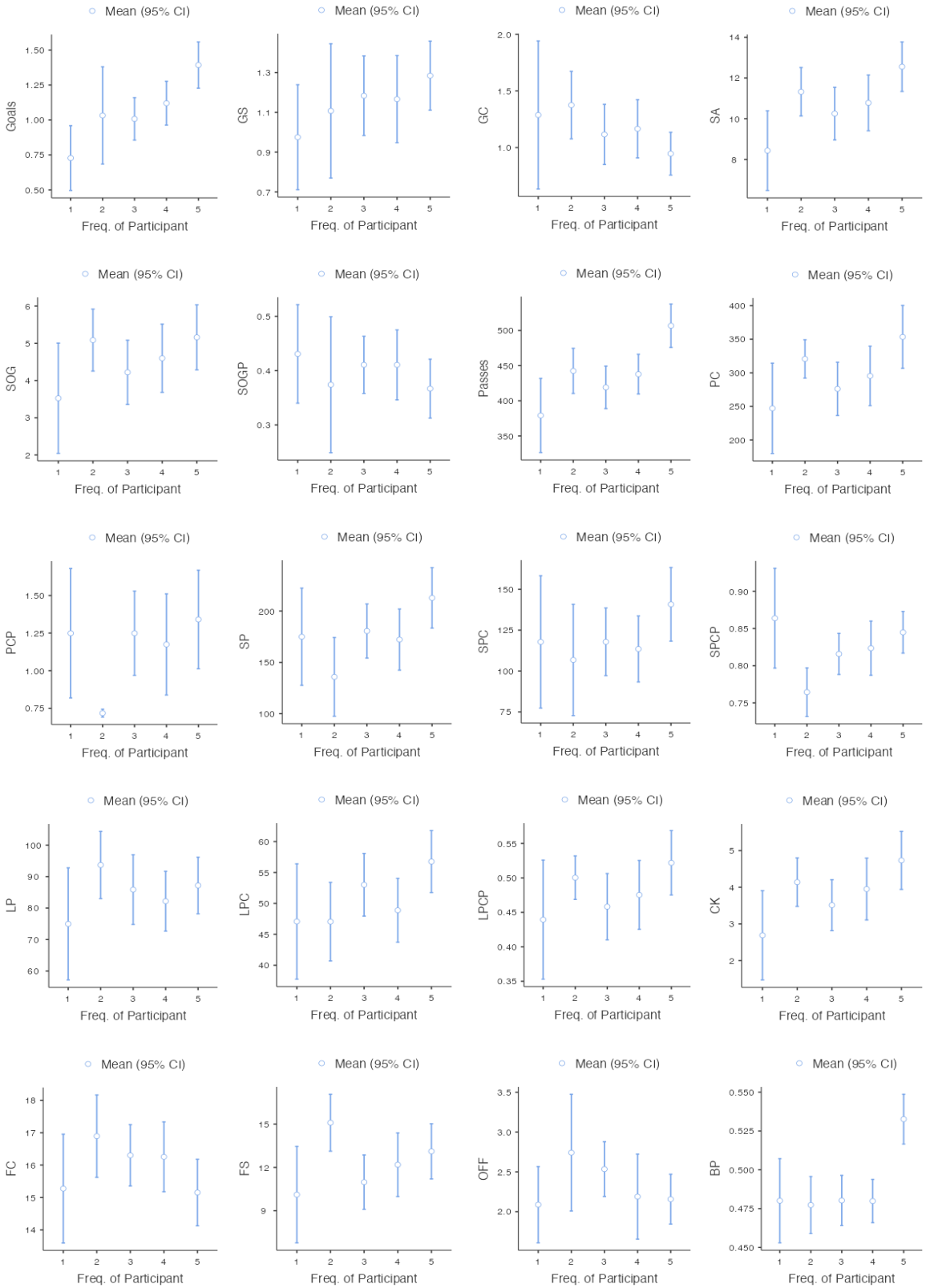
The official data was collected by Microsoft Excel version 16 with visual basic for application scripts from the official web site(http://www.fifa.com). The data was split by the frequencies of participant of World Cup basing on nations. First of all, the descriptive statistics were used for the identification of different features in general. And then the groups by the frequencies of participant of World Cup have compared with one-way ANOVA test and Turkey's test for post-hoc comparisons. The significant differences were confirmed when the differences found within 95 confidence interval.

3. Results and Discussion

3.1. Results

The results of this study were totally 2 parts that one is about general differences basing on the descriptive statistics and the other one is findings by one-way ANOVA test with Turkey's test as a post hoc comparisons. <Figure 1> is shown the mean and range of 95% confidence intervals by groups.

Figure 1. Mean and 95% confidence intervals of each variable used by frequencies of participant of world cup.



Note: GS-Goal Scored, GC-Goal Conceded, SA-Shot Attempt, SOG-Shot on Goal, SOGP-% Shot on Goal, PC-Pass Completed, PCP-% Pass Completed, SP-Short Passes, SPC-Short Passes Completed, SPCP-% Short Passes Completed, LP-Long Passes, LPC-Long Passes Completed, LPCP-% Long Passes Completed, CK-Corner Kicks, FC-Foul committed, FS-Foul Sustained, OFF-Offsides, BP-Ball Possession.

The results of one-way ANOVA test were meaningfully determined that <Table 3> is shown the results including results of Turkey's test as a post hoc test for Type 1 data. And <Table 4> is shown the results including results of Turkey's test as a post hoc test for Type 2 data.

Table 3. The results of one-way ANOVA test for the comparisons between groups with Turkey's test as post hoc comparisons for type 1 data.

Variables	Groups	M	SD	F	Post-hoc	Variables	Groups	M	SD	F	Post-hoc
Goals	1	0.728	0.4503	6.265***	1<5 3<5	SPC	1	117.806	78.7171	1.111	
	2	1.032	0.6528				2	106.752	63.8466		
	3	1.008	0.5055				3	117.858	68.8064		
	4	1.120	0.4347				4	113.476	56.0031		
	5	1.392	0.5820				5	140.775	79.2400		
GS	1	0.975	0.5124	1.060		LP	1	74.974	34.6547	1.162	
	2	1.107	0.6331				2	93.693	20.0634		
	3	1.184	0.6655				3	85.871	36.8555		
	4	1.166	0.6063				4	82.184	26.3812		
	5	1.285	0.6099				5	87.194	31.6605		
GC	1	1.288	1.2718	1.731		LPC	1	47.074	18.1212	2.207	
	2	1.375	0.5592				2	47.048	11.9143		
	3	1.116	0.8851				3	53.010	16.8620		
	4	1.166	0.7124				4	48.885	14.2986		
	5	0.946	0.6645				5	56.765	17.6161		
SA	1	8.435	3.7982	3.911**	1<5 3<5	CK	1	2.690	2.3643	2.601	
	2	11.325	2.2323				2	4.140	1.2398		
	3	10.250	4.3007				3	3.512	2.3120		
	4	10.778	3.7935				4	3.951	2.3377		
	5	12.554	4.2773				5	4.732	2.7827		
SOG	1	3.525	2.8777	1.507		FC	1	15.275	3.2666	1.563	
	2	5.085	1.5608				2	16.895	2.3888		
	3	4.221	2.8666				3	16.303	3.1534		
	4	4.600	2.5409				4	16.257	2.9890		
	5	5.160	3.0712				5	15.152	3.6144		
Passes	1	379.087	102.4881	6.389***	1<5 3<5 4<5	FS	1	10.111	6.4919	3.198*	
	2	442.472	60.2277				2	15.097	3.6983		
	3	419.054	100.5590				3	10.978	6.2676		
	4	437.842	78.4047				4	12.184	6.1149		
	5	506.686	108.6572				5	13.114	6.7278		
PC	1	247.087	130.7190	2.751*		OFF	1	2.087	0.9311	1.313	
	2	320.673	53.6146				2	2.742	1.3760		
	3	276.080	131.9559				3	2.535	1.1470		
	4	295.372	122.6066				4	2.188	1.4825		
	5	353.490	164.6356				5	2.157	1.1015		
SP	1	174.961	92.0310	2.737*	2<5						
	2	135.890	71.9395								
	3	180.517	87.6264								
	4	172.186	82.5481								
	5	212.781	103.5006								

Note: *p<.05, **p<.01,***p<.001.

GS-Goal Scored, GC-Goal Conceded, SA-Shot Attempt, SOG-Shot on Goal, PC-Pass Completed, SP-Short Passes, SPC-Short Passes Completed, LP-Long Passes, LPC-Long Passes Completed, CK-Corner Kicks, FC-Foul committed, FS-Foul Sustained, OFF-Offsides.

Table 4. The results of one-way ANOVA test for the comparisons between groups with Turkey's test as post hoc comparisons for Type 2 data.

Variables	Groups	M	SD	F	Post-hoc	Variables	Groups	M	SD	F	Post-hoc
SOGP	1	0.431	0.1766	0.597		LPCP	1	0.439	0.1679	1.462	
	2	0.374	0.2350				2	0.500	0.0592		
	3	0.411	0.1754				3	0.458	0.1600		
	4	0.411	0.1785				4	0.475	0.1385		
	5	0.367	0.1912				5	0.522	0.1644		
PCP	1	1.249	0.8379	10.339***		BP	1	0.480	0.0527	8.456***	1<5 2<5 3<5 4<5
	2	0.717	0.0487				2	0.477	0.0344		
	3	1.249	0.9331				3	0.480	0.0537		
	4	1.175	0.9335				4	0.480	0.0387		
	5	1.341	1.1544				5	0.533	0.0563		
SPCP	1	0.864	0.1305	4.382**	1>2 2<5						
	2	0.764	0.0611								
	3	0.816	0.0917								
	4	0.824	0.1010								
	5	0.845	0.0985								

Note: *p<.05, **p<.01, ***p<.001.

