

Use and safety of KAATSU training: Results of a national survey in 2016

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[Purpose] We examined the use and safety of KAATSU training by a national survey in 2016.

[Methods] We provided a questionnaire survey (web input) to attendees of the annual academic meeting of the Japan KAATSU Training Society and on the website of the academic society on October 29, 2016. The reply deadline was set at to about approximately 2 months.

[Results] Responses were received from KAATSU leaders or instructors of 232 facilities. KAATSU training has been applied for various types of situations; health promotion (87% of total facilities), diet (85%), beauty and anti-aging (70%), increase of muscle strength (71%), muscle hypertrophy (72%), and improvement of sports performance (53%), and for other situations. In addition, it has been used for rehabilitation (38%); orthopedic disease (38%), obesity (17%), diabetes (12%), cerebrovascular disease (11%), cardiovascular disease (8%), depression (7%), infertility (6%), neuromuscular diseases (5%), and immune diseases (3%). The ratio of the effectiveness or improvement of more than five tenths accounted for 92% of the total. The specific symptoms noted were as follows: dizziness, subcutaneous hemorrhage, drowsiness, numbness, nausea, itchiness and others. There were no serious side effects, such as cerebral hemorrhage, cerebral infarction, thrombosis, or rhabdomyolysis.

[Conclusion] Facilities under the guidance of appropriate KAATSU training leaders or instructors can achieve safe and beneficial effects, regardless of subject age, gender, or physical condition in 2016 just as back in 2006.

Key words: KAATSU training; national survey; safety; attention; questionnaire

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Introduction

KAATSU training is a novel method for muscle training, originally developed by Sato (2005). Unlike the hemostasis achieved by the use of a tourniquet which completely stops both the artery and vein, the KAATSU training is performed by moderate blood flow restriction using a specially designed belt; it is carried out while pooling the blood in the upper or the lower limb. Previous studies have shown that KAATSU training with various types of load resistances (such as weight, machine, and elastic band) is effective in rehabilitation medicine and health enhancement (Abe et al., 2006; Nakajima et al., 2011; Yasuda et al., 2014; Yasuda et al., 2015). At present, various subjects such as athletes, healthy persons, and elderly persons have performed KAATSU training, and KAATSU training is being widely used all over the world.

Since the Japan KAATSU Training Society was established in 2004, academic research on KAATSU training

has widely increased progressively in Japan. In 2006, Nakajima and colleagues examined the use and side effects of KAATSU training. They sent out questionnaires by postal mail, as a national survey, and obtained results from KAATSU leaders or instructors from a total of 105 facilities where KAATSU training has been adopted (Nakajima et al., 2006). Their study concluded that despite the fact that KAATSU training has been widely practiced at various facilities, it does not induce side effects such as serious complications.

According to the search engine results in PubMed, the number of academic research studies regarding KAATSU training has increased dramatically from 2006 to 2016. In addition, since prevention and treatment effects of KAATSU training for diseases can be expected, case reports on the use of KAATSU in the clinical setting for patients with various diseases have also been reported (Hughes et al., 2017). As a result, there is a high possibility that the

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symptoms aimed to be improved with the use of KAATSU training have become diversified in the last 10 years. Thus, we examined the use and safety of KAATSU training via a national survey in 2016.

Methods

Leaders and instructors of facilities belonging to the Japan KAATSU Training Society were asked to participate in this study.

We provided a questionnaire survey (web input; Google Form, Google company) by the annual academic meeting of the Japan KAATSU Training Society (oral message) and the website of the academic society (document message) on October 29, 2016. The reply deadline was set at approximately 2 months (until December 31, 2016).

We extracted the contents on facilities, subjects, effects or improvement, side effects from the KAATSU training national survey in 2016. The contents of the questionnaire survey used in this study are listed in Table 1.

This research was conducted based on the consent of the Japan KAATSU Training Society. In accordance with the Declaration of Helsinki, numbers were collected for individuals in data collection, but personal information of the individuals was not identified.

Results

We obtained replies from KAATSU leaders or instructors of 232 facilities. As for the classification of facilities, the sum of “personal trainer and KAATSU training instructor” (108 facilities), “sports club and fitness club” (55 facilities) and “bonesetters’ and osteopath’s offices” (25 facilities) accounted for 81% of the total (Figure 1A). Most of the facilities (84%) have started KAATSU training within the last decade (Figure 1B).

According to the results of the questionnaire, we can speculate that the subjects of 232 facilities were 12,827 persons (from November to December, 2016), which consisted of male (3,858 persons: 30.1%) and female (8,969 persons: 69.9%) subjects. Figure 2 shows the age of persons who have received KAATSU training. The training was distributed over a wide range of ages. In particular, persons from age 20s to 60s (53% in their 20s, 81% in their 30s, 91% in their 40s, 81% in their 50s, and 65% in their 60s) were presented more than half of all facilities.

