International Journal of Medical, Medicine and Health Sciences
ISSN: 2517-9969
Vol:12, No:9, 2018

Utilizing the Analytic Hierarchy Process in Improving Performances of Blind Judo

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***Abstract*—**Identifying, structuring, and racking the most important factors related to improving athletes' performances could pave the way for improve training system. The purpose of this study was to identify the relative importance factors to improve performance of the of judo athletes with visual impairments, including blindness by using the Analytic Hierarchy Process (AHP). After reviewing the literature, the relative importance of factors affecting performance of the blind judo was selected. A group of expert reviewed the first draft of the questionnaires, and then finally selected performance factors were classified into the major categories of techniques, physical fitness, and psychological categories. Later, a pre-selected experts group was asked to review the final version of questionnaire and confirm the priories of performance factors. The order of priority was determined by performing pairwise comparisons using Expert Choice 2000. Results indicated that "grappling" (.303) and "throwing" (.234) were the most important lower hierarchy factors for blind judo skills. In addition, the most important physical factors affecting performance were "muscular strength and endurance" (.238). Further, among other psychological factors "competitive anxiety" (.393) was important factor that affects performance. It is important to offer psychological skills training to reduce anxiety of judo athletes with visual impairments and blindness, so they can compete in their optimal states. These findings offer insights into what should be considered when determining factors to improve performance of judo athletes with visual impairments and blindness.

***Keywords*—**Analytic hierarchy process, blind athlete, judo, sport performance.

I. Introduction

BLIND judo was selected as an official sporting event at the 1988 summer Paralympic Games in Seoul, Korea [1]. Since then, International Blind Sports Federation (IBSA) has been organizing and hosting international blind judo games. Various international games, such as the IBSA World Championships, the International Paralympic Committee (IPC) Championships, the Paralympics Games, and the Asian Games for Persons with Disabilities, have provided opportunities for judo athletes with Visual Impairment (VI) and blindness to compete. In Korea, blind judo was introduced by Professor Kyusoo Kim at Yongin University in 1988. Since Yoosung Ahn won the gold medal in the 1988 summer Paralympic Games, many Korean judo athletes with VI, including blindness, have consistently achieved excellent outcomes at the international games. They recently won one gold medal, two silver medals, and two bronze medals in the 2016 Rio Paralympic Games in Brazil. However, Korean blind judo coaches have faced many challenges. For example, the number of judo athletes with VI and blindness is very limited, and the lack of training facilities makes it extremely difficult for individuals with VI and blindness to participate in sports. Furthermore, there is not enough funding and support for judo athletes with VI and blindness. Moreover, blind judo coaching methods are underdeveloped, so there is a strong need to improve the athletes' selection standards and training methods based on scientific evidence and procedures [2]. Despite these challenges, efforts are being made to expand the base of support for blind judo and improve the performance of judo athletes with VI and blindness through the establishment of many national games, such as the National Para Games and the Province Para Games, as well as by promoting various international games [3].

As a national endeavor to improve the performance of athletes with disabilities, the Icheon Training Center for Athletes with Disabilities (ITCAD) was built in Icheon, Gyeonggi Province in Korea in 2009. This facility has been effectively utilized to improve the performance of athletes with disabilities through systematic training and appropriate support [4]. The ITCAD has established an infrastructure for the development of adapted physical activity, professional training facilities for both national athletes with disabilities and without disabilities, and an infrastructure for the dissemination and improvement of sports for people with disabilities. Since its establishment, ongoing efforts have been made to enhance the training environment for athletes with disabilities, such as the expansion of various training facilities in the ITCAD.

In the past 10 years, disability sports have made remarkable progress in terms of budgets, administration, and training environments; however, the development of new athletes through the expansion of the base and the introduction of a systematic training program has been very slow. Some research efforts have been made to overcome the challenges mentioned above. Han, Kim, and Cho examined the effect of chokes on the physiological changes of judo athletes with VI and blindness [5]. Baek and Lee studied the types of scoring techniques for judo athletes with VIs and hearing impairments [6]. Sung investigated the differences in scoring techniques based on types of disabilities [7], and Cho conducted a video analysis of the game skills of judo athletes with VI and blindness [8]. Studies on the development of systematic training methods for judo athletes with VI and blindness have also been very limited. To the authors' knowledge, there is only one study that has examined the effectiveness of psychological skills training

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programs on the game performance of judo athletes with VI and blindness in Korea [9].