SOGP-% Shot on Goal, PCP-% Pass Completed, SPCP-% Short Passes Completed, LPCP-% Long Passes Completed, BP-Ball Possession.

3.1. Discussion

This study was to compare the different performances separated by the frequencies of participant to World Cup that there were meaningfully found many issues. The frequencies of participant to the soccer World Cup intends to initialize a level of experiences on the important matches. Regional characteristics of performances[19] might distinguish team performances in soccer. However, different performances were found, even though different levels of experience to participant World Cup were also influenced upon the different performances in this study. It seems to explain that the superior performance in region is important matter as well as quality of performances[20] in group stage and knock-out stage because of qualified position existed in each region. In this study, however, there were significant differences found between groups on Goals, Shot Attempt, Passes, Passes completed, Short Passes, Foul sustained, % of Passes completed, % of Short Passes completed, and Ball possession that those variables would be utilized to identify unique features by team or by nations when the distinguishing of performances are matter to alternate variables needed instead of using the levels of experiences to participant.

4. Conclusion and Suggestions

This study was to identify different performances with the levels of experiences in soccer World Cup. According to results of this study, there were significant differences on variables relevant to goals such as Goals and Shot Attempt. There were also significant differences on variables relevant to the characteristics of performances such as Passes, Passes completed, Short Passes, Foul sustained, % of Passes completed, % of Short Passes completed, and Ball possession.

Further researches are required that the effectiveness of utilization on researches relevant to a prediction models for distinguishing performance levels.

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6. Appendix

6.1. Authors contribution

	Initial name	Contribution
Author	HC	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑ -Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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The Effects of SCORING First on the Match Results in Football Matches

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Abstract

Purpose: *As a single goal in football has a great value compared to other sport, the importance of the first goal is also greater than other sport. This study aimed to identify the effects of scoring first on the match results considering a variety of match situational variables e.g. match venue, team quality, opposition team quality, the latest performance form, opposition's latest performance form and time, that were not considered in the previous football studies.*

Method: *All matches(N=162) from all teams(N=12) in K-league during 2020 season were selected as a sample. The data, officially provided from K-league website, were compiled using Microsoft Office Excel 2007 and IBM SPSS 25 was used to conduct statistical analysis. The mean and standard deviation were obtained through descriptive statistical analysis, and cross-tabulation analysis and chi-square analysis were conducted to analyze the mean differences between independent variables.*

Results: *Of all matches, a goal scored during 149 matches and 13 matched finished without a goal, that resulted 0:0. Of 149 matches, the teams that scored the first goal had a 68.5% chance of winning the matches. The winning rate(67.9%) when the home teams scored the first goal was lower than that of the away teams(69%), but there was no statistically significant difference. The winning rate(87.7%) when the top teams scored the first goal was statistically significantly higher than the winning rate(55%) when the middle teams and the bottom teams(52.3%) scored the first goal. The winning rate(47.5%) when scoring the first goal against the top teams was statistically lower than the winning rate(72.9%) when scoring the first goal against the middle teams and the bottom teams(80%). The winning rate of teams scored first goal at the end of matches(60-75 minutes: 88.2%, 75-90 minutes: 100%) was higher than the winning rate of teams scored first early(0-15 minutes: 64.3%, 15-30 minutes: 63.3%), but there was no statistically significant difference.*

Conclusion: *The first goal had a huge impact on the outcome of the game. In detail, the first goal had a significant impact on the outcome of the matches depending on the level of the teams that scored the first goal and the opposing teams, while the venue, recent performance form and time of the matches did not have a significant impact. Looking at these results, the need for research on the first goal, which greatly affects the outcome of the game, is emerging, and it is believed that systematic analysis is needed to suit the situational variables.*

[Keywords] ***Football, Performance Analysis, First Goal, Situational Variables, K-League***

1. Introduction

In goal throwing sport, in which a game is played through an invasion, players(teams) compete with the aim of scoring goals and reducing the number of goals lost. To score a single goal, players improve their technical skills[1][2] and increase their tactical understanding[3][4] through long period of training[5][6]. A single goal in football, one of the least-scoring sports, has a higher value than other sports.

As one goal in football has a great value, the importance of the first goal is also greater compared to other sports. Depending on whether the teams score a goal first and concede a goal, the team's game plans and tactics change during the game, and the players are psychologically affected as well. Previous studies showed that whether a goal was scored first had a significant impact on the match results, and 70 to 75% of the teams who scored first goal eventually won the game. For example, teams won 71.43%, drew 16.19%, lost only 12.38% of the matches when they scored first in Greek Super League in 2006/2007 season[7]. Similarly, 74.45% of the first-time goal-scorer teams won the matches in the Spanish Primera League during five seasons between 2005/2006 and 2009/2010 seasons, with 18.86% of the team finishing in a draw and 6.69% in a defeat[8].

Match venue(home or away) when team scores a first goal causes influence on the outcome of the match. Home teams scored first goal with a 57.54% of matches and the teams won 74.59% of the matches in Portuguese Professional Football League during 2009-2010 season whilst there was a 42.46% chance for the visitors to score the first goal and a 62.22% chance of winning the game when the visitors scored the first goal[9]. In the research analyzing European top 5 Leagues(Spain, England, Germany, Italy and France), home teams won 65-78% of matches when they scored first whilst away teams won 61-67% of matches when they scored the first goal. Among the five leagues, the French League had the greatest difference in winning rate between home teams(78.1%) and the visiting team(64.6%) when they scored a first goal. On the other hand, Italian League had the smallest chance of winning between home teams(65.3%) and away teams(62.3%) when they scored first[10].

Although previous studies considered the impact of the first goal on the match results and the location of the team(home/away) where the goal was scored, considerations for various other situational factors were insufficient. It was suggested that performance indicators found from previous research were influenced by various situational variables such as match venue[11][12], opposition team quality[13][14], match status[15][16], latest performance form[17], time[7] etc. For example, home teams created more shots, passes and higher ball possession compared to away teams and teams created higher ball possession against bottom teams than against top teams. It has been shown that there is a relativity during different scenarios. The simple average value of each variable calculated without considering these situational factors cannot be meaningful information in the actual field[18]. However, previous papers found results without considering situational variables, and they tends to ignore extraneous situational factors, suggesting that historical factors(opposition level, latest performance form) and external factors(match venue, rank, weather, competition type, referee) should be considered together to understand complex football matches[19][20]. Therefore, this study aims to determine the impact of the first goal on the match results considering a variety of out-of-match situational factors(match venue, team quality, opposition team quality, the latest performance form, opposition's the latest performance form, and time) that were not considered in the preceding studies.

2. Methods

2.1. Sample

All matches(N=162) including split matches(n=30) from all teams(n=12) in K-League during 2020 season were analyzed. The data was officially provided from K-League website(data.kleague.com).

2.2. Variables

Six independent variables were used to identify the effect of match venue, team quality, opposition's team quality, latest performance form, opposition's latest performance form, time. Match results were used as a dependent variables. <Table 1> summarizes the variables used in this study.

Table 1. The level and criteria of variables used in this study.

Variables	Level	Criteria
Venue	Home / away	Place match played
Team quality	Top / middle / bottom	Divided into three equal percent by final league position
The latest performance form	Top / middle / bottom	Divided into three equal percent by sum of points acquired from last 3 matches
Time	0-15 / 15-30 / 30-45 / 45-60 / 60-75 / 75-90	Divided into six equal percent by 90 minutes
Result	Won / drew / lost	Divided by match results

2.3. Statistical analysis

Match venue, team quality, opposition's team quality, latest performance form, opposition's latest performance form, time from all matches(N=162) in K-league during the 2020 season were compiled using Microsoft Office Excel 2007, and IBM SPSS ver.25 was used to process data. The mean and standard deviation were obtained through descriptive statistical analysis, and cross-tabulation analysis and chi-square analysis were conducted to analyze the mean differences between variables. All statistical significance levels were $p<.05$.

3. Results

Of all matches(N=162), a goal scored during 149 matches and 13 matches finished without a goal(resulted 0:0) in K-League during 2020 season. Of the 149 matches, teams that scored first won 102 matches(68.5%), drew 24 matches(16.1%) and lost 23 matches(15.4%).

3.1. Impact of first goal based on match venue

<Table 2> shows the number of first goal and the results of the competition according to the venue(home/away). The home teams scored the first goal in 78 of 162 matches(48.1%) and the visitors scored the first goal in 71 matches(43.8%), while the remaining 13 games(8%) scored 0-0 without a goal. The odds of winning when the home teams scored the first goal were lower than when the away teams scored the first goal, but there was no statistically significant difference(p>.05).

Table 2. First goal and match results depending on match venue.

Venue	Number of first goal	Result	x^2	p
Home	78	Won 53(67.9%)	0.04	0.98
		Drew 13(16.7%)		
		Lost 12(15.4%)		

Away	71	Won 49(69.0%)		
		Drew 11(15.5%)		
		Lost 11(15.5%)		

3.2. Impact of first goal based on team quality

<Table 3> summarizes the number of first goal and match results according to the level of team performance(top/middle/bottom). Among 162 games, the top teams scored the first goal in 65 games(40.1%), the middle teams in 40 games(24.7%), and the bottom teams in 44 games(27.2%). The probability of winning a game when the top teams scored the first goal was higher than that of winning a match when the middle or bottom teams scored the first goal, showing a statistically significant difference(p<.05).