Figure 3 shows the number of the facilities classified by the object of KAATSU training (Figure 3A) and the purpose of the use of KAATSU training with regard to symptoms (Figure 3B). As illustrated in Figure 3A, KAATSU training has been applied for various kinds of conditions;

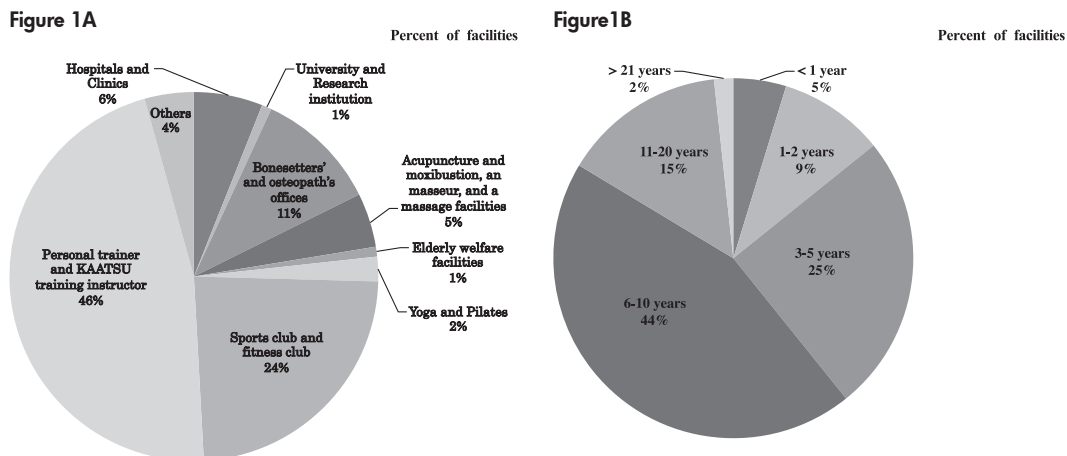


Figure 1. The types of the facilities (n=232) that participated in this study (A). The distribution of the period since the time that the facilities introduced KAATSU training (B).

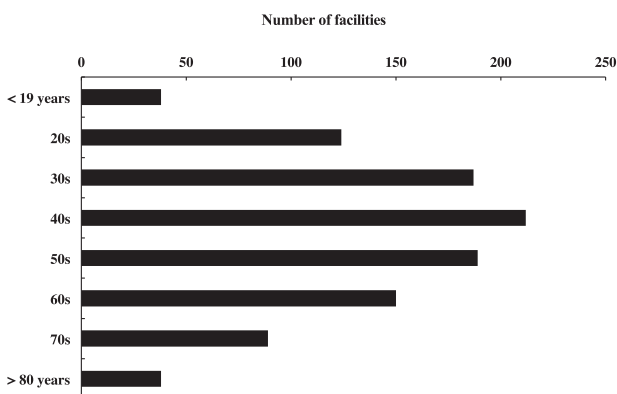


Figure 2. The age of persons who have received KAATSU training in the total of 232 facilities.

Table 1. A national survey in 2016 (Excerpts, with partial modifications)

