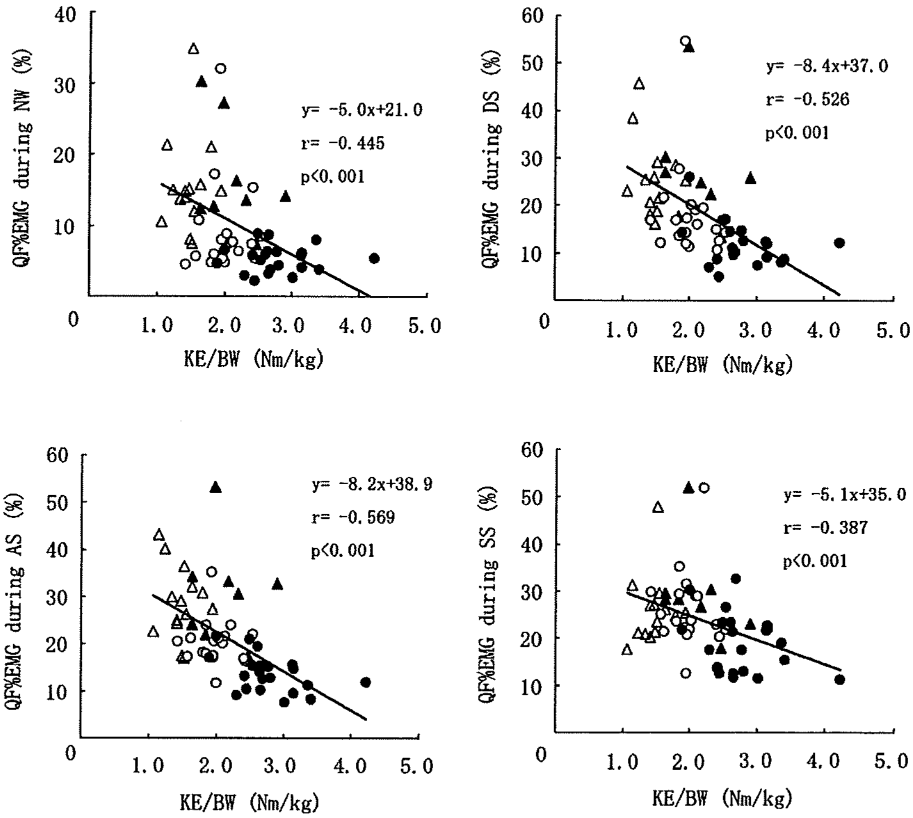

Figure 3 Relationship between KE/BW and QF%EMG.
NW: normal walking, AS: ascending the stairs, DS: descending the stairs.
SS: standing up from and sitting onto a chair.
● Young men (n=21) ○ Young women (n=19)
▲ Elderly men (n=8) △ Elderly women (n=14)

25.0~37.5% for TS%EMG, women: 10.9~20.1% for QF%EMG, 29.2~41.9% for TS%EMG) were above those for the young group. Although the reasons for this discrepancy could not be clarified, two factors might be involved. First, the possible difference in the strategy performing the measured actions between the elderly and young individuals would result in the inconsistency of the age differences in the levels of muscular activities and those in MVC torques per body weight. For example, the joint ranges of motion on ground contact during the ascending and descending stairs actions are narrower in the elderly individuals than in the young individuals (Hortobágyi et al., 2003), and the torques generating on the hip, knee and foot ankle joint during walking differ between the young and elderly individuals (DeVita & Hortobágyi, 2000). Hortobágyi et al. (2003) has considered that these differences may be attributed to the different strategies to perform the actions between the elderly and young individuals. Considering these findings, therefore, there is a possibility that age differences in the levels of muscular activities during daily physical actions that were not explainable only by the differences in MVC torques per body weight might be attributed to the age-related difference in strategies performing these actions.

Furthermore, age differences in voluntary activation during MVC may be also involved to explain the inconsistency of age difference in the levels of muscular activities during daily physical action and those in MVC torque. Assuming that voluntary activation during MVC in the elderly individuals tends to be lower than those in the young, the levels of muscular activities during daily physical actions, which are normalized by averaged integrated EMGs during MVC, might be overestimated in the elderly individual. However, previous findings of previous studies on the age-related difference in voluntary activation during MVC are controversial (Vandervoot & McComas, 1986; Hurley et al., 1998; Kent-Braun & Ng, 1999; Roos et al., 1999; Stackhouse, 2001; Morse et al., 2004; Morse et al., 2005). Since voluntary activation

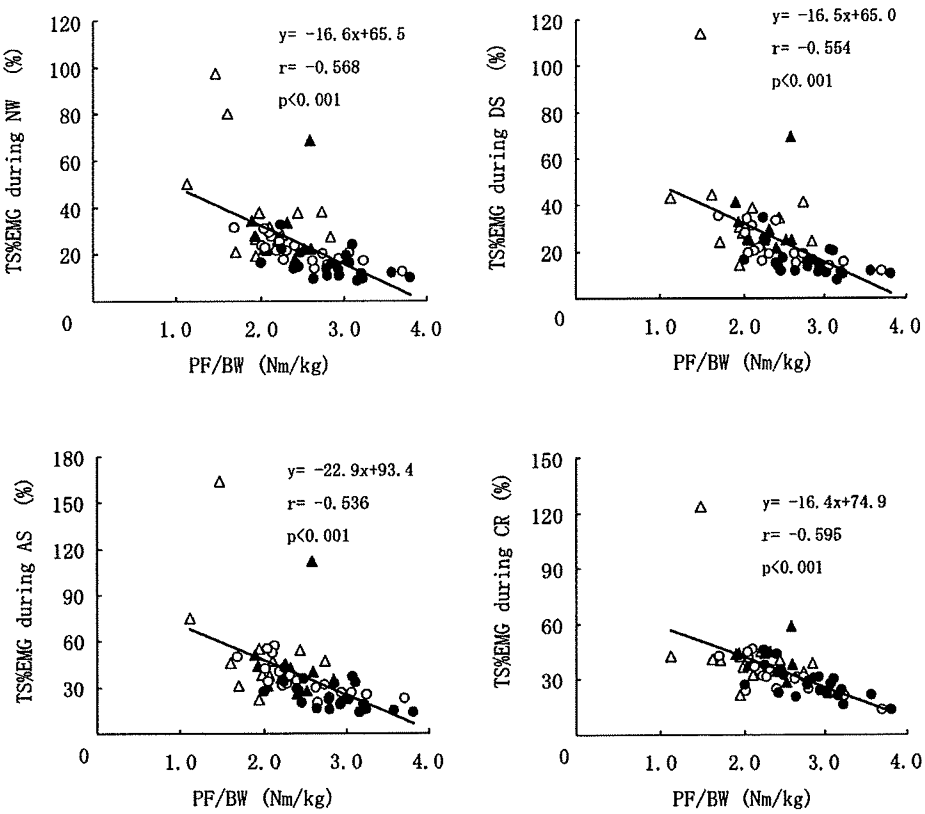

Figure 4 Relationship between PF/BW and TS%EMG.
NW: normal walking, AS: ascending the stairs, DS: descending the stairs.
CR: calf raise.
● Young men (n=21) ○ Young women (n=19)
▲ Elderly men (n=8) △ Elderly women (n=14)

during MVC was not determined in the present study, its difference could not be clarified. The joint and angles at which MVC torque was measured in the present study may yield the highest voluntary activation of the nervous system during MVC (Kubo et al., 2004) and exhibit no age difference (Hurley et al., 1998; Morse et al., 2005). Regarding this point, however, the measurement of voluntary activation using electrical stimulation should be verified in the future.

4.2. Gender difference in the levels of muscular activities during daily physical actions

In the young group, gender differences in the levels of muscular activities during daily physical actions were observed. This finding was consistent with the report of Sawai et al. (2006). To investigate whether the gender difference in MVC torque has an effect on those in the levels of muscular activities during daily physical actions, the %EMG of the young women was multiplied by the MVC, and divided by the MVC torque in the young men. The obtained values (QF%EMG: 6.2~17.9%, TS%EMG: 19.2~31.8%) were similar to those in the young men (QF%EMG: 5.2~19.1%, TS%EMG: 15.3~27.7%). This result indicates that gender difference in the levels of muscular activity during daily physical actions can be attributed to those in MVC torque, supporting the finding of Sawai et al. (2006). Similarly, in the elderly group, the %EMG of the elderly women was multiplied by MVC torque, and divided by MVC torque in the elderly men. The obtained values in the TS%EMG were similar to the average %EMG in the elderly men. In the QF%EMG, however, the obtained values were lower than those in the elderly men. This result indicates that the gender difference in QF%EMG for elderly individuals may be attributed to not only those in the MVC torques per body weight but also other factors.

