REHABILITATION MANUAL 38

MANUAL OF HEALTH PROMOTION FOR PERSONS WITH DISABILITIES IN MIDDLE AND LATE ADULTHOOD

Editor
REIKO FUKATSU

NATIONAL REHABILITATION CENTER
FOR PERSONS WITH DISABILITIES
JAPAN

(WHO COLLABORATING CENTRE)

September 2024

Note : This rehabilitation manual is published by the National Rehabilitation Center for Persons with Disabilities, which is a WHO Collaborating Centre for Disability Prevention and Rehabilitation, and not a publication of WHO. The publisher is responsible for the views expressed in this manual, and it does not necessarily represent the decisions or policies of the World Health Organization.

Rehabilitation Manual 38
Manual of Health Promotion for
Persons with Disabilities in Middle and Late Adulthood
September 2024

Editor: Reiko Fukatsu
National Rehabilitation Center for Persons with Disabilities
Nobuhiko Haga, M.D., Ph.D., President
4-1 Namiki, Tokorozawa, Saitama Prefecture 359-8555, Japan
Tel. +81-4-2995-3100
Fax. +81-4-2995-3102
E-mail whoclbc@mhlw.go.jp

Introduction

Aging is a process that occurs to anyone over time, with or without disabilities. After adulthood, aging results in changes in biological functions, such as muscle power and vital capacity, as well as immune functions against pathogens, and with age, we become more susceptible to illnesses, including arteriosclerosis, osteoporosis, hypertension, and diabetes. Although many aging-related physical changes are common to people with and without disabilities, those with disabilities may respond differently to the changes. For example, exercise guidance of frequent walking for the treatment of diabetes is not feasible for persons who have difficulty walking.

Spending many years at home is not uncommon not only for persons with congenital disabilities but also for those with acquired disabilities caused by illnesses or injuries. In this process, their body undergoes various changes, even without any changes in the primary illness itself, which include secondary changes caused by disabilities and aging, as mentioned above. In particular, no active intervention has been made for aging-related changes. For example, people who have developed disabilities in their 20s may experience lifestyle-related diseases, such as hypertension and diabetes, and physical changes, such as decreased muscle power and obesity, in their 40s and 50s. To provide them with appropriate corresponding methods according to the nature and extent of each disability, it is important to improve our general knowledge and methods for maintaining and promoting health.

At our center, Center of Sports Science and Health Promotion has played a central role in studying the health promotion for persons with disabilities and the methods, and some of the results are summarized in this manual. We hope that this manual will help persons with disabilities live in good health conditions.

Reiko Fukatsu

EDITOR

Reiko Fukatsu

National Rehabilitation Center for Persons with Disabilities

AUTHORS

Toru Ogata

Koji Tomiyasu

Kayoko Innami

Atsuko Yatabe

Yukiharu Higuchi

Fumiya Yamashita

National Rehabilitation Center for Persons with Disabilities

Table of Contents

Chapter 1.
Health promotion for persons with disabilities - current status and issues

1. Definitions and goals of health promotion for persons with disabilities

Persons with disabilities face not only exacerbation in their underlying disease itself but also in general physical conditions as they age. These include musculoskeletal degeneration caused by physical activity and lifestyle-related diseases. Medical intervention for secondary complications is considered when any of them becomes apparent as a disease. Since they often develop even in healthy persons as well in middle and late adulthood, the importance of health promotion for their prevention has been advocated. Moderate exercise and proper diet and nutrition play a central role in health promotion, with or without disabilities. However, it is sometimes difficult for persons with disabilities to directly adopt the exercise and eating habits advocated for healthy persons due to physical, mental, and/or social barriers. “Health promotion for persons with disabilities” is an attempt to specifically organize preventive efforts and measures against these health problems.

As health promotion for healthy persons is primarily focused on physical issues, the main goal of health promotion is to improve the numerical values related to physical functions, such as body weight and blood pressure. While such numerical goals are also important for persons with disabilities, also essential is a perspective from the ICF* model, which is an effective framework for understanding and solving problems of persons with disabilities. Although the ICF itself is not discussed in detail in this manual, the concept of ICF states that the problems of physical functions do not exist alone but develop in their interaction with activity and social participation[1)]. While efforts for health promotion as well as improvement of physical functioning is important, it should be relevant to the promotion of social participation, which is the major goal for persons with disabilities.

2. Health risks of persons with disabilities in the chronic stage and efforts starting from middle age

The recent improvement in the medical management of disabilities has lengthened life with disabilities. Persons with disabilities generally require some time to adjust their lifestyle to their disabilities, after which they work on maintaining their functioning. However, persons who develop disabilities in their 20s begin facing aging-related changes 30 years later when they are around the age of 50. The aging-related changes tend to appear earlier in persons with congenital or acquired disabilities than in healthy persons, and they experience the health problems caused not only by the diseases in the background of the disability but also by their lifestyle related diseases. For example, as the life expectancy of persons with thoracic spinal cord injury is becoming closer to that of healthy persons, hypertension, arteriosclerosis, and cancer are increasing as the causes of deaths[2)].

Coping with aging-related changes is a new challenge for persons with disabilities, even if they

*International Classification of Functioning, Disability and Health (WHO, 2001)

are accustomed to facing the primary diseases of their disabilities and keeping themselves in a stable physical condition. Some hesitate to change their established lifestyle, making it difficult for them to face new physical changes due to aging. However, it is important to learn to cope with and adapt to aging-related changes as they progress steadily. Thus, to live an active life in a stable physical condition as much as possible while maintaining their independence in the chronic stage, persons with disabilities must understand and take measures against the health risks of aging in the chronic stage (Figure 1).

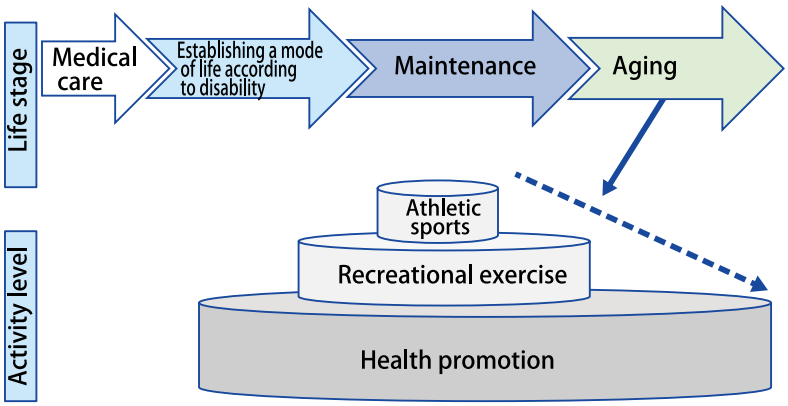


Figure 1. Understanding the activities according to life stage

1) Frequently observed physical problems

(1) Obesity

Globally, persons with physical disabilities tend to be obese[3]. Limited limb movements not only reduce the amount of daily energy consumption by physical activity but also tend to reduce the amount of energy needed to maintain the body due to a decline in basal metabolic rate, which is caused by decreased muscle mass. Eating a “normal diet” in such a condition can lead to excessive nutrient intake, resulting in body weight gain (Figure 2)[3].

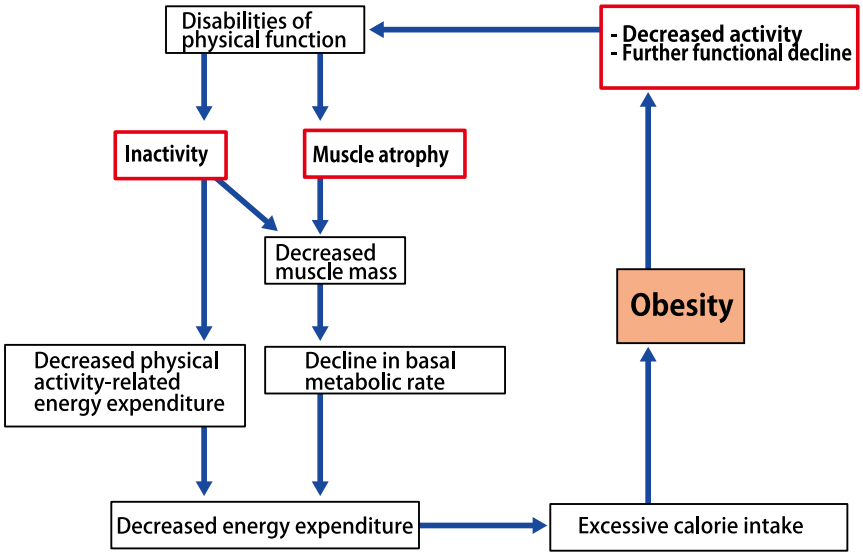


Figure 2. Relationship between physical disability and obesity

(2) Decreased physical endurance

On the other hand, decreased endurance leads to reduced physical activity and muscle power. To maintain a certain level of endurance, it is necessary to maintain certain amount of physical activity, both of which begin to decline when the balance between the two is lost. For those who are capable of walking in a standing position, walking becomes difficult when they lose the balance between their body weight and the extension force at their knee joints that support the body posture, leading to reduced physical activity and a further decline in endurance. For wheelchair users, the muscle power of the upper limbs (especially around the shoulder joints) must support their body weight during transfer into and out of wheelchair, and the functional maintenance of the shoulders and upper limbs is desired for keeping the amount of physical activity and endurance.

(3) Musculoskeletal problems

In addition to the decline in muscle power, there are many restrictions on movements associated with aging-related musculoskeletal changes. Walking with disabilities or living a life that puts a load on local joints, such as the shoulder joints of wheelchair users, requires caution as it may result in joint dysfunctions in early stages of aging. In addition, the high load on the spinal column due to postural abnormalities may lead to secondary spinal deformities that may in turn cause spinal neurological abnormalities. The pain and paralytic symptoms of the neurological disorders also restrict their movements, ultimately leading to reduced physical activity.

2) Problems other than physical factors

(1) Changes in the use of the welfare system

Applicable social services may change from childhood to adulthood and then to late adulthood. The welfare services they have previously received may change, which requires proper adjustments.

(2) Changes in the suitability of equipment

Age-related physical changes may require adjustment of the use of equipment, cane, or wheelchair. In some cases, changing the tools they have used for many years can be a difficult decision.

(3) Changes in the support environment

The mode of life can be significantly affected by the changes in the conditions of supporters and in the environment. In particular, if the main caregivers are family members, such as parents and spouses, their poor physical condition, separation, and death would significantly change the support system, and affect the functioning of the person with a disability.

3) Measures against health risk

(1) Regular evaluations

Though body weight is the most basic index of the physical condition, its regular measurement is not always established in persons with disabilities in the chronic stage. In particular, the body weight of wheelchair users cannot be measured easily at home, and a visit to a facility that has a dedicated scale is necessary. Although there has been a debate about determining the optimal body weight for persons with paralysis or amputation, monitoring at least the changes in body weight over time is the basis of health management. If the body weight shows a trend to increase, it is important to review dietary content and evaluate whether the body weight gain increases the load on the knee and shoulder joints, which could cause joint pain. On the other hand, unintentional body weight loss is often associated with a decline in muscle power, and it is necessary to pay attention to the decrease in physical fitness and to examine the cause of the decrease in dietary intake.

Regular medical checkups provided by local governments can be a good opportunity to review health condition, but wheelchair users need to confirm the accessibility to the location of medical checkups and the availability of appropriate test equipment prior to receiving the examination. At present, the system that takes the specificity of disabilities into consideration is lacking in many health checkup.

(2) Maintaining the amount of physical activity

For persons capable of walking, making a habit of recording the amount of walking, e.g. using a pedometer, is a simple approach to evaluate the amount of physical activity. Those unable to use a pedometer or the wheelchair users who have not established such an approach could learn information about the changes in the amount of their physical activity by simply recording the

number and duration of their outings[4]. Maintaining the amount of physical activity is often directly linked to the maintenance of muscle power and physical fitness. It can be a more practical method of health promotion than implementing a special exercise program.

If the amount of physical activity gradually decreases, its cause must be examined. Factors that could cause reduction in the amount of physical activity are the physical condition and psychological elements of the person, and the environment or condition of the caregivers. The physical factor of the person may include not only a decrease in the physical fitness but also disturbance of excretion rhythm and sleep disability. It should be noted that the influence of the weather and the poor physical condition of the caregiver can affect the frequency of outings.

(3) Reviewing life patterns

Although the health condition changes in the chronic stage are often directly perceivable as a decline in muscle power, body weight gain, or easy fatiguability, the changes in life rhythm often underlie these changes. In particular, life patterns may change due to changes in employment, moving, or the caregiver's condition. Failing to cope with those changes could lead to deterioration of the physical condition. In addition, attention must be paid to the maintenance of hygiene and the changes in excretion. Since these are not easily noticed by persons with disabilities, it is important for caregivers to ask relevant questions and judge whether there are any aspects that need intervention.

(4) Exercise

Decreased activity is not only a cause but also a result of decreased physical fitness (endurance and muscle power). Guiding persons with disability by finding an approach to increase their activity could put an end to the vicious cycle. That exercise is important, but it is also important to select the contents so that even those who have not previously had much chance of exercise could start easily. The immediate goal should be to continue the exercise for about a month.

4) Summary

The maintenance and promotion of health for persons with disabilities in the chronic stage can be organized by focusing on the amount of physical activity. As various changes occur in the chronic stage of disability, they are not able to maintain the same amount of activity that healthy persons can maintain at similar ages. Under such a condition, they may fall into the vicious cycle of decreased physical fitness and decline in activity, which persons with disabilities cannot easily resolve alone. It is important to approach the problem first evaluating the condition and the clarifying what can be corrected by intervention (Figure 3).

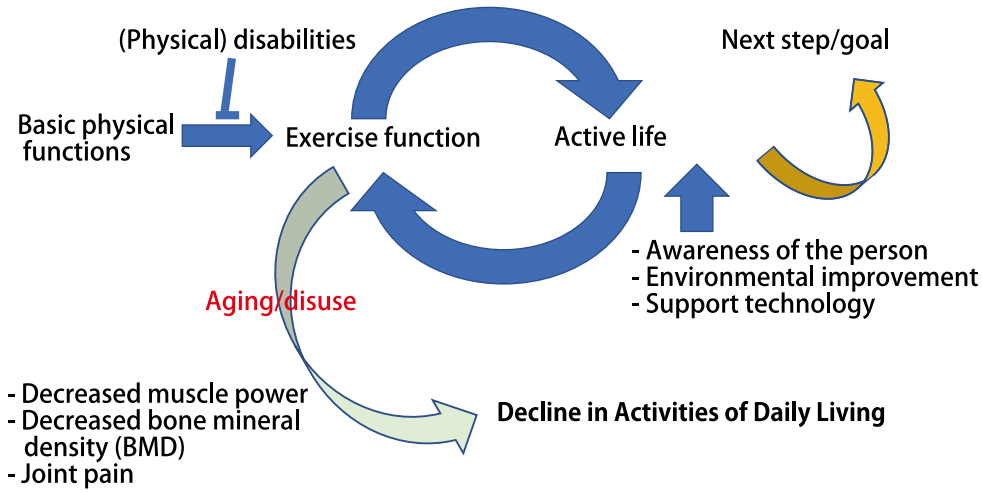


Figure 3. Intervention approach necessary for health promotion

References

1) Rauch A, Cieza A, Stucki G. How to apply the International Classification of Functioning, Disability and Health (ICF) for rehabilitation management in clinical practice. Eur J Phys Rehabil Med. 2008 ;44(3):329-42.
2) Ahoniemi E, Pohjolainen T, Kautiainen H. Survival after spinal cord injury in Finland. J Rehabil Med. 2011 ;43(6):481-5.
3) Liou TH, Pi-Sunyer FX, Laferrère B. Physical disability and obesity. Nutr Rev. 2005 ;63(10):321-31.
4) Lankhorst K, Oerbekke M, van den Berg-Emons R, Takken T, de Groot J. Instruments Measuring Physical Activity in Individuals Who Use a Wheelchair: A Systematic Review of Measurement Properties. Arch Phys Med Rehabil. 2020 ;101(3):535-552.

3. Disease prevention for persons with disabilities

The expected lifespan of Japanese individuals in 2019 was 87.4 years for females (2nd in the world) and 81.4 years for males (3rd in the world) (Table 1), showing an increase for both males and females compared to those in the previous year. According to the 2021 World Health Statics released by WHO, the country with the longest healthy lifespan for males and females is Japan with 74.1 years, followed by Singapore with 73.6 years and South Korea with 73.1 years, which shows that Asian countries occupy the top three[1)]. The Ministry of Health, Labour and Welfare of Japan cites "increasing health awareness and advances in medical technology" as its reasons. On the other hand, these Asian countries also need to take early measures against the aging of the population in the future. Since longevity is the ideal of humankind, maintaining good health is highly important. Here, we will first summarize general disease prevention measures regardless of disabilities and then discuss specifics for each disability.

Table 1. Expected lifespan by country and region in 2019

Ranking	Males (years)		Females (years)	
1	Hong Kong	82.34	Hong Kong	88.13
2	Switzerland	81.70	Japan	87.45
3	Japan	81.41	Spain	86.22

(Note) Switzerland: the data was collected in 2018.

1) Disease prevention

(1) Arteriosclerotic diseases

The high awareness of the desire to live a long healthy life can be glimpsed from the fact that the shelves of pharmacies are occupied by a wide variety of supplements. In the Edo period of the 17th century in Japan, Kaibara Ekiken wrote about the methods of health management in "Yojo kun (precepts for the care of health)," introducing "how to live a long healthy life" and "how to live in good health" with concrete spiritualism.

Today, heart disease and stroke are among the leading causes of death in Japan. Since around 1970, arteriosclerotic diseases have become a focus of attention with the westernization of lifestyle (such as moving by car) and eating habits, and obesity in children has become a social problem. Around 1980, antihypertensive and antihyperlipidemic drugs were developed by pharmaceutical companies and became widely prescribed, leading further to the release of many new drugs that were easy to take. Explanatory meetings on the mechanisms of action of drugs were frequently held for practitioners and working doctors who were in charge of primary care, and many patients benefited from them. At the same time, the importance of diet and exercise therapies as a prior

step to drug therapy was certainly enlightened by the academic societies and medical associations to which doctors belonged. The health boom involving the mass media has continued to date, recommending balanced nutritional intake (diet therapy) and moderate exercise if possible (exercise therapy). At the research on diabetes has progressed over the last 30 years, the diagnostic criteria based on the results of blood tests have been established. While novel and excellent oral diabetes drugs and insulin preparations have been developed one after another, the number of diabetes patients is, unfortunately, increasing in Japan. In addition to the increase of obesity during the period, it is attributable to the fact that Japanese individuals are much more susceptible to diabetes than Europeans and Americans.

Many studies have reported that smoking has definite adverse effects not only on lung but also on arterial vascular system. Education to encourage abstinence of smoking has become common supplemented by medication to gradually reduce the blood nicotine level, making it easier to recover from physical dependence on smoking.

In 2003, Dr. Hiroshi Ito of Keio University proposed the concept of "metabolic domino," which is frequently cited even today as an education tool for preventive medicine because it is easy to understand[2]. By correcting the lifestyle habits, that are the source of the domino , one can avoid obesity and prevent various diseases that can develop downstream (Figure 4). The diagnostic criteria for "the metabolic syndrome" were announced in 2005 in Japan. Furthermore, the specific health check-ups and specific health guidance programs for people aged 40 to 74 years with syndrome began in 2008 to reduce the mortality rate of arteriosclerosis-related diseases, which continues to this day.

