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Development of Golf Conditioning Questionnaire for Korean Elite Female Golfers

Dong Hyun Yoon[a,b], Jin-Soo Kim[c], Junwoo Kwon[d], So Young Ahn[d], Soon Hee Kim[e], Kwang-Jun Kim[f*]

[a]*Department of Rehabilitation Medicine, Seoul Metropolitan Government Boramae Medical Center, Seoul National University College of Medicine, Seoul, Korea*

[b]*Institute on Aging, Seoul National University, Seoul, Korea*

[c]*Exercise Medicine Research Institute, Edith Cowan University, Joondalup, WA, 6027, Australia*

[d]*Department of Physical Education, Seoul National University, Seoul, Korea*

[e]*Department of Golf, Yongin University, Yongin, Korea*

[f]*Department of Sport Science, Korean Institute of Sport Science, Seoul, Korea*

Abstract

PURPOSE: The purpose of this study is to develop and verify the validity and reliability of the Korean version of the Korea Institute of Sports Science (KISS) golf conditioning questionnaire survey.

METHODS: A total of 320 professional and elite-amateur female golfers were recruited and parallel analysis and exploratory factor analysis were conducted to evaluate the suitability of the intended five-factor model (physical fitness, injury, nutrition, mental, and performance strategy). Confirmatory factor analysis was also used to determine the questions by evaluating goodness-of-fit indexes.

RESULTS: 5-factor model was supported by showing Bayesian information criterion -386.75, Tucker-Lewis index 0.947, root square error of approximation 0.049 and standardized root mean square residual 0.03. The final model of the Korean version KISS golf conditioning questionnaire survey showed a comparative fit index of 0.928, Tucker-Lowis index of 0.908, root mean square residual of 0.066, and standardized root mean square residual of 0.077, confirming the suitability of the model.

CONCLUSIONS: This study demonstrated the feasibility and reliability of the Korean version KISS conditioning questionnaire survey for Korean elite female golfers. The objective evaluation prior to plan and execute conditioning using this evaluation tool will allows elite female golfers to obtain essential information to optimize the concurrent conditioning.

Key words: elite athletes, golfers, conditioning, questionnaire

Introduction

Currently, Korean female golfers continue to perform successfully in competitions in Korea and overseas, and with the star players, the industrial market for golf is growing exponentially (Kim & Park, 2015; Korea Golf Course Business Association, 2022; Seo et al., 2018). It has been shown that golf requires substantial aerobic capacity as golf consists of 18 holes during one round,

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Correspondence : norman7@kspo.re.kr

and the players maintain an average heart rate of 115.75 beats/min and maximum heart rate of 153.50 beats/min with an energy consumption of 1897.56 kcal while walking average of 6.4 km in 4.5 hours in one round (Park & Moon, 2014). As elite golf players need to compete under this severe condition for 3 to 4 consecutive days, concurrent conditioning is necessary to increase performance (Kim, 2014).

Golf is known to be a technique-oriented sport. However, the improvement of physical capacities, such as strength, power, and flexibility, is critical to support the execution of the proper techniques (Doan et al., 2006; Kim, 2010). As such, to enhance the performance of elite golfers, training to optimize their technique with concurrent conditioning to enhance the physical parameters is required (Hartmann et al., 2009; Smith, 2010; Tilley & Macfarlane, 2012). For example, Gordon and colleagues (Gordon et al., 2009) demonstrated a stable swing mechanism with conditioning based on physical coordination. With the evidence, the importance of concurrent conditioning in elite golf players continuously stresses as the essential component of successful performance.

