

# Effects of winter skiing on stress, heart rate, apprehension, and enjoyment in collegiate students: a single randomized controlled trial

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This study investigated the effect of winter skiing on stress levels in collegiate students and also observed psychological factors related to heart rate, apprehension, and enjoyment. Two hundred thirty-eight male students were randomly classified into the control group ( $n=117$ ) or the ski group ( $n=121$ ). The control group received lectures on skiing; however, the ski group received practical ski training. Psychological measures included stress, apprehension, and enjoyment; physical measures included heart rate at pre- and postday. There were significant correlations between stress and apprehension ( $r=0.366$ ) and stress and enjoyment ( $r=-0.441$ ). Specifically, apprehension negatively correlated

with enjoyment ( $r=-0.599$ ). Between both groups, a significant interaction effect was found among stress, apprehension, and enjoyment. Moreover, compared with the control group, the ski group's stress and apprehension were significantly reduced, whereas the enjoyment was significantly enhanced. This study suggests that winter skiing is a suitable sport for reducing stress and providing a high level of enjoyment for collegiate students.

**Keywords:** Ski, Stress, Enjoyment, Apprehension, Heart rate

## INTRODUCTION

Collegiate students typically experience various levels of stress from factors such as academic demands, financial pressures, and concerns over future employment. Such stress can take a toll on their psychophysical well-being, including their physical health (Aletta et al., 2018). In light of such consequences resulting from high amounts of stress, it is important for students to take measures to counter the negative effects.

Physical education classes offered at universities can provide benefits for college students by relieving stress. Many studies have been conducted on physical activity as a way to reduce stress for college students. However, there are very few studies that specifically focus on how winter skiing can improve health and reduce

stress in students during winter seasons. In addition, skiing can help students develop social skills by meeting people in the field, improve their ability to cope with cold temperatures, and make good memories of racing through high slopes at a ski resort. Although many studies show positive results from participating in recreational sports activities (Crocker et al., 1995; Dishman, 1994; Sallis et al., 2000), there is a lack of research on winter skiing.

Participating in sports can arouse feelings of apprehension and enjoyment at the same time. The level of enjoyment often determines whether a person will continue participating in that sport. In other words, the enjoyment of taking part in recreational sports induces positive emotional and psychophysiological responses and are powerful motivators to maintain the behavior (Gill et al., 1983; Klint and Weiss, 1987). On the other hand, any sports

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done without much enjoyment is likely to result in negative emotional reactions such as discomfort, dissatisfaction, and anxiety (Borkovec et al., 1983).

While there are disadvantages of winter skiing in terms of time and space constraints compared to other indoor sports, it can bring much enjoyment and stress relief through intensive classes that take place in a friendly and natural environment. However, most of the recent studies related to winter skiing have mostly focused on leisure satisfaction, intention to continue exercise, and class satisfaction. In other words, there have been no studies on the effects of participating in winter skiing on a participant's enjoyment, apprehension, or stress levels. Furthermore, it is not known whether the above-mentioned psychological factors are related to the human body's physical index such as heart rate. Therefore, this study investigated the effect of winter skiing on stress levels in collegiate students. Moreover, the relationship among heart rate, apprehension, and enjoyment were studied as they are related to stress.

## MATERIALS AND METHODS

### Participants

The study sample consisted of 401 collegiate students who participated in a winter ski program between the 15th and 18th of December 2017 at H-resort, located in Gangwon-do. Three hundred eighty-two students from Hanseo University were interviewed, of whom 240 (59.85%) were male and 161 (40.15%) were female. To achieve homogeneity, only male students were selected for the subjects. Thus, this study included 240 male subjects in which two participants were disqualified due to having undergone knee joint surgery 1 year ago. The remaining 238 participants were randomly allocated to one of two groups as shown in Fig. 1: control group (n = 117) and ski group (n = 121). Complete participant characteristics are illustrated in Table 1.

### Experimental design

This single, randomized, controlled trial was conducted at a ski resort for 3 days. The first assessment was conducted on December 15 and the second assessment was done on December 18 at the same resort. The study was approved by the Institutional Review Board at Sahmyook University (2-7001793-AB-N-012018034-HR). All participants were recruited through advertisements and a written informed consent was obtained before enrollment. First, all of the participants arrived at a ski resort to sign an informed consent form and to complete a self-reported questionnaire about

their health status included in the physical examination. After this procedure, each participant took part in the experiment conducted by an expert. All participants took part in the ski lessons for 4 days and 3 nights. Participants assigned to the ski group participated in the ski practice training while the control group, only received lectures on the first day. In other words, in order to compare the changes in heart rate, apprehension, and enjoyment of the ski group, the control group focused on theoretical education on day 1. Since both groups participated in actual ski practice on days 2, 3, and 4, only day 1 was analyzed for differences between the groups.