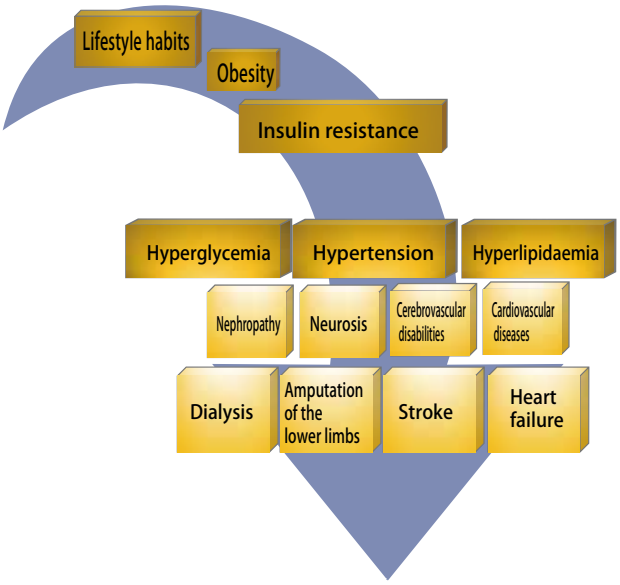


Figure 4. Metabolic domino

(2) Cancer

For the past 40 years, the leading cause of death in Japan has always been cancer. One in two Japanese suffers from cancer in their lifetime, and one in three die from the disease. According to the National Cancer Center website, the risk of cancer is almost halved by practicing five health habits (smoking cessation, cutting down on alcohol intake, reviewing eating habits, physical exercise, and maintaining proper body weight) (Figure 5).

Figure 5. Health habits that reduce the risk of cancer

The National Cancer Center also points out that "infection" transmitted from blood and body fluids, such as hepatitis B and C viruses, is the major cause of cancer. In particular, it recommends testing for hepatitis infections at a medical institution. Despite the unsolved problem of its side effects in Japan, WHO stated in 2018 that the human papillomavirus (HPV) vaccination is effective for cervical cancer and included it in its action plan. In addition to its prevention, early detection of cancer is also linked directly to lowering mortality.

(3) Infectious diseases

Humankind has lived with infectious diseases since ancient times. The world has faced several pandemic outbreaks, some of which caused enormous damage. Advances in bacteriology, virology, public health, clinical medicine, and engineering have identified pathogens and established effective prevention and treatment with drugs and vaccines. However, at present, even with much experience and scientific progress, only a few infectious diseases have been completely eradicated, including smallpox. The first countermeasure is to protect ourselves against infection (standard preventive measures). In general, it is important to wash hands before eating and drinking, maintain a clean living environment, and isolate ourselves based on the information on the infection route (such as

contact, droplets, air, and insects) during an epidemic. At the same time, proper nutrition, good sleep, moderate exercise, and stress reduction to raise the immunity levels of each individual are thought to be effective.

(4) Medical checkup

When a person experiences a poor physical condition, he/she visits a medical institution for examination, diagnosis, and treatment. However, a yearly health checkup is recommended, even if there are no subjective symptoms or any illnesses. It is desirable to detect cancer and other diseases at an early stage for prompt treatment with regular examinations, health screening, and health check-ups at the workplace, for which the local government subsidizes some expenses in Japan. The importance of regular dental examinations has also been reaffirmed in recent years.

2) Disease prevention for persons with disabilities

Health problems of persons with disabilities

There are various types, situations, and degrees of disability, including those that are congenital and those that occur in the middle of life due to illnesses or accidents. As described in the section on "Disease prevention," many of disabilities cannot be prevented by general disease-prevention measures. These disabilities include neurological diseases, such as Parkinson's disease, spinocerebellar degeneration, myasthenia gravis, multiple sclerosis, multiple system atrophy, amyotrophic lateral sclerosis (ALS), and Guillain-Barré syndrome, as well as those that may develop during childbirth. Dr. Kimiko Takeda of Tokyo Medical Lab states that early rehabilitation intervention to maintain muscle power and range of motion is important for persons with ALS, as well as building proficiency of caregivers in the operation of life-supporting equipment, which enables rehabilitation even at home[3].

Here, we will discuss the following three typical types of disabilities.

(1) Physical disabilities

The primary disability is generally defined as a functional disability or restriction caused by a disease or injury, and is distinguished from a secondary disability, which is a disability or restriction caused by the primary disability. The need to prevent the secondary disability in the process of rehabilitation has been emphasized because it can be prevented or corrected with proper care and medical intervention. The most commonly reported secondary disabilities are pressure sore, contracture, urinary tract infection, and depression.

Dr. Naoichi Tsuyama, who was the president of the National Rehabilitation Center for Persons with Disabilities from the 1980s to the early 1990s, stated, "The prevention of secondary disabilities is of the most importance in rehabilitation medicine," and advocated patients' self-reliance, stating, "Rehabilitation into society in the shortest period of time by avoiding unnecessary after-treatment/treatment and extension of hospital stay is crucial"[4].

Center of Sports Science and Health Promotion in the National Rehabilitation Center for Persons

with Disabilities Hospital currently provides medical examinations for the prevention and early detection of secondary disabilities with a team of doctors, public health nurses, nutritionists, and exercise therapists. The exercise capacity of a person declines with aging, with which the contents of necessary nutrition and exercise also change. Orthopedic evaluations, including joint function, and directions for future life improvement can be obtained by receiving medical examinations regularly.

Advances in engineering to support the weaknesses of physical disabilities can significantly contribute not only to a healthy life but also to the prevention of secondary health disabilities, which include prosthetic limbs and orthotics. Even if it has high performance, such support is meaningless if it is expensive and only available to a limited number of people. With regard to the development of wheelchairs, Amos Winter, who conducts engineering research at MIT, presented a wheelchair that defies mud and sand at the Technology Entertainment Design (TED) conference in 2012 under the title "Development of the cheap all-terrain wheelchair." The wheelchair was simple in construction durable on rough roads and easy to repair, with a price of under 200 dollars. The valuable lessons learned in the process of its development were also interesting. He showed an example in which its use allowed persons with disabilities to travel on their own for distances that were previously difficult to travel and to receive education and medical care even in countries with underdeveloped transportation infrastructure. This was the example of bringing joy and hope to persons with disabilities and also of contributing to the prevention of diseases that may develop in the future, not only physically but also mentally[5].

(2) Visual disabilities

In 2019, WHO reported that 2.2 billion people worldwide had some form of visual abnormalities, 1 billion of whom did not have access to medical care[6]. Currently, the number of persons with visual disabilities is increasing in Japan, partially due to aging. According to the survey conducted by the Japanese Ophthalmological Society, there were estimated 1.64 million persons with visual disabilities in Japan in 2007, with approximately 190,000 of the totally blind. Some eye diseases such as glaucoma progress without the persons' awareness, and it is important to receive accurate diagnosis and treatment at an early stage. After the age of 40, it is recommended to have a visual field test, cataract test, fundus examination, and optical coherence tomography (OCT), in addition to the visual acuity test performed in general medical checkups.

In addition, care for persons with visual disabilities is essential for the prevention of secondary disabilities. Humans are said to obtain 80% of information from their eyes. Thus, we must devise a means to accurately convey information that is updated frequently, such as that on infectious diseases, and information conveyed through tables and graphs, even if it takes time due to disabilities (See p.43 of this manual for the exercise necessary for maintaining the health of persons with visual disabilities). In addition, tools to improve the quality of life and ensure safety are also under development.

(3) Hearing disabilities

As of 2016, 297,000 persons with severe or extremely severe hearing disabilities in Japan have a physical disability certificate, according to a survey conducted by the Ministry of Health, Labour and Welfare. Immanuel Kant, a German philosopher of the 18th century, stated, “The blindness separates people from things, and the deafness separates people from people.” Obtaining and responding early to appropriate medical information when experiencing any changes in the physical condition is the basis of disease prevention. Using advanced devices, access to medical institutions has become easier for persons with hearing disabilities in the 21st century than before due to remarkable technological advancement. As we stated in the preface of this chapter that “healthy lifespan is important,” Harvard University reported that “engaging in a job that doesn’t feel boring or meaningless earns more health than earning income, assuming there is little stress and physical damage”[7]. Mitsubishi UFJ Research & Consulting Co.,Ltd. summarized the “current status and issues of employees with hearing disabilities” in 2019, which compared healthy persons in Western countries and Japan. It reported that the proportion of middle-aged and older employees with hearing disabilities was considerably low and that high educational background and high expertise/skills were the keys to solving the difference[8].

3) Summary

According to the 2021 statistics, the population aged 65 and older constitutes 29.1% in Japan, leading the world as a super-aging society[9]. However, there is a difference of about 10 years between expected lifespan and healthy lifespan, which is of more importance[10], and the entire country is working to shorten the difference. On the other hand, barriers sometimes stand in the way of daily medical examinations and health screening for persons with disabilities. Even in the medical examinations provided at the workplace, they are not able to climb the steps for chest X-ray examination. Many persons with disabilities come a long way to our hospital. If they do not work for a company, they rely on the medical checkup provided by the local government. A society where all hospitals can be accessed by persons with disabilities without barriers is needed.

References

1) World Health Statistics 2021: Monitoring health for SDGs Geneva: World Health Organization;2021
2) Hiroshi Ito. What is metabolic domino? -A new way of thinking about lifestyle-related diseases-. Japanese Journal of Clinical Medicine. 61:1837-1843, 200. (Japanese) .
3) Kimiko Takeda. Record of Invited Lecture by Dr. Kimiko Takeda. Japan Society for Homecare and Emergency Medicine. http://zaitakukyukyu.com/record1.html. (Accessed 2021-9-10). (Japanese) .
4) Naoichi Tsuyama. Hanamizuki Miscellaneous Article.1994. (Japanese) .

5) Amos Winter. The cheap all-terrain wheelchair. https://www.ted.com/talks/amos_ winter_the_ cheap_all_terrain_wheelchair/transcript?language=ja. (Accessed 2021-8-16).
6) World report on vision. World Health Organization. 2019. https://www.who.int/ publications/i/ item/9789241516570. (Accessed 2021-9-10).
7) Working later in life can pay off in more than just income. Harvard Health Publishing Harvard Medical School. 2018-6-1. https://www.health.harvard.edu/staying-healthy/working-later-in-life-can-pay-off-in-more-than-just-income. (Accessed 2021-9-10).
8) Shigehiro Yokoyama et al. Toward the success of employees with hearing disability. Mitsubishi UFJ Research & Consulting. 2019-5-10. https://www.murc.jp/report/rc/policy_rearch/politics/ seiken_190510_1/. (Accessed 2021-9-10). (Japanese) .
9) Ministry of Internal Affairs and Communications. Statistics topics. No.129. The elderly in Japan from the viewpoint of statistics. 2021-9-19. https://www.stat.go.jp/data/topics/pdf/topics129.pdf. (Accessed 2021-10-16). (Japanese).
10) Ministry of Health, Labour and Welfare. Reference materials for the promotion of health in Japan 21 (second). https://www.mhlw.go.jp/bunya/kenkou/dl/kenkounippon21_02.pdf. (Accessed 2021-9-10). (Japanese).

Chapter 2.
Approaches to health promotion

1. Exercise intervention for persons with disabilities and assessment of its effectiveness

1) Selection of exercise intervention method

Since the effects of exercise intervention vary depending on the method, its intended purposes need to be clarified when selecting a method, and then a decision is made based on the physical condition of the target person. Physical functions associated with exercise intervention can be divided into multiple factors, such as muscle power, endurance, flexibility, balance, and coordination movement. In particular, the first three factors have a significant impact on the health of persons with disabilities in the chronic stage, but they are also easily confused by them and their caregivers.

(1) Intervention for muscle power

Since muscles exert power through connecting bones across joints, its power appears as the force exerted by joint movements. Standing up is the movement of lifting one's weight upward against gravity with muscle power, for example. When moving an object, the holding power of the hand to prevent it from slipping off and the force exerted while moving it to a target place are generated by muscle power.

Muscle power increases proportionately to the cross-sectional muscle area, although a decline in muscle power can occur due to neurological disabilities; therefore, it is necessary to increase the cross-sectional muscle area, that is, to induce muscle hypertrophy, in order to increase muscle power. Alternatively, it is considered necessary to prevent the progression of muscle atrophy in order to prevent a decline in muscle power. In the field of sports, much knowledge has been gained on the theory of muscle strengthening, which is often helpful, although not all apply to persons with disabilities. The key is to repeat exercise with an appropriate load for a certain number of times regularly. Its method needs to be adjusted to prevent the movement from causing pain or excessive loads on the skin and joints.

(2) Intervention for endurance

Endurance is the ability to continue performing an exercise, which can be broadly divided into the endurance of muscles and the endurance of the cardiopulmonary function. It is important to keep in mind that in either case, endurance is improved by continuing an exercise for a certain period of time. However there are not many opportunities for continuous exercise in the daily living for persons with disabilities. Even active persons with disabilities may spend more time driving a car than driving a wheelchair themselves. Conscious efforts are required to secure the exercise opportunities for maintaining endurance in daily living. Endurance needs to be considered separately from the muscle power mentioned above, and the appropriate intensity and method need

to be chosen for the endurance exercise.

Persons with disabilities often complain of strong fatigue in their daily living and working situations. However, it can be difficult to determine whether the cause of the fatigue is a lack of endurance or other physical or psychological factors. An approach to physical function is considered when a decrease in body weight and muscle power is observed. However, a visit to a medical institution is recommended if there is a tendency of depression in psychological evaluation or if a problem with internal organ functions is suspected.

(3) Intervention for flexibility

The so-called flexibility of the body is determined by the range of joint movement and the extensibility of muscles and tendons. The flexibility gradually decreases when the range of movement of the body is limited due to disabilities. Increased muscle tone is also a factor that impairs flexibility for those with central nervous system diseases, such as cerebrovascular disabilities, spinal cord injury, and cerebral palsy, which are frequently accompanied by symptoms of muscle spasm. Persons with disabilities are highly aware of such a problem because the stiffness of their body is also associated with pain. Stretching to maintain flexibility is often incorporated into rehabilitation programs in the chronic stage. It should be noted, however, that the emphasis on stretching may sometimes be excessive so that the attention to muscle power and endurance mentioned above tends to be neglected. While flexibility is important, persons with disabilities must be aware of the difficulty of maintaining the physical condition by flexibility alone.

2) Positionig of evaluation in health promotion for persons with disabilities

The core approach of health promotion is to provide intervention against the decline in physical fitness, overweight, and thinness in persons with disabilities in the chronic stage. Since it is an intervention, it is indisputable that the evaluation of its effects is important. However, the selection of an evaluation method is not easy. There are two major reasons for the difficulty.

(1) Diversity of persons with disabilities

In addition to the diseases that had caused disabilities, there are various factors surrounding the persons with disabilities in the chronic stage, including secondary changes, complications, comorbidities, mode of life, and the presence or absence of caregivers. Therefore, it is difficult to establish the standard evaluation methods. To evaluate the body weight of a person with paraplegia, he/she must be able to stand to step on a general weight scale, and when using a weight scale for wheelchairs, the weight of the person is determined by subtracting the weight of the wheelchair from the weight of the person in the wheelchair. The standard body weight has been set for healthy persons. However, there is no standard body weight for persons whose lower limbs are paralyzed. Therefore, many issues on evaluation methods and judgement of evaluation values remain unsolved.

(2) Why are we promoting health?

For persons with disabilities in the chronic stage, a decline in physical fitness is a factor that causes various problems, including health maintenance. Since the decline in physical fitness itself is a physical problem, physical interventions and their effects are also thought to evaluate physical functions. On the other hand, the ICF* model is used to understand and solve the current problems surrounding persons with disabilities. In the concept of ICF, the problems of physical function do not exist independently, but in the interaction with activities and social participation. Thus, efforts for health promotion also need to be evaluated from the perspective of social participation. With this in mind, there is no common evaluation standard for all persons with disabilities, regarding, e.g., whether it is important to capture changes in body weight as an effect of an intervention, whether it is important to capture social participation, and what should be used as an index to evaluate the participation. Therefore, before starting a series of physical interventions, it is desirable to fully understand the type of disabilities, appropriate methods for capturing the physical changes, and the presence or absence of standard values. It is also helpful for them to be aware of their goals beyond health promotion and to consider evaluations toward those goals. Below, we will introduce the evaluation methods that can be used as references for physical changes and social participation aspects.

3) Evaluation of physical functions

(1) Evaluation of physical constitution and body composition

Body weight is the most accessible index of physical constitution, and keeping track of body weight over time is the first step in health management which enables detecting excessive weight gain or loss at an early stage. As mentioned above, it is difficult for wheelchair users with paralysis not only to measure body weight itself but also to evaluate whether the measured body weight is higher or lower than the “standard” value. However, measurement of body weight over time is useful for determining the effects of health promotion, as changes in body weight are expected to be seen within two to three months if it is effective. Although body weight can be corrected by height, persons with disabilities often have difficulty in measuring their height. In such a case, arm span (the length from the tip of the middle finger to the tip of the opposite middle finger when both upper limbs are spread to the left and right) can be used as an estimated height.

Body composition is used to estimate body fat percentage and muscle mass. In recent years, impedance methods especially the multi-frequency impedance method that utilize the electrical resistance of the body, have become popular. Although most of them measure the impedance in a standing position, some devices are capable of measuring body composition in a supine position. The dual X-ray absorptiometry (DXA) method, which calculates from the absorption of X-rays, and the air replacement method, which compares with the specific gravity of air, are known to be highly accurate for the evaluation of body composition. Since the measurement algorithm of many

*International Classification of Functioning, Disability and Health

impedance methods has been verified based on the comparison with high-accuracy data in healthy persons, it is a topic to be studied in the future whether these methods have the same accuracy for paralyzed persons and amputees.

(2) Evaluation of muscle power

When we say "physical fitness," it often includes muscle "power" and endurance, which, however need to be evaluated separately. It should be noted that large muscle mass as measured by above-mentioned method, does not necessarily guarantee high muscle power. Study of the reduction of muscle mass (sarcopenia) in the elderly suggests that a decline in muscle power precedes a decline in muscle mass[1].

The most accessible muscle power for measurement is the grip strength. It is generally considered to reflect the muscle power of the whole body, and its advantages are that it can be evaluated with known cutoff values in screening tests and that it can be easily measured over time. However, it is difficult to evaluate the muscle power of persons with disabilities because grip strength cannot be evaluated properly due to disabilities in many cases. The muscle power of the shoulders and lower limbs can be measured with a certain instrument, but it tends to show large errors depending on measurers.

The methods for evaluating muscle power using daily movements include the evaluation of the height (20, 30, or 40 cm) a person can stand up if he/she is able to stand (stand-up test)[2]. Muscle power of a person with paraplegia can be evaluated by measuring how many push-ups he/she can perform on a wheelchair within a certain period of time, although it is not common. In persons with paralysis, accurate evaluation of muscle power becomes difficult if there are fluctuations in their ability to make the movements necessary for muscle power measurement.

(3) Evaluation of endurance

Endurance evaluated by how long a movement can be continued, and it is used as an index directly linked to performance in sports, such as long-distance running. The standard evaluation method of endurance is to gradually increase the exercise intensity using an ergometer and measure the maximum oxygen uptake when reaching the maximum exercise intensity. On the other hand, its simple evaluation method is to evaluate the degree of a movement that can be performed in a certain period of time. For example, endurance can be evaluated as a distance covered in a 6-minute or 12-minute walk test. Wheelchair users can use these methods, though they require a relatively large space. To evaluate the endurance of a wheelchair user at our facility, he/she moves a wheelchair back and forth over a short distance, and the number of its movement is used as an index of endurance.

4) Evaluation of daily activities and social participation

(1) Evaluation of activities of daily living

The intervention effect can be evaluated by quantifying the degree of self-confidence in those items. Because health promotion is expected to improve the stability of the motion involved in each item of the FIM (Figure 1), the Functional Independence Measure (FIM) quantifies the degree of independence and evaluates the overall daily movements based on the total score[3] and is widely used in the field of rehabilitation. However, it is unlikely that health promotion will improve the FIM score since it dose not aim to change "what you cannot do" into "what you can do".

(1) Eating
(2) Grooming
(3) Bathing
(4) Dressing, upper body
(5) Dressing, lower body
(6) Toileting
(7) Bladder management
(8) Bowel management
(9) Transfers - bed/chair/wheelchair
(10) Transfers - toilet
(11) Transfers - bath/shower
(12) Walk/wheelchair
(13) Stairs

Figure 1. Items of FIM

In recent years, the 25-Question Geriatric Locomotive Function Scale (GLFS-25)[2] has been used in the field of orthopedics as a method for evaluating the overall function of the exercise equipment and the degree of difficulty in life. It should be noted that the scale was developed for evaluating locomotion disabilities in the elderly capable of walking. However, as the scale quantitatively evaluates the difficulty of daily movements, this also has characteristics of both simplicity and quantitativeness.