To optimize concurrent conditioning for elite athletes in specific sports, evaluation of overall basic information specific to the sport, such as sports-oriented damage, physical status including exercise status and nutritional status, is required (Smith et al., 2011; Son & Lee, 2013). Especially as golf is a unique technique-oriented sport, scientific evaluation of the injury, and physical and psychological characteristics that are specific to elite golf players is required before planning and executing the concurrent conditioning to enhance performance (Hume et al., 2005; Kim & Park, 2015; Seo et al., 2012). However, research on evaluating their needs is limited, especially for female golfers, prohibiting female golfers from planning and executing individualized and optimized concurrent conditioning (Horan et al., 2010; Kim, 2010; Smith et al., 2011). Therefore, the aim of this study is to develop an evaluation tool (questionnaire survey) for the plan of evidence-based concurrent conditioning as a preliminary study for developing conditioning guidelines for Korean female elite golfers. We validated the feasibility and reliability of the questionnaire survey consisting of detailed perceptions of physical, mental, injury and nutrient factors of individuals through conformity assessment and confirmatory factor analysis. This developed questionnaire survey for conditioning will provide basic information to professional and elite-amateur female golfers, as well as their coaches, to develop plans for concurrent conditioning to enhance their performances.

Methods

Participants

For this study, 144 professional female golf players (registered as teaching members, associate members, and full members in Korean Ladies Professional Golf Association [KLPGA]; age: 28.43±9.93 years, height: 165.55±5.40 cm, body weight: 61.8±7.84 kg) and 176 college age/high school female elite-amateur golf players (registered in Korean Golf Association and Korean Junior Golf Association; age: 16.49±1.89 years, height: 162.43±22.16 cm, body weight: 60.48±12.00 kg) were recruited. The survey was distributed and collected personally or electronically (Google Forms®, Google Workspace, Mountain View, California, United States.) in regular educational sessions for professional and elite-amateur golf players after a brief explanation of the purpose of the study. The survey was completed using self-administration methods, and written consent was obtained before the survey was distributed.

Evaluation Tool

To develop the evaluation tool (questionnaire survey), golf experts (professional golfers, coaches), sports psychologists, exercise physiologists, and statistic experts evaluate five areas of golf-related physical

fitness, injuries, nutrition, mental, and performance strategies factors, and 20 questions were selected through preliminary evaluation processes. Table 1 presents the number of sub-questions of the Korea Institute of Sports Science (KISS) version of the golf conditioning questionnaire before the final confirmation.

Conceptual Review of Preliminary Scale

After constructing the KISS version golf conditioning questionnaire consisting of 20 questions in five areas related to physical fitness, injuries, nutrition, mental (Lim, 2014; Luthans et al., 2007), and performance strategy (Kim & Choi, 2017), the validation of the scale was conducted for professional and elite-amateur female golfers. Prior to the confirmatory factor analysis, parallel analysis (Hayton et al., 2004) and exploratory factor analysis (Watkins, 2018) were conducted in advance to evaluate the suitability of the intended five-factor model to determine the number of factors.

Statistical Analysis

Data were analyzed using R software (v4.1.3, the R Foundation), with psych package (v 2.23, Revelle, 2023) and layaan package (v 0.6-12, Rossell, 2022). There were no outliers but the errors that occurred during survey completion were excluded from statistical analysis (3 cases). The prediction model of the KISS version of golf conditioning questionnaires was analyzed using linear regression analysis for key performance indicators (total number of strokes, average putts, green hit rate, fairway hit rate, and driver distance) and binomial variable logistic regression analysis for the status of warming-up, cool-down, and physical exercise execution.

Results

Participant Characteristics

Among a total of 339 participants, 19 were excluded for duplicate responses and insincerity, resulting in surveys from 320 participants being analyzed. One hundred and seventy-six were elite-amateur golfers, and the golfers classified as professionals were 144 (KLPGA associate member: 64, KLPGA full member: 65, Teaching Pro: 14). The characteristics of 320 participants are presented in Table 2. Briefly, the average age of the total participants(n=320) was 21.88

Table 1. *Preliminary KISS version conditioning questionnaire model structure*

	Concurrent conditioning question structure	Number of questions
Physical fitness	Strength, cardiovascular fitness, routine, and sleep/rest	4
Injury	Flexibility training, warm-up, cool-down, and rehabilitation exercise	4
Nutrition	Nutrition control, diet, high-carb diet, and supplementation	4
Mental	Efficacy and resilience	3
Performance strategy	Self-talk, emotional control, automaticity, goal setting, imagery	5
	Total number of questions	20

(SD 9.04). The average age of participants classified as elite-amateur golfers (n=176) was 16.49 (SD 1.89), and professional golfers (n=144) was 28.43 (SD 9.93). The average duration of golfing was 9.45 years (SD 7.49) in total participants (n=320). Among the participants, elite-amateur golfers (n=176) had 4.98 years (SD 2.54) of golf experience, and professional golfers had an average of 14.97 years (SD 7.90) of golf experience. The average height and body weight of the total participants were 163.82 cm (SD 16.92) and 61.07 kg (SD 10.35), respectively.