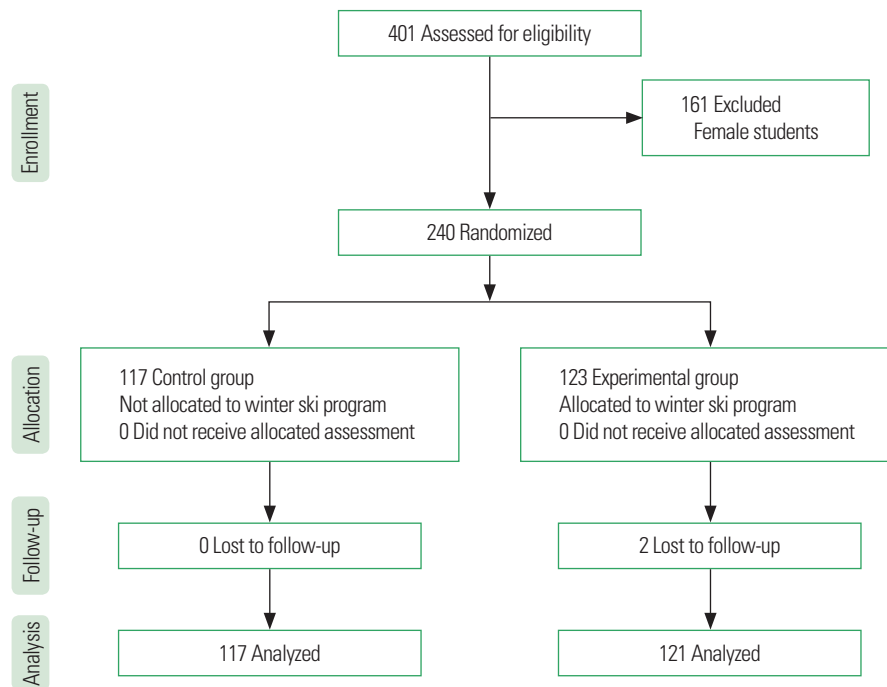
### Anthropometric measurements

Participants were weighed wearing light clothes and without shoes. To measure body composition, the bioelectrical impedance analysis method was used by BMS 330 and InBody 230 Body Composition Analyzer (Biospace Co., Ltd., Cheonan, Korea), respectively. This analyzer is a segmental impedance device measuring voltage drops in the upper and lower body. Eight tactile electrodes were placed in contact with the surfaces of both hands and feet: thumbs, palms and fingers, front soles, and rear soles. Analysis of body composition was measured before dinner and after voiding (Cha et al., 2014; Kim et al., 2015).

### Stress level of collegiate life

Prior to the study, all of the questionnaires were translated from English to Korean and then retranslated from Korean to English in order to ensure accuracy. All of the questionnaires, which were written in English, followed standardized methodological procedures (van Widenfelt et al., 2005). First, the original English version was translated independently into Korean by three bilingual Korean translators. After the forward translation was completed, a back translation by a native English speaker fluent in Korean and a Korean teacher of the English language was also completed. During all stages, the different versions were compared to maximize semantic and conceptual equivalence to the original version. Following this procedure, a pilot test of the questionnaire was conducted using ten volunteers. The volunteers had to report any type of difficulties regarding the clarity of the questionnaire as well as their general view (Jee and Eun, 2018).

The Academic Stress Inventory was used by the Spanish Society of Anxiety and Stress (Polo et al., 1996). This is a questionnaire with eleven situations that are considered potential stress generators in students in the academic arena. Each one of the situations offers a scaled answer of 5 points (1, no stress; 5, high stress) where



**Fig. 1.** Allocation of participants (consolidated standards for reporting of trials flow diagram).

**Table 1.** Physical characteristics of the participants

Variable	Group		Sum (n=238)
	Control (n=117)	Ski (n=121)	
Age (yr)	22.58±2.03	23.21±2.14	22.89±2.10
Height (cm)	175.25±5.57	175.03±6.06	175.14±5.81
Weight (kg)	70.51±10.42	72.48±11.80	71.48±11.14

Values are presented as mean ± standard deviation.

each participant gives a value according to their perception of whether or not it produces stress. The eleven situations considered to be potential stress generators are: test taking, oral presentations, class participation, seeking help from tutors, academic overload, size of class, lack of time, obligatory assignments, homework, group projects, and competition among classmates. The reliability in terms of internal consistency corresponds to a Cronbach  $\alpha$  coefficient of 0.84. In order to establish association, the score is converted from ordinal values into a cardinal level of academic stress in the following way: a value is 1–2 (sum score 11–22) is considered low level; a value of 3 (sum score 33), moderate level; and a value of 4–5 (sum score 44–55), high level.