(2) Amount of physical activity

For persons with disabilities in the chronic stage, one of the major purposes of rehabilitation is to maintain or improve the amount of physical activity, which can be considered an index related to social participation. They could use general sensors, such as pedometers and activity trackers, if they are able to walk, but the measurement of activities with those sensors is difficult in some cases, like wheelchair users to measure the amount of activity. In recent years, built-in wristwatch-type sensors have become widespread, and some of them have programs for wheelchair users. Although their measurement accuracy is controversial, repeated measurement in the same individual is sufficient as an index to grasp changes in physical activity over time.

On the other hand, one of the evaluation methods of the amount of physical activity that do not use sensors is questionnaire. A widely known example is the International Physical Activity Questionnaire (IPAQ). Various data have been obtained and reported using IPAQ[4]. It should be noted that IPAQ was not designed for persons with disabilities and that some of its questions may not be suited for them.

(3) Social participation

Continuation of employment is considered as “social participation of ICF”. However, because employment is not the only social participation, it is not common to use employment alone as an index of social participation. Employment could be a simple index of the frequency of outing, and thus be considered to have a certain relevance to social participation. However, outing involves not only the person but also other factors, such as caregivers and climate, and it is greatly affected by the lifestyle of the person. Therefore, a general comparison cannot be made. However, if a person exhibits a decreasing frequency of outing, it raises a concern to be examined.

5) Utilization of evaluation methods

In this section, we have introduced the indices for the evaluation of health promotion, focusing on physical and lifestyle aspects (Figure 2). Again, it should be noted that these indices do not have any standard evaluation values for persons with disabilities. As we accumulate more knowledge, appropriate evaluation of their numerical values would be possible in the future. However, for the time being, it is realistic to select an evaluation method that suits the status and situation of the person, to determine the effect of the intervention while continuously evaluating it, and to use it for correction.

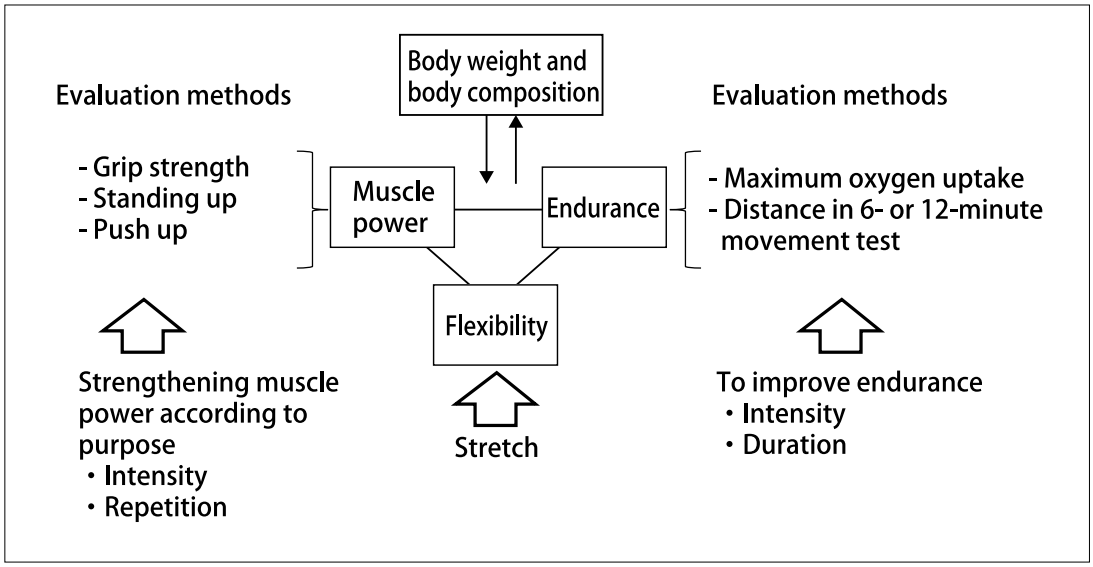


Figure 2. Factors essential for understanding exercise intervention and their evaluation

References

1) Shimokata H, Ando F, Yuki A, Otsuka R. Age-related changes in skeletal muscle mass among community-dwelling Japanese: a 12-year longitudinal study. Geriatr Gerontol Int. 2014 Feb; 14 Suppl 1:85-92.
2) Ogata T, Muranaga S, Ishibashi H, Ohe T, Izumida R, Yoshimura N, Iwaya T, Nakamura K. Development of a screening program to assess motor function in the adult population: a cross-sectional observational study. J Orthop Sci 2015; 20:888-95.
3) Tomioka Y, Uemura O, Ishii R, Liu M. Using a logarithmic model to predict functional independence after spinal cord injury: a retrospective study. Spinal Cord 2019; 57:1048-56.
4) Kim Y, Park I, Kang M. Convergent validity of the International Physical Activity Questionnaire (IPAQ): Meta-analysis. Public Health Nutr 2013; 16:440-52.

2. Nutritional guidance for persons with disabilities

Nutritional guidance for persons with disabilities is highly needed because their body weight fluctuates due to various changes in their lives, such as decreased physical activity caused by disabilities, which often affects their health.

The amount and content of meals and the amount of physical activity are related to the physical condition. When providing nutritional guidance, individual goals are set by selecting tasks based on dietary conditions and physical assessment. We assist persons with disabilities to achieve their goals by continuing physical measurements while advising for their diet and amount of physical activity.

After the initial improvement in diet, issues often resurface due to the taste and environment of individual persons with disabilities. The aggravation of health can be prevented by reviewing the measured values with the patient periodically and setting new goals as necessary.

The nutritional guidance should include the results of physical measurements and nutrition information.

1) Results of physical measurement and nutritional guidance

The nutritional condition can be inferred approximately from body weight changes. The changes in body weight over time can be reviewed with interest by the client if the measurement results are graphed, and it can give an opportunity to identify the aspects for improvement in the dietary contents and intake and the amount of physical activity.

In nutritional guidance, it is useful to use both body weight and body composition measurements in order to grasp the physical condition that cannot be estimated from the body weight measurement alone. The numerical values of body composition may indicate an improvement in the physical condition, even if there is no change in body weight from which persons with disabilities could learn the importance of continuing efforts for their goals.

2) Provision of nutrition information

Presentation with rich use of illustrations and concise sentences often allows patients to obtain information with interest.

(1) Displaying posters in corridors and gymnastic halls

This provides an opportunity to gain knowledge about nutrition freely during waiting times, passing by, and exercising against the wall. Suggested contents include nutritional values familiar foods and menus that they often eat, and dietary proposals for weight loss, In particular, viewing these posters can be an opportunity to review whether their intake of energy and salt is excessive.

Figure 1. Posters displayed in the hallway

Figure 2. Posters displayed in the hallway

Figure 3. Posters displayed on the wall of a gymnastic hall

(2) Displaying videos

The use of videos, instead of posters, adds movement and audio to the information, providing an opportunity for people to enjoy and get interested. Their use is effective especially in areas such as a waiting room.

Figure 4. A video displayed in a waiting room

Figure 5. A video displayed in the gymnastic hall

(3) Nutrition information provided on the website

Information posted on websites can be viewed without restrictions on location and time.

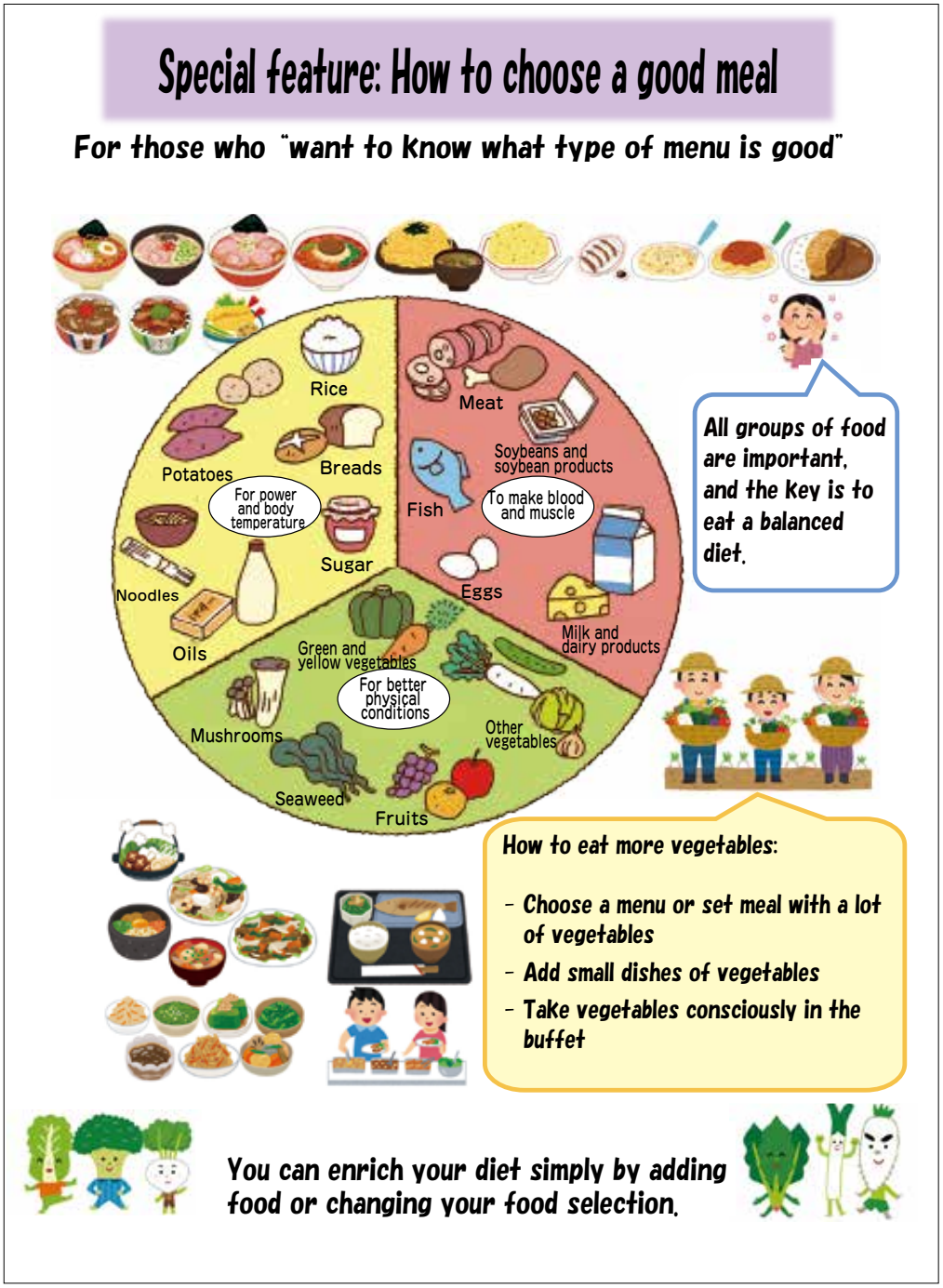


Figure 6. Example of nutrition information provided on a website

(4) Example of the handout for nutritional guidance

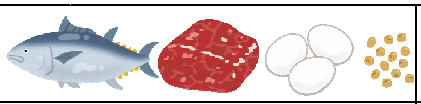
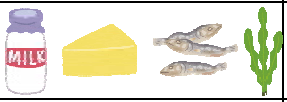
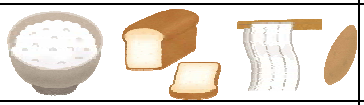
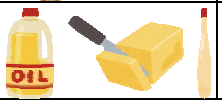
Dietary self-check		
①	Fish, meat, eggs, soybeans, protein 	
②	Milk, dairy products, small fish, seaweed 	
③	Green and yellow vegetables 	
④	Other vegetables and fruits 	
⑤	Carbohydrates, rice, bread, grains, cereal, sugar, noodles, potatoes 	
⑥	Oils and fats 	

Figure 7. Dietary self-check sheet

How to use the dietary self-check sheet:

At the end of the day, recall what groups of food you ate and record them on the sheet. Eating the missed groups of food the following day will prevent imbalanced nutritional intake.

(5) Others

The nutritional intake of daily diet can be calculated by using dietary diagnostic software. It shows the excess and deficiency of each nutrient, hinting to an improved diet.

Reference

1) Notification from the Director of Public Health Bureau, Ministry of Health and Welfare, No. 157, released on March 2, 1981: Dissemination of “Six Basic Foods” for Nutrition Education. (Japanese).

3. Issues in lifestyle habits of persons with disabilities and their measures

Persons with disabilities often have their own established lifestyle habits that have been influenced and shaped by the specificity and severity of their disabilities. In order to review their lifestyle habits, such as exercise and nutrition, for the prevention and improvement of lifestyle-related diseases, attention must be paid to the burden of daily living due to the nature and individual specificity of their disabilities.

1) To establish and maintain better lifestyle habits

Efforts to prevent lifestyle-related diseases, such as reviewing and improving eating habits and regularly exercise, are recommended in the health promotion measures of each community. It is important to review the daily living of persons with disabilities, in order to establish better lifestyle habits so that their daily living can be continued without an excess burden. As daily behaviors and activities cannot be easily changed by persons with disabilities by themselves, the cooperation of family members and supporters is needed.

(1) Reviewing eating habits

Many persons with disabilities may have already be given instructions for dietary restrictions, such as calorie restriction and salt reduction, due to the aggravation of lifestyle-related diseases as they age, such as obesity, diabetes, and hypertension, before or after the development of disabilities. However, changing eating habits by themselves can be challenging, such as unbalanced contents, salt concentration, amount and time of meal. They need to work on these issues with the help of their family members and supporters. In some cases, persons with disabilities or their family members may not be aware of such issues, and supporters need to make them aware of the need for improvement of eating habits. In addition, it is important to consult with a managerial nutritionist for specific advice when the adjustment of nutritional contents is needed due to thinness, defecation management, and pressure sores. Those who use self-help devices, with dysphagia, or with visual disabilities tend to have imbalanced nutrition due to low diet quality and reliance on nutritional foods that can be eaten easily because of their limited eating movement. In some cases, a caregiver may be required for all the activities related to eating, such as grocery shopping, cooking, and eating. If such activities are affected by the disabilities, it is important for the person with disabilities or the caregiver to consult with a rehabilitation hospital or a local healthcare center and receive necessary advice and support to improve his/her eating habits.

Support for eating habits requires not only individual measures but also ingenuity, such as personal experiences of menu creation, shopping, and cooking. These experiences are expected to bring about positive changes in life, such as deepening knowledge and interest in food and gaining opportunities for interaction. Therefore, it is desirable to have an established local environment for support, such as an environment where it is easy to shop and facilities where it is easy to gather.

To develop rich eating habits for persons with disabilities, collaboration is important between

supporters who are directly involved in the care and various rehabilitation and medical professionals.

(2) Establishing exercise habit

Exercise not only prevents physical functional decline but also improves health awareness and physical fitness, and it is of great significance for social participation. As the activity intensity in their daily living of persons with disabilities is low , it is often necessary for them to increase the amount of physical activity and to exercise regularly in order to prevent obesity and to improve muscle power. It is desirable to provide an effective exercise program that takes into account the specifics of the individual disabilities and living environment.

Issues may arise when performing an exercise, such as the lack of physical fitness, time to spare and means of outing. These issues are often solved with the support of family members and supporters.

In recent years, sports for persons with disabilities have become popular, with improved accommodation of exercise facilities and an increasing number of exercise therapists with specialized knowledge. The participation in exercise would increase by distributing the information on exercise opportunities not only to those with disabilities and their families but also to the community at large. This will also increase the motivation of persons with disabilities and the opportunities for exercise intervention. Furthermore, we expect that an environment where support could be easily obtained will be created by advancing the understanding of the community about the exercise for persons with disabilities.

(3) Making habit of outing (activity)

The outing can also lead to an improvement in physical fitness and motivation for activities. Tending to stay home and minimal interaction with society can cause disuse syndrome, which may affect mental health as well.

Factors that hinder the outing of persons with disabilities include individual and social factors.

1. Personal factors that hinder outing

Activities of daily living, such as defecation, bathing, and movement, often require much time and physical fitness for persons with disabilities. Thus, it may be physically too burdensome for them to keep the same life cycle as healthy persons. Alleviating the burden of activities of daily living due to the specifics of the disabilities, with appropriate caregiving by family members and supporters can lead to the maintenance of the quality of life (QOL), an affluent life, and promotion of social activities. (However, it should be noted that excessive life assistance could impair the feeling of self-efficacy). It is also important to evaluate the aging-related decline in activity ability and the necessary care as appropriate.

Persons with disabilities need to consult at a medical institution if they are not able to work due to physical pain, poor physical condition, and mental illness that last for a long time or

repeatedly. Insufficient self-management, such as irregular life, deficient sleep, disturbance in defecation, and urination problems, can lead to a poor physical condition that would hinder activities. It can be greatly affected by a decline in the health awareness of the life rhythm and eating habits, including an unbalanced diet. The cooperation and support of medical, nursing, and related professionals are needed if there is a problem in the self-management ability of a person with disabilities.

2. Social factors that hinder outing

There are many issues in the outing of persons with disabilities, depending on the means and convenience of transportation, the presence or absence of caregivers, environmental improvement (such as barrier-free, braille blocks on the sidewalk and toilets), congestion, and weather. Safe outing requires careful information gathering and planning about the environment along the way to and at the destination. Too busy scheduling is dangerous and can lead to poor physical condition. Environmental improvement and the enhancement of physical support are desired, as the outing of persons with disabilities is not easy due to those restrictions.

To encourage outing of persons with disabilities, it is desirable that there are many places in the immediate vicinity where they can interact with others and play roles in which they find joy. Interaction with others help increase physical activity, and improvement in the quality of activity is expected to further increase activity.

(4) Regular defecation (bowel movements)

Defecation is one of the indices for good health. Since defecation problems can interfere with social life and cause a poor physical condition, encouraging regular defecation is a major issue in daily living. It is important to keep a record of the frequency and time of daily stool, life rhythm, eating habits, and hydration for the regulation of defecation. These records can also be used for reviewing and adjusting oral medication and eating habits and for reviewing movements. If defecation is not managed well, improvement measures need to be considered not only by the person with disabilities and his/her family members but also by doctors and paramedical staff.

(5) Recommendation of smoking cessation

Smoking causes respiratory aggravation and arteriosclerosis. The aggravation of respiratory symptoms leads to decreased activity ability, and the development of arteriosclerosis can trigger further disabilities. Therefore, in addition to dietary and exercise interventions, the smoking status must be reviewed to prevent lifestyle-related diseases.

In recent years, the number of smokers has been decreasing due to rising cigarette prices and measures, such as restrictions on smoking areas. On the other hand, many persons with disabilities have difficulty quitting smoking. They may smoke a large number of cigarettes or have a long history of smoking. We propose various methods for abstinence from smoking for those who are

willing, provide psychological support of encouragement and monitoring, and recommend medical smoking cessation treatment if necessary. For those who cannot bring themselves to quit smoking, we try to motivate them continually while examining their daily lifestyle habits and stress status.

(6) Dental health

Periodontal diseases not only cause tooth loss but can also induce arteriosclerosis, and aggravate diabetes and respiratory diseases. Brushing teeth after each meal is often too much a burden for persons with disabilities, since they have difficulty in doing the sequence of tooth brushing actions due to hemiplegia, upper arm paralysis, and facial paralysis. Therefore, it is desirable for them to visit a dentist regularly to detect and treat carious cavities at an early stage and to make an effort to prevent periodontal diseases by receiving plaque removal and brushing guidance.

Regular eating habits are also important. Because proper mastication presents not only carious cavities but also food aspiration and obesity, it is recommended to develop a habit of “chewing slowly and well” on a daily basis.

2) Early detection and prevention of lifestyle-related diseases

Early awareness of physical changes and review of the entire lifestyle lead to the maintenance of good health of persons with disabilities. Regular physical measurements and medical examinations can be useful for the early detection and prevention of lifestyle-related diseases. Good lifestyle habits can be maintained by responding to the decline in activity function at an early stage.

For persons with disabilities in order to maintain a stable healthy life, it is essential to secure the community support system. Above all, it is important for supporters to listen to them and think together about the difficulties of their daily living due to aging and aggravation of disabilities and anxiety about their health.

