Study of Conditioning of National Team Mogul Skiers - Analysis of Conditioning for Winter Olympic Games -

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The purpose of this study was to evaluate the conditioning of elite mogul skiers through the 2001-2002 Federation International de Ski season (that is, the World Cup freestyle competition and the Salt Lake City Winter Olympic Games) using a single-case study method. Four elite mogul skiers were observed independently and measured in parameters such as athletic condition. The results indicated that during the competition season there was no significant change in the conditioning of the world-class skiers of this group. However, the conditioning of the intermediate skiers did change. It was concluded that it is preferable to use the single-case study method when analyzing physical conditioning.

Keywords: peaking, ski, randomization test

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1. Introduction

1.1. Background to this study

In order to achieve the victory that is the ultimate goal in competitive sport, it is important to control an athlete's entire environment. Every element of the preparation necessary to achieve victory in competitive sport corresponds to a means of controlling the environment.

When developing a training schedule, it is necessary for athletes and coaches/trainers to evaluate and understand the condition of the athlete precisely. Thus, indicators and means are required to evaluate and understand the current condition of the athlete.

Indicators for evaluating condition are roughly classified into two categories, objective indicators and subjective indicators. Studies utilizing objective indicators have discussed such factors as the availability of blood chemistry indicators (Shirai, et al., 1998), endocrinology indicators (Hartman, 1998; Lehmann, et al., 1992) and immunology indicators, such as immune globulin A and immune globulin (Glesseo, 1999). Moreover, many studies have conducted various types of physical tests, which are

closer to simulating competitive performance, as a way of evaluating condition objectively (Ishiguri, 1997; Kanno, 1992, 1996).

In contrast, Hooper, et al., (1999) and Kono (1990), in studies using subjective indicators, acknowledge the effectiveness of a questionnaire-based method of establishing perceived condition together with self monitoring of heart rate, body temperature, body weight and Profiling of Mood States (POMS). Nishijima, et al., (1990) studied the conditioning of football players during a championship season and suggested that self-monitoring with subjective judgment was useful for the conditioning of football players throughout the year. Waku, et al., (1995) evaluated condition for one month before a tournament, assessing three college Kendo students in terms of their POMS and perceived condition, concluding that continued evaluation of POMS was useful for evaluating the condition of college Kendo students, although the fluctuation in POMS did not correspond to the tournament results.

As described above, the common goal in condition studies conducted with various indicators is to comprehend biological body information more precisely by using a condition evaluation method that

reflects the characteristics of each competitive sport.

When comprehending the exact condition information of an individual, and of an elite athlete in particular, it is necessary to understand the unique characteristics of that individual. It is difficult to determine the individual properties, both physical and mental, of an elite athlete who has ability far above the average through traditional comparative-study methods. Thus it is hard to evaluate precisely the condition of elite athletes. To address this concern, the method of evaluating an individual athlete using a single-case study method incorporating subjective indicators has gained considerable attention in the field of conditioning studies targeting elite athletes of competitive sports (Kinugasa, et al., 2002).

Recently, analytical techniques such as randomization tests and Interrupted Time-Series Analysis (ITSACORR) have been developed to assist the visibly method (Bear, 1977, 1988; Michel, 1974; Parsonson & Bear, 1978) or to replace it, which made objective evaluation possible even in single-case studies.

The championship season of elite mogul skiers takes place from December to March. During this season, the official FIS (Federation International de Ski) World Cup Freestyle Ski events are held around the world. In addition, the World Championship and the Olympic Games are also incorporated into the season when athletes take part in those various tournaments. Therefore, athletes have to move to the place where each round of the FIS tournament is being held week after week. Under these circumstances, mogul skiers must adhere to a carefully planned conditioning program in order to maintain good condition for a long period of time.

Since elite mogul skiers frequently travel around the world, it is difficult to carry large amounts of delicate measuring equipment with them wherever they go. In addition, it is essential that they be able to get immediate feedback on the data that is gathered because they are constantly on the road and do not have a base at which the data can be collated and analyzed. Consequently, it is apparent that ease of measurement is an important consideration for the evaluation of elite mogul skiers' condition.

1.2. Purpose of this study

This study aimed to comprehensively understand and monitor the fluctuation of mogul skiers'

condition during a championship season by utilizing a subjective questionnaire-based method of condition evaluation. The aim was to ascertain an ideal level of conditioning for elite mogul skiers, targeting those skiers who performed brilliantly in national level tournaments, monitoring them throughout a complete season, when world class tournaments were continually being held, including the official FIS World Cup Freestyle Ski events and the 2002 Winter Olympic Games.