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- 1. What kind of facility is your facility?**
 - Hospitals and Clinics •University (Other than a university hospital) and Research institution •Bonesetters' and osteopath's offices •Acupuncture and moxibustion, masseur, and massage facilities •Elderly welfare facilities •Yoga and Pilates •Sports club and fitness club •Personal trainer and KAATSU training instructor •Others
 - 2. When did your facility introduce KAATSU training?**
 - < 1 year ago •1-2 years ago •3-5 years ago •6-10 years ago •11-20 years ago •> 21 years ago •Other timing
 - 3. What is the distribution of the age of your subjects who have taken KAATSU training in your facility? (Multiple answers allowed)**
 - < 19 years •20s •30s •40s •50s •60s •70s•> 80 years
 - 4. How many male subjects in your facilities?**
 - 5. How many female subjects in your facilities?**
 - 6. What is the symptom aimed to be improved with the use of KAATSU training in your facility? (Multiple answers allowed)**
 - Beauty and Anti-aging •Postpartum •Health promotion •Diet •Increase of muscle strength •Muscle hypertrophy •Improvement of sports performance •Rehabilitation •Others
 - 7. If you replied "Rehabilitation" in question 6. Please indicate the disease? (Multiple answers are allowed)**
 - Orthopedic disease •Cerebrovascular disease •Cardiovascular disease •Neuromuscular disease •Diabetes •Obesity •Kidney disease •Respiratory disease •Immune disease •Depression •Infertility •Others
 - 8. If you replied "Orthopedic disease" in question 7. Please indicate the disease and symptoms? (Multiple answers are allowed)**
 - Fracture •Sprain •Osteoporosis •Osteoarthritis of the knee •Other knee joint diseases •Femoral head necrosis •Other hip joint disease •Low back pain •Other lumbar spine disease •Cervical spine disease •Spine disease •Shoulder discomfort •Frozen shoulder •Other shoulder disease •Other arthritis disorder •After surgery •Others
 - 9. If you replied "Cardiovascular disease" in question 7. Please indicate the disease and symptoms? (Multiple answers are allowed)**
 - Hypertension •Hyperlipidemia •Obesity •Ischemic heart disease (myocardial infarction, angina pectoris) •Arrhythmia •Heart failure •After cardiac surgery •Others
 - 10. If you replied "Neuromuscular disease" in question 7. Please indicate the specific disease.**
 - 11. If you replied "Cerebrovascular disease" in question 7. Please indicate the specific disease.**
 - 12. If you replied "Kidney disease" in question 7. Please indicate the specific disease.**
 - 13. If you replied "Respiratory disease" in question 7. Please indicate the specific disease.**
 - 14. If you replied "Immune" in question 7. Please indicate the specific disease.**
 - 15. What types of exercises are combined with KAATSU training? (Multiple answers are allowed)**
 - Body weight •Barbell or dumbbell •Machine •Aero bike or cross trainer •Stair climber or treadmill •Stretching, gymnastics, yoga, and pilates •Walking and running (Do not use machine) •Sports performance •Others
 - 16. How often do your subjects visit your facility? (Multiple answers are allowed)**
 - Once a week •Twice a week •3 times a week •4-6 times a week •1-3 times a month •Every day •Others
 - 17. How long is each training time in your facility? Include the time for equipment removal in the interval. (Multiple answers are allowed)**
 - < 5 minutes •5-10 minutes •10-20 minutes •20-30 minutes •30-40 minutes •40-50 minutes •> 50 minutes •Others
 - 18. What is the factor that determines the pressure intensity for KAATSU training? (Multiple answers are allowed)**
 - KAATSU training guidance program •Age •Sex •Blood pressure •Symptoms of disease •Depending on the purpose of training •None •Others
 - 19. What is the factor that determines the load intensity for KAATSU training? (Multiple answers are allowed)**
 - KAATSU training guidance program •Age •Sex •Blood pressure •Symptoms of disease •Depending on the purpose of training •None •Others
 - 20. What is checked every time when doing KAATSU training? (Multiple answers are allowed)**
 - Interview (physical condition, etc.) •Blood pressure •Heart rate and pulse rate •Body weight •Body composition (% body fat, etc.) •Girth •Ratings of perceived exertion (RPE) •None •Others
 - 21. What do you check first before starting KAATSU training? (Multiple answers are allowed)**
 - Interview (physical condition, etc.) •Blood pressure •Heart rate and pulse rate •Body weight •Body composition (% body fat, etc.) •Girth •Blood sampling •Electrocardiogram •Oxygen saturation •One-repetition maximum (1RM) •Cardiopulmonary exercise test (CPX) •Physical fitness test •None •Others
 - 22. Are you doing regular physical measurements or tests?**
 - Yes •No •Yes, but not regular
 - 23. If you replied "Yes" or "Yes, but it is not regular" in question 22. Please indicate the specific disease. How long do you measure or test? (Multiple answers are allowed)**
 - Once a week •Twice a week •Once a month •Once in 2 months •Once in 3 months •Once in six months •Others
 - 24. If you replied "Yes" or "Yes, but it is not regular" in question 22. Please indicate the specific disease. What types of tests are you doing? (Multiple answers are allowed)**
 - Interview (physical condition, etc.) •Blood pressure •Heart rate and pulse rate •Body weight •Body composition (% body fat, etc.) •Girth •Blood sampling •Electrocardiogram •Oxygen saturation •One-repetition maximum (1RM) •Cardiopulmonary exercise test (CPX) •Physical fitness test •None •Others
 - 25. What percentage of the subjects who carried out KAATSU training showed an effect?**
 - Everyone •> Eight tenths •Five tenths - Seven tenths •Three tenths - Four tenths •One tenth - Two tenths •None
 - 26. If you replied "> one tenth" in question 25. Please indicate the specific effect. (Multiple answers are allowed)**
 - Muscle hypertrophy •Increase muscle strength •Weight loss •Beautiful skin •Paralysis improvement •Pain improvement •Stiff shoulder improvement •Low back pain improvement •Reducing Depressive symptoms •Other diseases improvement (Describe the disease name) •Others
 - 27. Please describe the symptom if there is a symptom that you may be concerned about during KAATSU training. (Multiple answers are allowed). Please describe in "Other" for symptoms not falling under the following items.**
 - Cool feeling •Numbness •Subcutaneous hemorrhage •Drowsiness •Pain •Nausea •Itch •Hypertension •dizziness •Others
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Figure 3A