Table 4 Descriptive data on relative EMG values.

Action type	Young group		Elderly group	
	Men	Women	Men	Women
QF%EMG (%)				
NW	5.2±1.9	8.9±6.5[a]	16.7±7.9[b]	15.6±6.8[b]
AS	13.6±3.9	19.9±4.8[a]	31.0±10.9[b]	28.7±7.6[b]
DS	11.7±4.6	18.1±9.8[a]	26.9±12.0[b]	26.0±8.0[b]
SS	19.1±6.3	25.5±8.5[a]	29.5±10.0[b]	26.0±7.3[b]
TS%EMG (%)				
NW	15.3±5.9	21.5±5.5[a]	31.2±16.1[b]	38.8±23.0[b]
AS	24.2±8.7	35.3±11.3[a]	46.9±27.7[b]	52.4±34.5[b]
DS	15.2±6.1	21.3±7.6[a]	33.8±15.6[b]	36.5±24.0[b]
CR	27.7±8.1	31.2±8.8[a]	41.5±9.0[b]	44.4±23.6[b]

QF: quadriceps femoris muscles, TS: triceps surae muscles.
NW: normal walking, AS: ascending the stairs, DS: descending the stairs.
SS: standing from and sitting onto a chair, CR: calf raise.
a: significantly different between the men and women within the same generation at $p<0.05$.
b: significantly different between the young and elderly within the same gender at $p<0.05$.

4.3. Utility of resistance exercises employing daily physical actions for improving the torque generation capability of lower limb muscles

Some studies have reported the effect of resistance training employing daily physical actions for middle-aged and elderly individuals (Aniansson & Gastafsson, 1981; Agre et al., 1988; Rook et al., 1997; Kubo et al., 2003b; deVreede et al., 2005). However, the findings of these previous studies are controversial. Kubo et al. (2003b) demonstrated gain of knee extension strength through training employing standing up from and sitting onto a chair, whereas Rook et al. (1997) who employed walking as training could not observe any gain of muscle strength. In another report of Kubo et al. (2008), although ankle plantar flexion torque was increased by a 6-month training employing walking, no change in knee extension torque was observed. The minimal levels of muscular activities required for improving muscle strength through resistance training are 30% to 40% relative to the maximal muscle strength (Hettinger, 1968). In previous findings on the effect of muscle mass and strength through resistance training for the middle-aged and elderly individuals (Taaffe et al., 1996; Bemben et al., 2000), gains of muscle mass and strength were observed at 40% of one repetition maximum as a training intensity. Since the level of muscular activities of the quadriceps femoris muscles during walking was less 30% in the present study, suggesting that this action may not be available for improving muscle mass and strength in the knee extensors. The findings of the present study indicate that the daily physical actions, except for normal walking, are considered to have intensity levels for improving muscle mass and strength in the elderly individuals.

4.4. Limitation of calculations for the levels of muscular activity during daily physical actions

In the present study, the levels of muscular activities were calculated from the whole period during all actions. Since the period when the muscle was not active was included in the whole period during the actions, the levels of muscular activities may be lower than the levels of muscular activities averaged over the muscle activity period. Thus, the levels of muscular activities were calculated during ground contact (stance) phase of the right leg from six randomly selected young and elderly individuals, respectively. As a result, the levels of muscular activities during the stance phase were higher than those during the whole period of the action, whereas no age differences in the ratio of the %EMGs in the stance phase of those in the whole phase (**Table 5**). This indicates that the results of the present study on the age difference in %EMG would not change, even if the %EMG was calculated in stance phase.

In the present study, the method of calculation of the levels of muscular activities during daily physical

Table 5 Descriptive data on the %EMG in the stance phase during normal walking (NW), ascending (AS) and descending (DS) the stairs

	Young group				Elderly group			
	%EMGstance	%EMG	S/T	CT	%EMGstance	%EMG	S/T	CT
QF								
NW	8.6±3.8	7.7±3.2	112	0.65	25.2±8.2	21.6±8.1	119	0.64
AS	29.9±14.5	22.8±10.6	131	0.69	44.9±12.2	35.4±9.8	128	0.70
DS	24.9±13.2	18.4±9.5	135	0.60	41.6±13.8	33.3±11.1	125	0.60
TS								
NW	41.9±28.4	32.5±27.4	138	0.65	65.1±35.7	49.9±27.6	132	0.64
AS	53.9±22.1	39.9±16.6	135	0.69	89.7±65.1	67.0±45.5	132	0.70
DS	27.6±17.4	26.9±16.3	101	0.60	43.3±23.4	47.7±29.4	93	0.60

QF: quadriceps femoris muscles, TS: triceps surae muscles.
* Data are expressed as the values relative to those during MVC (%).
% EMGtance: the levels of muscular activity during the actions when the foot was contacted on a ground.
The number of subjects were 2 men and 4 women in each group.
S/T (%): the ratio %EMGtance to %EMG calculated in the present study.
CT (sec): the contact time which a foot was contacted on the ground.

action was similar to that in the previous studies (Landers et al., 2001; Sawai et al., 2006). Knuston et al. (1994) has reported that this method would be appropriate for determining how much the muscles were active, based on the high reproducibility in calculation of the levels of muscular activities during the actions. However, since the EMG amplitude depends on muscle length (joint angle) (Pincivero et al., 2004) and contraction velocity (Seger & Thorstensson, 1994; Komi et al., 2000), the levels of muscular activity during daily physical action may be different depending on normalization methods. Although the EMG amplitudes during isometric and eccentric MVC are similar (Burden & Bartlett, 1999; Komi et al., 2001), those during concentric MVC are higher than those during isometric and eccentric MVC (Burden & Bartlett, 1999; Komi et al., 2001). In addition, the EMG amplitudes during concentric MVC become higher with increasing contraction velocity (Westing et al., 1991; Seger & Thorstensson, 1994; Aagaard et al., 2000). These points suggest that the levels of muscular activities in the present study might be lower than those normalized by the EMG amplitudes during concentric MVC. Previous findings on the relationships between muscle contraction types and the EMG amplitudes (Westing et al., 1991; Seger & Thorstensson, 1994; Burden & Bartlett, 1999; Aagaard et al., 2000; Komi et al., 2001) are in agreement that the EMG amplitudes during concentric MVC at a low velocity tend to be almost the same those during isometric and eccentric MVC. Although the daily physical actions examined in the present study were involved in both concentric and eccentric muscle activities, the velocity and tempo of the actions were set as relatively slow so that the middle-aged and elderly individuals could perform them. Therefore, the method of normalization in the present study could be of no matter.

5. Conclusion

The present study aimed to quantify the levels of muscular activities of lower limb muscles using surface EMGs during daily physical actions and to determine the association among the levels of muscular activities of lower limb muscles, age, gender, and maximal muscle strength in the young, middle-aged and elderly individuals. Gender differences were observed in the levels of muscular activities during daily physical actions in the young, and age differences within the same gender were observed for both men and women. It was also observed that the individuals with lower joint torques per body weight exerted higher levels of muscular activities during the daily physical actions (NW, AS, DS, SS, and CR). These results indicate that the gender and age differences in the levels of muscular activities during the daily physical actions are associated with those in the knee extension and ankle plantar flexion torques per body weight. In addition, the levels of muscular activities during all actions, except NW, were found to be 30% in the elderly group. This implies that the levels of muscular activities during daily physical actions can be provided with training stimulation for improving muscle mass and strength in the middle-aged and elderly individuals.

