Impact of COVID-19 and coping methods using text mining of taekwondo kyorugi athletes in Korea

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

Minsoo Jeon [iD] [1ABCD], **Hyosung Lim** [iD] [2AB], **Hyeri Oh** [iD] [3BD], **Hyo-Jun Yun** [iD] [4ABCDE]

[1] Department of International Sport, Dankook University, Chungcheongnam-do, Republic of Korea

[2] Department of Physical Education, Anyang University, Incheon, Republic of Korea

[3] Department of Physical Education, Korea National Sport University, Seoul, Republic of Korea

[4] Center for Sports and Performance Analysis, Korea National Sport University, Seoul, Republic of Korea

Abstract

Background & Study Aim: The recent outbreak of the COVID-19 virus, which has spread worldwide, started in December 2019, with confirmed cases continuing to occur in 2022. As of July 7, 2022, the cumulative number of COVID-19 cases was about 500 million, and the death toll was about 6.34 million. The World Health Organization declared COVID-19 a pandemic on March 11, 2020 and labelled it the highest level of infectious disease risk. The purpose of this study was knowledge both about likely changes facing athletes in Korea owing to the spread of COVID-19 and how they are coping with these – specifically taekwondo kyorugi athletes.

Material & Methods: A qualitative approach was chosen – an open-ended questionnaire was designed comprising four demographic questions and two questions addressing the impact of COVID-19 and coping methods. Questionnaire data from 184 adult taekwondo athletes were collected. For the text analysis, the latent Dirichlet allocation topic modelling algorithm was applied, and the coherence score index was used to select the number of topics. All data processing was performed using Python 3.

Results: From the coherence scores, three topics were identified under COVID-19 impacts and two under coping, as most suitable. The derived topics based on keyword distribution probabilities and the topic modelling analysis were as follows: first, the key impacts on the taekwondo athletes caused by COVID-19 were confirmed as anxiety due to training restrictions, self-care due to game postponement, and career instability due to game cancellation; second, the taekwondo athletes coped with COVID-19 by maintaining their performance through personal training and preparing for matches through personal quarantine

Conclusions: In the event of a similar situation in the future, new ways need to be identified that allow for training as well as competition during a pandemic. Additionally, preliminary efforts should focus on how to minimize anxiety among athletes whose careers and livelihoods are tied to their sport.

Keywords: anxiety • coping methods • open-ended questionnaire • performance • topic modelling

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Conflict of interest: Authors have declared that no competing interest exists

Ethical approval: The study was approved by the Ethical Review Committee of Korea National Sport University (No. 20220810-068)

Provenance & peer review: Not commissioned; externally peer-reviewed

Source of support: Departmental sources

Author's address: Hyo-Jun Yun, Center for Sports and Performance Analysis, Korea National Sport University, 1239 Yangjaedaero, 05541 Seoul, Republic of Korea; e-mail: hyojunyun@hanmail.net

INTRODUCTION

The recent outbreak of the COVID-19 virus, which has spread worldwide, started in December 2019, with confirmed cases continuing to occur in 2022. As of July 3, 2022, the cumulative number of COVID-19 cases was over 546 million, and the death toll was about 6.3 million [1]. The World Health Organization declared COVID-19 a pandemic on March 11, 2020 and labelled it the highest level of infectious disease risk [1].

Due to its severity and contagious nature, the virus has changed the lives, habits, and activities of everyone around the world. In particular, social distancing owing to COVID-19 has impacted our habits of going out and gathering with others and has encouraged remote meetings. Certain industries, and with that the individuals involved in those industries, have been particularly hit hard; sports and sporting events are among these. For example, in 2020, the Olympics, the largest sporting event in the world, scheduled in Tokyo, was postponed. Additionally, many other sporting events have been cancelled or postponed, resulting in many changes in the sports field due to COVID-19.

One noteworthy change during the pandemic is how athletes train [2]. In the case of Korea, group training and joint training were banned by an administrative order after COVID-19 began. This has created changes for athletes who are no longer able to perform their usual training routines, leading to considerable damage both physically and mentally. Most athletes maintain their performance through intensive individual exercise, but due to COVID-19, have been facing training restrictions, psychological anxiety, and with that, a decreased sense of self-fulfilment and enjoyment. This implies the need to come up with measures that can improve athletic performance in this environment. As the pandemic continues, research on countermeasures and counterplans is an ongoing requirement.