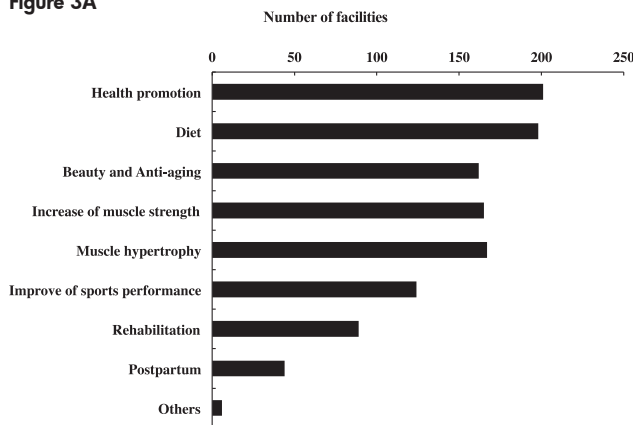


Figure 3B

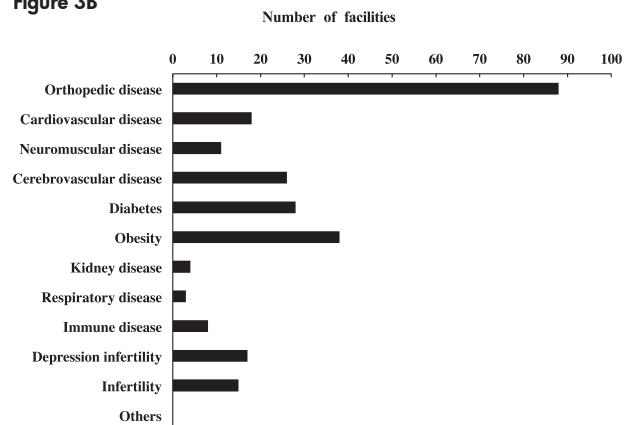


Figure 3. The object of the KAATSU training in each facility (A) and the symptom aimed to be improved with the use of KAATSU training (B). Numbers of facilities are indicated in each figure.

health promotion (202 facilities: 87%), diet (198 facilities: 85%), beauty and anti-aging (162 facilities: 70%), increase of muscle strength (165 facilities: 71%), muscle hypertrophy (167 facilities: 72%), and improvement of sports performance (124 facilities: 53%), and for other conditions. In addition, it has also been used for rehabilitation (89 facilities: 38%); orthopedic disease (88 facilities: 38%), obesity (39 facilities: 17%), diabetes (28 facilities: 12%), cerebrovascular disease (26 facilities: 11%), cardiovascular disease (18 facilities: 8%), depression (17 facilities: 7%), infertility (15 facilities: 6%), neuromuscular diseases (11 facilities: 5%), immune diseases (8 facilities: 3%) and others (Figure 3B). Furthermore, it has been found that 26 facilities are applying KAATSU for patients with designated intractable diseases (Table 2).

As for the specific contents of the KAATSU training, body weight (214 facilities: 92%), barbell or dumbbells (200 facilities: 86%) and others are shown in Figure 4A. Figure 4B and 4C show the distribution of the facilities classified by the training frequency and duration of

KAATSU training. Most of the facilities have been applying once a week training (218 facilities: 94%) and more than half of all the facilities have been applying the training twice a week (149 facilities: 64%) (Figure 4B). Regarding the length of each training time, the answers of 20-30 minutes (102 facilities: 44%) and 30-40 minutes (91 facilities: 39%) were frequently found (Figure 4C).

In each training session, most of the facilities have been applying interviews (226 facilities: 97%) and more than half of the facilities have been testing blood pressure (165 facilities: 71%) (Figure 5A). Before the first KAATSU training exercise, most of facilities have been applying an interview (231 facilities: 100%) and more than half of the facilities have been testing blood pressure (186 facilities: 80%) and heart rate or pulse rate (133 facilities: 57%) (Figure 5B). As for the response regarding the ratio of anthropometric measurements or physical fitness tests as “yes” (82 facilities: 35%) and “yes, but not regular” (79 facilities: 34%) accounted for 69% of the total (Figure 5C). Regular evaluation of the measurements and the tests was