Table 3. First goal and match results depending on team quality.

Team quality	Number of first goal	Result	x^2	p
Top	64	Won 57(87.7%)	23.42	0.00
		Drew 3(4.6%)		
		Lost 5(7.7%)		
Middle	40	Won 22(55.0%)		
		Drew 12(30.0%)		
		Lost 6(15.0%)		
Bottom	44	Won 23(52.3%)		
		Drew 9(20.5%)		
		Lost 12(27.3%)		

3.3. Impact of first goal based on opposition team quality

<Table 4> shows the number of first goal and match results according to the opposition team's performance level(top/middle/bottom). Teams scored first goal in 40 of 162 matches(24.7%) against top teams, in 59 games(36.4%) against middle teams, and in 50 games(30.9%) against bottom teams. The probability of winning a game against a top teams was lower than the probability of winning a game against a middle teams or bottom teams, showing a statistically significant difference(p<.05).

Table 4. First goal and match results depending on opposition's team quality.

Team quality	Number of first goal	Result	x^2	p
Vs top	40	Won 19(47.5%)	14.41	0.01
		Drew 13(32.5%)		
		Lost 8(20.0%)		

Vs middle	59	Won 43(72.9%)		
		Drew 6(10.2%)		
		Lost 10(16.9%)		
Vs bottom	50	Won 40(80.0%)		
		Drew 5(10.0%)		
		Lost 5(10.0%)		

3.4. Impact of first goal based on the latest performance form

<Table 5> shows the number of first goal and the results of the competition according to the latest performance form(top/medium/bottom). Teams that had top form scored first in 49 of 162 matches(30.2%), middle form in 59 matches(36.4%), and bottom form in 41 matches(25.3%). The chances of finishing the game with a victory when team had top form recently were higher than the chances of finishing the game with a middle or bottom form recently. However, there was no statistically significant difference(p>.05).

Table 5. First goal and match results depending on the latest performance form.

Performance form	Number of first goal	Result	x^2	p
Top	49	Won 40(81.6%)	8.06	0.09
		Drew 5(10.2%)		
		Lost 4(8.2%)		
Middle	59	Won 37(62.7%)		
		Drew 9(15.3%)		
		Lost 13(22.0%)		
Bottom	41	Won 25(61.0%)		
		Drew 10(24.4%)		
		Lost 6(14.6%)		

3.5. Impact of first goal based on opposition the latest performance form

<Table 6> shows the number of first goal and the results of the competition according to the latest performance form(top/middle/bottom) of the opposing teams. In 47 out of 162 matches(29%), the teams scored the first goal against the team with the "top" performance form recently, against the "middle form" teams in 61 matches(37.75), and against the "bottom form" teams in 41 matches(25.3%). The probability of finishing the game when the team scored against top form teams with a victory was lower than the probability of finishing the game with a victory against a team with a "middle form" or “bottom form" teams. However, there was no statistically significant difference (p>.05).

Table 6. First goal and match results depending on the opposition's latest performance form.

Form	Number of first goal	Result	x^2	p
Top	47	Won 28 (59.6%)	5.34	0.25
		Drew 11(4.6%)		
		Lost 8(7.7%)		
Middle	61	Won 41(67.2%)		
		Drew 10(16.4%)		
		Lost 10(16.4%)		
Bottom	41	Won 33(80.5%)		
		Drew 3(7.3%)		
		Lost 5(12.2%)		

3.6. Impact of first goal based on time

<Table 7> shows the number of first goal and the results of the competition according to the time first goal scored(0-15/15/30/30-45/45-60/60-75/75-90 minutes). The teams scored a first goals in 42 of 162 matches(25.9%) during 0-15 minutes, in 30 matches(18.5%) during 15-30 minutes, in 24(14.8%) during 30-45 minutes, in 23 matches(14.2%) during 45-60 minutes, in 17 matches(10.5%) during 60-75 minutes, and in 12 matches(7.4%) during 75-90 minutes. The probability of finishing a game with the first goal at the beginning of the game was lower than that of finishing a game with the first goal at the end of the game, however there was no statistically significant difference(p>.05).

Table 7. First goal and match results depending on the time goal scored.

Venue	Number of first goal	Result	x^2	p
0-15'	42	Won 27(64.3%)	16.26	0.09
		Drew 8(19.0%)		
		Lost 7(16.7%)		
15-30'	30	Won 19(63.3%)		
		Drew 7(23.3%)		
		Lost 4(13.3%)		
30-45'	24	Won 14(56.0%)		
		Drew 3(12.0%)		
		Lost 8(32.0%)		

45-60’	23	Won 15(65.2%)		
		Drew 4(17.4%)		
		Lost 4(17.4%)		
60-75’	17	Won 15(88.2%)		
		Drew 2(11.8%)		
		Lost 0(0.0%)		
75-90’	12	Won 12(100.0%)		
		Drew 0(0.0%)		
		Lost 0(0.0%)		

4. Discussion

This study sought to identify how the first goal of the 2020 Korean professional football K-League season affected the outcome of the matches.

The teams that scored the first goal in the matches(n=149) except for those that did not score the goal in K League during 2020 season had a 68.5% chance of winning the matches. These results were about 3-5% less than the winning rate(71.43%) of Greek professional football teams[7] and the winning rate(74.47%) of Spanish professional football teams[8]. Through these comparisons, it was confirmed that K-League teams were affected by the first goal in the results of the matches, but the teams were relatively less affected by the first goal compared to those in other professional football leagues.

The probability of winning a match was about 10% higher than previous papers[9][10] when home teams scored a goal. Based on these results, K-League teams could be inferred that the home teams did not benefit from the impact of the first goal compared to the teams of other professional football leagues.

Based on the team quality and opposition team quality, the probability of winning a match of top teams when they scored first was higher than that of winning a match for a middle teams or bottom teams, and the probability of winning a match against a top teams when they scored first was lower than that for a middle teams or bottom teams. In addition, higher frequency of performance indicators were found with top teams than weak teams, which was similar result with previous papers[13][14].

Previous paper found that there was a difference in attacking performance indicators depending on the team's recent performance and the opposing team's performance[17]. Similarly, In this study, there was a difference in the impact of first goals on the match result depending on latest performance form. However, there were no statistically significant differences. Looking at these results, K-League teams showed differences in attack processes(shots, passes, ball possession) depending on their recent performance, but it cannot be concluded that the difference is enough to affect the outcome of the matches.

The number of goals scored also affected the outcome of the game depending on time goal scored with a lower chance of winning the matches when the goal was scored early in the match than when the goal was scored in the end of the game. These results complement the limitations of not considering the time of the preemptive goal in previous studies, indirectly explaining that tactics change over time.

5. Conclusion

This study analyzed the impact of the goal on the outcome of the match, considering the situational variables at the moment of the first goal in K-League during 2020 season, and concluded that:

Firstly, the teams that scored the first goal had a 68.5% chance of winning the matches.

Secondly, the winning rate(67.9%) when the home teams scored the first goal was lower than that of the away teams(69%), but there was no statistically significant difference.

Thirdly, the winning rate(87.7%) when the top teams scored the first goal was statistically significantly higher than the winning rate(55%) when the middle teams and the bottom teams(52.3%) scored the first goal.

Fourthly, the winning rate(47.5%) when scoring the first goal against the top teams was statistically lower than the winning rate(72.9%) when scoring the first goal against the middle teams and the bottom teams(80%).

Fifthly, when the team had a good performance form recently, the winning rate(81.6%) was higher than when team with the middle form(62.7%) and the bottom form(61%) scored the first goal, but there was no statistically significant difference.

Sixthly, although the winning rate(59.6%) of teams scoring first against top form teams was lower than that against the middle form(67.2%) and bottom form(80.5, there was no statistically significant difference.

Seventhly, the winning rate of teams scored first goal at the end of matches(60-75 minutes: 88.2%, 75-90 minutes: 100%) was higher than the winning rate of teams scored first early(0-15 minutes: 64.3%, 15-30 minutes: 63.3%), but there was no statistically significant difference.

In conclusion, the first goal had a huge impact on the outcome of the game. In detail, the first goal had a significant impact on the outcome of the matches depending on the level of the teams that scored the first goal and the opposing teams, while the venue, recent performance form and time of the matches did not have a significant impact. Looking at these results, the need for research on the first goal, which greatly affects the outcome of the game, is emerging, and it is believed that systematic analysis is needed to suit the situational variables.

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7. Appendix

7.1. Authors contribution

	Initial name	Contribution
Author	JK	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑ -Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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A Biomechanical Analysis of the CLOSED CHANGE STEP Motion in Waltz by Pre-Taping and Post-Taping

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Abstract

Purpose: *The purpose of this study is to quantitatively identify the characteristics of lower extremity movements before and after taping during the closed change step motion in waltz for dance sports experts by using the functional taping, which is widely known for the prevention and treatment of the sports injuries, and also provide coaches and athletes with the appropriate posture and injury prevention by offering the basic data for the technical performance.*

Method: *As for the subjects of this study, 8 female experts with 5 or more years of experience in dance sports in the metropolitan city of B were selected and experimented. Prior to entering the experiment, a consent was secured from each subject, and the method of the experiment was explained, while the kinematic data were collected by using 5 digital cameras. As for the statistical processing of this study, the joint angle data were calculated before and after taping during the closed change step motion by using the SPSS 24.0. First, the mean and standard deviation were obtained, and in order to analyze the difference before and after taping, and time and phase, a corresponding sample t-test was conducted. The level of significance was set to α=.05.*

Results: *As a result of the experiment, it turned out that taping did stabilize the joint balance rather than causing problems for the mobility of the lower extremity joints via a biomechanical analysis of the lower extremities during the closed change step in motion waltz, and it is determined that it may have significance in that it provided the basic data required for the injury prevention as well as for the efficient performance of movements.*

Conclusion: *Gathering the conclusions as such, it is determined that taping may have significance in that it stabilizes the joint balance during the closed change step motion in waltz and provides the basic data required for the efficient performance of movement and the injury prevention.*

[Keywords] ***Biomechanics, Closed Change Step, Waltz, Taping, Angle***

1. Introduction

Among the various forms of movement, dance is an artistic form of physical expression, and mayalso be defined as a physical activity requiring aesthetic senses and rhythms, while requiring unlimited creativity. Unlike the general dance, where only artistry is emphasized, dance sports as a form of dance has a strong sports game like tendency, while inherently carrying aesthetic elements. It may also be said that there are many kinematic elements[1].