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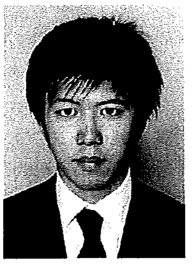

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Sit-to-stand Test to Evaluate Knee Extensor Muscle Size and Strength in the Elderly: A Novel Approach

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Abstract The present study examined whether a sit-to-stand score can be related to the force-generating capacity of knee extensor muscles. Fifty-seven subjects (28 men, 63.0±7.8 yrs, and 29 women, 64.2±7.5 yrs, means±SDs) performed a 10-repeated sit-to-stand test as fast as possible, on a steel molded chair. The time taken ($T_{sit\text{-}stand}$) was measured with a manual stopwatch. The leg length (L), defined as the distance from the *great trochanter* of the femur to the *malleolus lateralis*, was measured using a tape. A power index of the test ($P_{sit\text{-}stand}$) was calculated by using the following equation: $P_{sit\text{-}stand}=(L-0.4)\times \text{body mass}\times g\times 10/T_{sit\text{-}stand}$. The cross-sectional area of the quadriceps femoris muscle (CSA_{KE}) and the maximal voluntary isometric knee extension force (F_{KE}) were measured using MRI and a static myometer, respectively. There was no significant correlation between $T_{sit\text{-}stand}$ and each of CSA_{KE} and F_{KE}. On the other hand, the $P_{sit\text{-}stand}$ was highly correlated with CSA_{KE} and F_{KE}, even after the influence of body mass and L was statistically eliminated. These results indicate that $P_{sit\text{-}stand}$, derived from three variables of body mass, leg length, and time taken for a sit-to-stand test, can be a useful index to assess the force-generating capacity of the knee extensor muscles of elderly individuals. *J Physiol Anthropol 28(3): 123–128, 2009* http://www.jstage.jst.go.jp/browse/jpa2 [DOI: 10.2114/jpa2.28.123]

Keywords: ten-repeated sit-to-stand test, body size, force-generating capacity, knee extensor muscles

Introduction

It is well documented that mass and strength of skeletal muscles decrease with increasing age, notably for knee extensor muscles (Overend et al., 1992; Kubo et al., 2003; Candow et al., 2005; Kubo et al., 2007). For elderly individuals, the reduced force-generation of knee extensors is associated with deterioration of the ability to perform activities of daily life such as walking (Kim et al., 2000) and standing up from a chair (Hughes et al., 1996). Assessment of the ability to perform activities of daily life, especially in the elderly, has been an important topic in the fields of physiological anthropology and exercise sciences. To establish a convenient method for assessing the size and strength of knee extensor muscles is an important issue to develop proper exercise programs for improving physical fitness for the elderly to lead an independent life.

For elderly individuals, the ability to stand up from a sitting position on surfaces of various heights is related to independence (Corrigan and Bohannon, 2001), and the measure of such ability has been considered as an index of thigh muscle strength (Csuka and McCarty, 1985; Bohannon, 1998). In fact, some studies have already reported that sit-to-stand performance, determined as the time required to perform a given number of repetitions or the number of repetitions completed in a given amount of time, is significantly correlated to the strength or power of knee extensor muscles (Schenkman et al., 1996; Ferrucci et al., 1997; Lord et al., 2002). But there are also studies failing to find a correspondence between sit-to-stand performance and knee extensor strength. Csuka and McCarty (1985) found no difference between men and women in 10-repeated sit-to-stand time, although men were stronger than women in knee extension. Ferrucci et al. (1997) observed a departure from linearity in the relationship between the measures of sit-to-stand performance and muscular strength in older women. In their results, time for five chair stands was associated with the knee extensor and hip flexor strength only below 98 N and 147 N, respectively. These findings suggest that the measures of sit-to-stand performance in absolute terms (time in second or numbers of repetitions) are not consistently related with knee extension strength.

A sit-to-stand test is commonly performed using the same chair regardless of the body size of the individuals being tested. This leads to individual differences in the distance of the center of gravity in motion during the task. In addition, different body mass can result in inconsistent mechanical work. In other words, for the same time taken for a sit-to-stand test, work (and average power) done by individuals can be substantially different. Muscle size and strength are related to body size (Young et al., 1984; Samson et al., 2000). For reasonable assessment of force-generating capacity of the knee extensors muscles, the score of a sit-to-stand test should be represented by the average power generated during the task rather than the absolute time or number of repetitions. In fact, knee extension strength and leg extension power show good correlations with the average mechanical power in a rising phase, but not with the time (Lindemann et al., 2003).

The advantage of a sit-to-stand test is that anybody can easily perform the task using a chair and a stopwatch. It is technically possible to determine the power developed during standing up from a chair (Lindemann et al., 2003), but it would be more convenient for a larger population if we could estimate mechanical work and power by using easily available apparatus. One can conventionally calculate the average power during sit-to-stand test using the following variables: body mass, leg length, and time taken for the task. The purpose of the present study was how the power index and the time taken for a 10-repeated sit-to-stand test can be related to the size and strength of knee extensor muscles. We hypothesized that the power index reflects more accurately force-generating capacity of knee extensors than the time taken for the test.

Methods

Subjects

The present study examined men and women aged 50 or more, because muscle mass and strength begin to decrease from the age of 50 (Lynch et al., 1999). Fifty-seven subjects (28 men and 29 women, 64.2±7.5 yrs, 1.54±0.04 m, 50.7±6.0 kg) participated in this study. The means (±SDs) of age, height, and body mass were 63.0±7.8 yrs, 1.67±0.06 m, and 65.8±7.3 kg, respectively, in men, and 64.2±7.5 yrs, 1.54±0.04 m, and 50.7±6.0 kg, respectively, in women. Thirty-three subjects (58%) had regularly performed exercise for >30 minutes more than 3 times per week, 18 subjects (32%) 1 or 2 times per week, and 6 subjects (10%) were sedentary individuals. All participants were medically screened before participating in this study. They were free from cardiovascular, metabolic, immunologic disorders, and orthopedic abnormality. This study was approved by the Ethical Committee of the Faculty of Sport Sciences of Waseda University and was consistent with their requirements for human experimentation. Each subject was informed of the purpose and procedures of this study and possible risks of the measurements beforehand. Written informed consent was obtained from each subject.

Measurement of muscle cross-sectional area in knee extensors (CSA_{KE})

A series of cross-sectional images of the right thigh were determined using magnetic resonance imaging with a body coil (Signa 1.5T, GE, USA). Transverse scans were performed with a conventional T1-weighted Spin-echo sequence (repetition time: 500 ms, echo time: 10 ms, slice thickness: 10 mm, interspaced distance: 0 mm, FOV: 24–32 cm, phase FOV: 0.75, matrix: 256×256). The scan time was 104 seconds. A reference marker was placed on the skin at mid-thigh. This portion is where the muscle cross-sectional area of the thigh muscles is maximal (Kanehisa et al., 1994). The subjects lay horizontally to avoid contact between the posterior aspect of the thigh and the bed of the scanner. From the image obtained in which the reference marker was included, CSA_{KE} were determined using image analysis software (SliceOmatic ver4.3, Tomovision, Canada). Only the traced skeletal muscle areas were measured, excluding connective tissue, blood vessels, and fat tissue where visible. The measurement was carried out one time by an experienced analyst. To assess the accuracy of the measurement by the analyst, scanned images were analyzed three times, yielding coefficients of variance of CSA_{KE} of less than 2%.

Measurement of maximum voluntary isometric knee extension force (F_{KE})

The maximal voluntary isometric knee extension torque was measured with a specially designed myometer (VTK-002R/L Vine, Japan). The right side was tested with the subjects seated, keeping a 90-degree angle (full extension: 0°) of hip and knee joints. The axis of the knee joint was aligned with the axis of the lever arm of the myometer. The right inferior shin was firmly secured to the lever arm of the myometer with a strap. Prior to the test, each subject performed adequate warm-up, consisting of 2 to 3 times sub-maximal contractions to become familiar with the test procedure. Each subject performed a 2- to 3-s maximal voluntary isometric contraction two times, with at least 1 minute of rest between trials to avoid any fatigue effects. If the difference between the two values of torque was more than 10% of the higher one, the torque was measured one more time. The torque data during each task were amplified by a strain amplifier (DPM-611A, Kyowa, Japan) and A/D converted (Power Lab/16SP, ADInstruments, Australia) into a personal computer at 100 Hz with a low-pass filter (cutoff frequency: 20 Hz). The highest value out of the 2 or 3 torque measurements was adopted. The maximal voluntary isometric knee extension force (F_{KE}) was calculated by dividing the knee extension torque by the lower leg length, defined as the distance from the *lateral condyle* of the femur to the *lateral malleolus*.