In order to overcome the limitations of the previous research, the present study has introduced the AHP. The AHP is one of the most widely used decision-making methods [10], and it aims to capture the knowledge, experience, and intuition of the evaluator based on the relative assessment system using pairwise comparison [10]. AHP is an analytical method that structures and analyzes a problem in a way that is similar to the thinking process used by humans [10], [11]. It has the advantage of being able to construct a model by simultaneously considering the qualitative and quantitative factors of the determinants [10]-[12]. Due to the promising benefits of AHP, it has been widely used in various policy decision-making and strategic planning processes.

As a hierarchical decision analysis method, AHP has been used as a research topic in the field of exercise and sports science. For example, Yu used AHP for a priority analysis of the successful factors associated with province-related sports events [13]. Han applied AHP to the hierarchical structure analysis of a child's gross motor development test [14], and Yoo et al. used AHP to investigate important factors associated with Taekwondo demonstration team planning [15]. Moreover, Jeong applied AHP to prioritize and analyze the activating factors of sports for all [16]. Park used AHP to prioritize the factors that impact the horse riding industry [17]. In addition to applying AHP to these various fields of research, it has been employed to analyze the factors affecting sports performance. For instance, Park applied AHP to the selected determinants of the kendo competitions and developed an assessment model [18]. Hong used AHP to develop fitness training program models for wheelchair track and field athletes [4]. Therefore, the present study aimed to identify the factors affecting the performance of judo athletes with VI and blindness through a review of the literature. It also sought to identify the relative importance and priority of the elements of those athletic factors by structuring them. It is expected that this study will provide a database that can be used to improve the game performance of judo athletes with VI and blindness, as well as contribute to the expansion of blind judo so more people with VI can participate in this sport.

II. Methods

A. Participants

An expert group was formed and an AHP survey was conducted to identify the elements of performance needed to induce blind athletes based on their individual characteristics and to induce them to develop an effective training program based on their priorities. Table I shows the composition of the expert group for this study.

B. Instruments

1. Literature Review: First we gathered data on the athletic performance factors necessary for blind judo based on the findings reported in previous studies. We then selected the factors to use in the AHP analysis. In this literature review, the following keywords were used to identify the appropriate literature: VI, para judo, blind judo, judo, and judo performance. The literature was searched using those keywords primarily through RISS (Riss.kr, an academic database in Korea). Secondary sources, such as adapted physical activity and judo textbooks, were reviewed simultaneously.

TABLE I
Expert Group for the AHP Survey

Type	Current Position
General Judo	Professor in judo department
	Professor in judo department
	Head coach of Korea judo national team
	Head coach of a judo team in Korea
	Coach of a judo team in Korea
Blind Judo	Head coach of Korea blind judo national team
	Coach of Korea blind judo national team
	Chief referee of blind judo
	Head coach of a blind judo team in Korea
	coach of a blind judo team in Korea
Total	10

2. Expert Group: The AHP questionnaires were developed based on the factors selected from the literature review. After screening many factors related to blind judo, the main words were extracted and structured into three categories, ranging from level 1 to level 3 with the expert group, so the researchers could use the pairwise comparison method to identify the common elements at the same level.
3. AHP Survey: The AHP questionnaire was developed by classifying the elements of the blind judo factors selected with expert opinions into a hierarchical structure. The questionnaire for hierarchical analysis was constructed using the pairwise comparison method with the factors ranked on a 9-point scale.
4. Content Validity: The content validity of the AHP questionnaire was assessed and established by the expert group.

C. Procedures

The factors related to the performance of judo athletes with VI and blindness were extracted from the literature review. To structure the selected factors, each was categorized into one of three levels based on the expert group's opinions, and then they were classified to the same stages to create a framework for the AHP questionnaire. Based on the classified factors, the AHP questionnaire was developed and the content validity was evaluated by the expert group. The data collected through the questionnaires were analyzed to calculate the Consistency Index (CI), and the final priority rank of the selected factors was derived according to the calculated results. A flow chart of the overall research procedure is shown in Fig. 1.