The techniques and movements of the dance sports are primarily consisted of forward, backward, and rotation, while powerful movements and expressive power are required to elevate the artistic values[2].

In order to perform various movements in dance sports, the role of the lower extremities supporting the body,moving the body, and maintaining balance is important[3]. The lower extremities, which play the role of supporting the body, moving the body, and mitigating the impact when landing, are

consisted of the foot, lower leg, and thigh, which are the cornerstones of the body support[4]. Each movement requires balance, flexibility, and agility, etc., and the muscles of the entire body are mobilized to this end. While small in size, the muscles and joints of the lower extremities are frequently impacted, and muscular contractions frequent occur, and hence, it is necessary to withstand the repeated loads[5].

As rhythm exercises for health has widely expanded across Korea as well, many women complain about the injuries caused by the exercise and dance sports shoes which are worn without considerations for the individual physique and physical conditions just so that their looks would look elegant and long when dancing[6].

Sports injuries might occur across any part of the body, yet the part which causes the most injuries is the foot. Even in the rhythmic exercises, injuries to the feet occur far more frequently during training than the actual matches through the movements which do not conform to the anatomical principles, excessive speed, radicality, and frequent leaps, etc[7][8][9]. In particular, the rate of incidence for the lower extremity injuries during the musculoskeletal injuries was reported to be higher than that of other body parts[10]. When it comes into contact with the ground, the foot transmits the shock wave generated by the repeated impact across all parts of the body, causes loads on the joints, tendons, muscles, and ligaments, and causes such injuries as fatigue fracture of the tibia, chondromalacia of the knee, cartilage damage, and the lumbar spine damages, respectively[11].

Therefore, to prevent damages to the musculoskeletal system, taping methods have been developed and studied in a variety of ways to help reduce pains by attaching tape directly to the skins and muscles, as well as improve functions such as muscular strength and muscular endurance. Recently, sports taping is often practiced and seen in the sports fields for the purposes of improving athletic performance and preventing injuries. For the purposes of improving performance and preventing injuries by taping, taping is practiced via various methods as reports were made that taping impacts the improvements in the muscular functions[12][13][14].

According to a report by it is said that kinesio taping stretches the muscle to the farthest extent possible, and if the tape is attached to the muscle without being stretched, the skins and muscles revert to their normal position. If the skin is lifted by the tape, the space between the skin and the muscle expands, which in turn increases the circulation of blood, lymph, and tissue fluid through the space, thereby reviving the motor function of the muscle and reducing pains, etc[15][16].

As such, the taping therapy provides nervous suppression via the afferent sensory nerve stimulation and directly accepts the force generated as per the functional demands of the tape, and hence, since it is known to be effective in improving the sports performance, preventing injuries, and rehabilitating sports related to sports, a related study is needed[17].

Hence, this study seeks to quantitatively identify the characteristics of lower extremity movements before and after taping during the closed change step motion in waltz for dance sports experts by using the functional taping, which is widely known for the prevention and treatment of the sports injuries, and also provide coaches and athletes with the appropriate posture and injury prevention related basic data.

2. Research Method

2.1. Subjects

The subjects of this study were 8 female experts with 5 or more years of experience practicing dance sports in the metropolitan city of B, and their physical characteristics are as illustrated in <Table 1>.

Table 1. Participants characteristic(N=8).

N	Age	Height	Weight	Career
Skilled(8)	21.53±3.89	165.52±3.32	59.51±4.72	7.43±3.88

2.2. Measuring tools

The measuring tools and analysis equipment used in this study are as shown in <Table 2>.

Table 2. Measuring tools.

Instrument	Model	Company	Technique
Camera	Motionmaster100	VISOL	3D motion capture
Soft ware	KWON3D	VISOL	Analyze process
Trigger master	TM-0014	VISOL	Save & compatible

2.3. Method of measurement

1) How to attach taping

As for the tape applied for this study, a functional tape with a width of 5.0 cm was used, and the weight was placed on observing how changes in take place in the closed change step motion before and after the taping. Therefore, as for the application of taping, the generally used muscular taping and corrective taping methods were selected, which were attached by kinesio taping experts. The taping method is as illustrated in <Figure 1>.

Figure 1. Taping method[18].

Rectus Femoris **Quadriceps Femoris** **Tibialis Anterior** **Gastrocnemius**

2.4. Experimental procedure

This experiment was conducted at the kinesiology lab of P University, and 5 high speed cameras were installed horizontally on the top of a tripod in the front, rear, left, and right directions of the movement so that the lens center's height would be 1m at a distance of 8m each from the coordinate references, respectively. To set the spatial coordinates, the control point frame was set to 1m wide, 2m long, and 2m high, and was marked on the floor, so that the subjects could check the range[19].

After measuring the physical characteristics of each subject, to accurately and easily digitize during the image analysis, black clothes were worn by and at the subject's left and right lower extremities' joint points, following which 19 reflective markers were attached[20]. Since the motion performance speed during the closed change affects the biomechanical variables, the metronome was set to 120bpm to ensure that the motion performance speed is identical, and the subjects performed sufficient warm-ups at this speed. A sufficient space was secured for the experiment participants to perform the experimental tasks, and the experimental equipments capable of measuring the closed change step motion were deployed[21].

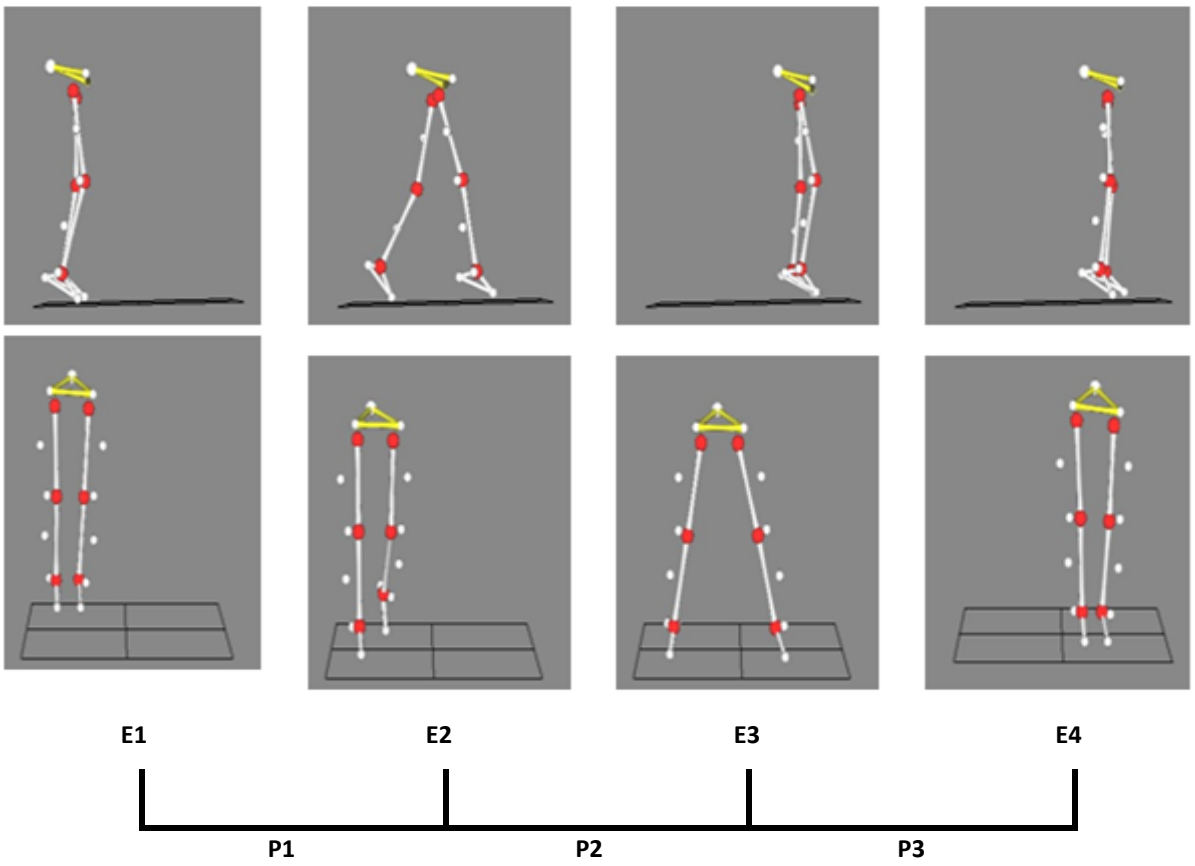
After sufficiently explaining the experimental movement to the subjects prior to the experiment, each subject was asked to perform the closed change step motion 10 times, among which,

the most accurate motion was selected and analyzed. The video camera was set to 100 frames/sec, and the shutter speed was set to 1/250 sec to analyze the hip, knee, and ankle joint angles, while the movement of major joints were analyzed[22][23].