Our study is part of this stream of research, as we look at the impact of the virus on athletes in Korea – specifically, those involved in taekwondo. Taekwondo is a combat sport that is largely an individual event, but also one that has always included group training. Due to its unique characteristics, taekwondo training is performed with partners who work together in a variety of styles. However, due to COVID-19, such athletic training has been restricted and most taekwondo matches have been postponed or cancelled, raising anxiety among these athletes. In the COVID-19 related studies in the taekwondo field, scholars have examined athletes' anxiety due to COVID-19 [3], online training development [4], and physical strength considerations for athletes returning from COVID-19 infections [5]. However, there is insufficient research and investigation into the link between the impacts of COVID-19 on these athletes and their coping measures – in particular – the status of their training countermeasures.

The purpose of this study was knowledge both about likely changes facing athletes in Korea owing to the spread of COVID-19 and how they are coping with these – specifically taekwondo *kyorugi* athletes.

MATERIAL AND METHODS

Participants

To achieve our objective of examining COVID-19's impact on athletes and their coping methods, we surveyed 200 adult taekwondo *kyorugi* athletes in Korea. The survey was completed by those willing to participate once its purpose and content were explained. After excluding response refusals and insincere data, the final survey included 184 participants. This corresponds to a standard error, at 95% confidence, of ±7% of the population, which, according to the 2022 Korean Sport & Olympic Committee (a public sports institution in Korea), is 2,826 adult taekwondo *kyorugi* athletes. In terms of demographics, the participants included 82 males and 102 females, 150 college athletes and 34 unemployed athletes. In terms of awards, 15 participants were world competition winners, 18 were Asian competition winners, and 151 were national competition winners. Additionally, 28 athletes had national team experience.

This study was performed in compliance with the Helsinki Declaration guidelines and approved by the Ethical Review Committee of Korea National Sport University. Each participant was voluntary, who was informed of the study objective and context and provided their written informed consent regarding privacy and information management policies.

Study design

For surveyed text data, text pre-processing is essential to improve the time and accuracy required for the analysis. In this study, text pre-processing was carried out in four steps. First, the collected data were tokenized per word, and then only noun words were extracted. Second, unnecessary words were removed. In our study, we considered words such as 'corona', continuously, and last year as stop words; these were therefore removed. Third, words with the same meaning but different expressions, such as players and athletes, were converted into a common word.

The traditional method of analysing text data can be applied to content analysis. However, content analysis has a high degree of researcher subjective intervention as the researcher needs to categorize the content and classify it according to the systematic method applied [6]. As such, it is time consuming to derive results from a large amount of qualitative information. To solve this problem, topic modelling, a text mining technique, can be applied. Topic modelling is a probabilistic algorithm that extracts latent topics from a set of unstructured documents. In a practical sense, it is more suitable modelling as multiple topics can exist in one document, unlike in the general clustering technique [7].

The topic modelling algorithm is seen as the beginning of the latent semantic analysis (LSA) algorithm proposed by Deerwester et al. [8] in 1990. Subsequently, Hofmann [9] proposed the pLSA (probabilistic latent semantic analysis) algorithm as an extension. However, in terms of disadvantages, the pLSA algorithm cannot calculate the probability of a new document; its formula can be complicated because of many parameters; and it over fits the training data [7]. To compensate for these shortcomings, Blei et al. [7] proposed the latent Dirichlet allocation (LDA) algorithm. This algorithm has advantages in that it can generate semantically consistent themes and the usefulness of data dimensionality reduction [10]. It is recognized as a standard in academia because of its effective performance. Therefore, in our study, we analysed the text data by applying the LDA algorithm.

In topic modelling, we need to determine how many topics there are in the entire document set, as the results will differ depending on the number of topics established in advance. The perplexity (see also glossary) and coherence (see also glossary) indices are often used to determine the number of topics. On the one hand, implicitly, the perplexity index means a degree of learning performance but has the disadvantage of being difficult to use to interpret the results [11]. On the other hand, the method first proposed by Newman et al. [12], the coherence index, evaluates topics according to the high similarity of the high-order words, including each topic calculated as a result of topic modelling. That is, if the coherence score is high, each topic calculated through topic modelling would be composed of semantically similar words. In our study, the number of topics was determined based on the coherence score.

Although topic modelling is done by machine learning through an algorithm, interpreting the meaning of each topic and the process of setting the topic name are considered the important steps [13, 14]. Therefore, as a critical method for this, the process of collecting the opinions of experts in related fields to assign the topic name should be followed [14, 15].