Table 2. Specific disease name and the number of facilities of KAATSU training

Orthopedic disease

•Fracture: 29 •Sprain: 27 •Osteoporosis: 18 •Knee osteoarthritis: 53 •Other knee arthrosis: 38 •Femoral head necrosis: 24 •Other hip arthrosis: 23 •Low back pain: 56 •Other low back pain: 19 •Cervical spine disease: 20 •Spinal disease: 11 •Stiff shoulder: 65 •Frozen shoulder: 51 •Other shoulder peripheral disease: 25 •Other joint disease: 48 •After surgery: 19 •Others: 0

Cardiovascular disease

•Hypertension: 21 •Hyperlipidemia: 11 •Obesity: 15 •Ischemic heart disease (myocardial infarction, angina pectoris): 7 •Arrhythmia: 6 •Heart failure: 2 •After cardiac surgery: 2 •Others: 0

Neuromuscular disease (Specific disease name)

•Parkinson's disease: 2 •Disc herniation: 2 •Cervical nerve root disease: 1 •Sciatica: 1 •Amyotrophic lateral sclerosis: 1 •Spinocerebellar degeneration: 1 •Spinal stenosis: 1 •Spastic paraplegia: 1 •Sequelae after left upper arm surgery: 1

Cerebrovascular disease (Specific disease name)

•Cerebral infarction: 17 •Cerebral hemorrhage: 8 •Subarachnoid hemorrhage: 1

Kidney disease (Specific disease name)

•Polycystic kidney: 1 •Chronic glomerulonephritis: 1 •Kidney stone: 1 •Dialysis: 1

Respiratory disease (Specific disease name)

•Chronic obstructive pulmonary disease: 1 •Bronchial asthma: 1 •Lung cancer: 1 •Asthma: 1 •Others: 1

Immune disease (Specific disease name)

•Rheumatoid arthritis: 6 •Collagen disease: 4 •Cancer: 1 •Others: 1

Figure 4A

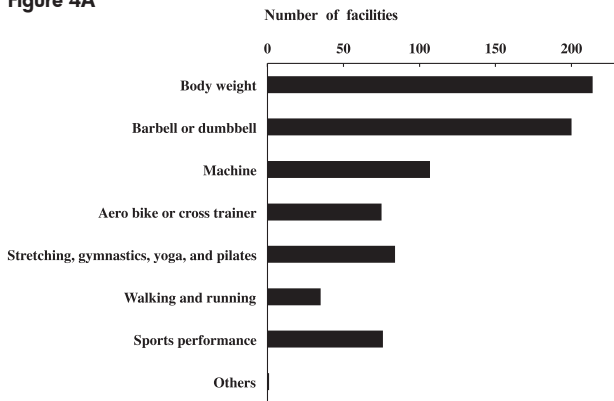


Figure 4B

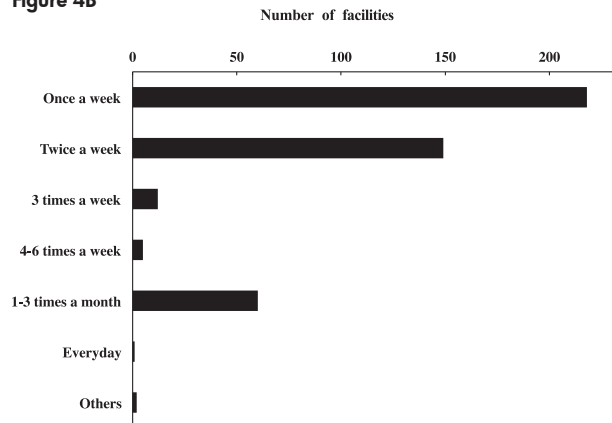


Figure 4C

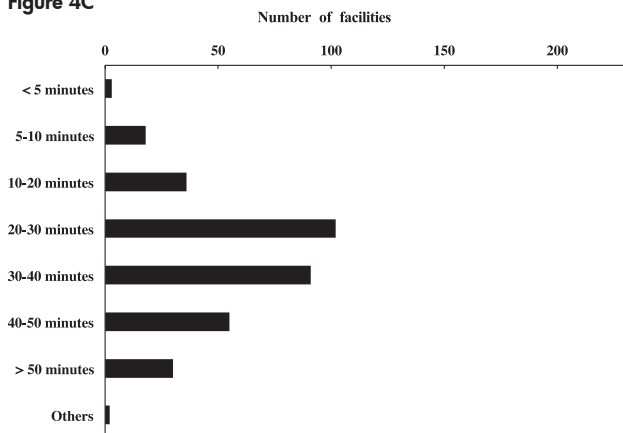


Figure 4. The specific contents of the KAATSU training (A), frequency of the KAATSU training (B), and duration of the KAATSU training (C). Numbers of facilities are indicated in each figure.

performed as follows: once a month (71 facilities: 31%), once in 3 months (51 facilities: 22%), once a week (35 facilities: 15%), once in 2 months (31 facilities: 13%) and others (Figure 5D). The specific contents of the measurements and the tests were as follows: body composition (118 facilities: 51%), body weight (99 facilities: 43%), interview (81 facilities: 35%), blood pressure (66 facilities: 28%), heart rate or pulse rate (56 facilities: 24%), girth (45 facilities: 19%), physical fitness test (33 facilities: 14%) and others (Figure 5E).