### Enjoyment scales

The scale used in this study was a visual analogue scale (VAS). All participants participating in the study were asked to mark

their state of self-perception on an online questionnaire. All of the participants were asked to rate “how do you feel at the moment about the winter ski program you have been doing” using a 10 cm bipolar rating scale. One end of the scale was labeled “0,” indicating no enjoyment while the other end of the scale was labeled “10,” indicating a high level of enjoyment. Participants marked a “V” along the scale according to their level of enjoyment. In other words, higher scores reflect greater levels of psychological enjoyment. The Cronbach  $\alpha$  of the VAS for enjoyment was 0.83.

### Apprehension scales

The apprehension scale used in this study was similar to the enjoyment scale described above. In other words, a VAS was used to measure apprehension. All of the participants were asked to rate “how much apprehension do you feel when you ski?” using a 10-cm bipolar rating scale. One end of the scale was labeled “0,” indicating no apprehension while the other end of the scale was labeled “10,” indicating a high level of apprehension. Participants marked a “V” along the scale according to their level of apprehension. In other words, higher scores reflect greater levels of apprehension. The Cronbach  $\alpha$  was 0.81.

### Heart rate

The heart rate of all participants was manually measured after

skiing. Participants in each group, consisting of 15 participants, checked their heart rate by placing their index finger and middle finger on the radial artery after a 5-min break according to the researcher's signal. After 10 sec, the number of heartbeats was multiplied by 6 and recorded.

### Winter ski program

Stress, heart rate, apprehension, and enjoyment were measured in the same intermediate gradient slope just before and after skiing. Since all the participants did not have skiing experience, only ski training was conducted without measurement on the first day of the 3-day course. The beginner level course used in the experiment was 900 m in length with an 8° slope and the intermediate level course was 2,300 m with a 10° slope. At the time of the measurement, the temperature of the ski area was between minus 4°C–6°C and humidity 30%–40%.

### Statistical analyses

All data are reported as mean (standard deviation). Sample size of this study was determined based on the software G\*Power v 3.1.3, for analysis of variance; considering a priori effect size  $f^2$  (V)=0.35 (medium size effect),  $\alpha$  error probability=0.05 and Power (1- $\beta$  error probability)=0.95; a sample size of 200 was recommended; the sample of this study included 238 participants. All data are reported as mean  $\pm$  standard deviation and as mean change over baseline (95% confidence interval). Prior to the main analysis, the Kolmogorov–Smirnov test was used to determine the normality of distribution of the examined variables. The effects of the interventions were assessed using an analysis of variance for repeated (2  $\times$  2) measures (group, time, and group by time interaction). An intention-to-treat analysis was performed to compare the ski group with the control group. The between-group factor was the study groups (i.e., ski vs. control) and the within-group factor was the day (i.e., day 1 vs. day 2). Specifically, the change

rates from pre- to posttest were yielded and analyzed by an independent *t*-test. SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA) was used for all analyses. The level of statistical significance was set at  $P \leq 0.05$ .

## RESULTS

### Difference in anthropometric indices

Before starting the winter ski program, two participants dropped out. Thus, this study analyzed 238 (99.17%) out of 240 male students (Fig. 1). The age ( $t = 1.364$ ,  $P = 0.174$ ), height ( $t = 0.283$ ,  $P = 0.777$ ), and weight ( $t = 1.361$ ,  $P = 0.175$ ) were not significantly different between groups (Table 1).

### Relationships among stress, heart rate, apprehension, and enjoyment

Table 2 shows the correlations among stress, heart rate, apprehension, and enjoyment. The stress index positively correlated with apprehension ( $r = 0.366$ ,  $P = 0.026$ ), whereas stress negatively correlated with the enjoyment index ( $r = -0.441$ ,  $P = 0.016$ ), with statistically significant correlations. Specifically, the apprehension index negatively correlated with enjoyment ( $r = -0.599$ ,  $P = 0.007$ ).