2.5. Analysis events

The closed change step motion was set to a total of 3 event and 4 phase, and the definition of each is as illustrated in <Figure 2>.

Figure 2. 4 event and 3 phase.



2.6. Date processing

As for the statistical processing, the data of lower extremities' joint angles before and after taping were calculated during the closed change step motion by using the SPSS 24.0. First, the mean and standard deviation were obtained, following by which, in order to analyze the difference before and after taping, and the time and situation, the corresponding sample t-test was conducted. The level of significance was set to α=.05.

3. Result & Conclusion

3.1. Changes in the lower extremities angle before and after taping

1) The E1 angular change before and after taping during the closed change step motion is as illustrated in <Table 3>.

Table 3. Lower limb joint angle(unit: deg).

			Mean±SD	*t*	*p*
Hip	R	Before	136.2±11.14	-4.001	.005**
		After	153.1±6.66		
	L	Before	134.1±5.83	-4.599	.002**
		After	149.8±7.63		
Knee	R	Before	169.9±12.62	-.465	.656
		After	171.8±6.11		
	L	Before	167.4±4.17	-2.097	.074
		After	173.3±4.93		
Ankle	R	Before	119.9±7.55	-2.247	.059
		After	128.1±7.51		
	L	Before	118.3±5.43	-2.737	.029*
		After	127.7±4.79		

Note: *p<.05, **p<.01.

In the right hip joint, the posterior bending and extension angles turned out to be larger than the posterior, and there was a statistically significant difference(p<.01). The posterior bending and extension angles turned out to be larger than the anterior in the left hip joint as well, and there was a statistically significant difference(p<.01). In the knee joint, the posterior bending and extension angles turned out turned out to be larger than the anterior in both the left and right parts, yet there was no statistically significant difference. In the right part of the ankle joint, the posterior dorsal and plantar bending angles were higher than the anterior, but there was no statistically significant difference. In the left part, the posterior dorsal and plantar bending angles turned out to be larger than the anterior, and there was a statistically significant difference(p<.05).

2) The E2 angular change before and after taping during the closed change step motion is as illustrated in <Table 4>.

Table 4. Lower limb joint angle(unit: deg).

			Mean±SD	*t*	*p*
Hip	R	Before	109.6±6.73	.234	.821
		After	108.7±14.29		
	L	Before	143.1±6.86	-4.618	.002**
		After	154.6±4.65		
Knee	R	Before	160.6±13.14	.868	.414
		After	156.2±15.94		
	L	Before	153.9±10.97	5.911	.001**
		After	127.5±6.66		
Ankle	R	Before	136.9±7.49	.644	.540
		After	134.8±3.38		
	L	Before	112.8±8.60	1.494	.179
		After	99.2±18.38		

Note: *p<.01.

In the right hip part, the posterior bending and extension angles turned out to be smaller than the anterior, yet there was no statistically significant difference. In the left hip part, the posterior bending and extension angles turned out to be larger than the anterior, demonstrating a statistically significant difference(p<.01). In the knee joint, the posterior bending and extension angles turned out to be smaller in both the left and right sides than the anterior, and there

was a statistically significant difference on the left side(p<.01). In the ankle joint part, the posterior dorsal and plantar bending angles turned out to be smaller in both the left and right sides than the anterior, yet there was no statistically significant difference.

3) The E3 angular change before and after taping during the closed change step motion is as illustrated in <Table 5>.

Table 5. Lower limb joint angle(unit: deg).

			Mean±SD	*t*	*p*
Hip	R	Before	121.5±8.62	3.212	.015*
		After	131.4±5.95		
	L	Before	118.9±7.27	1.350	.219
		After	124.9±7.94		
Knee	R	Before	160.1±8.73	1.653	.142
		After	151.3±10.50		
	L	Before	159.1±6.62	1.075	.318
		After	162.3±5.49		
Ankle	R	Before	126.5±11.24	.218	.833
		After	125.3±8.52		
	L	Before	123.8±2.78	3.437	.011*
		After	136.2±8.52		

Note: *p<.05.

The posterior bending and extension angles turned out to be larger than the anterior in the right hip joint, and there was a statistically significant difference(p<.05). The bending and extension angles also turned out to be large on the left side, yet there was no statistically significant difference. In the knee joint, the right side turned out to be smaller than the anterior, and the left side turned out to be larger, yet there was no statistically significant difference. In the ankle joint, the dorsal and plantar bending angles turned out to be smaller in the right side than the anterior, and the dorsal and plantar bending angles turned out to be larger in the left side, demonstrating a statistically significant difference(p<.05).

4) The E4 angular change before and after taping during the closed change step motion is as illustrated in <Table 6>.

Table 6. Lower limb joint angle(unit: deg).

			Mean±SD	*t*	*p*
Hip	R	Before	130.1±10.29	6.881	.000***
		After	152.7±5.73		
	L	Before	130.6±10.30	5.849	.001**
		After	148.9±7.66		
Knee	R	Before	162.2±6.76	4.210	.004**
		After	173.5±2.17		
	L	Before	169.0±2.30	3.433	.011*
		After	174.4±3.05		
Ankle	R	Before	124.9±5.52	5.116	.001**
		After	140.1±5.51		
	L	Before	126.9±8.35	2.606	.035*
		After	139.2±10.22		

Note: *p<.05,**p<.01,***p<.001.

In the right hip joint, the posterior bending and extension angles turned out to be larger than the posterior, and there was a statistically significant difference($p<.001$). The posterior bending and extension angles turned out to be larger than the anterior in the left hip joint as well, and there was a statistically significant difference($p<.01$). In the right knee joint, the posterior bending and extension angles turned out to be larger than the posterior, and there was a statistically significant difference($p<.01$). The posterior bending and extension angles turned out to be larger than the anterior in the left knee joint as well, and there was a statistically significant difference($p<.05$). In the right ankle joint, the posterior bending and extension angles turned out to be larger than the posterior, and there was a statistically significant difference($p<.05$). The posterior bending and extension angles turned out to be larger than the anterior in the left ankle joint as well, and there was a statistically significant difference($p<.05$).

4. Discussion

There was a statistically significant difference in the hip joint angle before and after taping during the closed change step motion in the right section(E1, E3, E3), and the posterior value turned out to be higher than the anterior value in the left section(E1, E2, E3). high, and there was a statistically significant difference. Such a result indicates that there was a significant difference in the hip joint's angular displacement following the process of moving the center of gravity in the waltz standby posture and the extension in progress of the pelvis in E3, whereby it is determined that there was a significant difference in the hip joint's angular displacement, and it is also determined that taping has secured the stability of the lower extremities' muscles and further improved the range of motion.

Reported that the hip joint angle according to the step and weight shift during the movements of Knee Back of the Latin dance demonstrated a large difference[24]. Report that the left pelvis, which plays the role of a support for the right pelvis during the Cha ChaCha Runaway Chassis Step movement of the dance sports, has expanded far more for the experts than the non-experts, indicating that the body of the expert is more upright, and hence, the results were demonstrated to be similar to the results of this study[25].

Examining the knee joint angle, the posterior value turned out to be higher than the anterior value in the right section(E4), and there was a statistically significant difference. In the left section(E2), the posterior value turned out to be higher than the anterior value, and there was a statistically significant difference. A comprehensive analysis of such results yielded that the angle after taping increased in E4 for both the left and right knee angles, and a statistically significant difference also turned out in this study. This is determined to have formed a stable posture by bringing the lowered right knee towards the left knee, then raising the right knee again to achieve parallelism with both knees.

Report that, during the Whisk Step motion of waltz, as for rumba, a bend rapidly occurs as the extended right leg is brought towards the left leg, and jive which had bending from the standby posture also maintains a similar angle for the next movement, and hence, there was a difference between rumba and jive[26]. Report that the range of motion for the knee joint increased, and the range of motion for the ankle joint decreased when the kinesio taping therapy did not use taping during a single foot jump training since taping facilitated bending and extension[27].

Report that the knee angle according to the application of the kinesio taping during the kick operation of soccer players turned out to have slightly increased after taping relative to that before taping, yet the difference of value was turned out to be minimal. It is reported that this means that the application of the kinesio taping did not affect the knee angle during the in-step kick movement, and hence, did not negatively affect the mobility of the joint[28]. Therefore, it turned out to be similar results for the results of this study in that the range of movement for the knee joint increased after taping than before taping.

In the ankle joint, the posterior value turned out to be higher than the anterior value in the right section(E4), and there was a statistically significant difference. The posterior value turned out to be higher than the anterior value in the left side(E1) and the left section(E3), and demonstrated a statistically significant difference.

Reported that, during the rumba forward walking movement, the angular displacement of the ankle joint turned out to be larger for the experts as a whole than the non-experts, which, in the rumba walking movement with the instep extended, performed better by the experts in the instep extension than the non-experts in the swing phase, and the results were similar to those of this study[29].

Analyzing these results comprehensively, it is determined that the angular displacement of the ankle joint turned out to be large due to the good dorsal extension, and the rise occurs while bringing the right foot towards the left foot and while the instep is extended, whereby the center of gravity is shifted from the right to the left.

