Age and Sex Differences in the Levels of Muscular Activities during Daily Physical Actions

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[Received April 4, 2008; Accepted July 29, 2008; Published online February 20, 2009]

The present study aimed to clarify age and gender differences in the electromyographic (EMG) activity levels of lower limb muscles during daily physical actions. Forty young and 22 elderly individuals performed five physical actions, i.e., normal walking, ascending and descending stairs, standing up from and sitting onto a chair, and a calf raise exercise. The surface electromyograms (EMGs) during these actions were recorded from the vastus medialis, rectus femoris, vastus lateralis, lateral gastrocnemius, medial gastrocnemius, and soleus muscles using a portable EMG recording apparatus. For the prescribed actions, the mean activity levels of the quadriceps femoris (QF%EMG) and triceps surae (TS%EMG) muscles were quantified and expressed as the relative values (%EMG) to that during the maximal voluntary isometric contraction (MVC). The %EMG values of QF and TS significantly differed among actions, with significant influences of age and gender. The %EMG of each of QF and TS was negatively correlated to MVC torque relative to body weight, developed in knee extension and ankle plantar flexion, suggesting that the observed age and gender differences in %EMG could be partially attributed to those in torque generation capabilities. Thus, the present findings indicate that the individuals with lower maximal isometric joint torque per body weight demonstrate higher muscular activity levels during daily physical actions. For these populations, the daily physical actions examined here may be resistance exercises for improving the torque generation capability of lower limb muscles.

Keywords: daily action, resistance exercise, surface electromyograms, age, gender

[International Journal of Sport and Health Science Vol.6, 169-181, 2008]
examine the effect of resistance training employing daily physical actions e.g. walking (Rook et al., 1997), ascending and descending stairs (de Vreede et al., 2005), and standing up from and sitting down onto a chair (Kubo et al., 2003b). These previous findings on the effect of muscle strength have been divided into affirmation (Aniansson & Gastafsson, 1981; Kubo et al., 2003b) and denial (Rook et al., 1997; de Vreede et al., 2005). This may be because the levels of muscular activities during training exercise differed among actions adopted as exercises. As noted in the principle of overload (Hettinger, 1968), gain of muscle mass and strength through resistance training require more than certain ratio levels of muscular activities relative to maximal muscle strength. Therefore, to discuss the effectiveness of daily physical actions as resistance exercises, the muscular activity levels during daily physical actions adopted as training exercises should be determined.

Another reason of discrepancy among the previous findings on the effect of muscle strength may be considered to be involved the differences in maximal muscle strength among the studied subjects. In other words, the load for exercising muscles during daily physical actions is only one’s body weight. Thus, the muscular activity levels during the actions may depends on the maximal muscle strength per body weight, which is also presumed to affect whether the training is effective. The findings of previous studies on the muscular activity levels during daily physical actions using surface electromyography (EMG) demonstrated gender (Sawai et al., 2006) and age (Landers et al., 2001; Hortobágy et al., 2003) differences and indicated that the gender and age differences might be affected by those in maximal muscle strength (Landers et al., 2001; Sawai et al., 2006). Although these findings support dependence of maximal muscle strength on the muscular activity levels during daily physical actions, there are no studies determined association the muscular level of lower limb with age, gender, and maximal muscle strength in each daily physical action.

The purpose of this study were to quantify the muscular activity level of lower limb muscles during daily physical actions and to investigate the association it with age, gender, and maximal muscle strength in the young, middle-aged and elderly individuals.

2. Methods

2.1. Subjects

A total of 62 subjects were participated in this study. The young group consisted of 21 men and 19 women aged 19 to 36 years and the elderly group consisted of 8 men and 14 women aged 58 to 72 years. The means and standard deviations of age, height, and body weight are shown in Table 1.

The present study was carried out with the approval of the ethical committee of the Faculty of Sport Sciences, Waseda University. Written informed consent to participate was obtained from the subjects after explaining them of the study purpose and measurement items.

