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Masahiro HORIUCHI※

Introduction

As the aged population increases in Japan, maintaining and improving the health of middle-aged and older persons is increasingly important. Appropriate habitual exercise is known to help aging persons stay healthy. However, in modern life there are fewer chances to exercise because of the developments that have made our daily lives more convenient. Therefore, people have developed significant health problems due to, or exacerbated by, lack of exercise, and it is thus necessary to acknowledge the need to exercise or to engage in sports.

There have been many reports on the effects of exercise training on physical fitness. For example, it has been reported that maximal oxygen uptake was improved by endurance training in aged people (Ehashi et al. 1991, Stratton et al. 1992). It has also been reported that muscle cross sectional area and maximal muscle contraction strength were improved by resistance training in aged people (Hurley et al. 1995, Pyka et al. 1994). Furthermore, it has been reported that habitual exercise also has an effect on mental health (Berger and Owen 1988, McCann and Holmes 1984, Roth and Holmes 1987). However, McAuley and Rudolph (1995) have reported that the effects of exercise on mental health were not consecutive compared to those on physical fitness.

Recently, researchers have pointed out that there are several problems faced by middle-aged and aged people when performing habitual exercise. Pollock et al. (1991) reported that high-intensity exercise reduced the persistence rate of exercise and increased the developmental rate of impediments. Thus, it has actually been reported that preferred intensity exercise should be proposed for aged people (Dishman et al. 1994). In order for middle-aged and older people to continue a habitual exercise program, the amount of time they have to exercise, and their health condition and amenity to a particular sport, must be taken into

※浅井学園大学人間福祉学部介護福祉学科

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account.

Takumi and Kurosawa (2003) have investigated the exercise characteristics and health promotional effects of mini volley, which was created in Hokkaido, and have reported that mini volley has many advantages as a life-long sport. In fact, the age groups of mini volley fans have grown, and the player numbers have increased. However, there have been few studies on the health benefits of mini volley.

The purpose of the present study was, therefore, to investigate the effects of mini volley on the physical fitness and the mood states of middle-aged women.

Methods

A. Subjects

The subjects were twenty healthy middle-aged women who habitually exercise (play mini volley and walk) twice per week (Exercise Group ; EG) and twenty healthy middle-aged women who do not habitually exercise (Control Group ; C). Their physical characteristics are shown in Table 1. Consent was obtained from all subjects after they were informed of the purpose, procedures, and possible risks of the study.

B. Measurements

Exercise frequency and duration

The exercise group performed 30-60 min walking per week in addition to mini volley twice per week for three months. The control group adhered to their usual daily routine for three months without engaging in a physical exercise program.

Physical Fitness Test

The six items which are on the fitness test used by the Ministry of Education, Culture, Sports, Science and Technology, Sports and Youth Bureau of Japan were measured. They are : hand grip strength, sit-ups, bending forward in a long sitting position, standing broad jump, repeated sideways jump and 1000 m fast walking, and these items were measured before and after the mini volley was

Table 1. Physical characteristics and walking reps in subjects.

	Age (yrs)	Height (cm)	Weight (kg)	Walking reps (reps/day)
Exercise Group (n=20)	48.3±4.8	155.9±5.3	54.7±4.4	10765±2202*
Control Group (n=20)	46.9±4.3	156.4±5.4	57.9±7.6	7197±2282

Values are means±SD.
* ; $p<0.05$ between two groups.

performed for three months. Hand grip strength was measured twice for each hand, and a mean value was defined as a measured value. Sit-ups were measured once for 30-seconds. Bending forward in a long sitting position, and the standing broad jump were measured twice, and the better value was defined as the measured value. The repeated sideways jump was measured twice, each for 20 seconds, and the better value was defined as the measured value. 1000 m fast walking was measured once in a gymnastic hall.

Profile of Mood States

The POMS (Profile of Mood States) was monitored before and after the mini volley for three months. The questionnaire consisted of sixty-five items total, and was divided into six categories as follows: Tension- Anxiety; T-A, Depression - Dejection; D, Anger - Hostility; A-H, Vigor; V, Fatigue; F and Confusion; C. All questions were multiple - choice from five answers (McNair et al. 1992).

Walking reps

Walking reps in a typical week were measured at the middle of the three month test period using Lifecorder EX (Suzuken, Japan).

Data analysis

The mean and standard deviation were used to describe all data. A two-way analysis of variance (time × group; ANOVA) with repeated measures and unpaired Students t-test were used, respectively. P values less than 0.05 were considered statistically significant.

Results

Physical fitness test and level of physical activity.