5. Conclusion

Gathering the conclusions as such, it is determined that taping may have significance in that it stabilizes the joint balance during the closed change step motion in waltz and provides the basic data required for the efficient performance of movement and the injury prevention. However, analytical studies limited to the lower extremities' segment during the movement were conducted, and since the effect of the movement of the upper extremities was not considered, it is inadequate to understand the overall movement of the closed change step motion in waltz. Accordingly, considering such matters in the future studies, the measurement of various muscle groups and studies concerning various subjects ought to be conducted.

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7. Appendix

7.1. Authors contribution

	Initial name	Contribution
Lead Author	JS	-Set of concepts☑ -Design ☑ -Getting results ☑ -Analysis ☑
Corresponding Author*	BH	-Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑
Co-Author	JL	-Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑

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The Knowledge Structure Analysis on PARA TAEKWONDO with Keyword Network Analysis

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Abstract

Purpose: *This study sought to explore knowledge structures and domains by analyzing research conducted concerning Para Taekwondo for it to be recognized as a discipline.*

Method: *This study sought to explore knowledge structures and domains by analyzing research conducted about Para Taekwondo for it to be recognized as a discipline. To this end, the classification and knowledge structure of the field of research on Para Taekwondo-related research were explored by using keyword-based knowledge network analysis research methods for a total of 42 Para Taekwondo-related studies conducted from 2004 to 2021.*

Results: *First, according to the analysis of the critical keywords of Para Taekwondo-related research, the keywords that represent the highest frequency were 'training' and 'intellectual impairment,' which represented 26 frequency each, accounting for 10% of the total keywords. Second, 'fitness' with nine frequencies accounted for 4 percent, followed by eight 'athletes' keywords, seven 'balance' keywords, seven 'competition' keywords, and six 'hearing impact' keywords. Secondly, the knowledge structure of Para Taekwondo-related research was analyzed as a whole. This study confirmed that the related structures were formed based on 'intellectual impairment' and 'training.' Thirdly, an analysis of the type of thesis related to Para Taekwondo found that major clusters were formed around the top keywords 'training' and 'intellectual impairment' with the highest degree centrality. Finally, the top keywords with the highest degree centrality of Para Taekwondo-related academic papers were 'training,' 'intellectual impairment,' 'athletes,' and 'fitness.' In addition, academic papers formed a major colony around 'training.'*

Conclusion: *Based on the results of this research, studies on various topics related to Para Taekwondo could be activated and Para Taekwondo could develop into a single academic area by expanding its scope.*

[Keywords] ***Para Taekwondo, Training, Fitness, Knowledge Structure, Keyword Network Analysis***

1. Introduction

Taekwondo for the disabled applies a classification by type of disability so that visually impaired, intellectually disabled, retarded(upper extremity amputation, wheelchair disability, etc.), and hearing-impaired athletes can fairly participate in the competition, according to their disability characteristics. In Korea, since the Korea Taekwondo Association for the Disabled was established in 2009 and approved as an official competition organization of the Korea Sports Association for the Disabled, it has promoted the development of Taekwondo for the disabled in Korea[1]. On May 23, 2021, Korea won a gold medal in the men's K44 class(75 kg) at the 2020 Asian Championships in Amman, Jordan[2]. In addition, Taekwondo for the disabled has recently seen an increasing number of international competitions involving athletes with disabilities and hearing impairments. As a result, competitions, including the National Sports Festival for the Disabled, are increasing in Korea, but the number of registered

athletes in Korea is far smaller than in other sports, raising the issue of supply and demand of athletes[3][4].

Meanwhile, Taekwondo is classified as an area of learning to strengthen its role as a Taekwondo suzerain and lead globalization. In this regard, a study[5] analyzed the research trends in Taekwondo in Korea and presented academic tasks, while another[6] conducted an analysis based on keywords from Taekwondo studies. Moreover, a study[7] collected Taekwondo studies and applied knowledge network analysis. In addition, several studies have been conducted to identify domestic and foreign Taekwondo-related research trends, classify the areas of Taekwondo, and explore the structure of Taekwondo[8][9].

In order to establish it as a single discipline, it is necessary to analyze the knowledge structure of the field to identify the relevant research contents and characteristics of the field[10]. As a result, keyword-based network analysis has recently attracted attention to analyzing knowledge structures in various fields. Analysis of research or knowledge structures using network analysis techniques has a methodical framework for identifying relationships by extracting relevant information, such as critical keywords, affiliated institutions, academic journals, authors, and references related to the study. Thus, keywords in research help us identify the content of research. Furthermore, they help explore the structure of the field because it can be visually represented by structuring relationships between knowledge in related fields based on network theory[7][11].

Therefore, for Korea's Para Taekwondo to expand its base as a domestic disabled sport and further lead the Para Taekwondo world, Para Taekwondo, like general Taekwondo, needs to be established as an academic field. To do this, it is necessary to analyze research trends related to Para Taekwondo. Accordingly, studies related to Para Taekwondo[12][13], and performance-related studies[14][15][16][17], are highly insufficient compared to prior studies related to Taekwondo. Therefore, despite the recent attention given to Para Taekwondo in the international community, it is necessary to analyze Para Taekwondo research and explore knowledge structures using keyword-based knowledge network analysis to activate and develop Para Taekwondo, which is biased against specific types of disability. Therefore, in this work, it is essential to analyze Para Taekwondo-related research and explore knowledge structures to examine the structure and domain of Para Taekwondo's research.

2. Research Method

2.1. Research materials

This study explores the structure of domestic Para Taekwondo research by applying keyword-based knowledge network analysis. To this end, domestic Para Taekwondo-related research was selected as a population, and research materials were selected according to the following procedures. First, an academic database(DB) was selected to collect domestic Para Taekwondo studies. At this time, three domestic academic DBs were selected to secure population-level Para Taekwondo studies in terms of the significant impact of academic database selection on research results[7]. DBs were the Korea Citation Index(KCI) of the National Research Foundation of Korea, the Korean Studies Information Service System(KISS) of Korean Studies Information(KSI), and the Research Information Sharing Service(RISS) of Korea Education Research Information. Second, this study searched and collected Para Taekwondo-related works from selected academic DBs. They were collected by searching for 'impairment' and 'Taekwondo' in the research title. In this study, data from each academic DB were collected to prepare a list of bibliographic information such as ointment, author's name, and academic journal to prevent overlapping and omission. A total of 76 studies were searched by May 2021. Third, among the collected studies, this research proceeded with eliminating studies that were not suitable for this paper. The conditions for removal were: 1)research that was not conducted on disabled people, 2)research that did not know the type of disability, and

3)unpublished when existing research works by the Korea Research Foundation. The final number of domestic Para Taekwondo studies identified through this process was 42. Fourth, in this study, keywords were adapted to English rather than Korean to utilize keyword-based knowledge networks. In this course, two taekwondo professors, two Parasports professors, and one English literature major, including the researchers, went through translating Korean keywords into English. Finally, in this work, a time series analysis was not conducted because the number of studies was minimal to determine how the knowledge structure of the Para Taekwondo study changes from a time-series perspective.

2.2. Analysis procedures and data processing

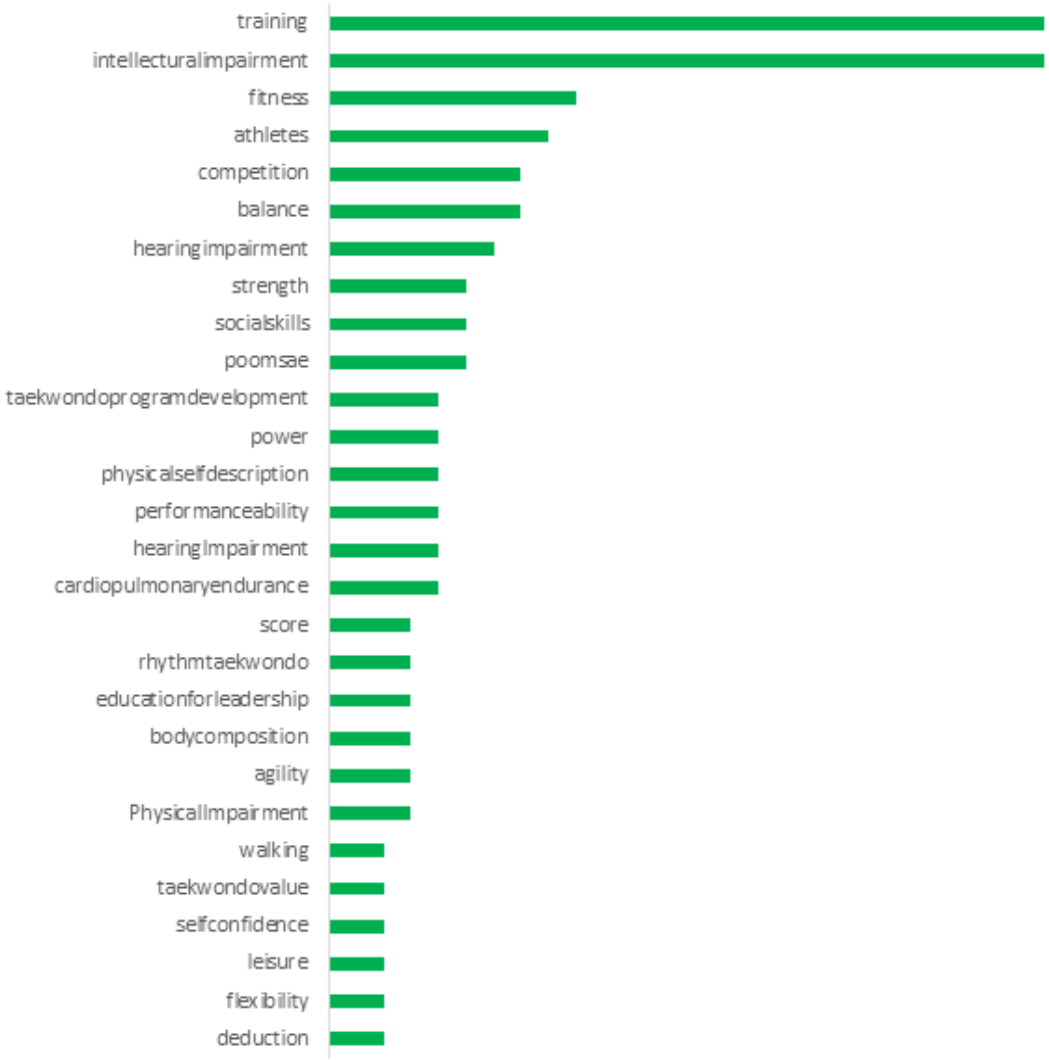
The procedure for exploring the knowledge structure of the Para Taekwondo in this study and applying keyword-based knowledge network methods is as follows. First, this study proceeded with the refinement process of keywords calculated from the collected data, conducting the standardization process for such items as synonyms and similar words. For example, the extracted keyword is “athlete”, “athletes”, “wheelchair athletes”, or “player”, but it has been standardized as "athletes" because it is written in a similar form. Second, this study used window size and Link Frequency Threshold to determine simultaneous presentation criteria in netminer to obtain co-occurrence frequency and applied window size and Link Frequency Threshold 4 or less across the entire interval to analyze. Third, this study conducted a network analysis of the constructed keyword matrix. Keyword-based analysis in knowledge network analysis requires the use of degree centrality, which quantifies the concept of centrality, as an analytical indicator to calculate the influence of keywords and identify knowledge structures. Link centrality is an indicator of how many links a keyword has with other keywords, and the higher the link centrality, the more it is considered a key topic[7]. Keyword-based knowledge network analysis of this work looks at the relationships among keywords in Para Taekwondo-related studies, and it applied 1-mode network analysis. This study also performed the analysis using Netminer 4.0(Cyram, Seoul) program to visualize each network analysis.