Determination of the Factor Number for the Questions

To determine the number of factors, parallel analysis and exploratory factor analysis were used. Five-factor model was supported in the parallel analysis as the number of factors intersecting between the eigenvalues of the original data and the eigenvalue from the correlation matrix was 5 (Table 3). Furthermore, we evaluated the fit of the factor structure from 3 to 5 factors using exploratory factor analysis, and oblique rotation was performed by applying the maximum likelihood method for each factor structure (Costello & Osborne, 2005). Five-factor model was also strongly supported by exploratory factor analysis confirming improved goodness-of-fit indexes from 3 factors to 5 factors, while the lowest Bayesian information criterion (BIC) value was demonstrated when target rotation previously set up was applied (BIC: -386.75; Tucker-Lewis Index [TLI]=0.947; root mean square error of approximation [RMSEA]: 0.049; standardized root mean square residual [SRMR]:0.03) (Table 3).

Confirmatory Factor Analysis

Confirmatory Factor Analysis was performed based on the factor number confirmed by exploratory factor analysis. During this process, we excluded 4 questions and as a result, a final model with 5 factors consisting of 16 questions was confirmed (Table 4). Question #9,

Table 2. *Participant characteristics*

		Basic statistics (SD, %)		
		Total (N=320)	Elite-amateur (N=176)	Professional (N=144)
Age		21.88 (9.04)	16.49 (1.89)	28.43 (9.93)
Years of experiences		9.45 (7.49)	4.98 (2.54)	14.97 (7.90)
Height (cm)		163.82 (16.92)	162.43 (22.16)	165.55 (5.40)
Body weight (kg)		61.07 (10.35)	60.48 (12.00)	61.80 (7.84)
Affiliations	High-school	177 (55.3%)	169 (96.0%)	7 (4.9%)
	Undergraduate	11 (3.4%)	3 (1.7%)	8 (5.6%)
	Postgraduate	2 (0.6%)	1 (0.6%)	1 (0.7%)
	Professional	125 (39.1%)	0 (0.0%)	125 (87.4%)
	Other	5 (1.6%)	3 (1.7%)	2 (1.4%)

Age, years of experiences, height, and body weight are presented as mean (standard deviation). Affiliations are presented as mean (proportion, %). SD, standard deviation. %, proportion.

"I think that controlling nutrition will help control conditioning." This question was excluded as confirmatory factor analysis for the 5-factor model demonstrated cross-load with questions for physical fitness. Questions # 16 to 18 for performance strategy were excluded as these questions reduce the goodness-of-fit of the model due to a low factor load of less than 4, and low common variance factor of less than 3 in exploratory factor analysis, and a low factor load of less than 5 in the confirmatory factor analysis. Moreover, questions # 16 to 18 were also partially cross-loaded with questions for mental factors, as these questions asked about positive self-talking, emotional control, and trust in own skills.

Goodness-of-Fit of the Final Model

The goodness-of-fit indexes of the final model are presented in Table 5. Both CFI (0.928) and TLI (0.908) showed higher values compared to the criteria for the compliant model (>0.9), and RMSEA (0.066) and SRMR (0.077) were also lower than the criteria for the

Table 3. *Factor number analysis for the KISS version golf conditioning questionnaire*

	BIC	TLI	RMSEA	SRMR
3-factor model	-358.03	.864	.081	.05
4-factor model	-379.78	.903	.069	.04
5-factor model	-360.21	.925	.060	.03
5-factor model (Intended rotation)	-386.75	.947	.049	.03

BIC, Bayesian information criterion; TLI, Tucker-Lewis Index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