Sit-to-stand test

A steel molded chair (0.40 m height and 0.36 m depth) was used for the sit-to-stand test. The subjects were asked to stand up from a sitting position and then to sit down 10 times as fast as possible. The subjects were instructed to stand up fully and to place their buttocks on the chair in a sitting position between repetitions. The time ($T_{sit\text{-}stand}$) was recorded using a stopwatch to the nearest 10^{th} of a second. The test started when the examiner said "Go" and stopped when the subject fully stood up on the 10^{th} repetition. Prior to the measurements, practice trials with submaximal effort were performed for positioning and learning of the task. The $T_{sit\text{-}stand}$ measurements were performed two times with an interval of 1 min between trials. The fastest time was adopted for the individual data. A power index of the test ($P_{sit\text{-}stand}$) was calculated using the following equation:

$$P_{sit\text{-}stand} = \frac{(L - 0.4) \times \text{body mass} \times g \times 10}{T_{sit\text{-}stand}}$$

where the 0.4 (m), L (m) and g (m/s^2) represent height of the chair, leg length (the distance from the *great trochanter* of the femur to the *malleolus lateralis*) and acceleration of gravity (9.8 m/s^2), respectively. The leg length was measured using a tape measure.

Statistical analysis

Descriptive data were presented as the mean and standard deviation (SD). Relationships among measurement variables were analyzed using Pearson's coefficient of correlation (r). After adjustment for body mass and L, a partial coefficient of correlation was used to test association among $T_{sit\text{-}stand}$, CSA_{KE}, and F_{KE}. In addition, after adjustment for gender (men=0, women=1), body mass, and L, a partial coefficient of correlation was used to test association among $P_{sit\text{-}stand}$, CSA_{KE}, and F_{KE}. The general linear model procedure of SPSS (SPSS12.0J, SPSS Japan, Japan) was used with the statistical significance determined at $p<0.05$.

Results

Relationships between $T_{sit\text{-}stand}$ and measurement variables

The mean value for $T_{sit\text{-}stand}$ in all subjects was 10.3±2.1 s (men: 10.5±1.9 s, women: 10.2±2.2 s). Figure 1 shows the relationships between $T_{sit\text{-}stand}$ and each of CSA_{KE} and F_{KE}. The $T_{sit\text{-}stand}$ was not significantly correlated with each of CSA_{KE}, F_{KE}, body mass, and L (Table 1). When the body mass and L were statistically controlled, however, there were significant negative correlations between $T_{sit\text{-}stand}$ and each of CSA_{KE} ($r_{Tsit\text{-}stand\ CSAKE \cdot BM,L} = -0.381$, $p=0.004$) and F_{KE} ($r_{Tsit\text{-}stand\ FKE \cdot BM,L} = -0.342$, $p=0.011$).

Relationships between $P_{sit\text{-}stand}$ and measurement variables

The correlation coefficients between $P_{sit\text{-}stand}$ and measurement variables are shown in Table 1. The $P_{sit\text{-}stand}$ was significantly correlated with each of gender (r=0.638, $p<0.001$), body mass (r=0.758, $p<0.001$), L (r=0.778, $p<0.001$), CSA_{KE} (r=0.801, $p<0.001$, Fig. 2), and F_{KE} (r=0.730, $p<0.001$, Fig. 2). The CSA_{KE} and F_{KE} were

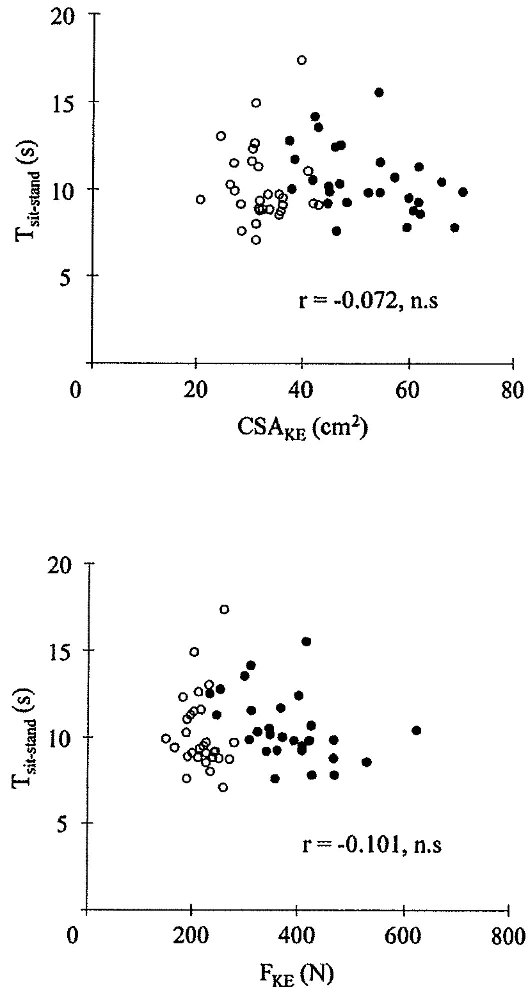

Fig. 1 Relationship between $T_{sit\text{-}stand}$ and each of muscle cross-sectional area of knee extensors (upper) and knee extension force (bottom). (●) middle-aged and elderly men (n=28), (○) middle-aged and elderly women (n=29).

Table 1 Correlation coefficients between the scores of the sit-to-stand test and measured variables

	$T_{sit\text{-}stand}$	$P_{sit\text{-}stand}$
Age	0.082	−0.191
Sex	0.075	0.638#
Body weight	0.172	0.758#
Lower limb length	0.159	0.778#
CSA_{KE}	−0.072	0.801#
F_{KE}	−0.101	0.730#

Significant at $p<0.001$.

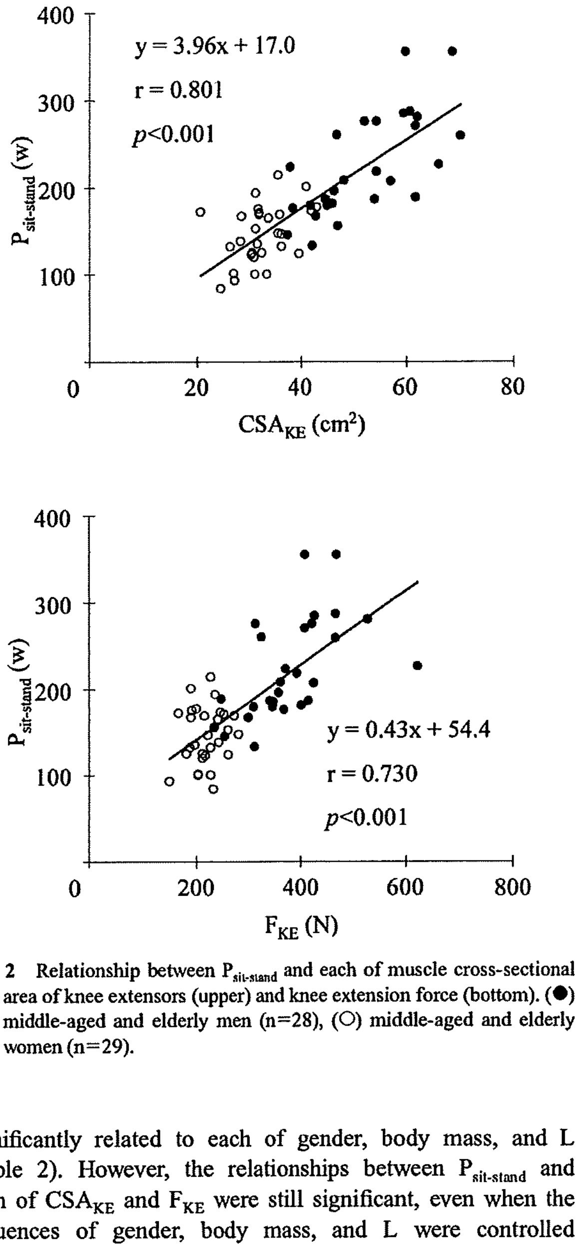

Fig. 2 Relationship between $P_{sit\text{-}stand}$ and each of muscle cross-sectional area of knee extensors (upper) and knee extension force (bottom). (●) middle-aged and elderly men (n=28), (○) middle-aged and elderly women (n=29).

significantly related to each of gender, body mass, and L (Table 2). However, the relationships between $P_{sit\text{-}stand}$ and each of CSA_{KE} and F_{KE} were still significant, even when the influences of gender, body mass, and L were controlled statistically (CSA_{KE}: $r_{Psit\text{-}stand\ CSAKE \cdot gender, BW, L}=0.438$, $p=0.001$, F_{KE}: $r_{Psit\text{-}stand\ CSAKE \cdot gender, BW, L}=0.415$, $p=0.002$).