3. Result

3.1. Analysis of keywords in the para taekwondo study in Korea

The first result of this study is the result of analyzing the frequency of keywords produced in Para Taekwondo-related studies. Here, 250 keywords were calculated for 42 Para Taekwondo-related studies conducted from 2004 to 2021, and the main top keywords used in Para Taekwondo-related studies are as follows. First, if one looks at <Figure 1>, the keywords representing the highest frequency in Para Taekwondo-related studies are 26 sessions of 'training' and 'intellectual impairment,' accounting for 10% of each. Second, 'fitness' representing the frequency of nine sessions accounted for 4 percent. Next, there are eight keywords for 'athletes,' seven keywords for 'balance,' seven keywords for 'compensation,' and six keywords for 'hearing impairment,' confirming the keywords for Para Taekwondo-related research.

Figure 1. Top 20 keywords in para taekwondo-related studies.



3.2. Knowledge structure of para taekwondo research in Korea

The second result of this study is the exploration of the knowledge structure of Para Taekwondo-related studies. Keyword network analysis method was used as an analysis method. Specifically, to see the relationship between adjacent keywords below window size 3, this study applied Link Frequency Threshold 3 or below to focus on 20 keywords. <Table 1> analyzes the degree centrality of Para Taekwondo research and presents the top 30 keywords. The keywords with the highest degree of centrality were "training" with 26 frequency and "intellectual impairment" with 26 frequency. <Figure 2> shows that the keywords that represent a cluster of keywords center around the two keywords 'training' and 'intellectual impairment,' representing a high degree. These keywords are studied in the Para Taekwondo field. In the case of 'training,' studies are highly associated with 'fitness,' 'athletes,' 'balance,' and 'cardiopulmonary endurance,' and keywords for 'intellectual impairment' are highly regarded with 'physical self-description' and 'body composition.' This confirms the knowledge structure of Para Taekwondo-related research and confirms that research is being conducted through access in the relevant domain within the scope of research centered on two keywords: 'training' and 'intellectual impairment.'

Figure 2. Knowledge map of para taekwondo-related studies.

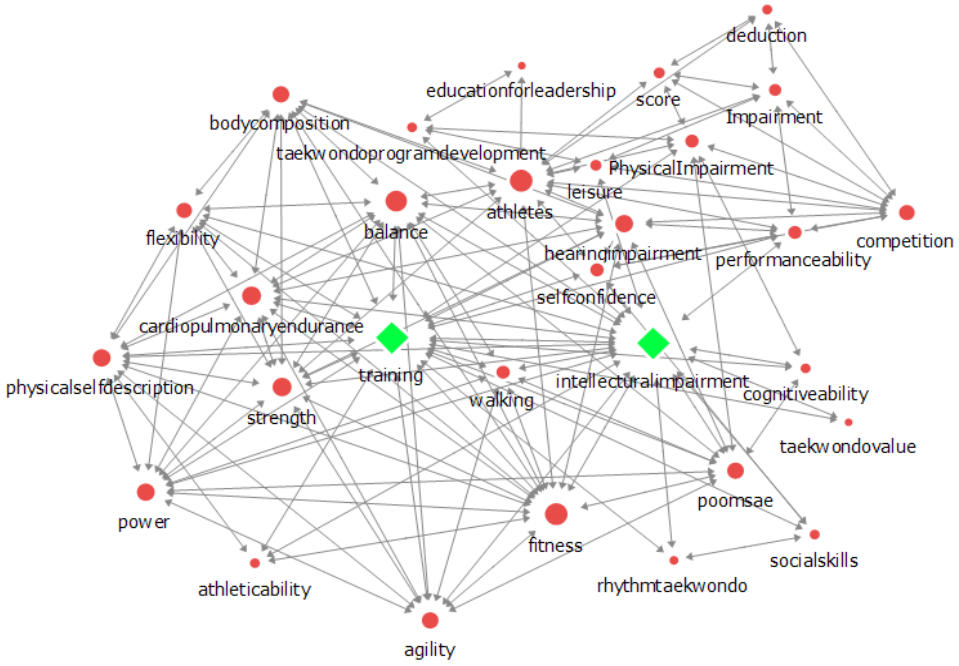


Table 1. The top 30 keywords of para taekwondo-related research.

No.	Keywords	Degree centrality	Co-occurrence	No.	Keywords	Degree centrality	Co-occurrence
1	Training	0.724	26	16	Performance ability	0.241	3
2	Intellectural impairment	0.724	26	17	Physical Impairment	0.241	3
3	Fitness	0.517	9	18	Self confidence	0.241	3
4	Athletes	0.517	8	19	Walking	0.241	3
5	Balance	0.482	7	20	Impairment	0.206	3
6	Strength	0.413	7	21	Score	0.172	3
7	Cardiopulmonary endurance	0.413	6	22	Leisure	0.172	3
8	Hearing impairment	0.379	5	23	Socialskills	0.137	2
9	Physical self description	0.379	5	24	Taekwondo program development	0.137	2
10	Power	0.379	5	25	Athleticability	0.137	2
11	Poomsae	0.344	4	26	Cognitiveability	0.137	2
12	Agility	0.344	4	27	Deduction	0.137	2
13	Bodycomposition	0.344	4	28	Rhythm taekwondo	0.103	2
14	Competition	0.310	4	29	Education for leadership	0.068	2
15	Flexibility	0.310	4	30	Taekwondo value	0.068	2

3.3. Knowledge structure by para taekwondo research types in Korea

The third study was conducted to explore research trends by type of Para Taekwondo-related research conducted in Korea. To this end, the dissertation and academic journals

were distinguished in a Para Taekwondo-related study conducted in Korea. The two types were divided into 22 academic papers and 20 dissertations. The distinction between <Table 2> and <Figure 3> is based on the degree centrality analysis for 120 keywords in 20 dissertations conducted from 2004 to 2021. The top keywords with the highest degree centrality in Para Taekwondo-related thesis were 'training,' 'intellectual impairment,' 'balance,' and 'fitness.' In addition, it forms a significant cluster around 'intellectual impairment' and 'training.' It shows the high connectivity between the top two keywords, and the keywords 'balance,' 'fitness,' and 'power' are being studied together.

Figure 3. Knowledge map of thesis.

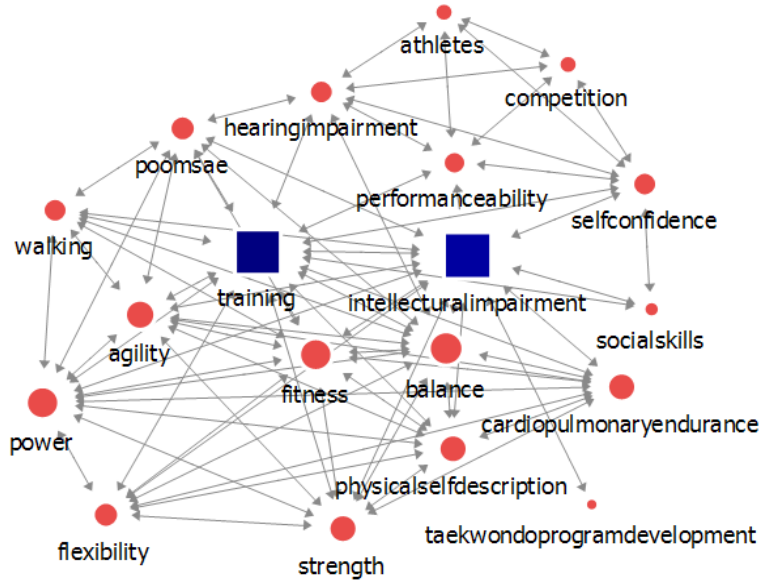


Table 2. Top 18 major keywords for degree centrality of thesis.