Measurements and data analysis

The survey tool consisted of four questions on demographic characteristics (gender, affiliation, highest prize, national team experience) and two questions on perceived COVID-19 impacts and COVID-19 coping methods. As for the perceived impacts and coping methods, open-ended questions were used based on prior research and a literature review. The questionnaire development process included a preliminary survey of 10 people to check the understanding of the questions. Additionally, the preliminary data collected were checked for internal validity in a meeting of three expert groups, and the final open-ended questionnaires selected were 'How has COVID-19 affected you as a taekwondo athlete?' and 'What countermeasures to COVID-19 are you taking as a taekwondo athlete?'

Based on the topic modelling results from our study, along with the original respondent text, we used an expert group (a researcher with experience with topic modelling and three taekwondo *kyorugi* athletes) to name the topics. All data processing was performed using Python 3 (see glossary).

RESULTS

Prior to topic modelling analysis, we conducted word frequency analysis to identify the major keywords. Consequently, we identified 215 words for COVID-19 impact and 149 words for coping methods. The top 10 words by frequency are shown in Table 1. In terms of COVID-19 impact, the frequent keywords were 'training' (n = 142), 'match' (n = 120), 'time' (n = 30), body (n = 27), and 'management' (n = 23). In terms of coping method, the frequent keywords were 'training' (n = 117), 'mask' (n = 39), 'individual' (n = 36), and 'management' (n = 26).

We set the number of topics from 2 to 10 to then calculate the coherence score. We found that the coherence score was highest at 0.613, when the number of topics was set to three for the impact; and was the highest at 0.609, when the number of topics was set to two for coping (Figures 1 and 2). We then conducted topic modelling by setting the number of topics to three for impact and two for coping.

Looking at the topics by probability distribution for impact, topic 1 appeared 40.9%, topic 2 39.4%, and topic 3 19.7%. The keywords in the participant responses composing topic 1 were 'training', 'rest', 'degradation', 'match', 'life', 'physical-fitness', 'weight', 'mask', 'thought', and 'limit'. The keywords composing topic 2 were 'match', 'body', 'time', 'care', 'goal', 'injury', 'treatment', 'athlete', 'daily',

Table 1. Top 10 most frequent words for COVID-19 impact (n = 215) and for coping method (n = 149).

Impact (n words)				
training (142)	match (120)	time (30)	body (27)	management (23)
goal (20)	life (19)	anxiety (18)	mask (16)	degradation (14)
Coping method (n words)				
training (117)	mask (39)	individual (36)	management (26)	match (19)
wearing (19)	weight-training (17)	body (15)	preparation (14)	weight (13)
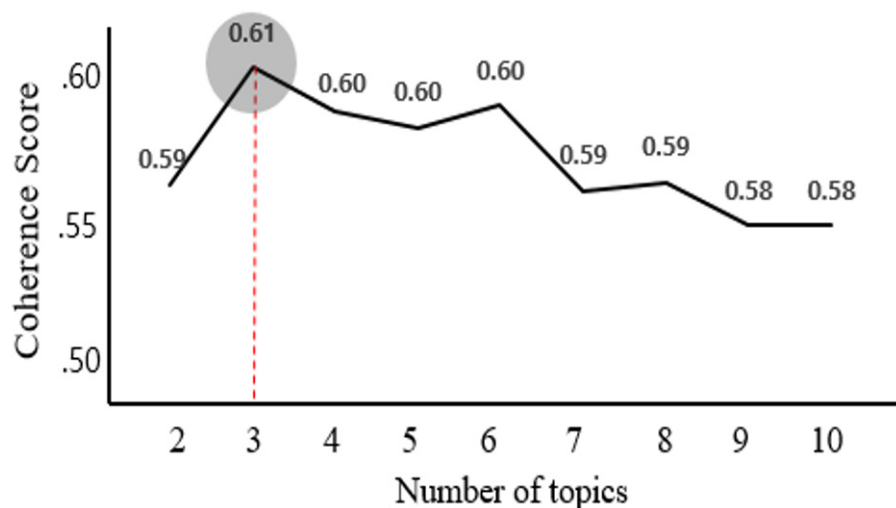
Figure 1. Coherence score of impact.
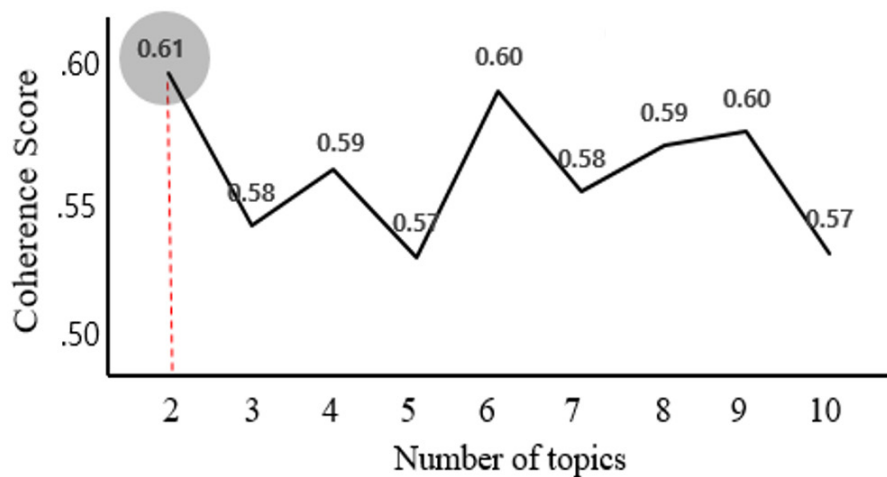
Figure 2. Coherence score of coping method.