2. Methodology

2.1. Procedure of the study

The procedure of this study was as follows:

- (1) Prepare subjective questionnaires regarding an athlete's condition, to be answered by both athletes and coaches
- (2) Perform measurements
- (3) Extract variable factors from subjective condition evaluations for each subject by using factor analysis
- (4) Examine the fluctuations in subjective condition evaluations at each stage of the season by using a randomization test
- (5) Examine the fluctuation at each stage of the season using ITSACORR

2.2. Subjects

The subjects of this study were elite mogul skiers who belonged to the All Japan Freestyle Team, three females (A: 23 years of age, B: 25 years of age and C: 26 years of age), one male (D: 20 years of age) and one coach of the All Japan National Team. Each subject was informed about the research/measurement details and understood that withdrawal was possible before participating. Each consented to participate in the study.

2.3. Measurement time period

The measurement time period was 88 days from December 12, 2001 to March 10, 2002, which included an alpine training camp just before the Olympic Games, the 2002 Winter Olympic Games and seven official FIS World Cup Freestyle events where subjects participated as members of the All Japan National Team. The season was divided into

Table 1 Subjective Condition Questionnaire
Check Sheet for Conditioning

name _____ (Athlete • Coach) Circle whichever applies

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	schedule							
Fill in after waking-up	resting heart rate							
	sleeping hours							
Fill in before exercise	physical condition	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	illness	sympton						
	injury	sympton						
	flexibility	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	muscle tension	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	fatigue	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Fill in at bedtime	flexibility	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	muscle tension	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	state of mind	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	fatigue	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	physical judgment	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	quickness	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	power	1 : bad, 5 : good	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
note								

three stages: the early events of the World Cup, the Olympic Games period, and the latter part of the World Cup championship. The stages were determined according to the training schedule of the All Japan National Team, accepted as common knowledge by both athletes and coaches.

- Stage 1, the initial period of the World Cup: 44 days, including all five FIS World Cup Freestyle Ski events held before the Olympics.
- Stage 2, the Olympic period: the 22 days of the 2002 Winter Olympic Games and the alpine training camp the previous week.
- Stage 3, the latter period of the World Cup: 22 days, including the two FIS World Cup Freestyle Ski events held after the Olympics.

Each tournament week had the following cycle: travel day (one day); official training (four days); event (one day); then on to the next travel day. The subjective measurement of athlete condition carried out by athletes and coaches was performed over the entire measurement period with the exception of moving days.

2.4. Measured items & measurement method

In order for athletes and coaches to carry out subjective measurement of athlete condition the questionnaires were prepared and the measurement was performed (Table 1).

2.4.1. Athletes' subjective self-evaluation

Measured items were classified into four categories – physical condition, mental condition, physiological condition and medical condition – as follows:

- (a) Physical condition: fatigue, flexibility, physical judgment, quickness, power and muscle tension
- (b) Mental condition: state of mind
- (c) Physiological condition: resting heart rate and sleeping hours
- (d) Medical condition: physical condition, illness and injury

These items were determined in accordance with those used in previous studies. The athletes themselves were asked to fill in the questionnaire form after it was explained how to do so. A scaling framework with five levels was used for evaluation: 5 good, 4 somewhat good, 3 normal, 2 somewhat bad and 1 bad. With regard to resting heart rate, sleeping hours, illness and injury, evaluation was entrusted to the athletes themselves.

2.4.2. Coach assessment of athletes' condition

The coach was asked to use the same monitoring form as the athletes to evaluate each athlete's condition as viewed from the coach's perspective. As with the athletes, the coach was asked to fill in the form after it was explained how to do so. However the coach was asked to assess only two items, physical condition and mental condition:

Figure 1 Variable Factors of condition for Subject A

- (a) Physical condition: fatigue, flexibility, physical judgment, quickness, power and muscle tension
- (b) Mental condition: state of mind

3. Results

3.1. Variable factors of subjectively evaluated condition

In order to examine the variable factors of subjective condition data obtained through the questionnaires, explanatory factor analysis was conducted by using principal component analysis and promax rotation. Those items with frequent missing values and with very low commonality were removed. Factors with eigenvalues of more than 1.0 were extracted through principal component analysis, and factor analysis was conducted. The factor score was calculated by using the regression method on measured items with more than 0.4 of a burden. As a consequence, the following factors were extracted from the items monitored in the questionnaire.