No.	Keywords	Degree centrality
1	Intellectural impairment	0.833
2	Training	0.833
3	Balance	0.666
4	Fitness	0.611
5	Power	0.611
6	Agility	0.555
7	Cardiopulmonary endurance	0.500
8	Strength	0.500
9	Physical self description	0.500
10	Poomsae	0.444
11	Flexibility	0.444
12	Hearing impairment	0.388
13	Self confidence	0.388
14	Walking	0.388
15	Performance ability	0.333
16	Athletes	0.222
17	Competition	0.222
18	Social skills	0.166

<Table 3> and <Figure 4> are the results of analyzing degree centrality for 132 keywords in 22 articles from 2004 to 2021. The top keywords with the highest degree of degree centrality in the paper related to Para Taekwondo were 'training,' 'intellectual impairment,' 'athletes,' and 'fitness.' In addition, it was found that the effective cluster forms centered on 'training' and that the keywords related to the three upper keywords 'intellectual impairment,' 'fitness,' and 'athlete' are highly connected, with the first higher keyword 'training.'

Figure 4. Knowledge map of article.

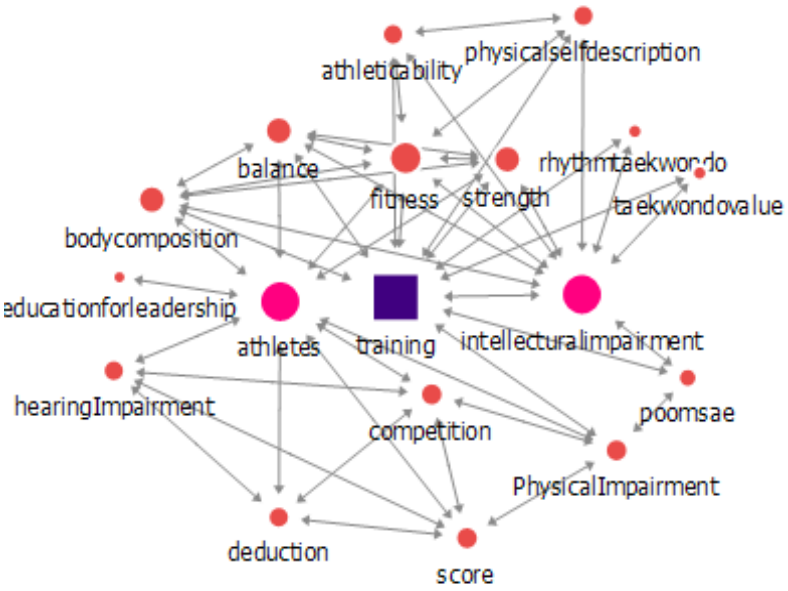


Table 3. Top 18 major keywords for degree centrality of article.

No.	Keywords	Degree centrality
1	Training	0.647
2	Intellectural impairment	0.588
3	Athletes	0.588
4	Fitness	0.470
5	Balance	0.352
6	Body composition	0.352
7	Strength	0.352
8	Competition	0.294
9	Score	0.294
10	Physical impairment	0.294
11	Hearing impairment	0.235
12	Athleticability	0.235
13	Deduction	0.235
14	Physical self description	0.235
15	Poomsae	0.176
16	Rhythm taekwondo	0.117
17	Taekwondo value	0.117
18	Education for leadership	0.058

4. Discussion

This study was conducted to examine trends in Para Taekwondo-related research and explore knowledge structures. In the case of Taekwondo, active research activities have been carried out, and attempts have been made to explore the knowledge structure of the study[7]. However, Para Taekwondo is only active in Korea for some types of disability, despite its continued development in the international community. In addition, to expand and develop the base of Para Taekwondo in Korea due to the lack of research related to Para Taekwondo, Para Taekwondo also needs to be studied to secure its identity as an academic.

This work analyzes the classification and knowledge structure of research disciplines through keyword network analysis on Para Taekwondo studies. Studies have shown that Para Taekwondo-related studies have been conducted around two top keywords, 'intellectual impairment' and 'training,' with 'fitness,' 'balance,' 'competition,' and 'hearing impairment' keywords associated with a high degree center structure. After analyzing the knowledge structure of Para Taekwondo-related research as a whole, this study confirmed that the research was conducted. Related structures were formed based on 'intellectual impairment' and 'training.' In the case of 'training,' it was confirmed that research was being conducted about 'fitness,' 'athletes,' 'balance,' and 'cardiopulmonary ending,' and the keyword 'intellectual impairment' about 'physical self-description, 'body composition,' and 'degree.' This research structure is believed to be because, in the case of Para Taekwondo in Korea, the two types are concentrated and activated. Many intellectual and developmental disabled people in the community often participate in Para Taekwondo to improve physical efficacy, improve physical fitness, and reduce problem behavior, and, accordingly, studies were conducted to identify related effects[18][19][20][21]. In addition, Taekwondo has a great physical and mental impact, given that various positive effects on taekwondo training are presented in studies of non-disabled people[22][23][24][25][26].

In addition, Para Taekwondo-related studies analyzed the types of knowledge structures by literary form, confirming that degree papers related to Para Taekwondo had primary cluster forms centered on 'training' and 'intellectual impairment' and that the keywords 'balance' and 'fitness' were conducted together. Specifically, the two critical keywords that form clusters and exact keywords that represent high connectivity form structural relationships between elements of fitness, such as 'power,' 'ability, 'cardiopulmonary ending,' 'strength,' 'physical self-description, and 'flexibility. This is believed to have been influenced by research designed and conducted to verify various effects by participating in Taekwondo programs for disabled people for more than a certain period[27][28][29][30][31][32][33]. In the case of Para Taekwondo-related academic journal research, degree centrality was the main cluster form centered on "training," and the keywords "intellectual impairment," "athletes," and "fitness" were highly connected. Specifically, if one looks at the cluster-type 'training' keywords and exact keywords that show high connectivity, there are structural relationships among 'athletes,' 'fitness,' 'balance,' 'body composition,' 'strength,' 'score,' 'physical impairment,' 'hearing ability, and 'ductability' keywords. The composition of such academic papers was relatively similar to that of the dissertation, but there were differences in keywords such as 'score,' 'competition,' 'athleticism,' and 'duction' related to the performance of Para Taekwondo players. Unlike the thesis, "Physical Impairment" appears as a primary keyword, such as Deaflympic, 2019. As a result of analyzing the types of knowledge structures by academic type, there were some differences between types, but the general keywords were similar. This is believed to have had a particular impact because the thesis was revised and supplemented to the relevant academic journals after the dissertation was carried out. Therefore, based on the results of this study, one can confirm the narrowness of the Para Taekwondo-related research field. Therefore, access will need to be made to various areas where subsequent research has not been conducted.

Based on the results, this research expects that various topics related to Para Taekwondo will be activated and that it will be recognized as an academic area, laying the foundation for

its further development. In a follow-up study, it is believed that the analysis of the specific flow of research trends can be analyzed and directed based on events that set the stage for change or significant issues in the Para Taekwondo system. It is also hoped to play a role in leading the Para Taekwondo in the international community and expanding the base of Para Taekwondo in Korea.

5. Conclusion and Suggestions

This work sought to explore knowledge structures and domains by analyzing studies conducted concerning Para Taekwondo. The conclusions are as follows. First, according to the analysis of the critical keywords of Para Taekwondo-related research, the keywords that represent the highest frequency were 'training' and 'intellectual impairment,' which represented 26 frequency each, accounting for 10% of the total keywords. The second was 'fitness' with nine frequencies, with four percent, followed by eight 'athletes' keywords, seven 'balance' keywords, seven 'competition' keywords, and six 'hearing impairment' keywords. Second, this study analyzed the knowledge structure of Para Taekwondo-related research as a whole and confirmed that the research was conducted. Related structures were formed based on 'intellectual impairment' and 'training.' In the case of 'training,' it can be confirmed that studies are being conducted concerning 'fitness,' 'athletes,' 'biomechanics,' 'balance,' and 'cardiopulmonary endurance,' and the keywords for 'intellectual self-description, 'body' and 'body composition.' Third, the research trends and knowledge structures of Para Taekwondo were analyzed separately into 22 academic papers and 20 dissertations. First of all, the analysis of the types of degree papers showed that Para Taekwondo-related degree papers consisted of major cluster studies centered on the top keywords 'training', 'intelligent impairment,' and 'balance' included in the top two keywords, 'training,' and 'intellectual impairment.' Finally, the top keywords with the highest degree centrality of Para Taekwondo-related academic papers were 'training,' 'intellectual impairment,' 'athletes,' and 'fitness.' In the case of academic papers, there was a significant cluster form centered on 'training,' and the keywords related to the three top keywords, 'intellectual impairment,' 'fitness,' and 'athlete,' centered on 'training' keywords, showing high connectivity.

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7. Appendix

7.1. Authors contribution

	Initial name	Contribution
Lead Author	MK	-Set of concepts ☑ -Design ☑ -Getting results ☑ -Analysis ☑ -Make a significant contribution to collection ☑ -Final approval of the paper ☑ -Corresponding ☑ -Play a decisive role in modification ☑
Corresponding Author*	SR	-Significant contributions to concepts, designs, practices, analysis and interpretation of data ☑ -Participants in Drafting and Revising Papers ☑ -Someone who can explain all aspects of the paper ☑