D. Data Analysis

The AHP questionnaire was constructed to investigate the degree to which the main factors impacted the performance of the blind judo athletes. Data were analyzed using the Expert

Choice 2000 program for planning an individualized training plan (ITP) based on a consistency indicator (CI) that is not greater than 0.1.

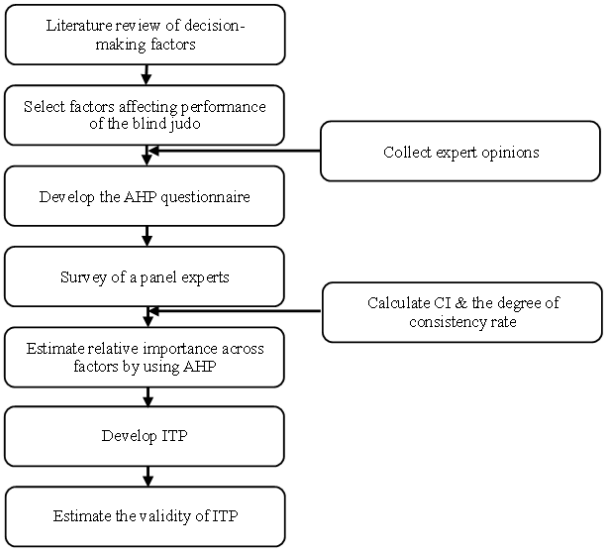

Fig. 1 Procedure flow chart

III. Results

A. Blind Judo Performance Factors

This study aimed to identify the performance factors that improve the athletic performance of blind judo athletes, and to create an ITP accordingly. To confirm the factors related to the performance of blind judo athletes, we conducted a thorough literature review to select the main words used to construct the AHP questionnaire. A representative academic database in Korea, RISS, was used to search the related literature using the keywords “judo” and “athletic performance,” and the researcher classified the literature into three categories: theses, journal articles, and textbooks. A total of 246 theses, 112 research articles, and 11 books related to 'Judo + Competition' were found.

In order to select the performance factors related to bind judo from the literature review, the words that were combined and various terms were categorized into several main words. Based on the information obtained from the guided textbooks and training manuals, the major factors were divided into judo techniques, physical fitness and conditions, and psychological factors (Fig. 2).

B. AHP

In order to create an ITP to improve the performance of athletes with VI and blindness, the relative priority rank of the blind judo performance factors was determined using AHP. Table II shows the relative ranking of all of the performance factors.

IV. Discussion

This study aimed to identify the performance factors associated with blind judo and to design an ITP adapted to individual judo athletes with VI and blindness. To achieve the purpose of this study, we used AHP to analyze the elements of the blind judo performance factors selected from a literature review of previous studies, and we determined the priorities using a three classification levels: level 1, level 2, and level 3.

The skill factor was found to be the factor that had the greatest impact on blind judo performance. Unlike in regular judo in which the competition result is typically determined by the athletes’ techniques after the fight using the judo-gi collar, blind judo uses different rules in which athletes with VI and blindness start by grabbing the judo-gi collar from the beginning. This might explain why the result of the game is determined by the skill of the athletes in a relatively short game time [8]. In particular, the skill aspect might be a more important performance factor in blind judo because it is already important to know how accurately athletes with VI and blindness can use the skill at the beginning of the game, since they are already holding the opponent's collar at that time. The AHP survey results showed that grappling and throwing were movement skills that had a high priority. This finding is aligned with the results reported in previous studies that considered the characteristics of judo athletes with VI and blindness [8], [9].

The performance factors related to athletes’ physical fitness and conditioning appeared to have a lower priority than the skill factors; this finding was different from the research results reported by Kim and Nam [19]. This finding might be explained by the starting point for blind judo athletes. In most individuals, VI is congenital rather than acquired, and they are blind when they begin their blind judo career. That is to say, the physical fitness levels of blind judo athletes might be similar to non-VI athletes. It was revealed that physical fitness was considered to be an important factor impacting performance, which is similar to non-VI athletes who compete in general judo. Many researchers have supported this finding. Kim, Nam, and Choi [20] and Park investigated the physical fitness levels of general Judo athletes using discrimination analysis [21]. Seo analyzed the correlations between physical fitness factors and found that an athlete’s judo performance can be enhanced when muscular strength, muscular endurance, cardiovascular endurance, agility, flexibility, and balance are improved [22]. The results of these prior studies and the priorities of the fitness factors found in the present study can be explained in the same context. A comparison of the differences between blind judo athletes and general judo athletes found that VI athletes have some unique characteristics derived from their particular disability of being blind. It was also clearly shown that there is no difference in the physical factors that athletes need to perform blind judo or general judo; and this part should be considered in all training processes, leading to improvements in physical strength and performance. Therefore, in the planning and execution of a training program, a trainer should confirm the current fitness levels of each athlete with VI and blindness and establish the fitness factors and specific goals needed to improve accordingly. The principle of fullness, which is the basic principle of training, could also be used as an additional scientific approach to improve the overall fitness factors of