Discussion

The main finding of the present study is that $P_{sit\text{-}stand}$ rather than $T_{sit\text{-}stand}$ was strongly correlated with each of CSA_{KE} and F_{KE}. The correlations were still significant, even when the influences of body mass and leg length were controlled statistically. This result agrees with the finding of Lindemann et al. (2003) and supports our hypothesis.

In the present study, the $P_{sit\text{-}stand}$ was calculated by three variables, i.e., body mass, leg length, and time taken for a 10-repeated sit-to-stand. On the other hand, Lindemann et al. (2003) obtained the power from body mass, distance of center of gravity from sitting to standing position, and the time taken during a single chair rising. The $P_{sit\text{-}stand}$ obtained in the present study included the phase in standing up from and sitting down onto a chair. The mean value for $P_{sit\text{-}stand}$ (184 W, males: n=28, females: n=29) is therefore considerably lower than the report of Lindemann et al. (2003) (647 W, males: n=17, females: n=16). It is possible that the $P_{sit\text{-}stand}$ of the present study could underestimate the power output of knee extensor muscles during the task. However, the present results regarding the correlations with CSA_{KE} and F_{KE} indicate that $P_{sit\text{-}stand}$ rather than $T_{sit\text{-}stand}$ is a useful index to assess the force-generating capacity of knee extensor muscles.

As another reason for the discrepancy mentioned above, the lower mean value for $P_{sit\text{-}stand}$ in the present study compared with the report of Lindemann et al. (2003) might be the result of differences in subjects' body size. The mean values for height and body weight of the subjects examined in the present study were 1.54±0.04 m and 50.7±6.0 kg, respectively. On the other hand, the corresponding values in the study by Lindemann et al. (2003) were 1.67±0.09 m and 74.9±11.2 kg. These differences could have affected the power values since both studies are based on body size, i.e., body mass and/or leg length.

The F_{KE} and CSA_{KE} were not significantly correlated with $T_{sit\text{-}stand}$ in the present study. However, the corresponding correlations were significant after controlling body mass and leg length. This result implies that body size has a substantial influence on the relationship between the time taken for a 10-repeated sit-to-stand and the force-generating capacity of knee extensors.

Buchner et al. (1996) reported that the relationship between walking speed and leg strength was nonlinear. They further indicated that there was a "threshold" of leg strength above which the leg strength did not affect walking speed. These findings suggest that there is no clear relationship between walking speed and leg strength in a group of subjects with relatively greater leg strength. From the findings of Ferrucci et al. (1997), the relationship between 5-repeated sit-to-stand time and knee extension force was nonlinear, but, below 98 N, the corresponding relationship became linear. Most of the subjects in the present study were moderately to highly active. The mean value for F_{KE} was 298.5±103.1 N (Men: 380.7±85.3 N, Women: 219.1±31.3 N). There was no subject with her/his knee extension force below 98 N. They did not have difficulty in performing the repeated sit-to-stand task. Knee extension strength in active elderly individuals is higher than those in sedentary elderly individuals (Klitgaard et al., 1990; Loard et al., 1993). Therefore, there is a possibility that the time scores for the subjects examined here might be assumed to be ranked in the "plateau region" of the relationship between $T_{sit\text{-}stand}$ and F_{KE}, as indicated in prior studies (Buchner et al., 1996; Ferrucci et al., 1997).

In the present study, the $P_{sit\text{-}stand}$ was significantly correlated with each of CSA_{KE} and F_{KE}. The findings that body mass and

Table 2 Correlation coefficients among variables except for $T_{sit\text{-}stand}$ and $P_{sit\text{-}stand}$

	Age	Sex	BW	L	CSA_{KE}	F_{KE}
Age		−0.075	−0.086	−0.123	−0.326*	−0.328*
Sex			0.755***	0.652***	0.791***	−0.790***
BW				0.730***	0.777***	0.716***
L					0.727***	0.609***
CSA_{KE}						0.851***
F_{KE}						

BW: body weight, L: leg length, CSA_{KE}: muscle cross-sectional area of knee extensors, F_{KE}: knee extension force.
*** Significant at $p<0.001$.
* Significant at $p<0.05$.

leg length were significantly related to CSA_{KE} and F_{KE} are similar to previous reports (Young et al., 1984; Samson et al., 2000). At the same time, this result implies that the relationships between $P_{sit\text{-}stand}$ and each of CSA_{KE} and F_{KE} are affected by body size. However, the corresponding correlations were still significant, even when the variables of body mass and lower leg length were statistically eliminated. Hence we may say that $P_{sit\text{-}stand}$, unlike a conventional method (time or number of repetitions of sit-to-stand), can be a useful assessment of the force-generating capacity of knee extensors, regardless of the difference in body size.

In conclusion, the present results indicate that the power index derived from the three variables of body mass, leg length, and time taken for a sit-to-stand test, but not the time only, can conveniently assess the force-generating capacity of knee extensors in middle-aged and elderly individuals.

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実践研究

運動実践者が一時的運動停止に導かれるハイリスク状況とその対処の評価

竹中 晃二　　大場ゆかり　　満石　寿

Koji Takenaka, Yukari Ooba and Hisashi Mitsuishi: Assessment of coping with high-risk situations for exercise skipping and lapse among regular exercisers. Japan J. Phys. Educ. Hlth. Sport Sci. 55: 000–000, , 2010

Abstract: The Relapse Prevention Model (RPM) has provided a framework for successful long-term maintenance of some types of health behavior. The purpose of this study was to identify high-risk situations for inducing exercise skipping and lapse, which may lead to real relapse, and to clarify the coping strategies in this regard for Japanese regular exercisers, from the viewpoint of the RPM. We examined 677 regular exercisers by obtaining open-ended responses about 1) their typical high-risk situations as immediate determinants interfering with their planned exercise, 2) their coping responses to those situations, and 3) subsequent patterns of exercise outcome. High-risk situations included fatigue, bad weather, bad conditioning or injury, work or academic obligation, troubles in personal life, and interpersonal relationships, although the frequency orders differed according to gender. Females were more aware that interpersonal relationships were associated with a higher incidence of exercise skipping and lapse than did males, whereas males identified fatigue as the highest risk. Positive coping strategies as problem solving and behavior strategies as execution of routine work were most commonly employed, and were associated with positive exercise outcome for both females and males. On the other hand, the usage of negative coping strategies tended to lead to skipping and lapse. These results suggest that adoption of coping strategies regarding high-risk situations is associated with exercise outcome, although the effects differ between males and females. These data demonstrate the importance of coping ability or strategy for exercise and suggest that skipping and lapse may result from ineffective coping with high-risk situations. These findings confirm and extend previous work on the application of the RPM for examining exercise skipping and lapse. Measurement issues and knowledge derived from this study are discussed in relation to future application to real practice.

Key words: RPM, exercise slip and lapse, exercise adherents, high-risk situations, cognitive and behavioral coping strategies
キーワード：RPM，運動スリップ・ラプス，運動アドヒアランス，ハイリスク状況，認知・行動的対処方略

問題提起

近年，人々が自身で能動的に移動したり，様々な労作業を行うことに代わる形態の利用，例えばクルマの利用・送迎，エレベータやエスカレータの利用など，身体活動を代替するための機械や道具が頻繁に利用され，また使用する機会も飛躍的に増大している．一方で，コンピュータなどの先端機器の発達によって人々のライフスタイル，仕事や娯楽の内容までもが座位中心生活を助長するようになっている．このように，日常生活における日々積み重ねて得られる総身体活動量の減少傾向は，暖衣飽食の傾向と相まって，生活習慣病罹

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患率の上昇，例えば糖尿病を強く疑われる者やその予備群の数を急激に増加させている（厚生労働省，2008）．

このような背景を踏まえて，国は「21世紀における国民健康づくり運動（健康日本21）」を策定し，一次予防に重点を置いた施策を打ち出した．健康日本21では，1)日常生活の中で，健康の維持・増進のために体を動かすなどの運動をしている人の増加，2)日常生活における歩数の増加（目標値：男性9,200歩，女性8,300歩），3)運動習慣者（1回30分以上の運動を週2回以上実施し，1年以上継続している人）の増加を目標として掲げ，具体的な数値目標が立てられている．しかし，平成16年国民健康・栄養調査の結果を見ると，この歩数目標値に達している男女は30％にとどまっており，また20-50歳代では，1週間に運動を全く行っていない男女が約30％も存在していることがわかった（厚生労働省，2006）．様々な機関や研究者は，頻繁に，健康づくり，また生活習慣病予防のために運動を実践する必要があることを情報として伝達している一方で，習慣的に運動を実践している人の数は増加していない．明らかに，運動の効果や方法を示す情報伝達・指示型のアプローチだけでなく，人々の行動を開始させ，継続させることに焦点を絞った行動変容の知識や方法を伝え，それらを実践・継続させるアプローチが必要とされている．