2.2. Measured actions

Five daily physical actions, i.e. standing up from and sitting down onto a chair (SS), calf raise (CR), normal walking (NW), ascending the stairs (AS), and descending the stairs (DS) were performed in this study. The specific action types are shown in Table 2. For SS and CR, all subjects performed 10 repetitions at tempo of once every 4 sec. An electronic metronome (SQ100-77, Seiko, Japan) was used for control of action tempo. Before the measurement of these actions, the subjects practiced these actions so that they could

<table>
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<th>Table 1 Physical characteristics of subjects.</th>
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<tr>
<td><strong>Young group</strong></td>
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<tr>
<td><strong>Men (n=21)</strong></td>
</tr>
<tr>
<td>Age (yrs)</td>
</tr>
<tr>
<td>Height (cm)</td>
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<tr>
<td>Body weight (kg)</td>
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</table>

<sup>n</sup>: the number of subjects.
<sup>a</sup>: significantly different between the men and women within the same generation at p<0.05.
<sup>b</sup>: significantly different between the young and elderly within the same gender at p<0.05.
perform at a constant tempo. A digital video camera (NV-DJ100, Panasonic, Japan) was used to determine the beginning and end of the actions. The sampling frequency was set at 30 Hz. The SS and CR were recorded in the sagittal plane by the video camera set 5 m away from the subjects. For NW, AS, and DS, the subjects were instructed to perform at their pace which they performed in their daily life. In the analytical zone, the acceleration and deceleration phases were not included. For NW, the subjects were instructed to begin to walk just (about 5 m) in front of the analytical zone and then to walk through the 10 m point where was the end point of the analytical zone. For AS and DS, the subjects were instructed to begin to walk about 3 m in front of the first stair step and to continue walking through the last step. Another instruction for these actions was to ascend and descend the stairs one step at a time. For NW, the motion of the lower limb was recorded by the video camera set up 5 m away laterally from the subjects along the center of the analytical zone, as described above; for AS and DS, the motions of the lower limb were recorded by an examiner with the video camera who stood laterally from the subject. The velocity and tempo of the actions calculated from the recorded pictures were described just below. The velocity of NW was 1.49±0.19 m/s in the young group and 1.51±0.15 m/s in the elderly group. The tempo of AS and DS was 1.83±0.15 step/s and 2.00±0.21 steps/s in the young group, and 1.84±0.14 steps/s and 2.11±0.27 steps/s in the elderly group. It should be noted that those in the young group were expressed as means and standard deviations of the 9 young subjects who were measurable for action velocity. No significant differences were observed in the velocity and tempo of all actions between both groups.

2.3. Measurement of maximal voluntary isometric contraction (MVC) torque

MVC torques during knee extension and ankle plantar flexion were measured using static myometers (VTK-002R/L, VTF-002R/L, Vine, Japan). The posture of the subjects in the measurement of knee extension (KE) was sitting position with hip and knee angles of 90° (a full extension position angle: 0°). The ankle was firmly attached to the lever arm of myometer with a strap and secured with the knee joint angle flexed at 90°. The lumbar was fixed with a strap to prevent the hip angle from fluctuating. The posture of the subjects in the measurement of ankle plantar flexion (PF) was the sitting position with knee and ankle angles of 0° and 90° (anatomical zero), respectively. The foot was securely fixed with a strap to prevent ankle joint angle from moving. The thigh was secured with a strap to prevent knee joint angle from moving. The measurement side was the right leg. It should be noted that the joint angle in measurement of KE and PF yielded the highest voluntary activation of the nervous system during MVC (Kubo et al., 2004) without age-related difference (Hurley et al., 1998; Morse et al., 2005). Prior to the measurement trials, all subjects performed warm-up trail. The trial consisted of muscle strength exertion subjectively perceived as 50% (2 or 3 repetitions), 80% (2 or 3 repetitions) and 100% (1 or 2 repetitions) of MVC. The subjects were instructed to exert fully for about 4 sec. To exclude the influence of fatigue, a rest interval was set between trials at least 3 min. The MVC torque of each action was measured twice or three. The torque data of each trial was amplified by a strain amplifier (DPM-611A, Kyowa, Japan). Afterwards, the obtained signals through an A/D converter (Power Lab/16SP, ADInstruments, Australia), and then recorded on a personal computer (ThinkPad, IMB, Japan) at 100 Hz sampling frequency and processed with a low-pass filter (cutoff frequency: 10 Hz). And then the maximal value in the torque curve was evaluated as the MVC torque (Fig. 1). In two or

<table>
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<th>Table 2 Types of the actions taken for the EMG measurements.</th>
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<tr>
<td><strong>Action type</strong></td>
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<tr>
<td>Standing up from and sitting down onto a chair (SS)</td>
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<tr>
<td>Calf raise (CR)</td>
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<tr>
<td>Normal walking (NW)</td>
</tr>
<tr>
<td>Ascending the stairs (AS)</td>
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<tr>
<td>Descending the stairs (DS)</td>
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three torque measurements, the highest value was adopted. Furthermore, to exclude the influence of body size, MVC torque was divided by body weight (KE/BW and PF/BW).