athletes with VI and blindness [23], [24].

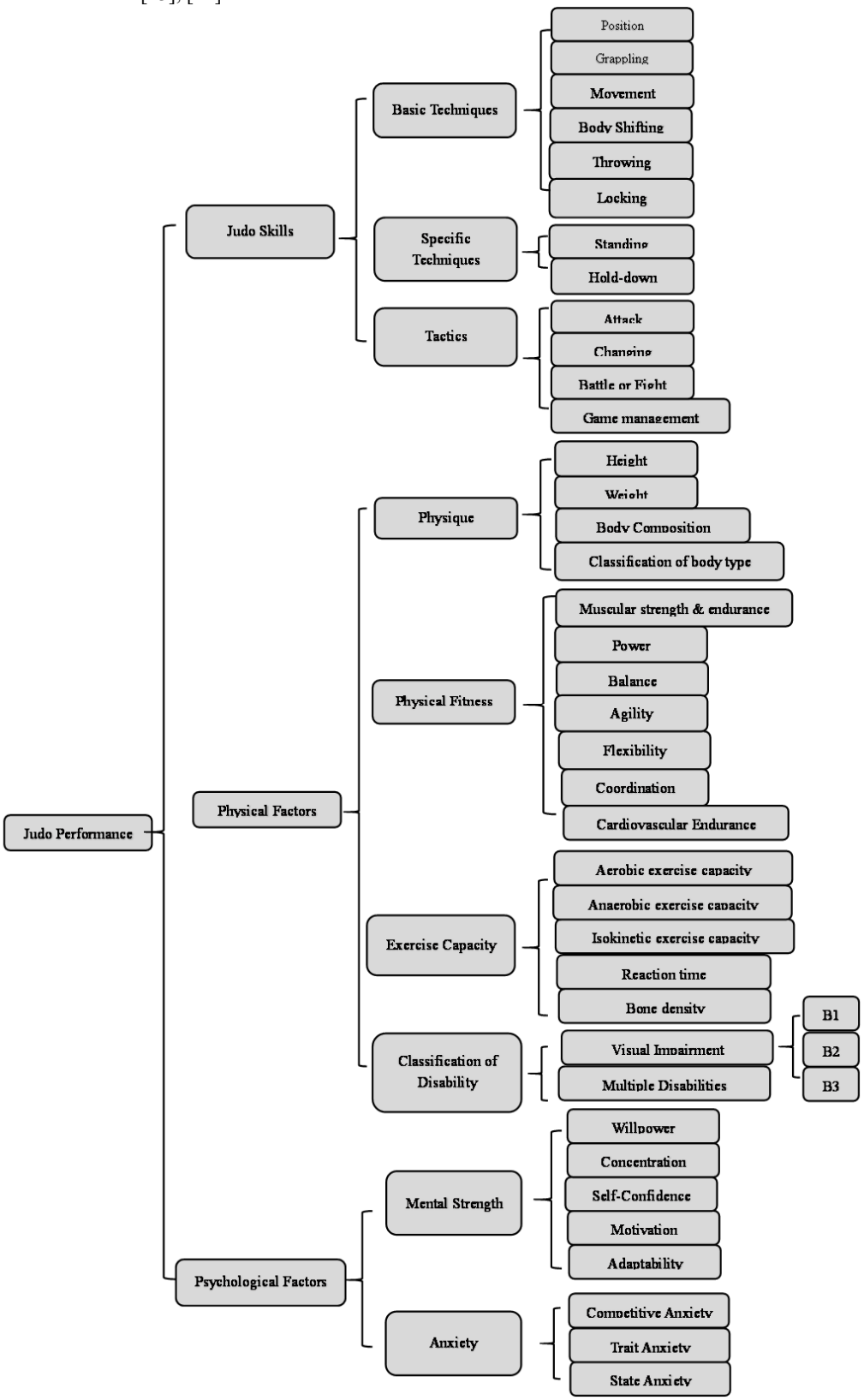

Fig. 2 Blind judo performance factors

TABLE II
THE RANKINGS OF PERFORMANCE FACTORS

Upper Hierarchy	Weight	Rank	Middle Hierarchy	Weight	Rank	Lower Hierarchy	Weight	Rank
Judo Skills	.675	1	Basic Techniques	.552	2	Position	.126	33
						Grappling	.303	8
						Movement	.073	38
						Body shifting	.17	28
						Throwing	.234	13
						locking	.094	37
			Specific Techniques	.114	8	Standing technique	.731	1
						Hold-down technique	.269	11
			Tactics	.334	5	Attach	.137	30
						Changing technique	.215	17
						Battle or Fight	.294	9
						Game management	.354	6
Physical fitness & conditions	.21	2	Physique	.111	9	Height	.217	15
						Weight	.199	22
						Body Composition	.409	4
						Classification of body type	.175	25
			Physical Fitness	.241	6	Muscular strength and endurance	.238	12
						Explosive Power	.134	31
						Agility	.121	34
						Balance	.134	32
						flexibility	.117	35
						Coordination	.098	36
						Cardiovascular Endurance	.16	29
			Physical Exercise Capacity	.477	3	Aerobic exercise capacity	.203	20
						Anaerobic exercise capacity	.231	14
						Isokinetic exercise capacity	.213	18
						Reaction Time	.172	27
						Bone Density	.181	24
			Classification of Disability	.17	7	VI	.452	3
						Multiple Disabilities	.548	2
Psychological factors	.114	3	Mental Strength	.644	1	Will Power	.211	19
						Concentration	.203	21
						Self-Confidence	.216	16
						Motivation	.195	23
						Adaptability	.175	26
			Anxiety	.356	4	Competitive Anxiety	.394	5
						Trait anxiety	.312	7
						State Anxiety	.294	10

In terms of psychological factors, general anxiety, which is usually felt by an individual in his/her everyday life, was found to have a higher relative priority than other types of anxiety, such as state anxiety. This is probably because, in general, the anxiety factor of a VI athlete is higher than usual considering that an athlete might experience anxiety at a specific moment, such as a game or a competition, and this affects his/her state anxiety, which could have a psychological impact on an athlete's performance. In addition, it is important to encourage blind athletes to develop their willpower and grit during competitions, so they can reduce the level of anxiety and to ensure that they feel confident about their performance.