The results of the physical fitness test are shown in Table 2. Values of each hand grip strength, sit-ups, and bending forward in a long sitting position in both groups did not change before and after mini volley. The values of these items in EG were higher than those in C, but there were no significant differences between the two groups. The values of the repeated sideways jump and standing broad jump in EG improved after mini volley, but these values in C slightly decreased. There was a significant difference in the repeated sideways jump (Figure 1, $p<0.05$) and standing broad jump (Figure 2, $p<0.05$) between the two groups. The values of 1000 m fast walking improved in both groups, and therefore the amount of changes before and after the mini volley was calculated and compared between the two groups. There was a significant difference between EG and C (Figure 3, $p<0.05$).

Table 2. Physical fitness test before and after mini volley.

	Exercise Group		Control Group	
	before	after	before	after
Right hand grip strength(kg)	29.9±5.1	29.7±5.6	27.9±6.8	27.6±5.8
Left hand grip strength(kg)	29.2±4.5	29.3±4.5	26.8±6.6	26.6±5.9
Sit-ups(reps)	15.4±4.4	16.0±3.6	12.5±5.2	13.5±5.2
Bending forward in a long sitting position(cm)	31.7±6.5	32.5±7.1	28.7±6.2	28.3±5.6
Repeated sideways jump(reps)	36.2±5.0	39.4±4.9	35.5±4.9	33.2±4.5
1000 m fast walking(min)	8.67±0.74	8.15±0.74	9.30±0.72	9.08±0.70
Standing broad jump(cm)	140.5±23.8	150.4±22.2	136.8±22.8	133.4±23.3

Values are means±SD. Significant differences were shown in following figures.

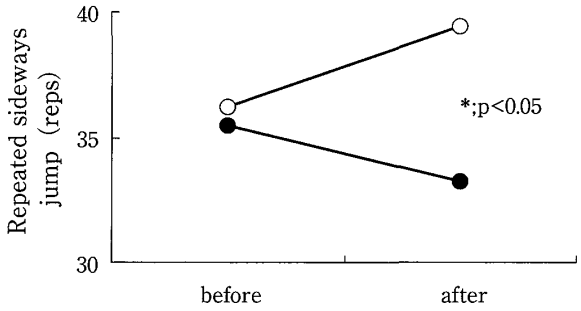

Fig. 1 Comparison of changes pattern of repeated sideways jump between exercise groups (○) and control group (●).

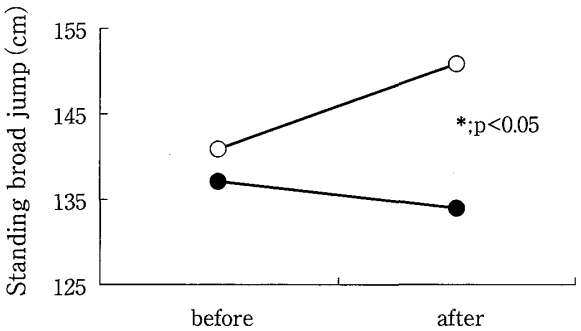

Fig. 2 Comparison of changes pattern of standing broad jump between exercise groups (○) and control group (●).

Walking reps per day are shown in Table 1. Walking reps per day in EG were significantly higher than those in C ($p<0.05$).

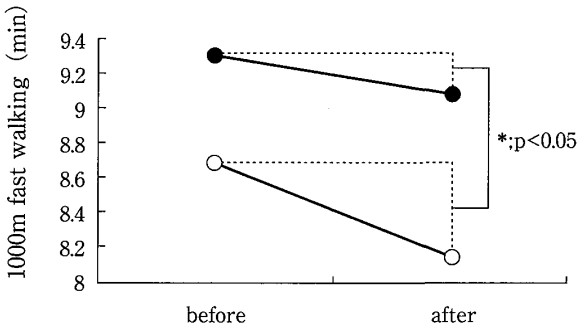

Fig. 3 Comparison of changes pattern of 1000 m fast walking between exercise groups (○) and control group (●).