and 'self-development'. The keywords composing topic 3 were 'anxiety', 'future', 'match', 'performance', 'professional-team', 'stress', 'participation', 'morale', 'career', and 'start' (Table 2).

Looking at the topic probability distribution for coping methods, topic 1 appeared 54.9% and topic 2 45.1%; the respondent keywords comprising topic 1 were training, individual, weight-training, home, gym, going-out, prohibition, rest, time, and physical-fitness. The keywords

comprising topic 2 were care, mask, weight, body, match, wearing, preparation, hand, injury, and video (Table 3).

DISCUSSION

Taekwondo athletes have been faced with various lifestyle changes owing to the spread of COVID-19. In terms of their training, their daily routines and competition schedules have been

Table 2. Analysis of topic modelling (LDA Algorithm) for COVID-19 impact.

Keyword (probability distribution)				
topic 1 *Anxiety due to Training Restriction* (40.9%)				
training (0.309)	rest (0.309)	degradation (0.309)	match (0.309)	life (0.309)
physical-fitness (0.026)	weight (0.023)	mask (0.021)	thought (0.018)	limit (0.017)
topic 2 *Self-Care due to Match Postponement* (39.4%)				
match (0.225)	body (0.072)	time (0.065)	care (0.063)	goal (0.034)
injury (0.027)	treatment (0.023)	athlete (0.020)	daily (0.018)	self-development (0.016)
topic 3 *Career Anxiety due to Match Cancellation* (19.7%)				
anxiety (0.088)	future (0.056)	match (0.042)	performance (0.041)	professional-team (0.039)
stress (0.032)	participation (0.031)	morale (0.030)	career (0.023)	start (0.021)

Table 3. Topic modelling (LDA Algorithm) analysis results for coping methods.

Keyword (probability distribution)				
topic 1 *Maintaining performance through individual training* (54.9%)				
training (0.259)	individual (0.123)	weight-training (0.061)	home (0.054)	gym (0.048)
going-out (0.047)	prohibition (0.046)	rest (0.044)	time (0.011)	physical-fitness (0.008)
topic 2 *Match Preparation through Quarantine* (45.1%)				
care (0.156)	mask (0.122)	weight (0.080)	body (0.077)	match (0.037)
wearing (0.031)	preparation (0.028)	hand (0.021)	injury (0.014)	video (0.012)

altered significantly. COVID-19 is now part of their daily routine for the first time. In particular, for athletes, the pandemic has become an important variable, as in the past, they have increased their physical condition or preparedness depending on upcoming competitions and training schedules. In this study, we were able to confirm the changes from the pandemic, as perceived by taekwondo *kyorugi* athletes and how they were coping with these. The implications were as follows.

As stated in section 2, we surveyed elite taekwondo athletes and asked them 'How did COVID-19 affect you as a taekwondo athlete?' – a question about impact – and 'How did you cope with COVID-19 as a taekwondo athlete?' – a question about coping methods. Based on this, from our keyword analysis, we found the highest frequency for the words training, match, and time in terms of COVID-19 impact. The implications were that taekwondo athletes had to discontinue their training and competition due to the pandemic and also faced a training time constriction. In other words, the biggest impact on taekwondo athletes due to COVID-19 can be interpreted as their inability to perform normal training and participate in competitions, which inevitably limited their ability to achieve their goals. In the study by Jeon et al. [16], they reported that a lack of training had a fatal effect on the performance of athletes preparing for a match.