V. CONCLUSION

This study was conducted to identify, structure, and rank the performance factors that impact blind judo athletes, and to establish an ITP based on the identified priority factors. We selected the key elements that directly affect an athletic performance based on previous research to identify the factors that impact performance. The results of the present study are as follows: among the various skill factors, basic skills, such as catching and grasping, should be considered to be the most important factors for the performance of blind judo athletes. This should be considered a priority in the training process. In addition, physical fitness and conditioning factors, such as strength and endurance, were factors that impacted athletic performance. Training plans should be developed and progress should be monitored. Moreover, specific physical fitness focused physical training (SPT) needs to be established and implemented.

This study's findings indicate that judo athletes with VI and blindness should prepare for judo competitions by assessing his/her psychological stability and controlling his/her anxiety by lowering the anxiety that originates from his/her disability.

It is also important that all training should include a training routine and use methods during the appropriately planned training period that have short-term and long-term goals. In addition, evaluations should follow at the end of the training to effectively plan and implement the next training plan.

Based on current study's findings, blind judo coaches can develop systematic and scientific training methods and routines for their judo athletes with VI and blindness to strengthen their judo skills and improve their physical fitness so they can deliver a better judo performance considering their unique needs and their abilities. Therefore, a follow-up study should be conducted focusing on physical fitness elements of the training methods the training methods of the physical fitness elements based on the disability conditions and the individual characteristics of judo athletes with VI and blindness.

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