(1) Physical measurement

Body weight is easily influenced by lifestyle habits, and it is a basic indicator for the entire lifestyle, such as diet and exercise. Since many of the persons with disabilities take inadequate nutrition due to their low physical activity and basal metabolic rate, it tends to be difficult for them to maintain proper body weight. However, they often do not know their body weight because they do not have the opportunity for measurement due to visual disabilities or difficulty in maintaining a standing position. Obesity and thinness lead to the onset or aggravation of lifestyle-related diseases and a decline in muscle power due to paucity of activity. Thus, regular measurement of body weight is important (See 3)-(1) on p.16).

Such physical measurements of persons with disabilities may be conducted at local medical institutions, welfare facilities, and gymnastic halls. It is desirable to create an environment that accommodations persons with disabilities for easy access to consultation.

(2) Medical checkups

Medical checkups for lifestyle-related diseases and dental care conducted in the community and companies are good opportunities to review lifestyle habits. Regular visits for medical examinations are encouraged as they may give a chance to review eating habits and exercise. However, few hospitals accommodate persons with disabilities due to limited accessibility and lack of personnel trained for disability. Since health guidance in general medical examinations are based on the healthy persons without disabilities, it is currently difficult to obtain proper advice that takes into account of disabilities. It is hoped that more hospitals will conduct health examinations that are tailored for the life of persons with disabilities.

(3) Evaluation of activity function

An aging-related decline in life function increases the burden of the daily living of persons with disabilities, which often force them to change their previous lifestyle habits. At around middle age and later in life, movement and wheelchair transfer activity tend to be less frequent in congenital physically disabled persons and those who have a long post-disability period, decreasing the amount of their physical activity. Many persons with disabilities in the chronic stage do not have a family doctor with whom they can consult about the aggravation of such disabilities. Therefore, persons with disabilities need to have an opportunity to be evaluated on their activity function and to learn about the countermeasures for the aggravation of disabilities and coping methods for daily living that incorporate a preventive perspective. Evaluation of the activity function of persons with disabilities at rehabilitation hospitals and facilities has been shown to provide necessary medical care and welfare support in some communities. We hope that such facilities continue to become accessible in more communities.

(4) Support enhancement through collaboration

To maintain better lifestyle habits, a support system for persons with disabilities needs to be built by collaboration of various people supporting them, such as doctors, paramedical staff, welfare personnel, and volunteers in the community. With good community support, persons with disabilities can be familiarized with the community around them, such as retail stores, exercise facilities, and welfare institutions, which would increase the amount of information input, expand the range of outings, and promote the development of social environments that would facilitate activity. Enhancement of such a community care system is essential for energizing the life of persons with disabilities and maintaining their better lifestyle habits.

References

1) Takashi Kadowaki et al. Health Examination and Guidance Guidelines for Metabolic Syndrome Risk Management, Nanzando. Tokyo, 2008: p220-244. (Japanese).
2) Midori Kaizuka et al. Rehabilitation Nursing to Improve QOL, Second Edition. Ishiyaku Publishers. Tokyo, 2012: p265-272. (Japanese).
3) Seiji Yasumura. Prevention and Support for Seclusion Recommended in the Community, Sun Messe Co. Ltd. Tokyo, 2006: p32-p45. (Japanese).
4) Satoshi Ueda. Understanding and Use of ICF, Moebunsha, Tokyo, 2005. (Japanese).
5) Ministry of Health, Labour and Welfare. Reference Materials for Health Promotion in Japan 21 (Second), 2012. (Japanese).
6) Ministry of Health, Labour and Welfare: Nursing Care Prevention Manual, Revised, 2012. (Japanese).
7) Ministry of Health, Labour and Welfare: Survey on the Difficulty of Living, 2018. (Japanese).
8) Ministry of Health, Labour and Welfare: National Survey on Health and Nutrition, 2019. (Japanese).
9) James F Sallies, Neville Owen: Physical activity & behavioral medicine, Sage Publications, Inc, 1999, p75-90.
10) Japanese Society for Tobacco Control: Studies on Smoking Cessation, Revised 4th Edition, Nanzando, Tokyo, 2019. (Japanese).

Chapter 3.
Exercise intervention methods according to disability

1. Exercise is essential for health promotion

The balance between exercise, nutrition, and lifestyle habits is said to be important for health. The imbalance between these increases the likelihood of contracting non-communicable diseases (NCDs), such as heart attacks, stroke, cancer, chronic respiratory diseases, and diabetes[22]. Many of these NCDs are also called lifestyle-related diseases (LRD's), and partly attributable to chronic lack of exercise.

Persons with disabilities are susceptible to LRD's due to their chronic lack of exercise caused by long-term bed rest and restricted movements and activities. Its adverse effect can induce secondary disability, leading to severer disability. Regular exercise can reduce the risk of LRD's and increase the opportunities for activity and participation.

In this chapter, we will explain exercise, one of the three pillars of health promotion.

1) Relationship between health promotion and physical fitness

Physical fitness is divided into physical and mental components, each of which is divided into physical abilities for behavior and for defense (Figure 1)[7]. Physical ability for defense shows resistance to stress and is important for survival. The use of the physical ability for behavior also has a positive effect on the physical ability for defense. The physical ability components utilized in exercise vary depending on its type. Exercise using momentary force requires instantaneous muscle power, while long-term exercise requires endurance. The endurance and muscle power are closely related to health and survival. Endurance is divided into whole-body endurance and muscular endurance. The whole-body endurance, as also known as cardiorespiratory endurance, can be an index of health.

Whole-body endurance is coordinated by the central circulation, which is centered on the heart, and the peripheral circulation, which transfers oxygen from blood vessels to organs, such as skeletal muscles, to meet their oxygen demands. The supply and demand of oxygen vary depending on the exercise level and external stress. Work or resistance cannot be exerted for a long time without enough aerobic capacity that meets exercise and stress, and the inhibiting factor of the aerobic capacity is rest[23].

Muscle power is essential for exercise . And it creates movements and actions in activities of daily living. Muscular endurance is required to repeat the movements that are made possible by muscle power. The physical ability components necessary for health promotion are endurance to continue the activities of daily living and muscle power to create movements.

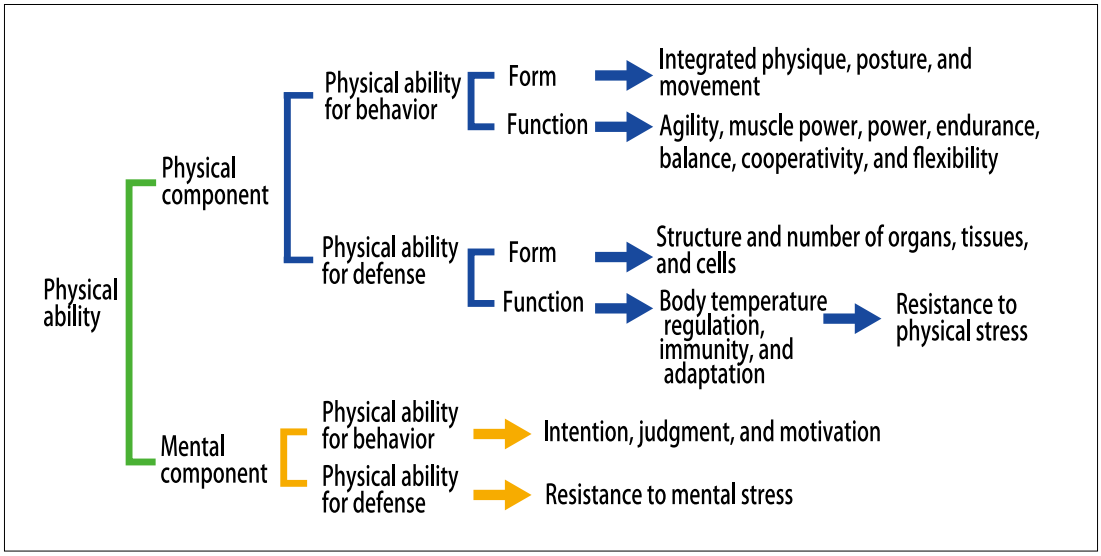


Figure 1. Components of physical ability Michio Ikai: Introduction to Exercise Physiology. 1963. Kyorin Shoin. p.144.[7]

2) Use of endurance and muscle power for health promotion

Aerobic capacity correlates negatively with NCDs. High aerobic capacity leads to the prevention of hypertension, decrease in electrocardiogram abnormalities during exercise, a lower degree of obesity, and lower incidence of dyslipidemia[1].

During the uptight walk on two legs, sufficient oxygenated blood must be delivered to the brain and the whole body against gravity. For thus, the heart pumping is supplemented by the contractile actions of skeletal muscles while the destination of the blood is adjusted by differentially contracting and relaxing blood vessels in the body. By stressing the systemic circulation with the stimulus of physical exercise, various regulatory systems are mobilized, such as neurological, humoral, chemical, and energy regulation required for exercise. The total mobilization of these regulation systems is thought to promote the secretion of neuromodulators, hormones, and enzymes that are beneficial for health promotion, together with the consumption of energy otherwise destined for storage. The beneficial effect can be enhanced by performing appropriate exercise on a daily basis.

Muscle power is mainly exerted by the movements of skeletal muscles and joints, which is an essential factor for producing ADL. ADL movements become difficult if the muscle power for the motion is insufficient. In recent years, skeletal muscle has been found to be an endocrine organ that secretes a bioactive substance called myokine. In addition, it has been reported that interleukin-6 (IL-6) is secreted not only in strenuous exercise that results in muscle damage and reconstruction, but also in milder exercise in which muscle damage enzymes are not detected in the blood, such as running. IL-6 has been shown to activate the energy metabolism of sugars and lipids and to be effective for the improvement and prevention of LRD's[9) 60].

These show that exercise is effective for the improvement and prevention of LRD's. However, it does not mean that persons with disabilities could exercise at random and expect its effect on health promotion. There are a few things to know before practicing an exercise that is effective for health

promotion.

3) What you should know before practicing an exercise for health promotion

(1) Understanding the energy production systems is helpful for adjusting the intensity and duration of exercise, leading to safe and effective exercise for health promotion.

Energy production by hydrolysis of adenosine triphosphate (ATP) is required for a person to exercise. The ATP is hydrolyzed to adenosine diphosphate (ADP) and inorganic phosphorus acid (Pi) by the action of ATPase, and energy is released in the process. The hydrolysis of ATP becomes the basis of muscle contraction, resulting in exercise. Before exercise, the synthesis of ATP from ADP is required, and its energy comes from anaerobic and aerobic energy production systems, according to the power exerted and exercise duration. They correspond to the ATP-creatine phosphate system (ATP-CP system) and the oxidation system, which are anaerobic, and the lactic acid system, which is aerobic (Figure 2)[1].

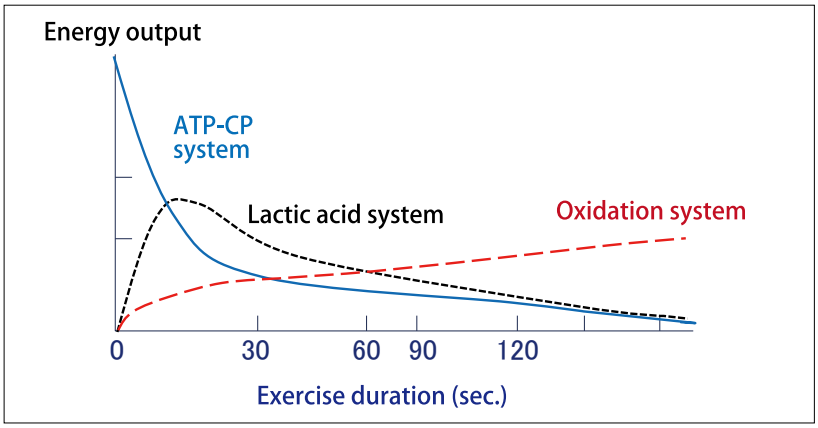


Figure 2. Relationship between energy supply system and exercise duration

Adapted from Masayoshi Yamamoto, Izumi Tabata: Muscle Energy Output and Physical Exercise Energetics. P113-205. 1989. Kobundo Shuppan[61]

Momentary muscle power is required to carry out most ADL. The ATP-CP system and lactic acid system are mainly used to exert muscle power, while the aerobic energy production system is important for repeating movements. Skeletal muscles, which enable movements, mainly use sugars and lipids as energy sources.

Notes about the functions of the energy production systems[1) 10)]

1. Energy production system utilized for ADL

In the ATP-CP system, creatine and phosphate in skeletal muscles bind to form creatine phosphate, which provides phosphate to ADP to resynthesize ATP.

In the lactic acid system, ATP is quickly produced in the process of rapid decomposition of glycogen in muscle into pyruvic acid and the reduction into lactic acid.

2. Energy production system necessary for health promotion and activities

In the aerobic system, glycogen in muscles, glucose in the blood, and glycogen in the liver are taken up by active muscles. They are then used for the TCA cycle and electron transport chain in mitochondria, and ATP is resynthesized by the use of oxygen. On the other hand, lipids resynthesize ATP via β-oxidation in mitochondria, and the adipose tissue of the whole body can also be used as an energy source. Thus, the capacity of lipids as the source of ATP resynthesis and energy is greater than that of sugars. The utilization rate of the energy production system changes depending on exercise intensity and duration. And the utilization of sugars and lipids becomes equal at about 50% of the maximum oxygen uptake ($\dot{V}O_2$ max). By reflecting this phenomenon in the exercise program for health promotion, we can adjust and select the intensity, duration, frequency, and type of exercise, which will likely promote the beneficial effects of exercise, such as the prevention and treatment of LRD's.

(2) Relationship between health promotion and physical fitness of persons with disabilities

1. Health specificity of persons with physical disabilities

The health status of persons with physical disabilities differs depending on the primary disease and the method of movement. Here, we will describe specificities of spinal cord injury (SCI), cerebral palsy (CP), and hemiplegia in cerebrovascular disease as examples.

a) Social life after SCI has dramatically increased over the last 40 years, and the LRD's, such as heart disease and cerebrovascular disease, have increased as the causes of death for persons with SCI[11]. These factors change body composition, such as skeletal muscle, body fat, and bones, leading to chronic lack of exercise due to a long-term decrease in the amount of physical activity (Figure 3)[24)25)31)]. Furthermore, abnormalities of abdominal visceral fat area, serum lipids, and bone mineral density (BMD) increase the probability of morbidity of LRD, which is enhanced by the adverse effect of lack of exercise[18)].

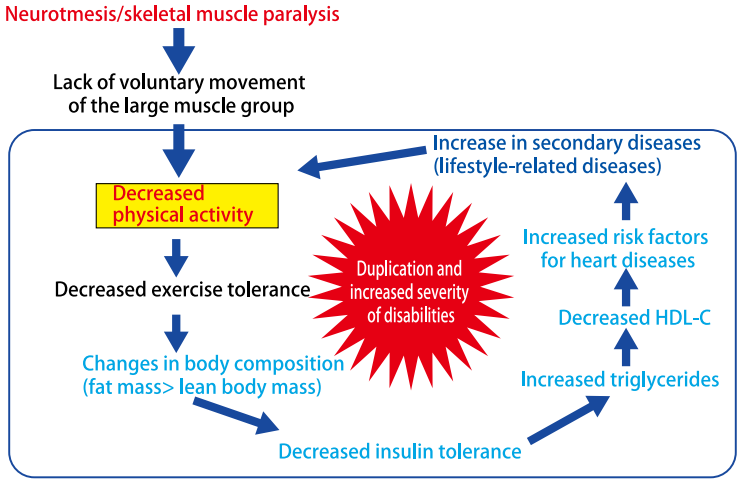


Figure 3. Vicious cycle model of inactivity resulting in chronic lack of exercise (in the case of spinal cord injury)

Washburn et al.: Spinal Cord 1999[31)]

b) Patients with hemiplegia exhibit many complications of LRD factors due to decreased exercise, in addition to disabilities and ADL. In persons with hemiplegia, movements in a wheelchair have about 1.5 metabolic equivalents (MET's), which is comparable to the value at rest [34]. Chronic lack of exercise contributes to secondary disabilities, such as reduction in the number of motor units mobilized for VO_2 max and exercise and reduced participation capacity of paralyzed muscles that restricts exercise performance[3)35)].

> *Metabolic equivalent (MET) is a quantified value of the intensity of various exercise and daily physical activities, with 1 MET being the state of sitting and resting[50)].
> For example, the exercise intensity of walking at normal speed (3.0 METs) is 3.0 times that of resting (1 MET).

c) Patients with CP exhibit adiposis, a decline in muscle power, a decline in aerobic and anaerobic exercise capacity, and decrease in exercise efficiency[3)]. A survey on LRD's and lifestyle showed that more than 50% of respondents had "poor condition" and that there were many LRD's-related items in the diseases that were being treated. In addition, many respondents complained pain in the neck, arms, or legs, and numbness mainly in the neck and arms. In terms of activities in daily living, 48% of respondents did not have a habit of regular exercise. Even for those who exercised regularly, its purpose was rehabilitation, and the main method of their health management was medical consultation[41)].

2. Characteristics of movements of persons with physical disabilities

Persons with physical disabilities have characteristic methods of movement. Their movements can be divided into wheelchair and walking in a standing position, such as walking with a cane or prosthetics and walking alone.

a) Wheelchair users have characteristic energy consumption due to the disabilities. The resting basal metabolic rate of persons with SCI is lower by 14-27% than healthy persons. It is lower than healthy persons who have walking movements in daily living[3) 9)]. Many wheelchair users are thought to be in a chronic lack of exercise due to low daily energy consumption caused by the decreased voluntary skeletal muscles, such as paralysis, and energy saving effect of the wheelchair during movement.

b) The movement of those who are able to walk in a standing position utilizes both the paralyzed and the healthy sides of the body. In persons with hemiplegia, the energy consumption of movement at a certain speed is higher than that of healthy persons. Furthermore, their oxygen uptake (VO_2) at a certain physical work capacity (PWC) is lower than that of healthy persons, and they have reduced exercise efficiency during walking[3)]. In addition, the walking of persons with CP is inefficient as they have higher energy efficiency during walking than healthy persons[3)]. Therefore, their low physical fitness and inefficient walking are thought to increase fatigue during movement.

(3) Effects of aging

Health promotion for persons with disabilities also needs to take aging into consideration. In terms of aging-related physical changes in the healthy people, $\dot{V}O_2$ max peaks in their 20s and then declines[1]. It has been reported that the probability of complaining about poor health conditions increases after the age of 70[36], and that about 30% will need nursing care due to the locomotive syndrome, which is a condition in which movement function decreases due to locomotor apparatus disabilities[8][37]. The aging-related decline in physical fitness and exercise function causes a major restriction in daily living. However, proper exercise and training can delay aging-related functional decline, as the 2018 physical fitness survey of the age group of 65-79 years old reported that the number of healthy elderly people increased compared to the previous survey[38].

On the other hand, the functional decline is more pronounced in the elderly with disabilities. Regardless of the age at the time of SCI, the body composition and physical fitness of persons with SCI decrease after more than 20 years of the injury. In particular, persons with SCI who do not have a habit of exercise have a high prevalence of LRD[18]. In addition, their body weight peaks in the 40s, likely enhancing the risk factors for metabolic syndrome in the age group earlier than in healthy persons[18]. On the other hand, regular exercise alleviates the effects of aging, as shown in an increase in muscle mass and reduction in diabetes risk factors, as in healthy persons[18].

In persons with CP, complications that hinder movements, such as cervical spondylosis and hip joint deformity, have been reported as aging-related secondary disabilities[3]. The maintenance and improvements in therapeutic approaches, lifestyle habits, and environment are being made for the prevention of these disabilities. However, an aging-related decline in overall physical fitness may appear earlier in persons with CP due to the lack of long-term exercise opportunities from a young age.

Thus, aging-related changes in activity function appear earlier in persons with various disabilities than in healthy persons. Secondary disabilities and chronic lack of exercise due to the characteristics of the disabilities contribute to the aggravation of serious conditions. However, regular exercise can lead to the prevention of functional decline in activity and help extend a healthy lifespan.