従来，運動を始めさせることを念頭に置いたアプローチだけが強調されてきたきらいがあり，いったん始めた運動習慣をいかに継続させるか，また停止させないかというアプローチにはあまり関心が払われてはいない（竹中ら，2006）．また，人は運動を始めたとしても，しばしば継続することに対して困難な状況に遭遇し，例えば体調不良や突然の仕事，旅行や天候によって中断してしまう状況が存在し，それらの状況をどのように乗り越えさせるかということも継続支援において重要な課題となる．一般に，健康行動の逆戻りや不健康行動の再発は，リラプス（relapse）と呼ばれ（Larimer et al., 1999），運動を習慣化させた人が運動を停止し，もとの座位中心の生活にもどることも同様にリラプスという用語が使用されている（例えば，Sallis et al., 1990）．わが国において，リラプスは，例えば市町村で開催される運動プログラムにおけるドロップアウト率のように，継続率の裏返しとしか見なされておらず，習慣化を見極める観点としては，プログラム終了時や調査時のように，ある時点において継続できているかいないかという二者択一でしか認識されていない（竹中ら，2006）．しかし，リラプスの経験は，運動習慣を確立していく過程の一部であり，リラプスの動的過程を検討することでその予防につなげることができる．

運動を開始したとしても時間経過と共に実施率が低下していく様相は，いくつかの著書において記載されている（例えば，Dishman, 1988; Weinberg and Gould, 1999）ものの，どのようなタイミングで，またどういう経過を経てリラプスが生じるかについては必ずしも明確でない．その理由として，リラプスを定義する基準や測定方法が曖昧であり，研究者によっても内容が異なっているためである．例えば，Krug et al.（1991）の研究では，運動を行い始めた糖尿病患者が少なくとも1週間運動を行わないことをリラプスと定義している．この研究では，患者が定期的な運動習慣を確立するまでに70％の患者がリラプスを経験し，また64％の者が2回以上のリラプスを行っていることを報告している．Sallis et al.（1990）は，地域に住む住民を無作為に抽出し，郵送による調査を実施している．この調査では，過去に少なくとも6ヵ月の間，高強度の運動を行っており，その後少なくとも3ヵ月運動を停止したことをリラプスとしてその回数を調査した．その結果，運動実践者の20％が1，2回のリラプスを，また別の20％の者が3回以上リラプスを経験していた．このようにリラプスを規定する期間は研究者ごとに変わっており，さらにリラプスの把握が調査対象者の回顧的自己報告に頼っていることも研究間で共通の認識を持ちにくくしている．

リラプスを1つの連続する過程と見なし，運動停止の期間によって分割する考え方もある．Simkin and Gross（1994）は，1週間の停止をラ

プス（lapse）とし，3週間の停止をリラプス（relapse）とした．同様に，Dishman（1988）やMarcus and Stanton（1993）も，短期間の不活動をラプスとし，長期間の不活動をリラプスとして分けて考えている．さらに，ラプスのように，わずかな期間の停止だけでなく，運動実践者が予定していた運動を何かの事情で行えない場合も存在する．禁煙の研究では，すでに断煙できた者が，ある状況下，例えばストレスの高い状況で1，2本のタバコを吸ってしまうことをスリップ（slip）と表現しており，同様に，単発の運動停止もスリップと呼ばれている（Stetson et al., 2005）．すなわち，スリップは，後に発展するラプスやリラプスへの入り口と見なされている．本研究では，スリップおよびラプス，すなわち単発の運動停止や1週間程度の運動停止に絞って研究を行う．

健康行動のリラプス予防プログラム，例えば一度禁煙を達成した人が再度喫煙を行うことを予防するプログラムの多くは，依拠する理論モデルとして，再発予防モデル（Relapse Prevention Model：以後RPMと略す）を使用している．RPMは，薬物・アルコール依存治療の行動維持プログラムとして発展してきた認知行動モデルであり，例えばいったん断酒したアルコール依存患者がどのような経過で再発するかを説明している（Larimer et al., 1999; Marlatt and Gordon, 1985）．RPMは，図1に示すように，リラプスを促進させる要因や状況を詳細に分析し，リラプスにつながるスリップ・ラプスを誘発する決定要因に注目している．健康行動の対象が運動であれば，スリップ・ラプスに導きやすいハイリスク状況に対して適切な対処が実施されれば，それらを回避することもできる．RPMによれば，健康行動の実践を阻害させるようなハイリスク状況があり（例えば，疲労感があったり，ジョギングを行おうと思っている矢先に急に仕事がはいったり，天候が悪いような状況），それらの状況に対して適切に対処できた場合にはセルフエフィカシーが増加し，その後にリラプスを生じる可能性が減少していく．セルフエフィカシーとは，運動実践を継続することができるという見込み感のことで，ここでは運動実施を妨げるハイリスク状況においても運動を継続することが「できる」というバリア・セルフエフィカシーに相当する（竹中・上地，2002）．一方，人は，ハイリスク状況に対して適切な対処方略を持っていなかったり，不適切な対処方略を選択した場合（例えば，こんな悪天候の中でジョギングを行えば風邪を引くので止めておこうと考えることやわざと他の作業を行って時間を引き延ばす行為）にセルフエフィカシーが低下する．同時に，望ましくない行動を行うことによる肯定的な結果期待（例えば，今夜運動を止めたら時間も有効に使えるし，第一疲れなくてよいと考えるような合理化）を抱き，一度スリップ・ラプスが生じれば，禁欲違反効果（Abstinence Violation Effect：例えば，今までジョギングを継続してきたが，一度止めてしまったので後はもう続けても仕方がないという思い）が生じ，後に罪悪感を伴うことで諦めにつながりやすく（Larimer et al., 1999），その後リラプスの可能性を高めていく．

残念ながら，運動習慣に特化してRPMを用いた研究は，exercise, physical activity, relapse prevention model という用語を用いてPubMed