The ratio of the effectiveness or improvement of more than five-tenths accounted for 92% of the total (Figure 6A). The specific contents of effectiveness or improvement of KAATSU training were as follows: muscle hypertrophy (178 facilities: 77%), increase muscle strength (170 facilities: 73%), stiff shoulder improvement (170 facilities: 73%), weight loss (169 facilities: 73%), beautiful skin (133 facilities: 57%), low back pain improvement (133 facilities: 57%), pain improvement (124 facilities: 53%) and others (Figure 6B).

The specific contents of the symptoms were obtained as follows; dizziness (85 facilities: 37%), subcutaneous hemorrhage (73 facilities: 31%), drowsiness (58 facilities: 25%), numbness (35 facilities: 15%), nausea (34 facilities:

15%), itchiness (32 facilities: 14%) and others. On the other hand, there were no answers about major side effects such as cerebral hemorrhage, cerebral infarction, thrombosis, or rhabdomyolysis (Figure 7).

Discussion

Most of the facilities obtained a sufficient training effect by KAATSU training. In addition, some symptoms were present following KAATSU training, but there was no serious symptom. Thus, considering that academic papers and facilities concerning the KAATSU training have progressively increased in the last 10 years, the facilities under the guidance of appropriate KAATSU training leaders or instructors can produce beneficial effects and safely regardless of age, gender, and physical conditions.

In this study, there were many female subjects in the age range of 30-50s. The subjects had the main characteristics of physical condition (healthy persons), type of exercises (body weight, barbell and dumbbell), frequency (1 to 2 times a week), and purpose (health promotion and diet). More than 80% of the facilities started KAATSU training after the questionnaire survey in 2006; sports facilities and clinics (bonesetters' and osteopaths' offices) accounted for 81% of the total. In addition, an estimated 12,827 sub-