4) Quality of exercise for effective health promotion

(1) Exercise intensity

Setting exercise intensity appropriate for the physical condition and ability of each person is effective in health promotion, including improvements in lactate threshold (LT)[1], ventilatory threshold (VT)[1], and high-intensity interval training (HIIT). HIIT is a training method of repeating high-intensity and short-term acid-free exercise before complete recovery[26].

Aerobic exercise that uses LT as an exercise intensity index, which is derived from the changes point in the blood lactate concentration (blood LA) during the exercise load test, is considered safe and effective in the health promotion of persons with disabilities, considering the primary disease and physical symptoms (Figure 4). The LT intensity is equivalent to about 50% of $\dot{V}O_2$ max, and

it is also used in “Pace with a smile” exercises for the prevention and treatment of LRD, such as hypertension, angina pectoris, and myocardial infarction[1) 39)]. In addition, LT reflects sympathetic nerve activity as LA being above LT is synchronized with serum epinephrine, regardless of the part of the agonist muscle[28)] even in the exercise of arm and legs. It can also be monitored during exercise in persons with SCI, CP, and hemiplegia[11)], and the heart rate equivalent to LT intensity is approximately 100-120 beats per minute, which is comparable to that of healthy persons. On the other hand, some persons have difficulty exercising at LT intensity, such as those with cervical spinal cord injury (CSCI). For such persons, an exercise intensity lower than LT is used, which is called “Pace with a happy face” and known to have positive effects on muscular endurance and sugar metabolism[14)]. Therefore, low and medium exercise intensity equivalent to “Pace with a happy face” and “Pace with a smile” (with a heart rate approximately at 80-130 beats per minute) is considered desirable for the health promotion of persons with disabilities.

The health promotion of persons with disabilities also requires the maintenance and improvement of muscle power that supports ADL. Training can improve muscle power, even at the age of 90[12)]. Those aged over 60 years can maintain their muscle power by continuing training even if its intensity is about 20% lower than that of the training they normally perform[12)]. It is thought to be sufficiently effective even for persons with disabilities who have paralysis or low physical fitness. Therefore, in the health promotion of persons with disabilities, muscle power training with medium intensity may help to prevent functional decline in activity.

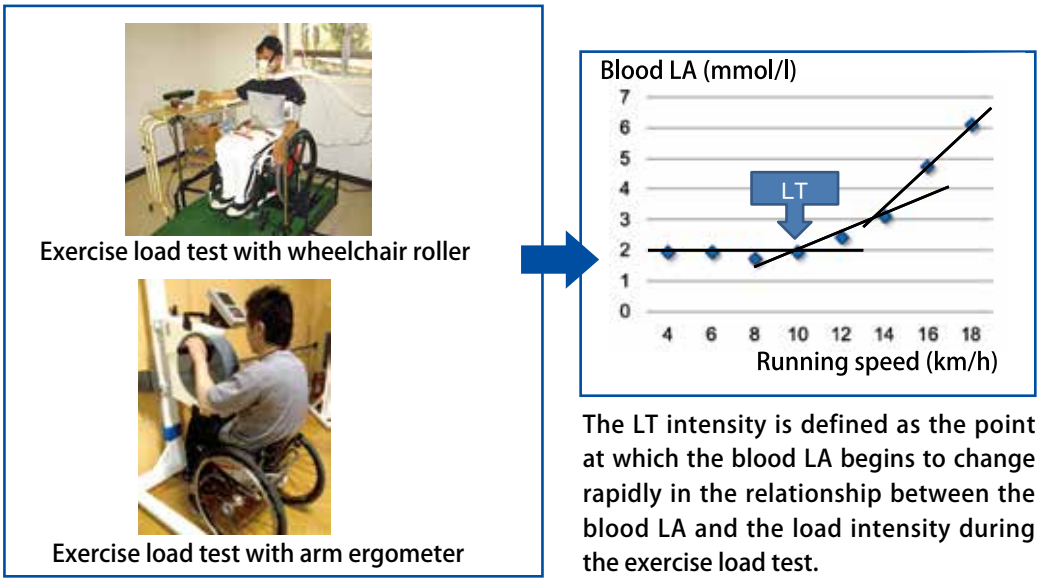


Figure 4. Calculation of exercise intensity that is useful for health promotion (LT intensity)

○ Method for checking exercise intensity

・Using a wristwatch-type heart rate monitor, the exercise intensity can be monitored continuously and adjusted to the situation.

・Exercise intensity can be easily checked by palpation. Immediately after exercise, the pulse rate can be checked by palpating the radial artery on the thumb side of the wrist (Figure 5). Then, the pulses are counted for 15 seconds, and the number is estimated the pulse rate during the exercise into the following formula pulse count for estimated pulse rate during exercise = 15 seconds × 4 + 10[1].

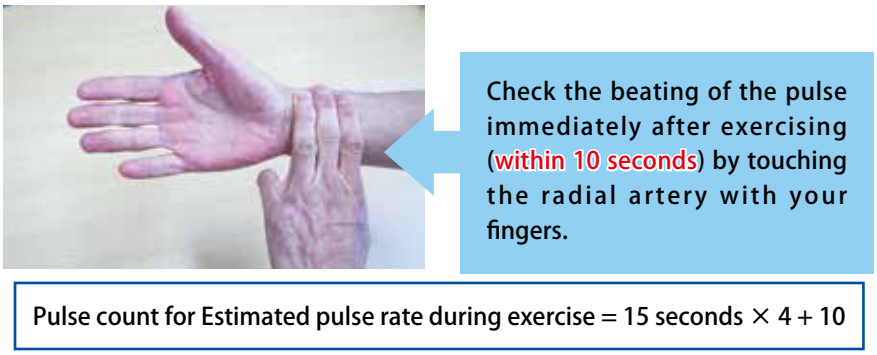


Figure 5. Measurement of the pulse and estimates of heart rate during exercise (simplified version)

For example, if the pulse count for 15 seconds was 27, the pulse rate during exercise is estimated to be 27× 4 + 10 = 118, which is equivalent to a “Pace with a smile”.

The subjective scale (Borg Scale) can be used if the heart rate cannot be obtained (Figure 6) [1]. This scale expresses the fatigue level of humans as a subjective symptom from “very easy” to “very hard,” with a numerical value of 6-20. Multiplying its value by 10 is said to be equivalent to the heart rate. On this scale, an intensity equivalent to 10-13 corresponds to a “Pace with a smile”.

On this scale, an intensity equivalent to 10-13 corresponds to a Pace with a smile.

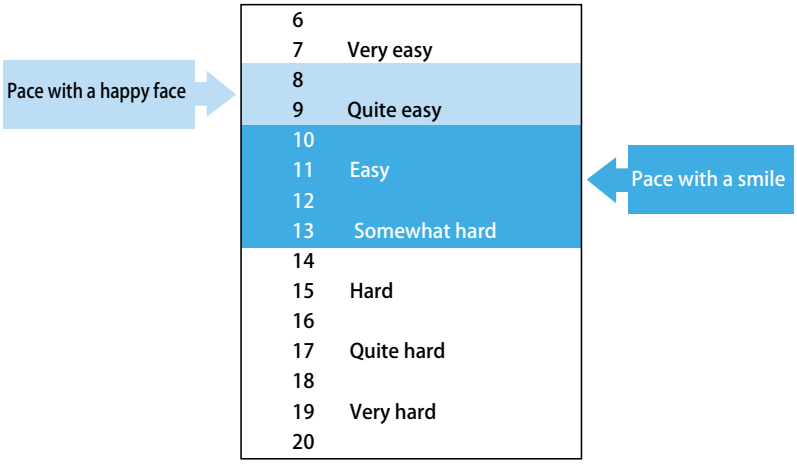


Figure 6. Subjective exercise intensity (Borgs Scale)

(2) Exercise duration

Exercise duration is also an important factor in health promotion.

Exercise guidelines for SCI recommend two sessions of medium- and high-intensity aerobic exercise a week, each for at least 20 minutes, for a total of at least 40 minutes[27]. In a study of 20 persons with SCI who did not have a habit of exercise, at least one session of "Pace with a smile" a week, each for 30 minutes or longer, for 3 months resulted in a significant decrease in abdominal circumference, arteriosclerosis index, and HbA1C[13]. In addition, 44 persons with disabilities performed low- and medium-intensity aerobic exercise at least three times a week, each for 20 minutes, for three months, and the exercise duration of 150 minutes per week resulted in a significant decrease in body weight and TG[15]. Based on a practical study of persons with disabilities, it is recommended to perform low- and medium-intensity aerobic exercises for at least 30 minutes a day and at least 150 minutes a week.

(3) Exercise frequency

When a person performs an exercise, the energy supply system of the body works to match the intensity of the exercise as soon as the exercise begins, mobilizing necessary organs. However, this energy supply system creates a debt called "oxygen deficit" or "oxygen debt" in providing a supply that matches the intensity of the exercise. This debt, causes (is paid back by) "excess post-exercise oxygen consumption (EPOC)" that keeps the resting oxygen uptake and heart rate after exercise significantly higher than before exercise for several hours and compensates for the debt energy after exercise[1)20)]. One of the effects of exercise is due to be the continuation of energy consumption performed by this compensatory action. Therefore, it is considered effective to perform an exercise every other day and at least three times a week.

5) Health-promotion exercise programs

In consideration of the specificity of the disabilities, movement method, physical fitness level, and age, we summarized the intensity, duration, and frequency of aerobic exercise essential for health promotion and muscle power training essential for the prevention of functional decline in activity (Table 1). Important issues in the exercise guidance are shown in Figure 7.

Table 1. Health-promotion exercise programs

		Endurance training (Aerobic exercise)					Muscle power training	
Movement method	Physical fitness level	Intensity	Duration		Frequency	Subjective scales	Intensity	Frequency
Wheelchair	With exercise restrictions	Plus 10 beats per minute	30 minutes or more/day	150 minutes or more/week	3-5 times	Somewhat hard	About 50% of maximum muscle power	At least one session a week
	Low	Pace with a happy				Easy		
	Normal	Pace with a smile				Somewhat hard		
Standing position	With exercise restrictions	Plus 10 beats per minute				Somewhat hard		
	Low	Pace with a happy				Easy		
	Normal	Pace with a smile				Somewhat hard		

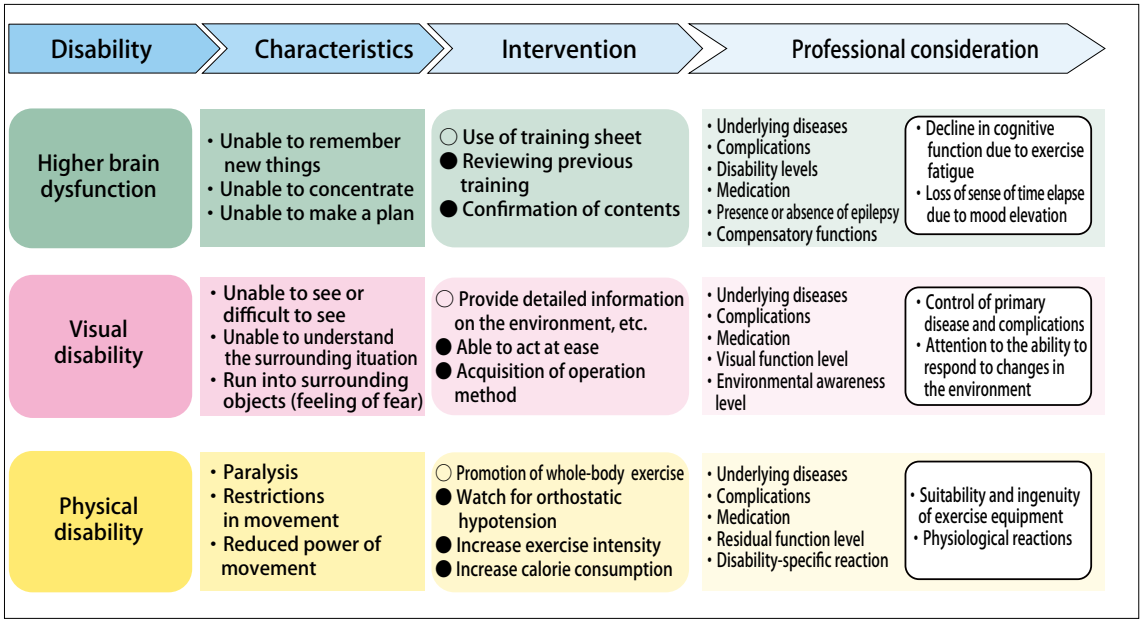


Figure 7. Important issues in exercise guidance according to the specificity of the disabilities (examples)

J. Musclosketal Medicine: 28(1):82-88, 2017[15]

6) Before starting a health-promotion exercise program

Before carrying out an exercise program related to health promotion, persons with disabilities are recommended to consult with a doctor and exercise specialists about the situations that could adversely affect the exercise practice due to secondary disabilities caused by their long-standing primary disabilities[4].

The recurrence rate of cerebral infarction increases year by year after the first onset[32]. The recurrence of myocardial infarction in the first year after the onset was reported to be 17.4%[33]. Persons with disabilities with a chronic lack of exercise require sufficient consideration for the risk of sudden death and recurrence of vascular diseases during exercise programs and recreation. Many wheelchair sports enthusiasts with SCI suffer from elbow and shoulder pain[17], which can interferes with exercise practice. Attention should also be paid to the risk of convulsion in persons with CP[19]. Therefore, medical examination a prior to exercise is essential.

It is recommended to participate in the health-promotion exercise program based on the examination and advice of doctors and exercise specialists. It is necessary to receive such examination and advice regularly to review the effects and situation of the exercise.

7) Group health-promotion exercise programs

Health-promotion exercise programs can also be practiced in a group format (Figure 8). Group programs often incorporate recreational sports but are characterized by the absence of emphasis on competition and outcomes. It is recommended to revise rules and tools dependent on the selection of events taking into consideration the characteristics of the group, personal tastes, environment, and mode of daily living. The specificity of exercise and exercise intensity should be examined for selecting an event. The intensity varies depending on the event and its duration; for example, about 10 METs for playing soccer for 45 minutes, 6.0 METs for playing basketball for 30 minutes, and 4.8 METs for performing a jazz dance for 30 minutes for those without physical disabilities[2]. With due consideration of the characteristics of disabilities of group members, the participants can adjust the activity and intensity and enjoy practicing the exercise by for example using a balloon instead of a soccer ball, using a basket on the floor instead of a basketball hoop, or performing a jazz dance using only limited parts of the body.

Ball game in wheelchair　　Rhythmic exercise of the upper limbs

Figure 8. Group health-promotion exercise programs

8) Health-promotion exercise programs adjusted to life stage

Figure 9 shows the changes in life stage through the senescence process while extending healthy lifespan from medical rehabilitation to social rehabilitation and then to daily living and social activities[43]. Health-promotion programs incorporate exercise adjusted to each recovery stage. In the health promotion of persons with disabilities, the practice of exercise program that reflects recovery stages also should incorporate ICF[6] and sustainable development goals (SDGs)[5].

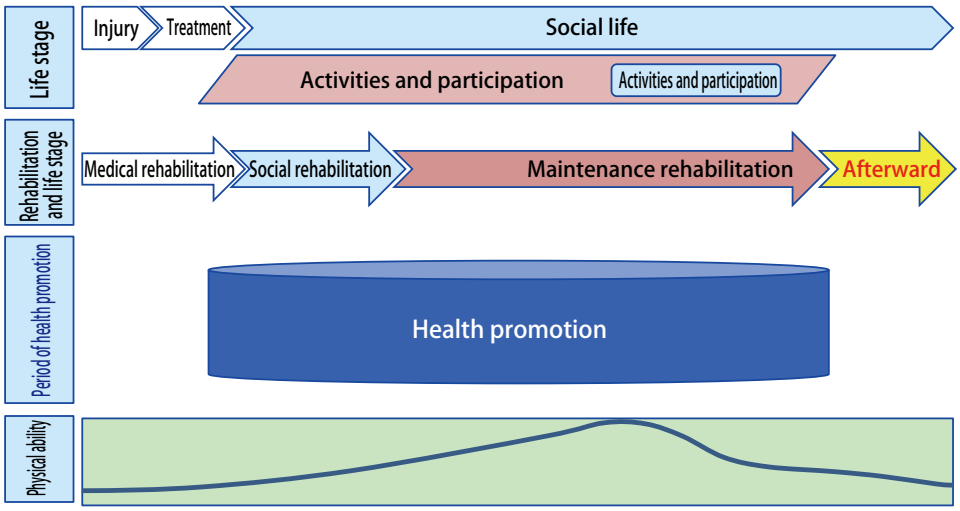


Figure 9. Implementation of health promotion according to life stage (in the case of persons with acquired disabilities)

Adapted from Yukiharu Higuchi. Japanese Journal of Rehabilitation. No. 168. 2016. p.40-43[43]

9) Exercise instructors

Exercise instructors who guide the health promotion for persons with disabilities must be familiar with sports medicine and health promotion for persons with disabilities. However, since in many countries, few specialists are involved in the health promotion of persons with disabilities, the development of specialists with the creation of curricula is urgently needed.

2. Health-promotion exercise program

To evaluate the effects of health promotion program on persons with disabilities, we recruited a total of 61 persons with higher brain dysfunction (higher group), visual disabilities (visual group), physical disabilities (wheelchair group, standing group), and intellectual and developmental disabilities (intellectual and developmental group) as participants in a health promotion program. Their exercise, nutrition, and life style were examined. They performed exercises at least once a week, each for 20 minutes or longer, at a “Pace with a smile.” As a result of the intervention, body weight, BMI (wheelchair group), abdominal visceral fat percentage (higher group, visual group), and abdominal visceral fat area (intellectual and developmental group) showed an effect of the health promotion

program. TG (intellectual and developmental group) and HDL-C (higher group, visual group) tended to increase. The results reflected the specificity of disabilities and movement methods[16].

1) Exercise intervention for persons with physical disabilities

(1) Effects of health-promotion exercise program on persons with spinal cord injury (SCI)

Twenty persons with SCI in the chronic stage were divided into a exercise-program practice group (6 persons), a sports practice group (8 persons), and a non-exercise group (6 persons). They were observed over three months. The exercise-program practice group performed exercise at a "Pace with a smile" at least once a week, each for 30 minutes or longer. As a result, the exercise-program practice showed a significant effect of exercise on arteriosclerosis index, HbA1C, and leptin[13].

(2) Effects of a health-promotion exercise program for a hemiplegic person after cerebrovascular disease

A male wheelchair user in his 40s with left hemiplegia due to cerebral hemorrhage underwent a health-promotion program utilizing a "Pace with a smile" exercise. As a result, his body composition, abdominal visceral fat area, blood pressure, and serum lipids decreased, while his aerobic capacity increased[42]. Through exercise interventions that take into account the characteristics of the disabilities and those of movement methods, the health-promotion exercise program is considered beneficial for the prevention and reduction of risk factors for secondary disabilities and lifestyle-related diseases in persons with disabilities.

(3) Exercise environment

Persons with disabilities often practice exercise in the public gymnastic halls, training facilities, hospitals, other commercial facilities, and at home. For persons with CP who have not had a habit of exercise, a barrier in exercising is identified as the lack of accommodating environment, such as "appropriate place to exercise" and "a knowledgeable instructor,"[41]. Ideally, exercise should be practiced in a facility that can be easily accessed with a wheelchair or a cane, an environment with training equipment that can be easily used, and a space in which smooth movements can be carried out.

On the other hand, exercise necessary for health promotion can often be performed in activities of daily living, and exercise that does not require equipment can be used in daily living. Selecting a mode of exercise that suits the living environment from the exercise program menu is thought to lead to an increase in the amount of physical activity. Examples of the mode of exercise are described in the following section.

(4) Modes of exercise

1. Aerobic exercise with equipment

a) Wheelchair exercise (examples)

• Arm ergometer

This exercise can be performed in a sitting position as well as in a standing position. It enables pedaling exercise using the muscles of the upper body (Figure 10-1). Exercise load and monitor heart rate can be easily quantified, and the exercise effect can be easily predicted. The arm ergometer shown in Figure 10 has an improved handlebar that can be easily moved even by persons with reduced grip force (Figure 10-2). In addition, since the exercise program is for health promotion, the maximum load should be set to about 50 watts or below. The exercise should be devised to have about 3 METs, which does not make a high load.