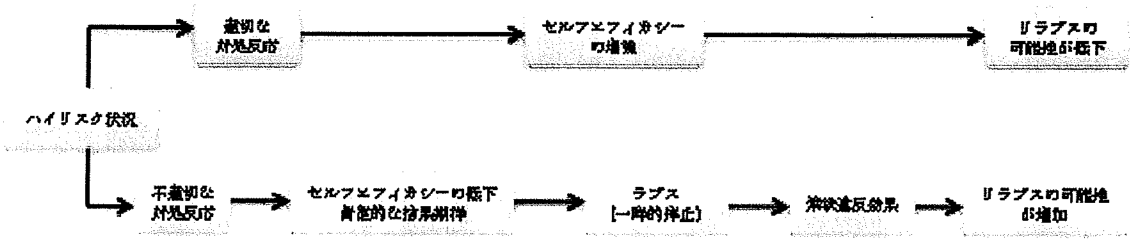

図1　リラプス過程の認知行動モデル（Marlatt and Gordon, 1985）

および PsycINFO で探索した限り，わずかに Belisle et al. (1987), Marcus and Stanton (1984), Simkin and Gross (1994), Stetson et al. (2005) の4例だけである．これらの研究のうち，Simkin and Gross (1994) および Stetson et al. (2005) の2研究は，ハイリスク状況とその際に行う対処方略の関係を見ることに焦点を絞って研究を行っている．Simkin and Gross (1994) の研究では，RPMの概念を適用し，特に運動実践の継続を妨げる状況に対して実施する対処方略の種類と程度をリラプスとの関係で見ている．彼らは，14週間の運動プログラムに参加する29名の健常女性に対して，プログラム開始時に，ラプスに導く10項目のハイリスク状況に対する対処能力を測定し，リラプスを起こした者と起こさなかった者について，ハイリスク状況への対処方略得点を比較した．その結果，リラプス者は，そうでない者と比べて，プログラム開始前に測定した行動的・認知的対処方略の得点が有意に低かった．Simkin and Grossは，この研究結果から，リラプスは運動実践を妨げるバリア要因に不適切に対処することによって生じており，そのために対処・課題指向の問題解決能力の重要性を強調している．Stetson et al. (2005) の研究では，運動実践者がスリップ・ラプスを生じやすいハイリスク状況を調べ，その際，実践者が行う対処方略を認知的方略と行動的方略に分類している．彼らは，表1に示すように，ハイリスク状況に対して2つのタイプの対処方略，すなわち認知的対処方略（課題指向の問題解決，肯定的再評価，合理化）と行動的対処方略（運動前に行ういつもの行動，ソーシャルサポートの誘発，回避・引き延ばし活動）に分類して研究を行った．認知的対処方略においては，「課題指向の問題解決」が運動を行うことを妨げているバリア要因に対して直接的な解決法や計画づくり（例えば「この仕事を早めに片付けて少しでも運動を行おう」，「今日はフィットネスクラブに行けなかったので代わりに自宅の周りを散歩しておこう」など）を意味し，「肯定的再評価」とは，運動後の爽快感や体型・容姿，筋肉のつき具合などについて運動の効果を再評価すること，最後の「合理化」とは運動を行わないですむ言い訳（例えば，「このような天候の中で運動を行ったら体調を崩してしまう」，「今日は，体調が

表1 ハイリスク状況における対処方略の分類（Stetson et al., 2005）
右部分は，著者らが用いたコード

方略の分類	内　容	本研究で用いたコード
認知的対処方略		
課題指向の問題解決	バリア要因を克服するための思考	P1：内容の再考，P2：スケジュールの再考，P3：直接的問題解決（バリアの克服），P4：代替活動の実施，P5：実施の時間短縮，P6：サプリメントの使用，P7：目的の確認，P8：その他
肯定的再評価	肯定的な自己教示や恩恵と負担の重みづけ	A1：体型・容姿・体重の維持・改善，A2：体力増強，A3：ストレス解消・気分転換，A4：楽しみイメージ，満足感，A5：疲労回復，A6：停止による損失の熟考，A7：自尊心の増強，A8：その他
合理化	運動停止を正当化	R1：運動停止の言い訳・正当化（健康，休養，勉学，仕事など），R2：責任転嫁，R3：その他
行動的対処方略		
運動前に行ういつもの行動	運動実施を促す事前の行動	B1：いつもの準備，B2：トレーニングウエアへの着替え，B3：靴を履いて外出，B4：運動機器の持参，B4：運動施設への訪問，B7：ウオーミングアップ，B8：その他
ソーシャルサポートの誘発	他者からの援助の模索	S1：友人・家族からの応援，S2：友人・家族と一緒に行うこと，S3：インストラクターへの指導依頼，S4：金銭的援助，S5：送迎依頼，S6：その他
回避・引き延ばし活動	運動実践のバリア要因への積極的希求	T1：他作業（勉学・仕事など）の実施，T2：ビデオ・TV鑑賞・ゲーム・読書，T3：電話，T4：家族・友人との交際，T5：他の時間稼ぎ，T6：その他

すぐれないので，こういうときに運動を行ったら病気になってしまう」など）である．先の2つの方略がハイリスク状況に対する肯定的な対処方略とされ，最後の「合理化」は停止を助長する方略と考えられている．一方，行動的対処方略では，「運動前に行ういつもの行動」，「ソーシャルサポートの誘発」，および「回避・引き延ばし活動」の3種類の方略がある．「運動前に行ういつもの行動」とは，ハイリスク状況への遭遇に際して，まずはトレーニングウエアに着替える，取りあえずシューズに履き替えて外にでてみる，取りあえず運動する場に行ってみるなどの行動である．2つ目の「ソーシャルサポートの誘発」とは，友人に一緒に行ってもらうように依頼する，家族に応援してもらうなどの他者からの援助である．最後の「回避・引き延ばし活動」とは，何か別の作業，仕事，テレビ視聴などを行って運動実践の開始を引き延ばしたり，回避する行動的対処方略である．「運動前に行ういつもの行動」および「ソーシャルサポートの誘発」がハイリスク状況を乗り越える有効な方略であるのに対して，「回避・引き延ばし活動」は運動の停止を招きやすくしている．

以上の研究結果を踏まえ，本研究の目的は，わが国における運動習慣保持者がリラプスの初期段階と言えるスリップ・ラプスを生じさせやすいハイリスク状況の具体的内容を明らかにし，ハイリスク状況に際して用いる対処方略の内容によって，その後の運動実践にどのような影響が生じるのかを質問調査を用いて調べることである．これら有効な対処方略が明確になれば，すでに継続して運動を行っている人たちに対してリラプス予防の方法を教授することもできる．

研究方法

1. 調査対象者

調査対象者は，現在，運動指導を行っている者，またはこれから運動指導に携わろうとしている者で，学生時代に何らかの運動部に所属していた，または過去および現在において運動を継続して行っている男性282名，女性395名の計677名であり，年齢は16-62歳（平均38.9±9.9歳）であった．運動習慣の年数は全員が同一の運動・スポーツ種目を1年間以上継続的に実践していると回答しており，本研究においては，彼らを運動習慣保持者としている．また，対象者のうち3/4は実際に運動を指導している者であった．なお，本調査は，指導者を対象としたセミナーなど複数の機会を利用し，調査協力にあたっては，対象者に口頭で依頼を行い，また実際の調査にあたっては説明文の冒頭に同意文書を掲載して同意を得た．

2. 調査内容

調査は，まず調査者が調査内容の説明を含む質問表を配布し，以下のような教示を行いながら対象者に対して自由記述を求めた．また，それぞれの部分には口頭で説明を加え，特にハイリスク状況については，例を示しながら原因・理由となる事柄を抽出できるようにした．

1）ハイリスク状況の内容

「あなたは定期的に（6カ月以上継続）運動を行ってきていて，しかしなぜか行う気にならないという状況が発生したことがあると思います．つまり，そのとき，あなたは運動を行うべきだと心の中で強く思っていながら，しかしどうもやる気が起こらない状況です．それらの経験の中から代表的な内容を一つ選んで，その際の前後関係，場所，天候，時間，人との関係，身体の状況を詳しく書いてください．」

2）ハイリスク状況に対する認知的対処方略

「次に，そのような状況に遭遇して，あなたは心の中でどういうふうに考えましたか．主要な内容を1つだけ挙げてください．」

3）ハイリスク状況に対する行動的対処方略

「そのような状況に遭遇して，あなたは何かを行おうとしましたか．主要な内容を1つだけ挙げてください．」

4）運動実践の有無

「その結果，運動を行いましたか，また行いませんでしたか．」

3. 分析方法

ハイリスク状況の内容については，行動科学，スポーツ科学を専攻する教員2名および大学院生6名によって，まずはStetson et al. (2005) の区分け（場所，天候，時間帯，状況の社会的特徴，および実施者の体調）に倣って分類を行った．その後，新たに分類できる項目，また内容が質的に類似する項目ごとに整理し，最終的に，それぞれの内容を，疲労，悪天候，体調不良・怪我，仕事・学業，実生活における問題，人間関係，運動内容（マンネリ化）の7項目に分けた．さらに，どの項目にも属さない内容や少数事例をその他と分類し，合計8項目について男女別に頻度表を作成した．

次に，回答のあった，ハイリスク状況に対する認知的および行動的対処方略について，ハイリスク状況に対する対処方略を検討している他領域の研究（アルコール依存者対象：Larimer et al., 1999；禁煙者対象：O'Connell et al., 2007）に見られる分類内容を参考に，それぞれの内容が認知的方略として，また行動的方略として妥当であるか否かを確認した．また，コーディングの基準については，Stetson et al. (2005) の分類表（表1）に倣い，新たに独自のコーディング基準表を開発した．その後，この基準表に基づき，先のハイリスク状況の分類作業と同様に，複数の研究者による合議によって分類を実施した．

結　果

1. ハイリスク状況の内容

表2は，運動の一時的停止を招きやすいハイリスク状況について，男性および女性において回答した人数と割合，および頻度別順位を示し，加えて性差を示す χ^2 値，および男女の合計についての人数，割合，および頻度別順位を記述している．調査対象者それぞれの回答に，ハイリスクの内容が複数あると見なした場合は，複数回答として集計を行った．