From our topic analysis based on the surveyed content, we identified three total topics. Looking at the keywords in topic 1, we found 'training',

'rest', 'degradation', and 'match'. The implication here was that the athletes were anxious about the deterioration of their physical strength and performance as they were unable to train due to limited training places and time due to COVID-19 restrictions. Therefore, based on this, we named the first topic 'Anxiety due to Training Restriction'. As training for athletes is critical enough to be explained as a factor affecting the outcome of a match, an increase in the psychological anxiety around the lack of such training is understandable.

As athletes have strong emotions, such as anxiety, stress, and anger, due to COVID-19, the importance of 'psychological prevention', a concept related to psychological training for stress management in pandemic situations, is being emphasized to overcome such anxiety [17]. According to the recent study by Kim and Chang [18] on the effects of COVID-19, more than 60% of elite athletes report that psychological training, namely, psychological prevention, is necessary. That finding supports our results as well.

The keywords for topic 2 were 'match', 'body', 'time', and 'care'. As most taekwondo matches were cancelled or postponed due to COVID-19, athletes appeared to emphasize the need for self-management. Therefore, based on this, the second topic was named 'Self-Care due to Match Postponement'. Participation in competition is also a driving force for athletes to improve their performance and develop themselves [19, 20]. However, at the same time, continuous competition plays a part in terms of injury and body care.

Therefore, the implications from our results indicate that as matches were postponed because of COVID-19, there were negative impacts for the athletes, but also some positive ones, such as better injury management and treatment goal setting.

The keywords for topic 3 were anxiety, future, match, and performance. We found that athletes had career performance anxiety when matches were cancelled because of COVID-19. Therefore, based on this, the third topic was named 'Career Anxiety due to Match Cancellation'. In the case of elite athletes, their salaries or career paths are determined based on competition performance; thus, the implication is that anxiety about their career paths increased due to the cancellation of most matches. In particular, since we do not know when the number of infected people with COVID-19 will decrease, the anxiety among athletes may continue to grow.

We found the keywords for coping methods to be 'training', 'mask', and 'individual'. Despite the COVID-19 situation, our results show that taekwondo athletes were trying to maintain or improve their performance as much as possible through personal training and hygiene. In the current COVID-19 situation, as athletes are unable to participate in group training, they are finding ways to achieve individual training in gyms or outdoor spaces. Since taekwondo is performed based on weight class competition, references to individual body management and weight were also high-ranking keywords.

Based on our topic analysis of the surveyed contents, two topics comprised coping. In topic 1, the keywords were 'training', 'individual', 'weight-training', and 'home'. The implication was that these athletes were trying to maintain their performance through individual exercises at home or at a gym, while group training was prohibited due to COVID-19. Therefore, based on this, the first topic for coping methods was named. 'Maintaining performance through individual training'. Thus, because of limited space and environments created by COVID-19, these athletes were maintaining their performance within these limitations. Specifically, we confirmed that these athletes were unable to train with others due to COVID-19, so they trained alone at home or at a gym.

In terms of topic 2, we found the keywords 'care', 'mask', 'weight', and 'body'. The implication was that athletes were still prepared to participate in a match at any time through personal quarantine. Therefore, based on this, the second topic on coping methods was named 'Match Preparation through Quarantine'. As athletes became infected with COVID-19, matches were cancelled or rescheduled abruptly. We found that athletes were trying not only to avoid being infected with COVID-19 but also to maintain a condition that allowed them to participate in a match immediately. The implication was that besides the goal of match performance, the experience of the match was just as important and a key factor in improving performance while accumulating experience [21].

CONCLUSIONS

In terms of impact: the first significant issue was that of anxiety due to training restrictions; the second was that of self-care due to match postponements; and the third was that of career anxiety due to match cancellations.

In terms of coping: the first issue was that of maintaining performance through personal training; and the second was that of preparing for matches through personal quarantine.

However, our study has some limitations. Although we investigated the impact of COVID-19 and coping methods among taekwondo athletes, similar basic investigations are still needed on the impact of the pandemic and the responses by athletes in other sports fields. The few studies with a similar profile include the works of Predoiu et al. [22-24].

Moreover, additional research is needed on training methods and program development for athletes in such pandemic situations. The pandemic is a situation that we did not predict. In the event of a similar situation in the future, we should be more prepared. Specifically, those involved in the sporting industries should consider how to train and compete under these conditions and make preliminary efforts to minimize player (athlete) anxiety.

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