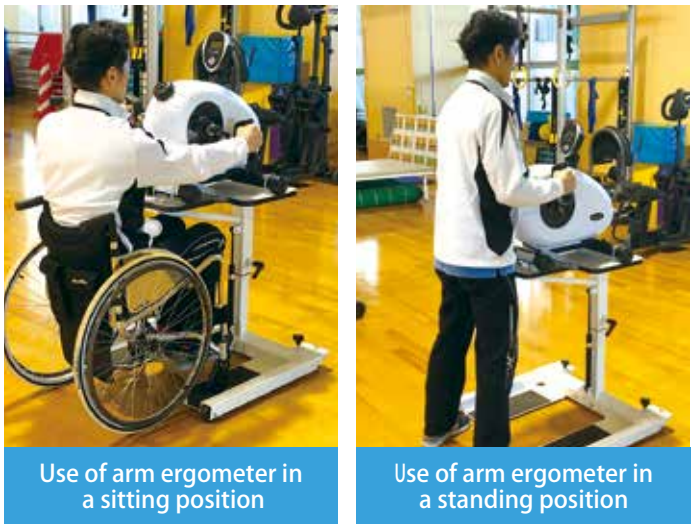


Figure 10-1. Arm ergometer
(manufactured by Yamato Sports)

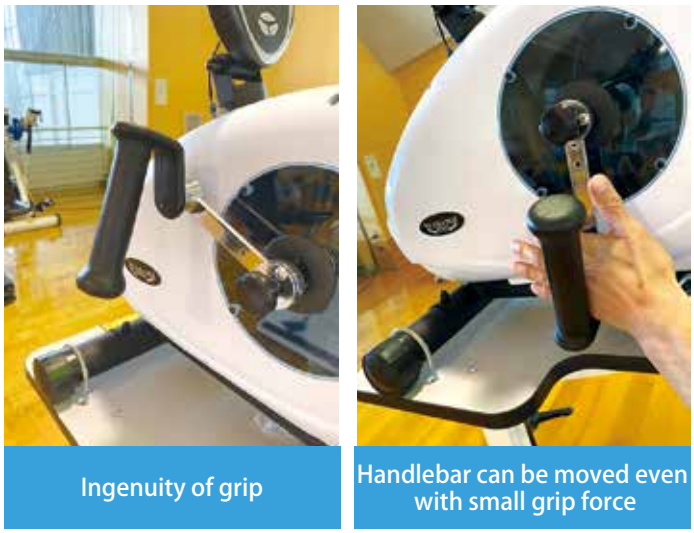


Figure 10-2. Ingenuity of arm ergometer
(manufactured by Yamato Sports)

• Passive bicycle ergometer

Automatic pedaling exercise with a built-in electric motor (Figure 11) has a positive effect on the cardiovascular system, musculoskeletal system, and nervous system, such as an increase in venous return and an increase in the reactive contraction of skeletal muscles due to the stretching effect, compared to resting[40) 50)]. Persons with physical disabilities who have difficulty in rhythmic pedaling exercise due to a decline in muscle power can perform the exercise continuously, supplementing the lack of muscle power, and can use it as endurance exercise. With the exertion of kicking power, exercise with about 2.0 METs could be achieved.

Figure 11. Passive bicycle ergometer
(MOTOmed viva1: manufactured by Reck)

• Wheelchair roller

Exercise close to actual running can be achieved by using the indoor running equipment as shown in Figure 12-1. It is also effective for persons who want to practice wheelchair operation. As shown in Figure 12-2, the wheelchair is prevented from drifting away and meandering while driving, with two rollers of a diameter of 15 cm and a width of 76 cm installed is parallel at a distance of 5 cm, while it is fixed to the frame with a belt.

The duration, running speed, and running distance are indicated by a meter, and a friction belt is attached to the roller so that the load can be adjusted. This kind of running equipment can be used for an exercise program. When driving without frictional resistance load, exercise with about 2-8 METs can be achieved depending on the running speed.

Figure 12-1. Wheelchair roller

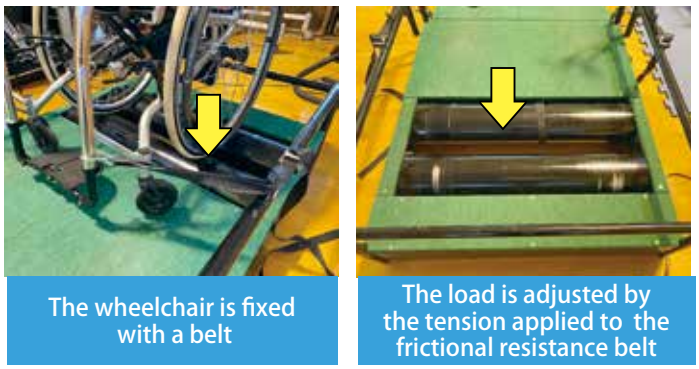
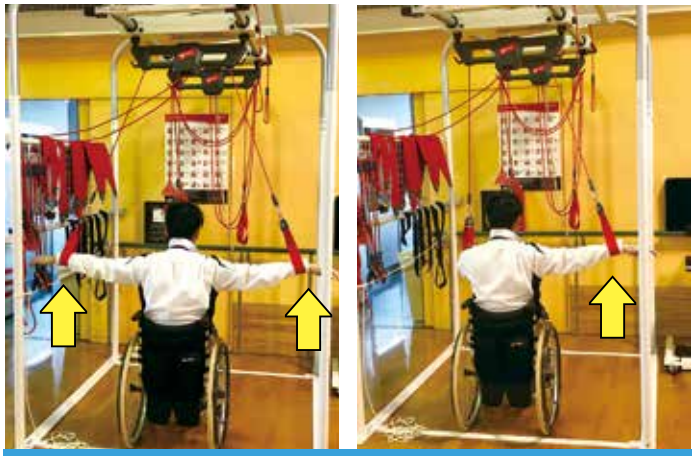


Figure 12-2. Ingenuity of wheelchair roller

• Unburdened exercise (Figure 13)

This exercise supplements the residual function of the upper limbs of persons with severe disabilities, such as those with upper limb disabilities, leading to endurance exercise. The improvement in the cardiovascular system and metabolic system can be achieved with low-output muscle power. In this exercise, heart rate can be increased by 10-20% from the resting level by rhythmically moving the voluntarily contractible muscles of the upper limbs and adjusting the number and duration of movements, number of sets, and degree of unloading. Exercise with about 2 METs can be achieved.



Example) The person pulls the elbows and wrists, adjusts the load according to the residual function and muscle power, and performs rhythmic singing exercise within the range of movement while supplementing the muscle power of the shoulders and arms

Figure 13. Unburdened exercise

b) Standing exercise (examples)

• Walk-like exercise (EasyStand glider)

This is a walking-like exercise that combines and synchronizes the rhythmic pushing exercise of the upper limbs and linked passive exercise of the paralyzed lower limbs (Figure 14). Although it is a highly effective aerobic exercise, there are risks of orthostatic hypotension symptoms, injury due to limited range of joint movement of the lower limbs, and incontinence due to abdominal stimulation, and prior explanation and monitoring are required[30]. Exercise with a maximum of about 5 METs (equivalent to running at an easy trot of a healthy person)[30] can be achieved, even by a quadriplegic person with C6 SCI.

Figure 14. Walk-like exercise
(Easystand Glider: manufactured by Altimate Medical)

• Leg ergometer

Leg ergometer is a fixed bicycle that enables pedaling exercise (Figure 15). Its advantage is that it can adjust the load. The exercise can also be performed while monitoring the pulse rate, running distance, and pedal rotation speed, and they should be adjusted as appropriate for the physical condition even during exercise. In addition, in our health-promotion exercise program, the exercise is often carried out with a load of 2.0-5.5 METs or lower depending on the condition of the person. In this exercise, it is crucial that the person is able to maintain balance in a sitting position and move up and down on the ergometer.

Figure 15. Leg ergometer

• Upper and lower limb combined bicycle ergometer (Figure 16)

This equipment allows a person to perform a pedaling exercise for the upper and lower limbs simultaneously. Whole-body aerobic exercise using this equipment is effective for persons with an unstable standing posture. This exercise can be performed by those who cannot maintain balance in a sitting position on an ergometer or have difficulty moving up and down on an ergometer. On the other hand, it is necessary to pay attention as it may increase pain and numbness due to the accompanying joint movement if the ranges of movement of the lower and upper limbs are different from the range of motion of a pedal exercise.

Figure 16. Upper and lower limb combined bicycle ergometer

In our health-promotion exercise program, the exercise is often carried out with a load of 2.0-5.5 METs or lower according to the condition of the person.

2. Aerobic exercise without equipment

a) Wheelchair exercise (examples)

• Continuous exercise of the upper limbs

Figure 17 shows a rhythmic exercise that can be performed in a sitting position. Utilizing the muscles of the upper body, this exercise is performed at a rhythm that can be maintained for a certain period of time within the range of joint movement. In this exercise, the load can be adjusted by moving the upper limbs rhythmically and changing the number of movements, duration, number of sets, and the use of dumbbells, and exercise with up to about 3 METs can be achieved.

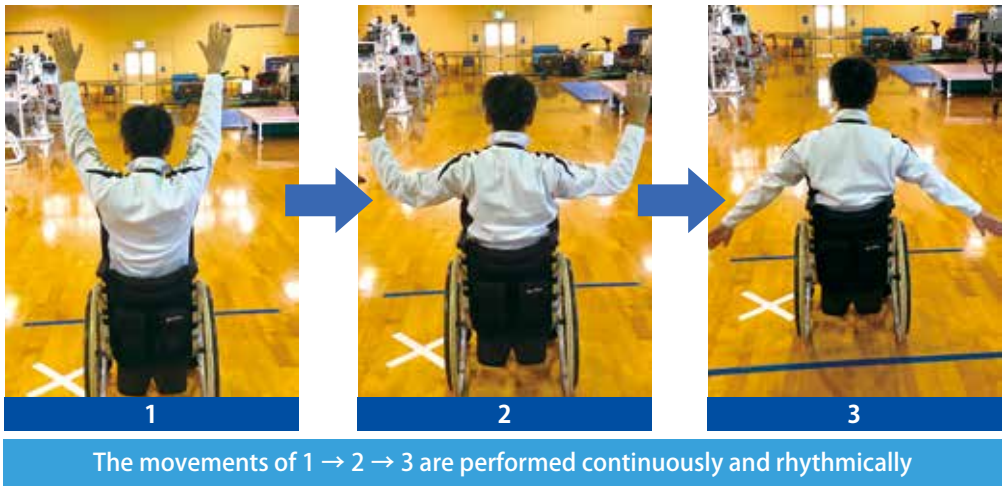


Figure 17. Continuous exercise of the upper limbs

• Jogging with a wheelchair

Jogging is the easiest exercise that can be practiced indoors or outdoors (Figure 18). However, it is essential to learn wheelchair operation skills for safe running first. The intensity of this exercise varies depending on the speed and movement method, and exercise with about 2-5 METs can be achieved.

Jogging on wheelchair
(environment with good visibility)

Figure 18. Jogging

• Shuttle jogging

A person can jog by moving back and forth within the distance he/she can run (Figure 19). Because the speed increases as the person gets used to running, safety precaution is important against falls and collisions. The intensity of this exercise varies depending on the running speed and the driving pace. Exercise with about 2-6 METs can be achieved.

Figure 19. Shuttle jogging

• Slow jogging & stopping

Slow jogging & stopping (Figure 20-1) [21] in a wheelchair is the improved type of slow jogging & turning exercise[29] that can be performed in a wheelchair. Although this exercise has a low running speed, its subjective scale corresponds to 13 or "Somewhat hard" on the Borg Scale. When practicing this exercise, it is important to caution about falling due to backward movement. The installation of the anti-tumble bar shown in Figure 20-2 leads to the prevention of backward falls. The intensity of this exercise varies depending on the running speed and driving pace. Exercise with about 2-7 METs can be achieved.

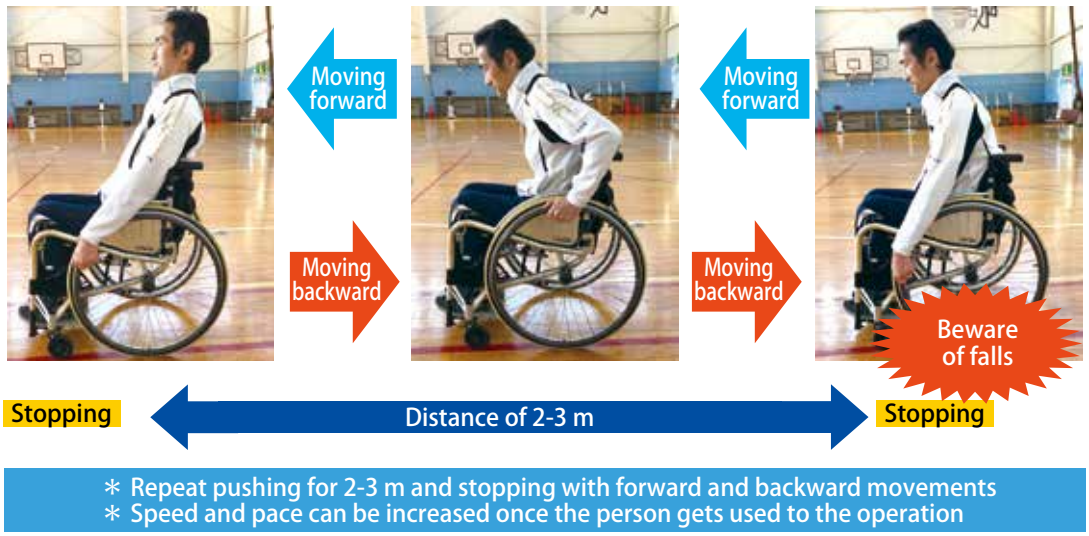


Figure 20-1. Slow jogging & stopping

Adapted from Higuchi: MB Med Reha No.253:37-42. 2020[21]

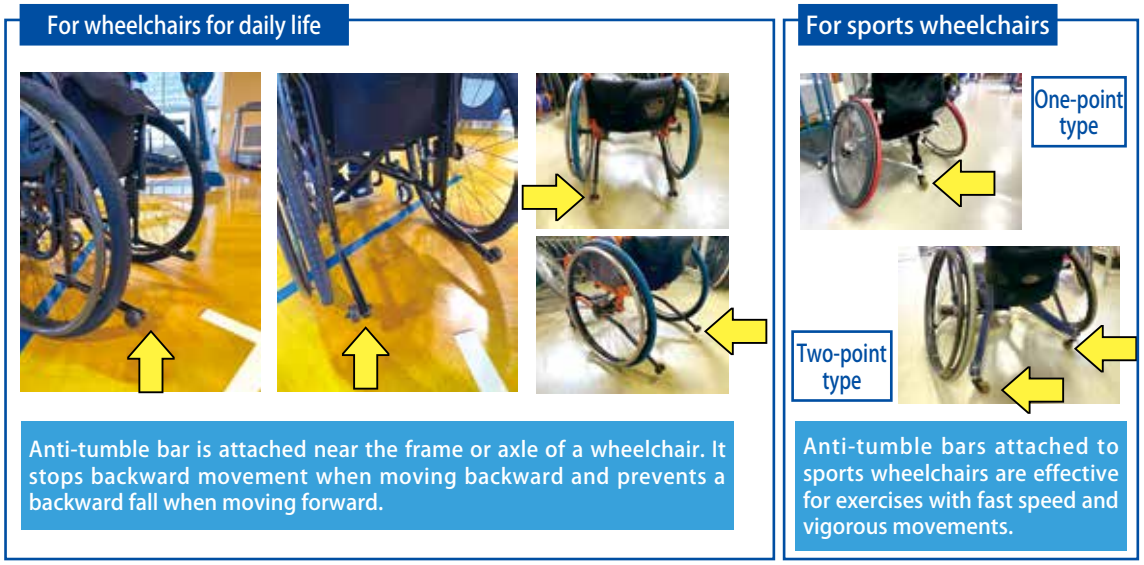


Figure 20-2. Anti-tumble bar

b) Exercise in a standing position

• Walking

Walking is the easiest exercise to practice indoors or outdoors (Figure 21), and can be easily practiced in daily living. However, it is important to pay attention to walking speed for safety and to avoid falls. The intensity of this exercise varies depending on the walking speed, pace, and terrain. Exercise with about 2-5 METs can be achieved.

Walking with a cane
(environment with little unevenness)

Figure 21. Walking

• Step exercise

This exercise repeats climbing and descending from a stand or a step with a height of about 5-30 cm (Figure 22).

The exercise is effective for maintaining and improving leg muscle power and whole-body endurance by adjusting the height to safely repeat up-and-down movement while paying attention to falls. Optimal exercise intensity can be set by adjusting the heart rate, the height of the step ladder, the number of steps, and the duration. When performing the exercise, it is also important to prevent falls by holding handrails or parallel bars. The intensity of this exercise varies depending on the height of the step, pace, and duration. Exercise with about 4-6 METs can be achieved.

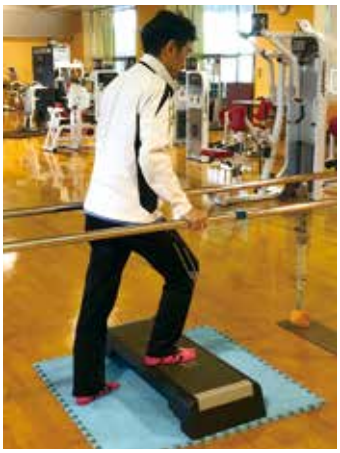


Figure 22. Step exercise

• Step & stamping exercise

As shown in Figure 23, this exercise repeats steps back and forth and left and right while holding on to parallel bars or handrails. Since stamping exercise does not involve movement this, aerobic exercise can be performed even by those who have difficulty in walking or step exercise. The intensity of this exercise varies depending on the height at which the legs are raised, stride, pace, and duration. Exercise with about 4-5 METs can be achieved.

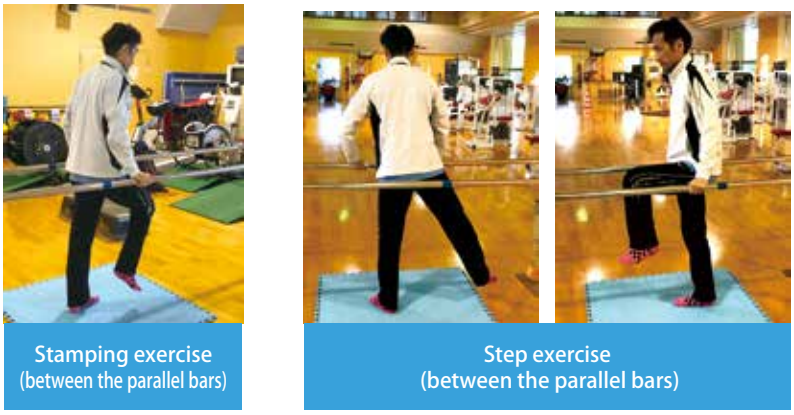


Figure 23. Step & stamping exercise

3. Muscle power training with equipment

• Muscle power training machines

Using the training equipment shown in Figure 24, muscle power and endurance can be effectively maintained and improved by applying a load to target skeletal muscles. Those who are inexperienced in movement can also use this equipment for movement learning. However, efforts for injury prevention are needed, such as paying attention to transfer activity and range of joint movement.

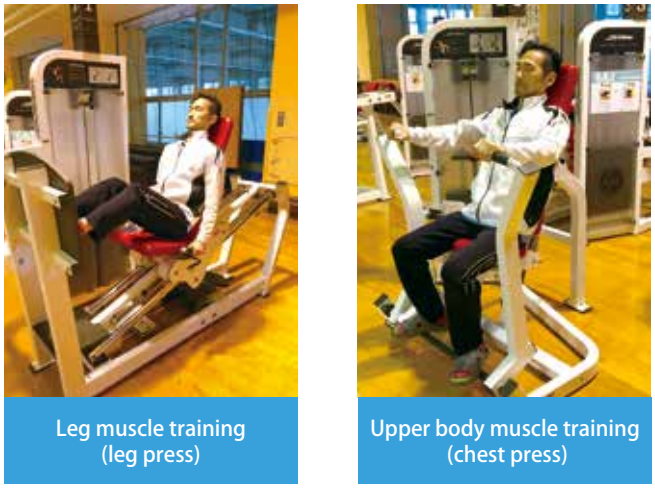


Figure 24. Muscle power training machines

• Free-weight training equipment

Muscle power training can be easily performed by using sandbags and dumbbells. However, correct movements and postures need to be mastered for injury prevention, and it is recommended to use the equipment with the assistance and supervision of an instructor until the person becomes familiar with its operation.