Figure 5A

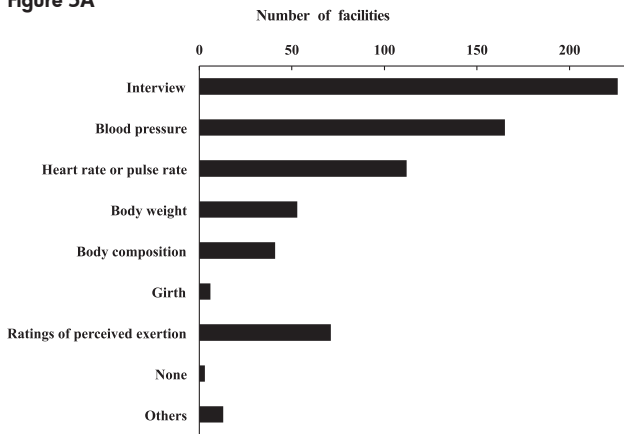


Figure 5B

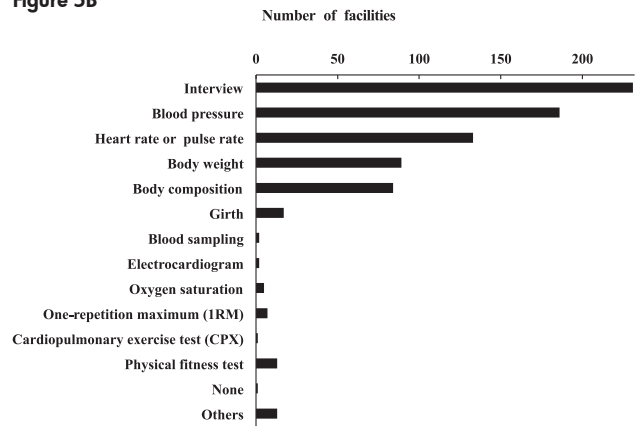


Figure 5C

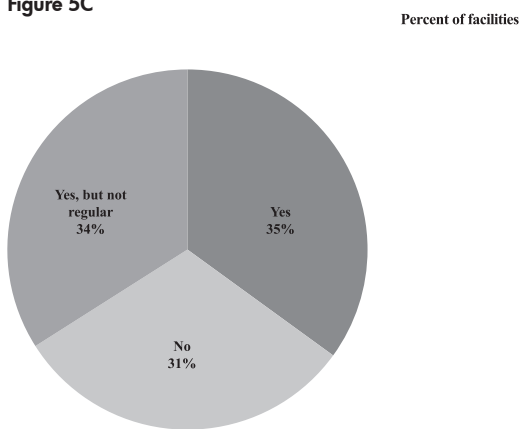


Figure 5D

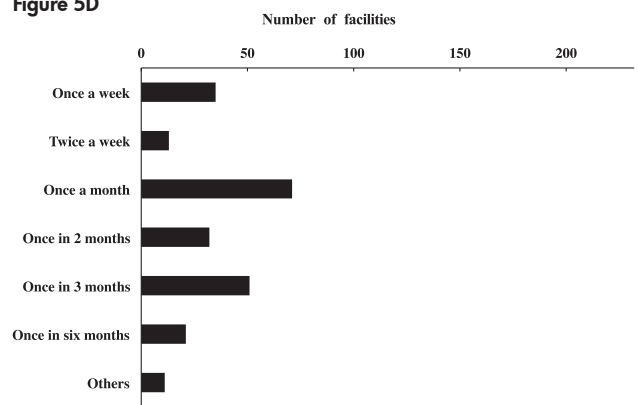


Figure 5E

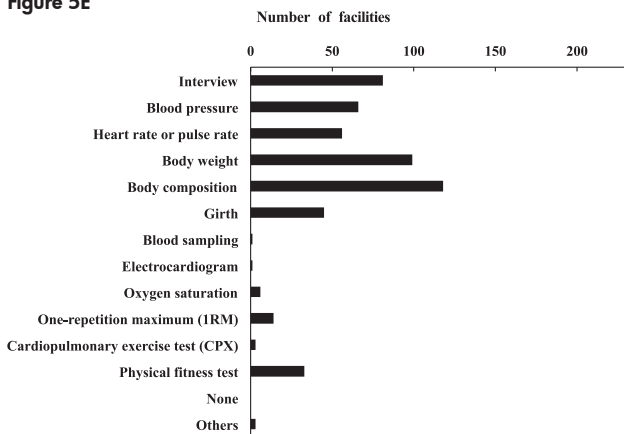


Figure 5. The checklist of the KAATSU training for each session (A) and the checklist before the first KAATSU training (B). The distribution of the regular evaluation on anthropometric measurements or physical fitness tests (C). Frequency of the measurements or the tests (The subjects replied “Yes” or “Yes, but not regular” in question 22.) (D) and specific contents of the measurements or the tests (The subjects replied “Yes” or “Yes, but not regular” in question 22.) (E). Numbers of facilities are indicated in Figures 5A, 5B, 5D, and 5E.

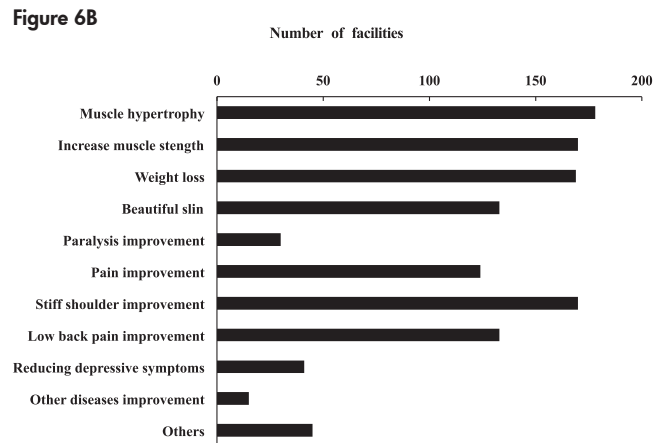
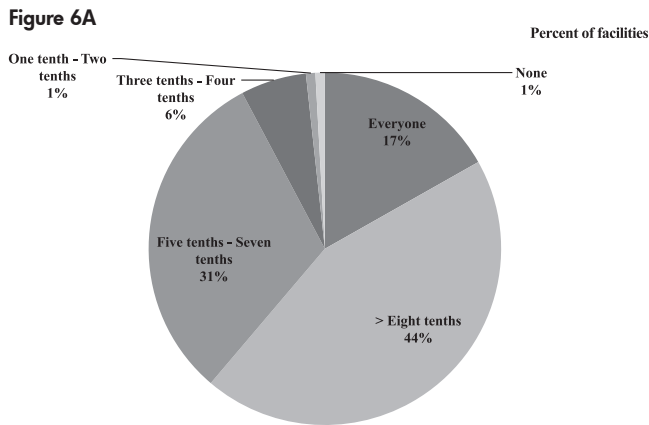


Figure 6. The distribution of the persons who felt effectiveness or improvement of KAATSU training (A). The specific points of effectiveness or improvement of KAATSU training (B). Numbers of facilities are indicated in Figure 6B.