全体としては，スリップ・ラプスを生じさせやすいハイリスク状況として多くあげられた内容は，疲労（158），悪天候（151），体調不良・怪我（150），仕事・学業（135）であった．しかし，男女別に示した頻度別順位は男女で若干様相が異なって表れた．疲労は，男女合計，また男性では最も頻度の高いハイリスク状況であったが，女性では3位であった．疲労に関しては，χ^2 検定の結果，男性の方が女性よりも有意に多く回答を示した（$\chi^2(1)=4.25, p<.05$）．一方，人間関係においては，女性の方が男性と比べて有意に多く回答した（$\chi^2(1)=12.54, p<.001$）．

2. ハイリスク状況に対する認知的対処方略

表3は，ハイリスク状況に対する認知的対処方略の3種類について男女ごとに人数を集計し

表2　運動実践の一時停止を導きやすいハイリスク状況（複数回答）

ハイリスク状態	男性　n=282	順位	女性　n=395	順位	χ^2	総計　n=677	順位
疲労	77 (27.3)	1	81 (20.5)	3	4.25*	158 (23.3)	1
悪天候	59 (20.9)	4	92 (23.3)	1	0.53	151 (22.3)	2
体調不良・怪我	66 (23.4)	2	84 (21.3)	2	0.44	150 (22.2)	3
仕事・学業	63 (22.3)	3	72 (18.2)	4	1.74	135 (19.9)	4
実生活における問題	29 (10.3)	5	49 (12.4)	6	0.73	78 (11.5)	5
人間関係	15 (5.3)	7	54 (13.7)	5	12.54***	69 (10.2)	6
運動内容(マンネリ化)	28 (9.9)	6	36 (9.1)	7	0.13	64 (9.5)	7
その他	41 (14.5)		53 (13.4)		0.17	94 (13.9)	

それぞれのセルにおける数字は人数，割合，および順位を示している．χ^2 値（df=1）は性差を分析．
*p<.95, ***p<.001

たものである．χ^2 検定の結果，人数の偏りは有意であった（$\chi^2(2)=7.88, p<.05$）．残差分析を行った結果，表3における人数の下部に示すように，女性が男性よりも多く「肯定的再評価」を使用していることがわかった．「肯定的再評価」では，男女とも，表1に示すA1（体型・容姿・体重の維持・改善）に関わる評価が見られた．A1に関しては，統計分析を行うには不十分な情報量であるものの，特に体型についての記述から，願望の性差，すなわち女性では「美容・外見」を，一方，男性では「逞しさ」を理由に挙げる傾向が見られた．

表4は，ハイリスク状況に対して認知的対処方略の3種類を行うことによって，その後に運動を実施したか，または停止したかという対処方略とその後における運動実施の有無との関係について，男性，女性，そして合計別にそれぞれの人数を示している．χ^2 検定の結果，男性（$\chi^2(2)=19.08, p<.01$），女性（$\chi^2(2)=62.47, p<.01$），合計（$\chi^2(2)=74.55, p<.01$）それぞれにおいて人数の偏りが有意であった．残差分析を行った結果，表5に示すように，男性，女性，そして合計別にそれぞれの対処方略を行うことで運動実施の有無に有意な人数の偏りが見られたが，男性においては，ハイリスク状況に遭遇して「肯定的再評価」を行ったとしても運動実践に影響を与えていないことがわかった．

3. ハイリスク状況に対する行動的対処方略

表6は，ハイリスク状況に対する行動的対処方略の3種類と性との関係を人数として示している．χ^2 検定の結果，人数の偏りは有意であった（$\chi^2(2)=6.08, p<.05$）．残差分析を行った結果，表6における人数の下部に示すように，「回避・引き延ばし活動」においてのみ男性では人数が多く，女性では少ないことがわかった．

ハイリスク状況に対する行動的対処方略の3種類を行うことによって，その後に運動を実施したか，また停止したかの関係については，男性，女性，そして合計別にそれぞれの人数を表7に示している．χ^2 検定の結果，男性（$\chi^2(2)=$

表3　男女別に示したハイリスク状況に対する対処方略（認知的対処）の実施度数

性	課題指向の問題解決	肯定的再評価	合理化
男性	47(23.2%) 1.16	44(21.7%) −2.78**	112(55.2%) 1.57
女性	61(18.9%) −1.16	106(32.9%) 2.78**	155(48.1%) −1.57

それぞれのセルにおける上部数字は人数と割合，下部数字は残差　**p<.01

表5　ハイリスク状況における対処方略（認知的対処）と運動実施の有無：残差分析の結果

	運動実施の有無	課題指向の問題解決	肯定的再評価	合理化
男性	運動実施	4.26**	−0.28	−3.39**
	運動停止	−4.26**	0.28	3.39**
女性	運動実施	5.30**	3.73**	−7.67**
	運動停止	−5.30**	−3.7**	7.6**
全体	運動実施	6.72**	3.04**	−8.18**
	運動停止	−6.72**	−3.04**	8.18**

**p<.01

表4　ハイリスク状況に対する対処方略（認知的対処）とその後の運動実施の有無

運動実施の有無	課題指向の問題解決			肯定的再評価			合理化		
	計	男性	女性	計	男性	女性	計	男性	女性
運動実施	86	35	51	92	20	72	89	41	48
運動停止	22	12	10	58	24	34	178	71	107

それぞれのセルにおける数字は人数

19.08, $p<.01$)，女性（$\chi^2(2)=114.24, p<.01$)，合計（$\chi^2(2)=191.14, p<.01$）において人数の偏りは有意であった．残差分析を行った結果，表8に示すように，男性，女性，そして合計別にそれぞれの対処方略が運動実施の有無に有意な人数の偏りをもたらすことがわかった．しかし，男性では，「ソーシャルサポートの誘発」の方略を実施しても運動実践に影響を与えていなかった．

χ^2検定を行ったり，χ^2値から導き出される関連性の指標を用いる場合には，期待値が5未満の桝目が全体の桝目の数の20％以上ある分割表に対しては注意が必要であることが指摘されている．表7においては，この制限が適用されることから，1)カテゴリーを併合する方法，および2)フィッシャーの正確確率検定によってさらなる分析を行った（青木，2008）．

前者では，運動実施，また停止に導きやすい方略カテゴリーを併合（「運動前に行ういつもの行動」と「ソーシャルサポートの誘発」を併合し，「回避・引き延ばし活動」と2カテゴリーにする）して2×2の分割表にして分析を行った結果，男女とも有意な結果を得た．よって，運動実施，また停止に導きやすい方略の違いは明確であった．一方，フィッシャーの正確確率検定（2×2以外の場合）では，2群の比率差の多重比較を行うことが推奨されており，テューキーの方法を選択した．多重比較を行った結果，運動実施に関して群間の比率の差は，女性と男女全体で「運動前に行ういつもの行動」と「ソーシャルサポートの誘発」の間の差が有意でないものの，その他の比較はすべて有意な差を示した．以上より，本研究において，表7および表8の結果を基にして考察を行うことは妥当と考えた．

表6　男女別に示したハイリスク状況に対する対処方略（行動的対処）

性	運動前に行ういつもの行動	ソーシャルサポートの誘発	回避・引き延ばし活動
男性	62(39.7%) −1.63	8(5.1%) −1.39	86(55.1%) 2.36*
女性	108(48.2%) 1.63	20(8.9%) 1.39	96(42.9%) −2.36*

それぞれのセルにおける上部数字は人数と割合，下部数字は残差　*p<.05

表7　ハイリスク状況に対する対処方略（行動的対処）とその後の運動実施の有無

運動実施の有無	運動前に行ういつもの行動			ソーシャルサポートの誘発			回避・引き延ばし活動		
	計	男性	女性	計	男性	女性	計	男性	女性
運動実施	152	57	95	24	6	18	33	18	15
運動停止	18	5	13	4	2	2	149	68	81

それぞれのセルにおける数字は人数

表8　ハイリスク状況における対処方略（行動的対処）と運動実施の有無：残差分析の結果

	運動実施の有無	運動前に行ういつもの行動	ソーシャルサポートの誘発	回避・引き延ばし活動
男性	運動実施	6.47**	1.34	−8.58**
	運動停止	−6.47**	−1.34	8.58**
女性	運動実施	9.00**	3.10**	−10.87**
	運動停止	−9.00**	−3.10**	10.87**
全体	運動実施	12.10**	3.40**	−13.86**
	運動停止	−12.10**	−3.40**	13.86**

**p<.01