4. Muscle power training without equipment

• Self-weight training

Self-weight training that uses his/her own body weight (Figure 25) is also effective. Most of the self-weight training use the movements taught in the rehabilitation of activities of daily living. Squatting exercise, which mainly trains quadriceps, and calf raise, which trains the triceps surae by repeating the heel-raising exercise, help maintain and improve the muscle power of the lower limbs. When performing the training, it is important to prevent falling by using auxiliary tools, such as parallel bars. Push-up movement can be performed on a wheelchair or bed, and it can be used to maintain and improve the muscle power of the upper limbs. Self-weight training is effective for maintaining and improving daily activity functions when a developed training environment or guidance is not available.

Figure 25. Self-weight training

2) Exercise intervention for persons with visual disabilities

Persons with visual disabilities have barriers that interfere with their daily living due to a lack of sufficient information obtained from their eyesight. The disability causes various psychological problems and social losses due to the inability or difficulty in seeing[44]. It causes restrictions on movements and activities, such as a decrease in walking speed due to the decreased information of the surrounding conditions[45], leading to a decrease in physical activity. In addition, the practice rate of sports and recreation in persons with visual disabilities is low at about 20%[46], and many of them are thought to have a chronic lack of exercise. Our survey showed that persons with visual disabilities have

a high sense of health and that many lead disciplined life. Many have to continue to receive treatment for diabetes or hypertension, and they tend to rely on medical institutions for health management[47]. Based on these factors, it is essential for persons with visual disabilities to prevent and improve on secondary disabilities due to chronic lack of exercise.

(1) Current state of health promotion for persons with visual disabilities

Aiming to resolve this current state, we continue to examine health-promotion programs for persons with visual disabilities. As a first step, we provide guidance on exercise, life, and nutrition to eliminate obesity caused by lack of exercise. In particular, our exercise program places emphasis on providing the "Pace with a smile" exercise, which has an appropriate exercise intensity. In order for persons with visual disabilities to exercise regularly, disability specific support should be provided, such as movement support by explaining the surrounding environment in advance and schedule support. Supplementing the lack of visual information caused by the disability, supports the daily living and allows them to move at ease, leading to the practice of regular exercise. It has been found that exercise intervention that ensures at least 120 minutes of exercise per week is effective for reducing body fat.

Health promotion can be practiced by conducting a proper exercise program based on the characteristics of disability. In this chapter, we will describe the methods and important points for conducting health-promotion exercise programs that take into individuality of persons with visual disabilities at home and facilities.

(2) Preparations required prior to exercise guidance

It is difficult for persons with visual disabilities to move in their surroundings and avoid danger as they lack visual information. It is crucial to use guide help for their movements and activities. It is also important to ensure the safety of the place where they exercise and to provide information that is easy for persons with visual disabilities to understand.

1. Support for movements and activities using guide help*1

It is difficult for persons with visual disabilities to move alone in places with which they are not familiar. Therefore, it is necessary to use guide help, and they require support to move from home to the exercise facility by a specialized guide helper*2. Establishing a support system that enables persons with visual disabilities to move and carry out activities safely would increase their exercise opportunities.

---

*1 Guide help (movement assistance): In this manual, this refers to the human guidance for those with visual disabilities to the destinations of their safe and comfortable outing[48].

*2 Guide helper: In this manual, this refers to a person who assists the movement of those with visual disabilities.

2. Ensuring the safety of the places for exercise

To ensure safety, two things are essential: “environmental improvement” carried out by instructors and “environmental awareness” that gives a spatial image to persons with visual disabilities.

a) “Environmental improvement” carried out by instructors

Preparations

1. Secure a movement route (guideline).
2. Do not put anything on the floor that may cause a fall.
3. Cover the grooves and gaps that may lead to a fall.
4. Move away protruding objects or objects that may come into contact.
5. Cover immovable equipment with cushioning materials.
6. Isolate dangerous areas by partitioning.
7. Use curtains to adjust the light from the outside and avoid a bright environment.

Things to keep in mind

1. Develop a safe activity environment in order to prevent accidents and injuries.
2. Check the safety of the equipment.

b) “Environmental awareness” that gives a spatial image for persons with visual disabilities

Preparations

1. Inform the entire environment, such as the size of the room for exercise implementation and the location of objects.
2. Have the persons with the disabilities confirm the hardness and size of the tools to be used by touching them as a whole.
3. Inform the operation and trajectory of machines.

Things to keep in mind

1. Environmental awareness should be carried out in advance to reduce fear due to lack of information.
2. Check in advance whether the parts to be touched are damaged, and if so improve them.

(3) Provision of information that is easily understood

1. Specific explanation in words[48)]

- When communicating with persons with visual disabilities, refrain from giving abstract instructions, such as “it,” “this,” and “that,” and use more specific expressions that are not ambiguous.
- All explanations should use expressions seen from the perspective of the person with visual disability. They become more specific when the distance is added based on “left and right,” “up and down,” and “front and back.”

- When explaining movements, use expressions that make it easy for the person to imagine the movements, such as “grasping” and “throwing quickly,” and use words of the objects and movements that the person is familiar with.

2. Additional information through tactile sensation
- Information can be more easily understood if movements and tactile sensation are added to oral explanation.
- Speed, movement, and force can be easily understood by using tactile sensation between the instructor and the person with visual disabilities, such as touching and moving hands and shoulders.
- Since touching increases the risk of infectious diseases, its prevention is also important.

3. Provision of location information with sound
- The direction and distance to the target can be indicated by using sound, such as clapping hands, whistling, and hitting objects.
- Use of sound is effective for guiding from a distant position.
- The sound should originate from the direction of travel, and it should be easily identified by the exercising person.

4. Explanation of directions using the dial of the clock
- Information can be provided by using the dial of an analog clock.
- Information is provided in the form of the person standing in the center of a horizontal clock.
- Direction can be easily recognized by using the position of the numbers on the clock.
- For example, 12 o’clock is on the front, 3 o’clock is on the right, 6 o’clock is on the back, and 9 o’clock is on the left.

3) Practice and effectiveness of exercise programs for persons with visual disabilities

The intensity of the Pace with a smile exercise was found to be effective for eliminating obesity in persons with visual disabilities[49]. In the case of persons with visual disabilities who have reduced daily physical activity, the effect can be brought about by providing an opportunity to exercise safely with appropriate exercise intensity. Based on this principle, we created exercise programs for persons with visual disabilities and examined their effects and points to be addressed in the exercise programs (Table 2).

Table 2. Common points of health-promotion exercise programs for persons with visual disabilities

	Aerobic exercise			Muscle power training	
Status	Intensity	Daily duration	(total)Weekly duration	Intensity	Frequency
Low physical fitness	Pace with a happy face	10 minutes or longer/day ＊Be active 10 minutes longer than usual	70 minutes or longer/week	About 40% of maximum muscle power	1-2 sessions/ week
Persons with lifestyle-related diseases	Pace with a smile	20 minutes or longer/day	120 minutes or longer/week	About 50% of maximum muscle power	
Maintenance and promotion of health	Pace with a smile	30 minutes or longer/day	150 minutes or longer/week	About 50% of maximum muscle power	

(1) Practical examples of an exercise program for persons with low physical fitness or ADL dependence

The exercise programs shown in Table 3 were practiced by five persons with visual disabilities. As a result, those who completed an active schedule (120 minutes or longer per week) showed improved body weight, body fat percentage, abdominal circumference, triglyceride, and HDL-cholesterol. Their subjective physical condition and health status improved as well.

The exercise program needs to be practiced according to the principles of intensity, duration, and frequency. These principles were supplemented by schedule support appropriate for the level of daily living of the persons with visual disabilities. This schedule support requires the consideration of the specifics of the disability and the level of daily living, and the points of focus for the intervention are summarized below.

Things to keep in mind for active schedule support

- Set sufficient time for moving and changing clothes before exercise.
- Maintain the same environment and schedule to practice the exercise and make it a habit.
- Confirm the schedule in advance by distributing it at least one week prior to the exercise.

Table 3. Exercise programs for persons with low physical fitness or ADL dependence

Item	Content	
Type of exercise	Aerobic exercise	Muscle power training
Mode of exercise	Bicycle ergometer	Machine
Exercise intensity	Pace with a happy face (persons with low physical fitness) Pace with a smile (ADL persons with dependence)	About 60% of maximum muscle power
Exercise frequency	2-5 days/week	1-3 days/week
Exercise duration	50 minutes/session (100-250 minutes/week)	20 minutes/session (20-60 minutes/week)
Intervention period	4 months	

(2) Practical example of an exercise program for persons with severe obesity

The exercise program shown in Table 4 was carried out by a person with visual disability who had a visual acuity of light perception in the right eye and hand motion in the left eye. It resulted in an improvement from the severe obesity category to the mild obesity category, and maximum oxygen uptake improved to the level of the age average. The weight loss goal was to practice aerobic exercise for at least 120 minutes per week. It is essential to take into account the physical fitness, exercise history, and specifics of the disabilities for the selection of aerobic exercise events. The points of focus for the exercise guidance are summarized below.

Table 4. Exercise program for persons with severe obesity

Item	Content
Type of exercise	Aerobic exercise
Mode of exercise	Treadmill
Exercise intensity	Pace with a smile
Exercise event	Slow jogging: A combination of low-speed walking at 4 km/h and step exercise
Exercise frequency	3 sessions a week
Exercise duration	40 minutes/session (120 minutes or longer per week)
Intervention period	4 months

"Slow jogging + step exercise" refers to an exercise method that combines low-speed walking at 4 km/h on a treadmill and step exercise.

【Things to keep in mind when performing an exercise event】

- Give consideration so that they do not feel anxious or fear full.
- Start with an event that can be performed on one spot.
- Events should be highly reproducible and do not require special skills.
- Introduce events that can be performed at ease.
- Breaks should be take at the timing of the performer.
- Create an environment that allows independent movement and operative.

4) Exercise items for persons with visual disabilities

We will introduce items of aerobic exercise and muscle power training that persons with visual disabilities can practice in a health-promotion exercise program, as well as their advantages and disadvantages.

(1) Aerobic exercise

Aerobic exercise increases endurance, making the person feel less tired in daily living. It is also effective for preventing life-related diseases as it enables the person to walk and perform physical

activity for a longer period of time.

1. Aerobic exercise that can be performed alone (at home)

We will introduce the advantages and disadvantages of home aerobic exercise, as well as items of the exercise.

Advantages

- The exercise can be started anytime without having to prepare equipment or tools.
- The exercise can be practiced anywhere (indoor or outdoor).
- The exercise can be started even in a short amount of time.
- The exercise can be incorporated into the schedule, such as between daily activities.
- The exercise can be practiced at one's own timing independently of the surrounding environment.

Disadvantages

- There are restrictions related to the exercise environment, and the items are limited.
- The exercise intensity and movements need to be adjusted according to one's physical condition.

Exercise items

○ Stamping (Figure 26)

Target persons: Those who have low physical fitness or who are planning to start an exercise.

Purpose: To maintain and improve endurance and to increase the amount of physical activity.

Support body balance with a handrail or desk and be careful of imbalances and falls

Figure 26. Aerobic exercise (stamping)

Methods:

- Relax your shoulders, face forward, and stand in a good posture.
- Stamp on one spot.

• Bend your elbows lightly and shake your arms as much as you would when walking.
• Breathe in a natural rhythm.

Points of attention:

• Raising a thigh too high makes it easier to lose balance.
• Do not step hard and relax when practicing the exercise.
• Hold a handrail or a stable stand and be careful not to fall.

Exercise intensity: about 3 METs[51)]

○ Stepping up and down (Figure 27)

Target persons: Those who would like to prevent obesity or to increase the amount of physical activity.

Purpose: To maintain and improve muscle power and endurance, to increase the amount of physical activity, and to prevent lifestyle-related diseases.

Figure 27. Aerobic exercise (stepping up and down)

Methods:

• Use a stand or step, such as stairs.
• Touch the wall or handrail with one hand.
• Get onto the stand with one foot, like going up the stairs.
• Raise the other foot onto the stand and stand upright on both feet.
• Step down from the stand with the foot that was first raised on the stand.
• Return the other leg to the original upright position.
• You move forward when climbing the stand, and move backward when descending from the stand.

Points of attention:

• Start with a low step.
• Be sure to touch the wall or handrail to check your position.

• When stepping down, check the floor behind with your feet before landing.
• Beware of falling backward.
• Hold a handrail or a stable stand, and be careful not to fall.

Exercise intensity: about 3.5 METs[51)]

○ Jogging on one spot (Figure 28)

Target persons: Those who would like to lose weight or to improve their physical fitness.

Purpose: To maintain and improve endurance, to increase the amount of physical activity, and to prevent and improve lifestyle-related diseases.

Support body balance with a handrail or desk and be careful of imbalances and falls

Figure 28. Aerobic exercise (jogging on one spot)

Methods:

• Touch the wall or handrail with one hand.
• Jog on one spot.
• Raise your feet lightly to a height of 1-2 cm from the floor.
• In terms of pace, move your legs in small steps with a constant rhythm.
• Bend your elbows lightly and swing your arms slightly.
• Practice this exercise in a relaxed state.
• Practice this exercise as you breathe in a natural rhythm.

Points of attention:

• Keep the speed of light panting.
• Check the position by touching the wall or handrail until a certain position is maintained.

Exercise intensity: about 8 METs[51)]

2. Aerobic exercise for two people (at home)

We will introduce the advantages and disadvantages of home aerobic exercise for two people, as well as items of the exercise. The partner should be a sighted person.

Advantages

- You can talk and have fun while practicing the exercise.
- You can have fun and practice the exercise for a long time.
- Both partners can be healthy.
- It leads to motivation to practice and continue the exercise.

Disadvantages

- The schedule needs to be coordinated with a partner.
- The exercise can be practiced only to the extent of the partner's exercise capacity.

Exercise items

○ Stamping with a partner (towel or pole) (Figure 29)

Target persons: Those who have low physical fitness or who are planning to start an exercise.

Purpose: To maintain and improve endurance, to increase the amount of physical activity, and to perform an aerobic exercise in pairs with fun.

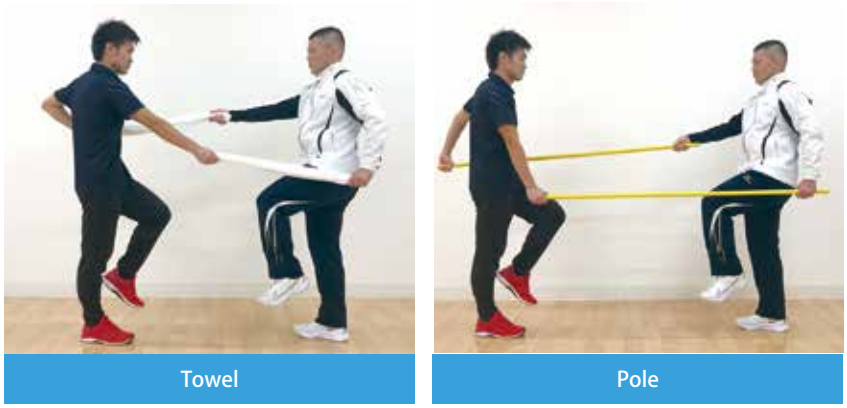


Figure 29. Aerobic exercise with a partner, stamping on one spot (towel and pole)

Methods:

- Stand facing the partner.
- Hold a towel or another item with the partner.
- Stamp on one spot.
- Bend your elbows lightly and shake your arms to pull the towel back.

Points of attention:

- Do not raise thighs too high.
- Do not stamp heavily.
- Do not forcefully pull the towel that the partner is holding.
- The speed of the partner is adjusted to that of the person with visual disabilities.

Exercise intensity: about 3 METs[51)]

4. Aerobic exercise that uses equipment (at exercise facilities)

We will introduce the advantages and disadvantages of aerobic exercise using equipment at exercise facilities, as well as the events of the exercise.

Advantages

- Various adjustments to the equipment can be made to suit the target person.
- Many types of equipment are installed in exercise facilities.
- Exercise content can be set based on heart rate and time. In addition, the duration, distance, calories, speed, rotation speed, and heart rate are measured, making it easy to set training standards.
- You can also practice walking and running.
- The exercise can be practiced with constant speed and rhythm.
- The load can be adjusted by speed, load, and inclination.
- The exercise can be practiced for a long period.

Disadvantages

- There is no audio display, and the characters displayed on the LCD screen are small and difficult to see.
- It requires confirmation by an assistant.
- Many types of equipment have touch panels, which are difficult to operate independently.
- A safe posture cannot be maintained unless the equipment is held by hands.
- Fear of stepping off or falling is likely to occur when running.
- Space is required to install the equipment.
- The use of the gym requires cost.

Exercise items

○ Recumbent ergometer

Target persons: Beginners of the exercise using equipment and those who are not confident with their physical fitness

About the equipment:

- It is an ergometer with a backrest seat.
- You put your back on the backrest seat and pedal with your feet facing forward.
- A stable sitting posture can be maintained with the wide backrest seat and seating surface.
- It can be used even by persons with a small stature depending on the model.

○ Bicycle ergometer

Target persons: Beginners of exercise using equipment and those with obesity or joint diseases

About the equipment:

- An ergometer that a person can ride like a bicycle.
- You sit on the saddle, raise your upper body, and pedal with the posture toward the bottom of

the feet.

- Fine adjustments according to your body shape can be made with the handlebar and saddle.
- Exercise intensity can be adjusted by measuring the pulse rate with the ear sensor.

*However, switch and panel operations may require assistance or support.

*In addition, a pulse rate monitor with voice and rhythm navigation functions can be used to adjust exercise intensity and pace (KARADA Trainer: SEGA TOYS).

○ Treadmill

Target persons: Those who are able to walk and run and those who are able to walk and jog with a guide

About the equipment:

- Exercise apparatus for running and walking indoors
- The equipment automatically rotates the belt on the equipment, enabling running exercise.
- Load can be adjusted by increasing the rotation speed of the belt and increasing the tilt angle of the equipment itself.
- You can walk and run while holding onto the handles (arms or handlebars) on the front and sides.

(2) Muscle strengthening exercise

Muscle strengthening exercise makes daily living safer and easier, such as making it easier to move and climb stairs by increasing muscle power.

1. Self-weight muscle strengthening exercise that can be practiced alone (at home)

We will introduce the advantages and disadvantages of muscle strengthening exercise that can be practiced at home, as well as its exercise items. When practicing the training, falls can be prevented by supporting the position with a handrail or desk.

Advantages

- The training can be started anytime as it does not require any equipment.
- The training can be practiced even in a small room.
- The training can be practiced anywhere (indoor and outdoor).
- The training can be practiced in a short amount of time.
- The training can be incorporated into the schedule, such as between daily activities.

Disadvantages

- The person must learn the correct posture to apply proper load.
- It is difficult to choose a method due to a large variety.
- It is necessary to learn a number of items.