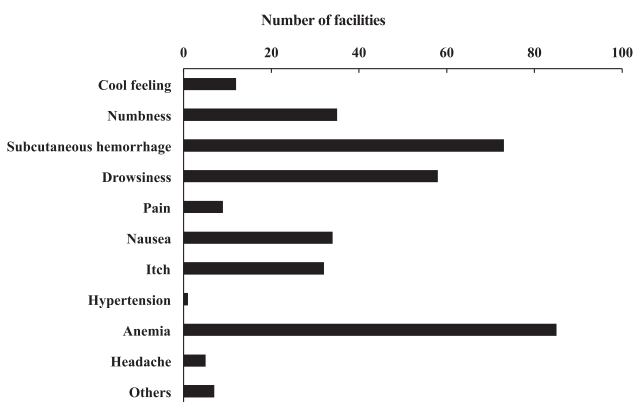


Figure 7. The specific symptoms when there are symptoms of concern following KAATSU training.

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jects included patients with various diseases as well as healthy persons. Similar to the previous study (Nakajima et al., 2006), this study demonstrated that the KAATSU training has beneficial effects and it is safe for orthopedic disease (Takarada et al., 2000; Loenneke et al., 2013; Nakajima et al., 2015; Segal et al. 2015; Amano et al., 2016; Bryk et al., 2016; Hiraizumi et al., 2016; Gaunder et al., 2017; Tennent et al., 2017), neuromuscular disease (Uchida et al., 2012), cardiovascular disease (Fukuda et al., 2013; Madarame et al., 2013), cerebrovascular disease (Arun Kumar et al., 2013; Satoh, 2014), immune diseases (Mattar et al., 2014; Jørgensen et al., 2016). In addition, kidney diseases, respiratory diseases, and other disease received survey responses stating the beneficial effects and safety. These results indicate that the KAATSU training has been widely used for the patients with various diseases.

At 26 facilities of the total, KAATSU training was also performed for 6 diseases corresponding to designated intractable diseases (Designated incurable disease) by the Ministry of Health, Labor and Welfare in Japan. Recently, there were 2 case reports on the effect of KAATSU training for idiopathic femoral head necrosis (designated intractable diseases), which were performed by medical staff

at medical institutions. Thus, it is a significant point to build a strong support system (between KAATSU training facilities and medical institution / staff) when KAATSU training is performed for various patients (especially designated intractable diseases).

Similar to the previous study (Nakajima et al., 2006), the symptoms such as dizziness, subcutaneous hemorrhage and numbness were reported, but there were no serious side effects (i.e., pulmonary embolism and paralysis by nerve compression). In addition, the previous study reported there was one report on cerebral hemorrhage and rhabdomyolysis, but in the present study, there were no serious severe symptoms (i.e., cerebral hemorrhage, pulmonary infarction, cerebral infarction, venous thrombosis, or rhabdomyolysis). This means that the KAATSU training by proper training leaders and instructors can achieve beneficial effects without serious side effects. On the other hand, a recent study (Tabata et al., 2016) reported a risk of rhabdomyolysis by the KAATSU training, however there was no detailed description on the KAATSU training method; it reported that the rhabdomyolysis occurred as a result of KAATSU training with a training instructor. Therefore, the KAATSU training leaders and instructors

should maintain / improve their knowledge and skills by participating in academic conferences and reading scientific papers on the KAATSU training. Furthermore, periodic tests (interview and others) are important to maintain the safety of subjects.

It is not a serious side effect, but the symptoms of drowsiness, nausea, and headache were given in responses. It can be speculated that these symptoms were induced by the vagal nerve reflex (Iida et al., 2007). Therefore, it is necessary to confirm the cause (i.e., excessive pressure intensity and strong stress) by KAATSU training. However, 3 facilities answered "None" in the question of "What is the factor that determines pressure intensity for KAATSU training?" "What is checked each time when doing KAATSU training?". In addition, 71 facilities (31% of the total) answered "None" in the question of "Are you doing regular physical measurements or tests?". Consequently, it appears that these situations are major factors, which cause various symptoms. Therefore, these symptoms will decrease dramatically if the KAATSU leaders or instructors check the KAATSU pressure intensity at every session and carry out the periodic test regularly (Nakajima et al., 2007).

There were some differences between this study and previous study in the collection process (web input vs. mail) and subjects (limited to members vs. not limited to members of Japan KAATSU Training Society). In addition, the contents of the questionnaire survey are partially revised and added in this study. Therefore, it is necessary to pay attention to the interpretation, when we compare the results of questionnaire survey between in 2006 and in 2016.

In conclusion, the facilities where appropriate KAATSU training leaders or instructors can safely produce beneficial effects regardless of age, gender, and physical conditions were noted in 2016 as well as in 2006.

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