Table 4. *Confirmatory factor analysis for the KISS version golf conditioning questionnaire*

		Factor load	Standard error	Standardized factor load	z-value	Cronbach's alpha
Physical fitness	Question # 1	1		0.773		.87
	Question # 2	1.008	0.051	0.789	19.935	
	Question # 3	1.005	0.059	0.835	17.021	
	Question # 4	1.049	0.064	0.768	16.403	
Injury	Question # 5	1		0.794		.86
	Question # 6	0.993	0.069	0.850	14.462	
	Question # 7	0.998	0.068	0.717	14.649	
	Question # 8	0.91	0.06	0.775	15.126	
Nutrition	Question # 10	1		0.685		.65
	Question # 11	0.717	0.096	0.530	7.457	
	Question # 12	0.716	0.104	0.606	6.876	
Mental	Question # 13	1		0.574		.83
	Question # 14	1.948	0.197	0.880	9.902	
	Question # 15	1.965	0.195	0.934	10.083	
Performance strategy	Question # 19	1		0.751		.77
	Question # 20	1.156	0.091	0.834	12.77	

usable model (<0.08) (Table 5). As a result, the 5-factor model consisting of 16 questions was confirmed to be a suitable model (Appendix 1).

Discussion

The purpose of this study was to develop the KISS version conditioning evaluation tool as a preliminary study to develop evidence-based concurrent conditioning guidelines for Korean elite female golfers. As such, we developed and validated the feasibility and reliability of the KISS version questionnaire survey consisting of 16 questions under 5 factors in the current study. The developed questionnaire survey will help to evaluate the needs of Korean elite female golfers and provide essential information on planning and executing the optimized concurrent conditioning to enhance performance.

To validate the construct validity of the evaluation tool (KISS questionnaire survey) we conducted a factor analysis (Atkinson et al., 2011). The construct validity of a questionnaire survey is determined by whether the questions are suitable to evaluate a series of hypothetical concepts in the development stage. As such, parallel analysis was used to determine the factor number in factor analysis and parallel analysis determines the number of factors by comparing the eigenvalues from the original data and eigenvalues obtained in the correlation matrix of the original data (Hayton et al., 2004).

Parallel analysis determines the number of factors by comparing the eigenvalues from a correlation matrix or covariance matrix of the original data with the eigenvalues of the original data. In other words, this analysis helps objectively decide the factor number by determining the significant difference between the original data and the random data (Hayton et al., 2004). As such, our intended 5-factor model consisting of physical fitness, injury, nutrition, mental, and performance strategies was supported by parallel analysis showing the intersection in the eigenvalue of original data and eigenvalues from the random data in the 5-factor model.

We evaluated the fit of the factor structure from 3 to 5 factors using exploratory factor analysis. The exploratory factor analysis is the statistical method to identify the pattern of the data and reduce the dimensions of multivariate data (Costello & Osborne, 2005; Hoelzle & Meyer, 2012). Through exploratory factor analysis, we determined potential factors and the degree how much these potential factors explain the variance of the data. This also assisted in understanding data structure by extracting factors by considering the correlation between variables and allowed us to apprehend the relationship between variables (Costello & Osborne, 2005; Hoelzle & Meyer, 2012). This study performed oblique rotation by applying the maximum likelihood method on each factor and observed improved fit of the factor structure from 3- to 5-factor models. Therefore, the 5-factor model was confirmed by the support of exploratory factor analysis, with the lowest BIC value in the 5-factor model.

In addition, confirmatory factor analysis was performed based on the factor number determined by factor analysis and exploratory factor analysis. Confirmatory factor analysis is one of the multivariant statistical methods examining whether the priori assumed factor structure corresponds to the real data (Costello & Osborne, 2005; Hoelzle & Meyer, 2012). Through this statistical method, we excluded 4 questions among 20 questions developed previously and confirmed a total of 16 questions under 5 factors by examining questions based on hypothetical assumptions and interpreting relationships between variables.