3.1.1. Analysis of variable factors of subjectively evaluated condition for Subject A (Figure 1)

As for the variable factors of subjective condition for Subject A, after items with frequent missing values and with low commonality were removed according to content validity from the 18 items targeted in the questionnaire, four factors were extracted from the 16 remaining items, which accounted for 62.4% of all variance.

3.1.2. Analysis of variable factors of subjectively evaluated condition for Subject B (Figure 2)

As for the variable factors of subjective condition for Subject B, after items with frequent missing values and with low commonality were removed according to content validity from the 18 items targeted in the questionnaire, four factors were extracted from the remaining 16 items, which accounted for 74.9% of all variance.

3.1.3. Analysis of variable factors of subjectively evaluated condition for Subject C (Figure 3)

As for the variable factors of subjective condition for Subject C, after items with frequent missing values and with low commonality were removed

Figure 2 Variable Factors of condition for Subject B

Figure 3 Variable Factors of conditioning for Subject C

Figure 4 Variable Factors of condition for Subject D

according to content validity from the 18 items targeted in the questionnaire, four factors were extracted from the remaining 17 items, which accounted for 70.1% of all variance.

3.1.4. Analysis of variable factors of subjectively evaluated condition for Subject D (Figure 4)

As for the variable factors of subjective condition for Subject D, after items with frequent missing values and with low commonality were removed according to content validity from the 18 items targeted in the questionnaire, four factors were extracted from the remaining 17, which accounted for 73.9% of all variance.

3.2. Variable analysis on subjectively evaluated condition at each stage of the season

The following three analyses were conducted by using the most significant factors (shown as 'Factor 1' in the figures) in the subjective condition data, extracted by factor analysis of items in the questionnaire.

- (1) The factor score of Factor 1 was calculated to examine the difference among the average

values at each stage of the season by using the score to conduct a randomization test. The Rand IBM (Edgington, 1995) was used as the analysis software and the significance level was fixed to be under 5%.

- (2) Using the factor score of Factor 1, the differences in the intersection and slope of the regression line for each stage of the season was tested using ITSACORR, and the fluctuations in subjective condition were examined. ITSACORR was used as the analysis software (Crosbie, 1993) and the significance level was fixed to be under 5%.

Variable analysis of subjective condition for Subject A at each stage of the season (Figure 5):

- (i) Significant fluctuation was not observed at any stage of the season.
- (ii) Significant difference was observed between the slope at Stage 1 (the initial period of World Cup) and at Stage 3 (the latter period of World Cup) ($p < 0.05$).

Figure 5 Fluctuation of Factor 1 for Subject A

Figure 6 Fluctuation of Factor 1 for Subject B

Variable analysis of subjective condition for Subject B at each stage of the season (**Figure 6**):

- (i) Significant fluctuation was not observed at any stage of the season.
- (ii) Significant difference was not observed in the intersect and slope at any stage of the season.

Variable analysis of subjective condition for Subject C at each stage of the season (**Figure 7**):

- (i) Significant difference was observed between the average values at Stage 2 (the Olympic period) and Stage 3 (the latter period of the World Cup) ($p<0.05$).
- (ii) Significant difference was not observed in the intersect and slope at any stage of the season.

Variable analysis of subjective condition for Subject D at each stage of the season (**Figure 8**):

- (i) Significant difference was observed between the average values at Stage 2 (the Olympic period) and at Stage 3 (the latter period of the World Cup), and between Stage 1 (the initial period of the World Cup) and Stage 3 (the latter period of the World Cup) ($p<0.01$).
- (ii) Significant difference was observed between the intersect at Stage 1 (the initial period of the World Cup) and at Stage 3 (the latter period of the World Cup) ($p<0.05$).

4. Discussion

The athletes were affected by the same variable factors that influenced subjective condition.

Figure 7 Fluctuation of Factor 1 for Subject C

Figure 8 Fluctuation of Factor 1 for Subject D

However, the areas of the questionnaire that demonstrated fluctuations in subjective condition differed (**Figures 1, 2, 3, 4**). In other words, the subjective condition indicators that showed fluctuation during the season vary depending on the individual. Therefore, this study should have considered the individual nature of subjective condition fluctuation and used indicators according to each individual.