2.4. Measurement of surface electromyograms (EMGs)

The EMGs during MVC and the prescribed daily physical actions were measured by a bipolar lead method using a portable EMG recording apparatus (ME6000T8, MEGA Electronics Ltd, Finland). The studied muscles were the following; the vastus medialis, rectus femoris, vastus lateralis, lateral gastrocnemius, medial gastrocnemius, and soleus muscles of right leg. Ag/AgCl electrodes of 15 mm diameter (N-00-S, Blue sensor, Ambu, Denmark) were attached over the bellies of the 6 muscles with an interelectrode distance of 20 mm for the measurements. Before application of the electrodes, the skin area was shaved, cleaned with isopropyl alcohol, and abraded with coarse tape in order to reduce skin impedance and ensure good adhesion of the electrodes. One electrode functioned as a gland electrode as well as a preamplifier. After the signals of EMG were amplified 412-fold through the preamplifier, they were A/D converted through a band-pass filter (8-500 Hz/3 dB), at a sampling frequency of 1000 Hz, and stored in a built-in memory card. After the trials, EMG data were downloaded onto the personal computer (ThinkPad, IBM, Japan). Furthermore, the EMG signals and the recorded video pictures were synchronized through a synchronization unit (PH-100A synchronizer, DKH Co. Ltd., Japan) so that the digital video camera could capture rays of light.

All obtained EMGs data were full-wave rectified, and then averaged integrated EMGs during MVC and the measured actions were each calculated from them, respectively. For MVC, the averaged integrated EMGs were calculated over 1 sec including the point when the torque was maximal (Fig. 1). For SS and CR, the beginning and end of the actions were confirmed on the video pictures and the integrated EMGs were averaged over the 10 repetitions. For NW, the averaged integrated EMGs were calculated over a 10-meter walk; for AS and DS, those were calculated over a 14-step stairs while ascending or descending. The averaged integrated EMGs during the actions were quantified and normalized as the relative values (%EMG) to that during MVC. In the present study, the %EMGs of the quadriceps femoris muscles were calculated for each of the three constituent muscles, i.e. the vastus medialis, rectus femoris, and vastus lateralis muscles, and then the averaged value of the %EMG for them was evaluated as the level of muscular activities of the quadriceps femoris muscles (QF%EMG). Likewise, the %EMGs of the triceps surae muscles were calculated for each of the three constituent muscle, i.e. the latelal gastrocnemius, medial gastrocnemius, and soleus muscles, and the averaged value of %EMGs for these three muscles were evaluated as the level of muscular activities of the triceps surae muscles (TS%EMG).

2.5. Statistical analysis

All measurement results were expressed as means± standard deviations. The differences in age, height, body weight, and MVC torque were analyzed using a two-way ANOVA (age×gender). When a significant
interaction (age×gender) was found, a one-way ANOVA was performed. For QF%EMG and TS%EMG, the effects of action type, age and gender on QF%EMG and TS%EMG were analyzed using a three-way ANOVA (action×age×gender), respectively. When a significant interaction (action×age×gender) was found, a two-way ANOVA (action×group; young men, young women, elderly men, and elderly women) was performed to examine the main effects and interaction. When the F value was significant, a post-hoc test was performed by Tukey's HSD. When the differences among the actions were examined, the four actions of NW, AS, DS, and SS were selected regarding QF%EMG and the four actions of NW, AS, DS, and CR were selected regarding TS%EMG. Pearson product-moment correlation coefficient (r) was calculated to determine the association between %EMG during each action and each of KE/BW and PF/BW. In addition, after adjustment for age, a partial correlation was examined between %EMG and MVC torque per body weight. For the present statistical processing, a statistical analysis software was used (SPSS12.0J, SPSS Japan, Japan). In all analyses, the significant level was set at p<0.05.

3. Results

3.1. MVC torque

Table 3 shows MVC torque in the young and elderly groups. For both men and women, KE and PF in the young group were significantly greater than those in the elderly group; in both age groups, those of men were significantly higher than those of women. Similarly, the age differences within the same gender and the gender differences within the same age group were significant in KE/BW and PF/BW, except for the gender difference in PF/BW of the elderly group.

3.2. Relationship between %EMG and MVC torque per body weight

Figure 2 shows typical examples of full-wave rectified EMG during all actions for one young and one elderly man. In both individuals, the muscular activities patterns of the quadriceps femoris muscles and the triceps surae muscles during the actions were similar. However, the elderly individuals exhibited higher %EMG than the young individuals.