Profile of Mood States

All raw scores obtained in POMS were converted to T scores. The POMS profile before and after mini volley in both groups is shown in Figure 4. The kinetics of the T scores in C were almost the same before and after measurement. In contrast, the kinetics of the T score in EG showed a typical iceberg style, in which the scale of vigor was higher than that of the other negative moods. Moreover, the scales of Tension-Anxiety and Depression- Dejection decreased

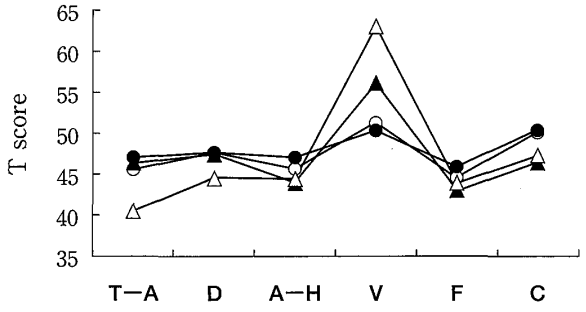

Fig. 4 The POMS profile of before and after mini volley in the two groups.
● ; control group before,
○ ; control group after,
▲ ; exercise group before,
△ ; exercise group after
T-A ; Tension-Anxiety,
D ; Depression-Dejection,
A-H ; Anger-Hostility,V ; Vigor,
F ; Fatigue and C ; Confusion.
Significant differences were shown in following figures.

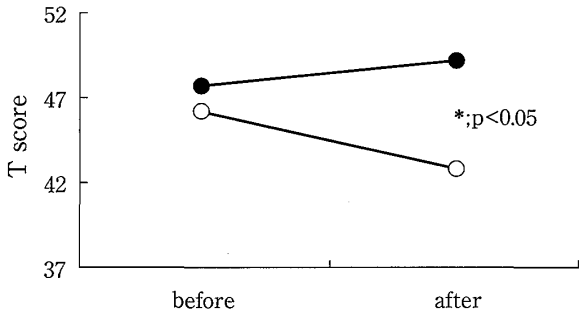

Fig. 6 Comparison of changes pattern of Depression-Dejection T scores in POMS between exercise groups (○) and control group(●).

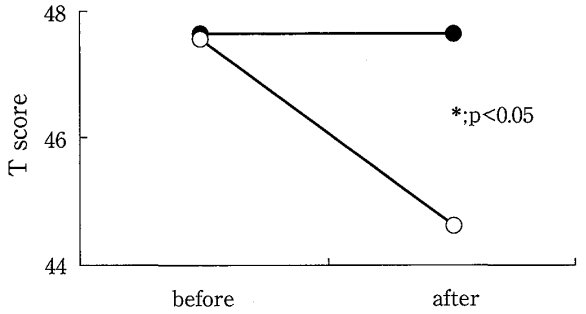

Fig. 5 Comparison of changes pattern of Tension-Anxiety T scores in POMS between exercise groups (○) and control group (●).

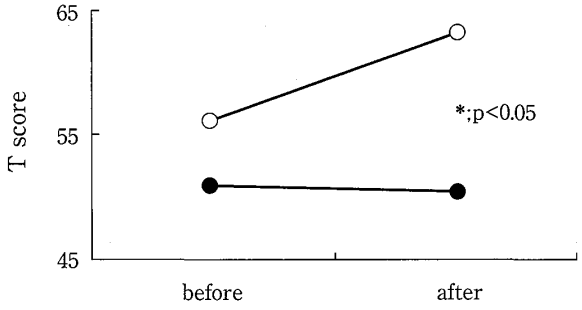

Fig. 7 Comparison of changes pattern of Vigor T scores in POMS between exercise group (○) and control groups (●).

after mini volley and the scales of vigor increased. The scales of negative moods, Tension-Anxiety, Depression-Dejection, Anger- Hostility, Fatigue and Confusion in C were higher than those in EG as a whole. In contrast, the scale of vigor in EG was higher than that in C.

There was a significant difference in the scales of Tension-Anxiety (Figure 5, $p<0.05$), Depression-Dejection (Figure 6, $p<0.05$) and Vigor (Figure 7, $p<0.05$) before and after the mini volley between EG and C.

Discussion

In the present study, we investigated

the effects of mini volley on physical fitness and mental health. With respect to physical fitness, performance in lower body exercises was significantly improved. In addition, regarding the profile of mood states, the scores of Vigor, Tension-Anxiety, and Depression-Dejection were significantly improved, respectively.

The values of hand grip strength, sit-ups, and bending forward in a long sitting position in EG were higher than those in C before and after mini volley, but there were no significant differences between the two groups. The reason for this was presumed to be that there is no motion involving gripping or clutching something in mini volley, unlike in racket sports like tennis, badminton, or baseball. For this reason, mini volley might not affect hand grip strength. However, in previous studies it was reported that exercise training improved the muscular strength of the upper body (Brown et al. 1990, Treuth et al. 1994) and flexibility (Voorrips et al. 1993). The results of the present study were not in agreement with those of previous studies. The reason may be derived from differences in the exercise intensity and experimental procedures used. The purpose of the previous studies (Brown et al. 1990, Treuth et al. 1994, Voorrips et al. 1993) was to investigate training effects, and thus the exercise intensity was high and rigidly controlled in the laboratory, furthermore, the subjects may have been more motivated to work out. In contrast, the mini volley program in the present study was not designed to investigate the effects of training. In addition, the subjects in the present study participated in the mini volley study only for their own amusement. For these reasons, mini volley might not have affected muscular strength used in upper body exercises.