### Effect of winter ski on psychophysiological conditions

As shown in Table 3, a significant effect of winter skiing was found concerning decreased stress levels. Stress levels were significantly decreased in the ski group, while it only slightly decreased in the control group. Although apprehension levels increased in the control group, apprehension levels in the ski group showed a sig-

**Table 2.** Relationships among stress, heart rate, apprehension, and enjoyment

Item	Value	Stress	Heart rate	Apprehension	Enjoyment
Stress	<i>r</i>	1	0.016	0.366	-0.441
	<i>P</i>		0.807	0.026	0.016
Heart rate	<i>r</i>		1	-0.006	-0.016
	<i>P</i>			0.929	0.802
Apprehension	<i>r</i>			1	-0.599
	<i>P</i>				0.007
Enjoyment	<i>r</i>				1
	<i>P</i>				

**Table 3.** Psychophysiological measurements before and after winter ski and the significance of group, time, and the group  $\times$  time interaction in control and ski groups

Item	Time	Group		<i>P</i> -value <sup>a</sup>		
		Control (n=117)	Ski (n=121)	G	T	G $\times$ T
Stress	Pre	27.45 $\pm$ 3.44	27.50 $\pm$ 3.30	0.001	0.001	0.001
	Post	26.72 $\pm$ 3.98	13.85 $\pm$ 5.62			
Heart rate	Pre	86.48 $\pm$ 16.64	87.48 $\pm$ 17.39	0.429	0.275	0.151
	Post	86.98 $\pm$ 14.02	83.86 $\pm$ 11.42			
Apprehension	Pre	8.06 $\pm$ 2.11	8.05 $\pm$ 2.24	0.001	0.001	0.001
	Post	8.15 $\pm$ 1.92	6.58 $\pm$ 2.19			
Enjoyment	Pre	3.42 $\pm$ 2.25	3.07 $\pm$ 2.10	0.001	0.001	0.001
	Post	3.01 $\pm$ 2.15	5.77 $\pm$ 2.53			

Values are presented as mean  $\pm$  standard deviation.

<sup>a</sup>Gained by 2  $\times$  2 repeated-measures analysis of variance.

**Table 4.** Comparison of the change rate (%) between times for psychophysiological measurements in both groups

Item	Group		t	P-value <sup>a)</sup>
	Control (n=117)	Ski (n=121)		
Stress	-0.69±22.27	-48.95±21.35	17.057	0.001
Heart rate	4.15±25.28	0.10±26.61	1.205	0.229
Apprehension	17.48±97.76	-0.01±100.32	1.363	0.174
Enjoyment	53.60±181.43	203.06±253.13	5.249	0.001

Values are presented as mean ± standard deviation.

<sup>a)</sup>Gained by independent t-test.

nificant reduction compared with prevalence. A significant effect of the ski-intervention was found in the enjoyment index (interaction  $P = 0.001$ ) when comparing between the control and ski groups.

### Comparisons of change rates of psychophysiological conditions

As shown in Table 4, the  $\Delta\%$  of stress was significantly different between groups ( $t = 17.057$ ,  $P = 0.001$ ). Although the enjoyment index was increased in both groups, the  $\Delta\%$  of enjoyment was significantly different between groups ( $t = 5.249$ ,  $P = 0.001$ ). There were changes in the heart rate and apprehension, but not statistically significant.

## DISCUSSION

The aim of this study was to investigate the effect of winter skiing on stress levels in collegiate students. Moreover, this study analyzed the degree of change in the heart rate, apprehension, and enjoyment levels related to stress after skiing.

Stress is one of the main determinants of a person's health status (Backé et al., 2012). Excessive and continuous stress has long-term effects that contribute to the onset and development of many diseases (Ribeiro et al., 2018). The high demands of modern life have negatively affected the academic performance and achievement of students (Pozos-Radillo et al., 2014). Ribeiro et al. (2018) reported the negative association between stress and quality of life in university students caused by the deterioration of various areas related to physical and mental health. In the present study, all most of the participants had low to moderate levels ( $27.47 \pm 3.36$ , not seen in this study) of stress. Polo et al. (1996) reported academic stress levels in the following way: a value of 1 to 2 was considered low level; a value of 3, moderate level; and a value between 4 to 5, high level. A research focused on laboratory-induced stressors and major life events to ascertain the relation between stress and psychophysical health. Exercise as a moderator of stress-illness

relation was examined by explaining leisure physical activity and aerobic fitness as potential buffers of the association between minor stress on psychophysical symptoms in college students (Carmack et al., 1999). Their findings suggested a buffering effect for leisure physical activity against physical symptoms and anxiety associated with minor stress. They also reported that participation in leisure physical activity as opposed to aerobic fitness levels is important to the stress-buffering effect of exercise. In fact, exercise has been less frequently studied as a moderator but has yielded promising results (Brown, 1991). Two aspects of exercise have been examined, including physical activity and physical fitness; however, both components are necessary to confirm the effects against stress.