The goodness-of-fit was evaluated to examine the consistency of the model and the original data. The current study used incremental fit index, CFI and TLI, reporting fitness level as a value between 0 and 1 by comparing the null model that assumes independence of all variables in the structural equation with a research model (Bentler & Bonett, 1980; DiStefano & Hess, 2005). In general, a higher value from CFI and TLI

Table 5. *Conformity indexes of final 5-factor model KISS version golf conditioning questionnaire survey*

	Chisq (df)	BIC	CFI	TLI	RMSEA	SRMR
5-factor model	287.333 (94)	9660	.928	.908	.066	.077

Chisq, Chi-square; df, degree of freedom; BIC, Bayesian information criterion; CFI, comparative fit index; TLI, Tucker-Lewis Index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

close to 1 is demonstrated in the model explaining the data well, and a value higher than 0.9 is a criterion for appropriate model fit. In addition, RMSEA and SRMR are absolute fit measures representing maximum likelihood method-based chi-square distribution and average residuals calculated from differences in covariance (or correlation) matrices between the model and the data (Pavlov et al., 2021; Steiger, 1990). The smaller values in these two indexes suggest the well-structured model and RMSEA smaller than 0.06 or 0.07 represent an acceptable model, and SRMR below 0.05 and below 0.08 represent a good fit model and acceptable model, respectively. In this study, both CFI and TLI demonstrate a value higher than 0.9, RMSEA 0.066, and SRMR 0.077, validating that our 16-question under the 5-factor questionnaire survey is appropriate.

To the best of our knowledge, this study was the first study to develop and validate an evaluation tool for concurrent conditioning. As such, the developed evaluation tool, the KISS version questionnaire survey for conditioning in Korean elite female golfers will provide essential information on the needs of the golfers to plan and execute optimized-concurrent conditioning. However, to develop and distribute the guidelines for concurrent conditioning in Korean elite female golfers, further study is required to develop the predictive model to enhance the performance of the golfers using a developed evaluation tool for conditioning. However, the current study has a few limitations to discuss. The feasibility and reliability were examined on only the elite female golfers limiting the application of this evaluation tool to elite male golfers. To expand the usage of the developed evaluation tool, the feasibility and reliability of this survey need to be examined in male elite golfers. Moreover, only the Korean version of the KISS conditioning survey was validated, further study to validate the English version of the KISS conditioning survey is needed to expand the usage of this evaluation tool.

Conclusion

In conclusion, this study developed a KISS version of the golf conditioning questionnaire survey consisting of 20 questions under 5 factors, physical fitness, injury, mental, and performance strategy, and validated the feasibility and reliability of this questionnaire survey on professional and elite-amateur female golfers. With the questionnaire survey developed in this study, the objective evaluation of conditioning management for professional and elite-amateur female golfers will be possible and provide the essential information to plan and execute the concurrent conditioning prior to the competition. Furthermore, future studies evaluating the relationship between each factor in this evaluation tool and performance factors are required to provide fundamental information on concurrent conditioning guidelines to enhance the performance of Korean female golfers.

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APPENDIX

Appendix 1. *KISS ver. Golf conditioning questionnaire*

Factor	Items
Physical fitness	1. I think weight training is important for improving performance and managing conditioning.
	2. I think cardiopulmonary endurance exercise is important to improve performance and conditioning management.
	3. I think adequate sleep and rest are important to improve performance and conditioning management.
	4. I think having a routine is important to improve performance and conditioning management.
Injury	5. I think flexibility exercise is important to prevent golf-related injuries.
	6. I think pre-game warm-up exercises are important to prevent golf-related injuries.
	7. I think it's important to cool-down after the game to prevent golf-related injuries.
	8. I think rehabilitation exercises are important after golf-related injuries.
Nutrition	9. I think three meals a day (breakfast, lunch, and dinner) are essential.
	10. I think eating a high-carb diet helps improve performance.
	11. I think additional supplements and nutritional supplements helps improve performance.
Mental	12. I think I can achieve most of the planned goals.
	13. I tend to recover quickly even if I experience difficulties or stress.
	14. I generally endure well for hard and difficult things.
Performance strategy	15. I set a detailed goal for the game
	16. I think about my routine before the game