The questionnaire method in this study extracted indicators of subjective condition from both the

athletes themselves and their coach. In each case, the questionnaire items that showed the most fluctuation in the athletes' subjective condition were extracted (Factor 1). The coach's evaluation of each athlete's subjective condition was not one of these primary factors but was considered to be a secondary factor in most cases. It is likely that a coach evaluates an athlete's subjective condition more properly in accordance with technical level, athletic experience and the personality of the athlete. Thus these things should be investigated in the future. In addition, it is

probable that a third party's evaluation of an athlete's condition would give an indication of future results because mogul ski events are scored by judges.

Next, the fluctuation of Factor 1 was divided up according to the three stages of the season in order to investigate the rise and fall of the average value during each term as well as the slope of the regression line. As a result, the process of peaking for the Olympic Games was able to be examined.

The subjects in this study were elite mogul skiers belonging to the All Japan National Team. Although they were all part of the same team, different fluctuations of subjective condition were observed among them. It was also apparent that world top-ranked athletes showed less condition fluctuation than middle-ranked athletes.

In evaluating the subjective condition of Subject A across the whole season, a significant variable trend was not observed in any of the three stages of the season, even in Factor 1 which most reflected the subjective condition of subject A (**Figure 5**). This fact suggests that subjective condition was maintained without major fluctuation throughout the season, which shows the characteristic conditioning of the athlete (AU) who is constantly ranked high, though not highest, and gets good results in general ranking competitions and was ranked highly at the Olympic Games.

In evaluating the subjective condition of Subject B across the whole season, a significant variable trend was not observed in any of the three stages of the season in Factor 1, which reflected the subjective condition of Subject B (**Figure 6**). This fact suggests that Subject B was able to maintain a stable level of conditioning and that this level could be considered to be ideal because, even though the athlete's World Cup result was not conspicuous, she achieved a higher rank at the Olympic Games, which was the main goal.

In evaluating the subjective condition of Subject C across the whole season, a significant difference was observed in the average value of Factor 1, which most reflected the athlete's subjective condition, between Stage 2 and Stage 3 (**Figure 7**). Although the average value was significantly high in Stage 3, the conditioning of Subject C was not ideal because Stage 3 was not so important for this athlete who regards the Olympics as the most significant event. It is assumed that this result was caused by the fact that the athlete was making her Olympic debut and she

was not accustomed to a season so full of big events.

In evaluating the subjective condition of Subject D across the season, Factor 1, which most reflected the subjective condition of the athlete, showed a difference in the average value and the intersect of the regression line between Stage 1 and Stage 3, and in the average value between Stage 2 and Stage 3 (**Figure 8**). Thus this athlete could not maintain condition at a constant level during each phase and the slope of the regression line indicated negative values and declined toward the end of each stage. This result suggests that the conditioning of the athlete was not truly optimal. It is considered that this result was due to this being the athlete's first season in the World Cup and was therefore unable to regulate condition all the way through the season.

Top mogul skiers are required to maintain good conditioning for the World Cup events held in any given week during the tour season. Therefore, the single-case study method is effective because it employs self monitoring which enables the athlete to comprehend his or her own condition by checking the fluctuation of condition across a whole season.

Moreover, fluctuations of subjective condition measured throughout a season can be useful for the subsequent year in identifying and reflecting upon key moments with regard to conditioning because the yearly championship schedule is almost the same. The accumulation of data and the analysis of each athlete's tendencies can prevent the deterioration of condition. What is more, it is possible to utilize accumulated conditioning analysis for long term condition planning for the Olympic Games held every four years.

As mentioned above, the most important point for mogul skiers is ease of measurement when evaluating condition. The merit of self-monitoring is that it is the easiest of evaluations, which makes this method most suitable for the mogul event.

5. Conclusion

Targeting elite mogul skiers, fluctuations in condition throughout a season were evaluated in a comprehensive way by using a subjective conditioning questionnaire. As a result, it was concluded that:

1. It is necessary to consider the characteristics of each athlete and to manage conditioning individually because fluctuations in the

condition of elite mogul skiers throughout the season showed differences depending on the individual.

2. Longitudinal monitoring of the variable factors of subjective conditioning can help us understand the characteristics of subjective conditioning for each athlete during the season, and the accumulation of trend data can be put to practical use in the form of feedback to the athlete which can then be reflected upon. Therefore, this kind of monitoring test utilizing a subjective conditioning questionnaire is useful as a method of providing subjective condition evaluation for elite mogul skiers.

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