Skiing in the open outdoors is a sport that involves dynamic body movements, like many kinds of exercise. Skiing is also very energy-consuming and involves speeds that are up to 20% faster than other technical sports (Bilodeau et al., 1991; Karvonen et al., 1987, 1989). For ski racers, speed and economy are major centers of attention which integrate physiological, mechanical, and technical factors (Kvamme et al., 2005). Since the development of skiing, several investigators have examined physiological responses and further compared the relative economy of skiing techniques (Hoffman et al., 1998; Mognoni et al., 2001; Saibene et al., 1989). Recently, skiing is known to be a sport that uses a lot of motion to draw energy as mentioned by the above researchers, but it is not yet known whether it results in stress reduction. There is also no investigation on whether skiing affects heart rate, apprehension, and enjoyment, or whether conversely, heart rate, apprehension, and enjoyment affect stress.

In the present study, a significant effect of winter skiing concerning decreased levels of stress was found. Stress levels were significantly decreased in the ski group, while it only slightly decreased in the control group. In other words, skiing was found to greatly reduce stress levels in students. This study hypothesized that skiing would have some effect on heart rate and apprehension in reducing stress and that enjoyment would increase through ski lessons. The number of heart beats per minute is often used as a physiological indicator for measuring or evaluating an individual's health condition, cardiopulmonary function, or exercise intensity. Heart rate is a simple and helpful mediator of cardiovascular function. Heart rate is normally 60 to 80 beats per min for adults over 18 years of age, and continues to increase if intense exercise continues. In the submaximal intensity, there may be slight changes, but it remains mostly constant and then decreases after exercise, eventually returning to the resting heart rate. The heart rate of the

control group slightly increased after skiing, whereas the heart rate of the ski group slightly decreased after skiing. However, there were no significant differences in heart rates between groups. Meanwhile, although the changes of apprehension levels in both groups were similar with the changes in heart rate, the apprehension levels in the ski group were significantly lower than those of the control group after skiing. Enjoyment decreased in the control group, whereas it significantly increased in the ski group. These results are in the same context as the results showing a negative correlation between apprehension and enjoyment, as shown in Table 2. Specifically, the enjoyment level of the control group just before skiing on the first day was higher than that of the ski group, however the enjoyment level of the control group just after skiing on the second day was lower than that of the ski group. As shown in Table 4, the change in enjoyment increased by around 50% in the control group whereas it increased by around 200% in the ski group. In other words, skiing can reduce stress in college students, as well as affect the psychophysical factors that cause stress. This study has confirmed that there was a mild relationship among stress, apprehension, and enjoyment. In addition, this study also confirmed that there was a moderate relationship between apprehension and enjoyment.

A very important factor for stress reduction is enjoyment. Enjoyment can be described as a positive affective state that reflects feelings such as pleasure or fun. Correlational and descriptive studies have indicated that enjoyment may be associated with physical activity in youth (DiLorenzo et al., 1998; Fisher et al., 1996; Motl et al., 2001; Sallis et al., 1999). Enjoyment is also a predictor of physical activity participation (Dacey et al., 2008; McArthur and Raedeke, 2009). Expected enjoyment from physical activities can increase exercise intentions (Ruby et al., 2011) and the mere anticipation of positive emotions predicts physical activity adoption and maintenance (Dunton and Vaughan, 2008). When considering the results from this study, skiing can provide enjoyment to college students that can lead to the benefits described by the studies above. Morgan (1980) reported that any sports activity is effective for mental health. More specifically, 85% of regular exercise participants experience a pleasant mood after exercise, improve their self-esteem and vitality, and reduce various negative emotions. In other words, skiing participation may increase the enjoyment degree whereas, decrease the stress level in academic courses in the university. Skiing provides a fun pastime that allows people of all skill levels and ages to enjoy in an outdoor environment. The results from this study suggest that winter skiing is a suitable sport that reduces stress and increases enjoyment in collegiate students.

Ultimately, this study confirmed that winter skiing can improve psychological well-being, including stress and apprehension, in collegiate students. The positive changes in psychological conditions may have led to increased enjoyment, suggesting that the results were influenced by a psychophysiological effect in which the winter ski program played a key role.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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