Takumi and Kurosawa (2003) have reported that the maximal length of stride and 10 m walking record of mini volley players were significantly higher than those of novices at other sports, like health and sports lesson. They suggested that jumping, holding on, and running which were needed to play mini volley, increased the performance of the lower limbs. It has been reported that endurance training improved maximal oxygen uptake (Ehashi et al. 1991, Stratton et al. 1992). Regarding 1000 m fast walking, aerobic capacity seems to be needed in addition to muscular strength of the lower limbs. Moreover, the walking reps per day of EG in the present study were higher than that of C. It follows from what has been said thus far that mini volley has affected the muscular strength of the lower body and aerobic capacity.

Variations of the physical fitness tests in both groups were low. A three month period might be insufficient to improve

physical fitness. However, in middle-aged people, there is no proof that physical functioning can improve substantially because of the aging body (Ueno et al. 2003). In other words, even if physical functioning does not improve in middle-age, it might be reasonable to suppose that habitual exercise slows down the symptoms of aging.

It has been reported that aerobic exercise increased vigor and reduced tension, anxiety, depression and dejection in humans (Berger and Owen 1988, McCann et al. 1984, Roth et al. 1987). The results of the present research were in agreement with these previous studies. It has been thought that beta-endorphin, a brain hormone, was related to effects of exercise on mood in humans (Forge 1995). As beta-endorphin was not measured in the present study, we are not able to state what effect mini volley had on beta-endorphin. However, Odagiri et al. (1996) have investigated the relationships between exhaustive mood states and changes in stress hormones during an ultraendurance race. In their study, it was reported that the plasma beta-endorphin and noradrenalin concentrations in the vigor group were significantly higher than those in the distress group. They also reported that the plasma adrenocorticotropic concentrations in the vigor group were significantly lower than those in the distress group. There is a possibility that upsetting the homeostasis of the distress group reduced hormone responsiveness. Although the experimental procedure and exercise intensity in their study were different from those in the present study, it is quite likely that habitual mini volley affects beta-endorphin, and that this is why the scores of Vigor increased and those of Tension-Anxiety and Depression-Dejection decreased.

In conclusion, habitual exercise affects physical functioning, in particular lower body functioning, and a recreational sport like mini volley was found to increase vigor and reduce negative feelings.

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ミニバレーが中年女性の体力と気分に及ぼす影響

Masahiro HORIUCHI

抄　　録

本研究は，ミニバレーが中年女性の体力や気分に及ぼす効果を検討することを目的とした。被験者は，北海道在住でミニバレーチームに所属している中年女性20名と，コントロール群としてミニバレー群と同様の年齢，体格で，日常定期的な運動を行っていない女性20名の合計40名とした。介入期間は3ヶ月間とし，この前後に体力測定と気分調査を行った。体力の指標として握力，上体起こし，長座体前屈，反復横とび，1000m急歩，立ち幅跳びの6項目を実施した。また，全被験者に歩数計を装着してもらい，1週間の身体活動量を測定した。気分調査にはPOMSを用いた。その結果，身体活動量はミニバレー実施群が有意に大きい値を示した（$p<0.05$）。体力測定では，反復横とびと立ち幅跳びにおいて有意な交互作用が認められた。そのほかの項目には，有意な交互作用が認められなかった。そこで，1回目から2回目の変化量を検討した結果，1000m急歩において両群の間に有意な差が認められた。気分の調査では，POMSの活気，緊張－不安，抑うつ－落ち込みのそれぞれの尺度において，それぞれ有意な交互作用が認められた。ミニバレー実施群は活気が高くその他のネガティブな気分が低く表れていた。一方，非運動群は怒りと混乱の尺度以外は増加傾向にあり，活気尺度が減少していた。

以上のことから，定期的な運動の継続的実施は下肢機能の維持・向上に有効であることが明らかになった。また，ミニバレーボールのようなレクリエーション的なスポーツは，気分を向上させ，ネガティブな気分を晴らすことが明らかになった。

Key words：下肢機能，POMS，介入