The relationships between KE/BW and QF%EMG and between PF/BW and TS%EMG are shown in Figure 3 and 4, respectively. For all actions, the QF%EMG and TS%EMG were significantly correlated with KE/BW and PF/BW, respectively. The MVC torque per body weight and %EMG were also significantly correlated with age (KE/BW: r = −0.559, PF/BW: r = −0.495, QF%EMG: r = 0.308~0.673, TS%EMG: r = 0.445~0.523, all p<0.05). After adjustment for age, the corresponding relationships were still significant (QF%EMG and KE/BW: r = −0.273~0.315, TS%EMG and PF/BW: r = −0.403~0.482, all p<0.05).

3.3. Age and gender differences in QF%EMG and TS%EMG

Table 4 shows QF%EMG and TS%EMG values during each action. The results of three-way ANOVA (action×age×gender) showed an interaction between gender and age. Thus, a two-way ANOVA (action×group) were performed, resulting in no interactions between action and group for QF%EMG and TS%EMG.

Table 3 Descriptive data on joint torque and joint torque per body weight.

<table>
<thead>
<tr>
<th>Joint torque (Nm)</th>
<th>Young group</th>
<th>Elderly group</th>
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<tbody>
<tr>
<td>KE</td>
<td>184.5±41.2</td>
<td>140.6±25.8</td>
</tr>
<tr>
<td></td>
<td>111.6±21.2</td>
<td>72.9±12.3</td>
</tr>
<tr>
<td>PF</td>
<td>187.2±34.7</td>
<td>152.7±19.3</td>
</tr>
<tr>
<td></td>
<td>137.2±27.1</td>
<td>100.6±19.4</td>
</tr>
<tr>
<td>Joint torque per body weight (Nm/kg)</td>
<td>2.78±0.52</td>
<td>2.11±0.44</td>
</tr>
<tr>
<td>KE/BW</td>
<td>2.01±0.30</td>
<td>1.46±0.23</td>
</tr>
<tr>
<td></td>
<td>2.82±0.45</td>
<td>2.28±0.29</td>
</tr>
<tr>
<td>PF/BW</td>
<td>2.48±0.50</td>
<td>2.03±0.47</td>
</tr>
</tbody>
</table>


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.
The QF%EMG of NW was significantly lower than those of other actions, regardless of age and gender (all \( p < 0.001 \)). The QF%EMG of DS was significantly lower than those of SS (\( p < 0.001 \)). The TS%EMG in NW and DS were significantly lower than those in AS and CR.

For both men and women, QF%EMG and TS%EMG in the elderly group were significantly higher values than those in the young group (all \( p < 0.05 \)). The percentage of QF%EMG values of young group relative to those of elderly group ranged from 31% (NW) to 65% (SS) in men and from 57% (NW) to 98% (SS) in women. The corresponding values of TS%EMG were between 45% (DS) and 67% (CR) in men and between 55% (NW) and 70% (CR) in women.

In the young group, QF%EMG and TS%EMG in men were significantly lower values than those in women (all \( p < 0.05 \)). The percentage of %EMG of young women relative to those of young men ranged from 58% (NW) to 75% (SS) in QF%EMG, and from 69% (AS) to 89% (CR) in TS%EMG. In the elderly group, No gender differences in QF%EMG and TS%EMG were observed in all actions.

**Figure 2** A typical example of EMG during measured actions in a young man (left panel) and elderly man (right panel). The level of muscular activity in QF and TS were expressed by averaged values of three constituent muscles. A: normal walking, B: ascending the stairs, C: descending the stairs, D: standing up from and sitting onto a chair, E: calf raise.

Subj. M, 21 yrs, KE/BW: 2.82 Nm/kg, PF/BW: 3.57 Nm/kg.
Subj. H, 67 yrs, KE/BW: 1.96 Nm/kg, PF/BW: 2.58 Nm/kg.
4. Discussion

The present findings were that 1) age and gender differences were observed in QF%EMG and TS%EMG during daily physical actions, and 2) the QF%EMG and TS%EMG were negatively correlated with KE/BW and PF/BW, respectively. The relationships were still significant, after the influence of age was excluded, suggesting that the levels of muscular activities during daily physical actions were influenced by MVC torque per body weight regardless of age.

4.1. Age difference in the levels of muscular activities during daily physical actions

Age differences in the levels of muscular activities during daily physical actions were observed in this study. In terms of the average values in both age groups, however, the age differences in the MVC torques were not consistent with those in the levels of muscular activities during daily physical actions. Namely, the %EMG for both men and women in this study did not correspond to the values calculated by following: the %EMG multiplied by MVC torque per body weight in the elderly group, and divided by MVC torque per body weight in the young group. The obtained values (men: 13.4~24.8% for QF%EMG,
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...
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 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.
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 (Taafe 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

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

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 \( p < 0.05 \).
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 actions 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 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 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.

Reference