Home exercise items

○ Squatting using a chair (Figure 30)

Target persons: Those who have slight difficulty or anxiety in getting up from a chair

Purpose: To maintain and improve ADL (such as the standing-up, walking, and stepping onto the stairs)

Target muscles: gluteus maximus, quadriceps, and biceps femoris

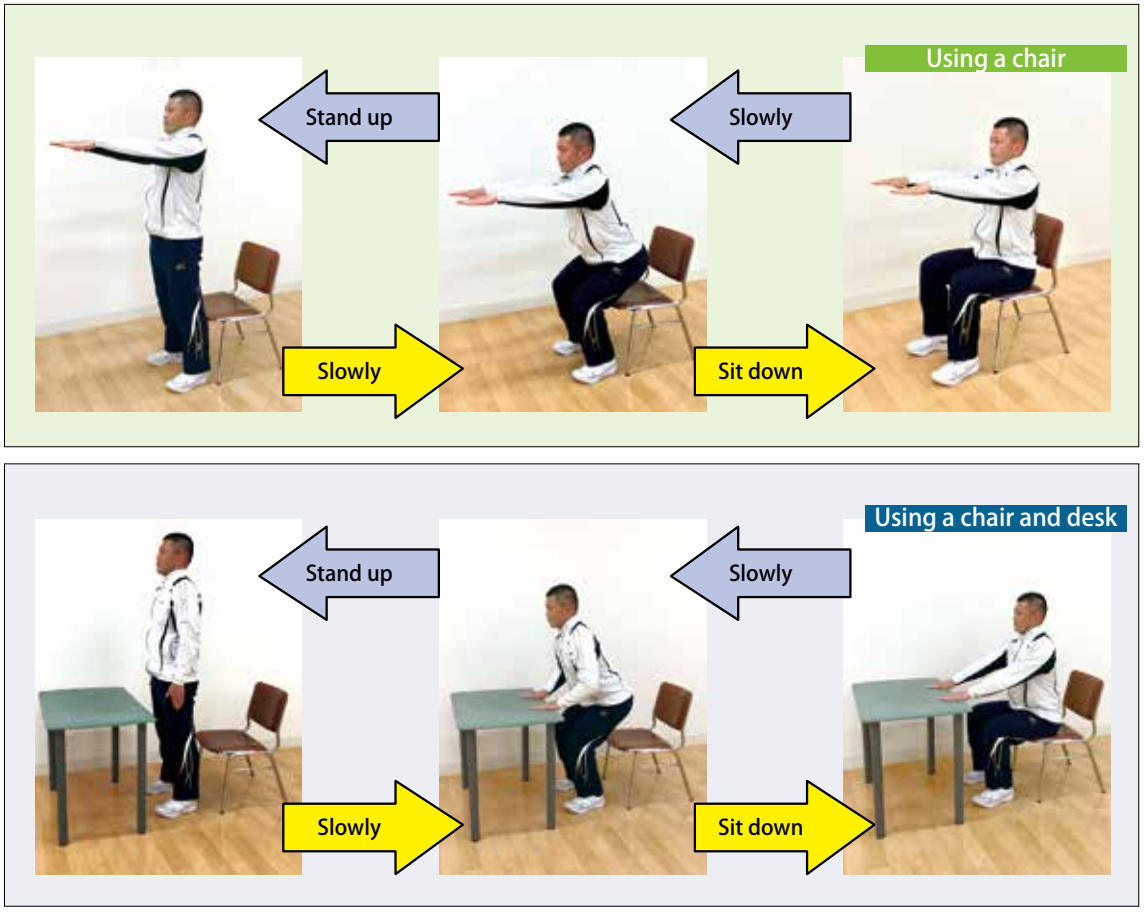


Figure 30. Muscle strengthening exercise (squatting)

Methods:

- Sit on a chair.
- Spread your legs about the width of your shoulders.
- Turn your left foot toward 11 o'clock and your right foot toward 1 o'clock.
- Extend your hands toward 12 o'clock and raise them until they are level with your shoulders.
- While exhaling, slowly stretch your knees and stand up.
- Keep your knees facing the same direction as the toes and do not extend them in front of the toes.

• While inhaling, slowly bend your knees so that your buttocks stick out behind you and return to your original posture.

Points of attention:

• If you have difficulty in balancing, place a desk in front of you and put your hands on the desk to practice the exercise.
• Be careful not to fall backward.
• Do not hold your breath.
• Be sure to perform the training in the correct way as inadequate movements can hurt your knees and lower back.

○ Standing on one leg (Figure 31)

Target persons: Those who stagger or feel uneasy when going up and down the stairs

Purpose: To maintain and improve balance sensibility

Target muscles: quadriceps, gluteus medius, flexor digitorum brevis, and others

Figure 31. Balance training (standing on one leg)

Methods:

• Stand with your hands on a desk or wall and stretch your back.
• Raise one leg to the extent that it does not touch the floor.
• Stretch the knee of the supporting leg and balance with one leg.

Points of attention:

• Be careful not to fall, as you may lose your balance when standing on one leg.
• The training should be practiced in a place where body balance can be supported with a wall, handrail, or desk.
• If you are about to lose your balance, return to the original posture.
• Do not raise your legs too high.

○ Calf raise (Figure 32)

Target persons: Those who do not walk much at home and those whose feet get tired after walking for 2-3 minutes

Purpose: To maintain and improve muscle power that supports the body during walking

Target muscles: gastrocnemius and soleus

Figure 32. Muscle strengthening exercise (calf raise)

Methods:

- Support body balance by touching the wall or handrail.
- Raise your heel while exhaling slowly.
- Slowly lower your heel while inhaling.
- Keep your weight on the base of the great toe.
- Raise and lower your heels with your knees extended.

Points of attention:

- Be careful not to fall, as you may get on your toes and lose your balance
- The training should be performed in a place where body balance can be supported with a wall, handrail, or desk
- If you are about to lose your balance, return to a standing posture on both feet as soon as possible
- The training can be performed barefoot. However, if toes experience too much load, adjust the load by wearing shoes.

○ Front lunge (Figure 33)

Target persons: Those who feel it is tiring to go next door or go out in the neighborhood and those who have slight difficulty in shopping and taking purchased items home

Purpose: To maintain and improve the flexibility of the lower limbs, balance ability, and muscle power

Target muscles: gluteus maximus, gluteus medius, quadriceps, and biceps femoris

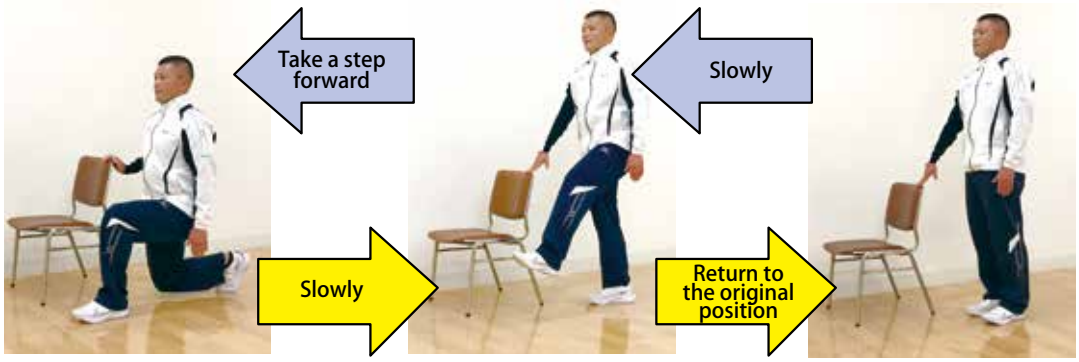


Figure 33. Muscle strengthening exercise (front lunge)

Methods:

- Stand with your back straight at a position where you can touch a chair, handrail, or desk.
- Raise one leg and take a big step forward slowly in the direction of 12 o'clock.
- Take a step with a space of 2-3 shoes.
- Exhale while taking a stepping movement.
- Keep the knee of the front foot directly above the heel, the thighs level with the floor, and the head to the buttocks in a straight line.
- Kick the floor with the front foot to return to the original posture.

Points of attention:

- Be careful when you step down and land on your feet, as this may cause you to fall if you have high instability and cannot land well.
- Be sure to perform the training where there is a chair, handrail, or desk.
- If you are about to lose your balance, return to the standing posture on both feet as soon as possible.
- Perform the training on a non-slip floor (for example: performing the exercise with socks on a wooden floor is dangerous).
- Do not take too big a step.

2. Self-weight muscle strengthening exercise for two people (at home)

We will introduce the advantages and disadvantages of home muscle strengthening exercise that can be performed in pairs, as well as items of the exercise. The partner should be a sighted person.

Advantages

- You can talk and have fun while performing the training.
- You can have fun and perform the training for a long period.
- The training leads to mutual muscle-power improvement.
- The training leads to motivation to practice and continuation of the exercise.

Disadvantages

- The schedule needs to be coordinated with a partner.

• The person must have the same level of muscle power as a partner.

Exercise items

○ Squatting with a partner (Figure 34)

Purpose: Those who have slight difficulty or anxiety in getting up from a chair

Target muscles: gluteus maximus, quadriceps, and biceps femoris

Figure 34. Muscle strengthening exercise (squatting with a partner)

Methods:

- Face your partner and stand with your legs open slightly wider than your shoulders.
- Turn your left foot toward 11 o'clock and your right foot toward 1 o'clock.
- Hold the partner's hands and pull backward to maintain balance.
- While inhaling, slowly bend your knees so that your buttocks stick out behind you.
- Sit down until your thighs are parallel with the floor.
- Keep your knees facing the same direction as the toes and do not extend them in front of the toes.
- Slowly stretch your knees while exhaling and return to the original posture.

Points of attention:

- Do not hold your breath during the movement.
- The pulling forces of two people need to be kept equal.
- If the pulling force of one person is larger than that of the other, attention is needed as it results in falling backward.

○ Front lunge with a partner (Figure 35)

Target persons: Those who can carry out partner squatting and would like to further improve their muscle power

Purpose: To maintain and improve the flexibility of the lower limbs, balance ability, and muscle power

Target muscles: gluteus maximus, gluteus medius, quadriceps, and biceps femoris

Figure 35. Muscle strengthening exercise (front lunge with a partner)

Methods:

- Stand facing your partner at a distance of 1 m.
- Raise one leg and step out to make a space of 2-3 shoes.
- Put your palms together in front of your chest with your partner.
- Push the palms of your partner and drop your hips straight down while balancing.
- Keep the knee of the front leg directly above the heel, the thigh level with the floor, and the head to hips in a straight line.
- Return to the original posture while stretching your knees.

Points of attention:

- If you are about to lose your balance, return to the standing posture on both feet as soon as possible.
- Perform the training on a non-slip floor (performing the training with socks on a wooden floor is dangerous).
- Do not take too big a step.

3. Muscle strengthening exercise using equipment (at exercise facilities)

We will introduce the advantages and disadvantages of muscle strengthening exercise that can be practiced at an exercise facility and present examples (weight stack type machine).

Advantages

- Many machines can be used.
- The equipment is fixed, and the training can be practiced at ease.
- It is easy to learn the exercise form due to the fixed movement trajectory.
- Weight can be adjusted simply by inserting and removing a pin.
- Easy to work on the target muscle.

Disadvantages

- You need to learn how to operate the equipment.
- It is necessary for an instructor to watch over the training until you get used to environmental awareness and the operation of the equipment.
- Each equipment has different models, and you must learn the operation of each model.

(3) A combination of simultaneous aerobic exercise and muscle training

○ Movement like jumping rope (Figure 36)

Target persons: Those who are able to exercise regularly and who would like to increase physical activity and calorie consumption

Purpose: To improve endurance, to promote fat burning, and to maintain and improve muscle power of the lower limbs

Target muscles: quadriceps, gastrocnemius, and soleus

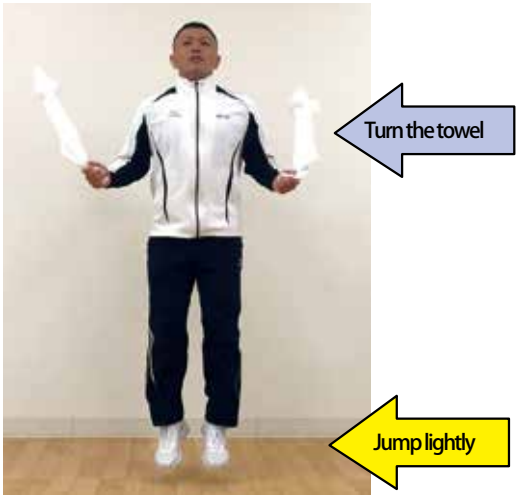


Figure 36. Aerobic exercise + muscle strengthening exercise (movement like jumping rope)

Methods:

- Tie the tips of the towels and use them as skipping ropes.
- Bend your knees lightly and perform a light bending and stretching exercise on one spot.
- Gradually speed up and start with a low jump.
- Gradually increase the pace and jump in small steps.
- For the moving of the upper body, turn the towels in a circular motion on the sides of the body.
- Jump in a timely manner according to the rotation of the towels.

Points of attention:

- Land on the left and right feet at the same time.
- Land at the base of the toes, not at the heels.
- Do not jump too high.
- Keep towels out of contact with surrounding furniture and objects.

Exercise intensity: about 8-12 METs[51)]

5) Exercise intervention for persons with higher brain dysfunctions

(1) Are persons with higher brain dysfunctions more likely to have a lack of exercise?

Higher brain dysfunction is known as a disability that is often not visible from the appearance, and the disability may be noticed when performing some movements, work, or activities. The specificity of the disability differs depending on the site of the brain injury, and the symptoms of dysmnesia, disturbance of attention, executive function disorders, and social behavior disorder constrain daily living or social life[52].

The main causes of higher brain dysfunctions were reported to be traumatic brain injury and cerebrovascular diseases, such as cerebral infarction, cerebral hemorrhage, subarachnoid hemorrhage, and moyamoya disease[52]. In particular, the disease factor for those whose primary disease is cerebrovascular disease is predicted to be life-related disease, such as hypertension and obesity, and continuous treatment and management are required even after the onset. Furthermore, specificities of executive function disorders and disturbance of attention affect participation and activity, which clearly leads to chronic lack of exercise. In addition, the lack of health promotion according to the specificity of the disabilities, such as the effects of drug administration on exercise and vague recommendations for exercise, is thought to be one of the factors that contribute to the lack of exercise.

(2) Current state of health promotion for persons with higher brain dysfunctions

Health promotion programs for persons with higher brain dysfunctions have not yet been developed. However, since higher brain disabilities caused by life-related disease, such as cerebrovascular disease, have been reported, it is thought that many individuals with higher brain dysfunctions also need support for health promotion. In particular, it is predicted that persons with higher brain dysfunctions who do not have overlapping disabilities of physical functions are moving away from active life due to a decline in cognitive function and complications, rather than functional problems. Thus, we must eliminate the chronic lack of exercise that may be caused by the management of the primary disease and disabilities and extend their healthy lifespan.

In this chapter, we will describe the health-promotion exercise programs for persons with higher brain dysfunctions who do not have disabilities of physical functions, as well as their effects.

(3) Exercise program that takes the specificity of the disabilities into considerations

Among the health-promotion exercise programs for persons with physical disabilities introduced in Chapter 3-2, the exercise programs and events for persons who are able to move in a standing position and for persons with visual disabilities can be used for persons with higher brain dysfunctions. With reference to these exercise programs, we are working to create exercise programs for persons with higher brain dysfunctions.

(4) Consideration for intervention guidance for persons with higher brain dysfunctions

The intervention guidance that takes the specificity of the disabilities into consideration is needed for an effective health-promotion exercise program for persons with higher brain dysfunctions. Below are examples of such efforts.

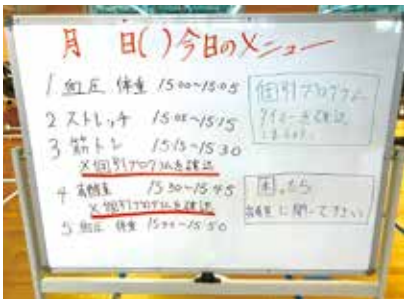
1. Approach to dysmnesia

The approach to dysmnesia is carried out as follows, utilizing confirmation of the program and vital checks.

a) Post the exercise program so that it can be seen by participants (Figure 37).

b) Create a record notebook or check sheet for each person and use it to compensate for memory. Measure body weight, blood pressure, heart rate, and body temperature before and after performing the exercise program, and record them in the notebook. Review the recorded contents with a supporter and begin the exercise if there is no abnormality in the measurement results (Figure 38).

c) Review the record notebook with a supporter and look back on your physical and living conditions.



- Present exercise program
- Explain the flow of training in advance
- Check or call out when you do not understand the task

Figure 37. Approach to memory and executive function (presentation of exercise program)

	Before exercise				
Date	Physical condition	Body weight	Blood pressure		HR
September 19	◯ △ ×	78.5	125	75	70
September 22	◯ △ ×	77.5	120	80	66
	○ △ ×				
	○ △ ×				
	○ △ ×				

A record notebook is used to compensate for the management of physical condition and memory.

Figure 38. Approach to dysmnesia (record notebook)

2. Approach to executive function disorder

To perform actions according to the specificity of the disabilities of the person and situation, such as checking the training schedule and asking the instructors, the approach to executive function disorder is conducted as follows.

a) Explain the posted training content and flow (Figure 37).

b) Post the exercise program in a location where it can be viewed at any time.

c) Encourage to check and act when the tasks are unclear.

d) When confused, raise your hand and talk to the supporters.

3. Approach to attention disturbance

While practicing the exercise program, unusual changes will be experienced due to an increase in heart rate and body temperature, such as changes in physical condition and relationships with others. Thus, some participants become absorbed in an exercise program and unable to switch to the next action. Therefore, the following consideration is given to encourage the switching of attention.

a) Use a clock and digital timer during the exercise program (Figure 39).

b) Sounds and timer are used as signals to switch attention, concentration, and movement.

c) Switching is promoted by giving a timer to those who have difficulty in switching.

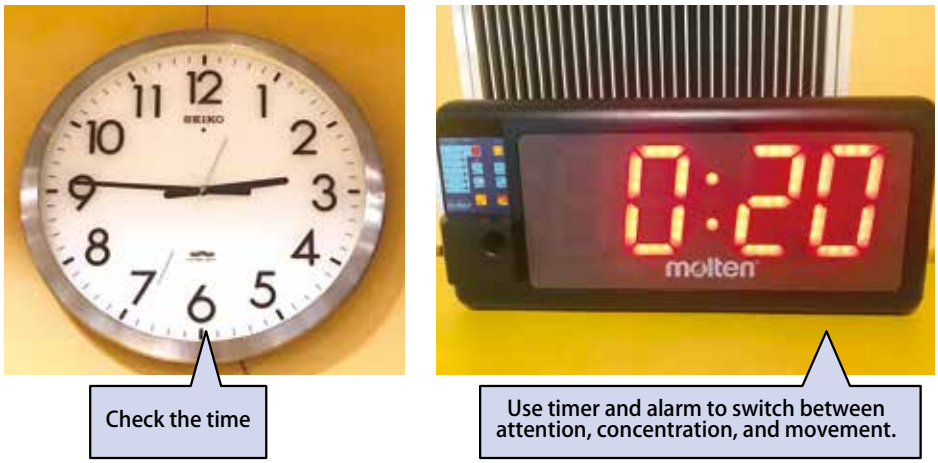


Figure 39. Approach to disturbance of attention (use of timer and clock)

4. Approach to social behavior disorder

To eliminate the triggers of problematic behaviors (such as failure and anxiety) as much as possible, the following measures are taken.

a) Practice the exercise in the same environment, which gives a sense of security.

b) When changing the environment or event, explain and confirm the change repeatedly in advance.

c) Set small steps and encourage them to achieve a sense of accomplishment by complimenting and encouraging their actions.

d) If a problematic behavior is observed, change the direction of attention by distracting attention, calling out, or changing locations.

(5) Effects of health-promotion exercise program in a case

A person with severe dysmnesia who improved his physical fitness and cognitive function through a health-promotion exercise program and "can do" sports experience program is presented below[52].

The participant was a male in his 30s who presented with memory and orientation disabilities, anosodiaphoria, executive function disorders, disturbance of attention, decreased initiative, and decreased general intellectual function due to higher brain dysfunction. His physical fitness tended to be lower than that of his age group. The exercise program is shown in Table 5.

Table 5. Effects of health-promotion exercise program in a case

Item	Content	Notes
Exercise intensity	Pace with a smile	• Adjust exercise intensity • Introduce an item of interest • Break down tasks into small steps • Give a sense of accomplishment
Exercise duration	45 minutes/session	
Exercise frequency	3 sessions/week	
Period	About 3 months	
Exercise item	Experience of recreation event	

The program resulted in an improvement in overall physical fitness. In addition, we introduced a recreation event that he showed interest for the recreation event experience and broke down tasks into small steps, which gave him a sense of accomplishment that he "can" practice exercise. By incorporating this "can-do" sports experience, he became able to engage in various activities enthusiastically. It is thought that the "can-do" sports experience according to the specificity of the disabilities could be a good stimulus for higher brain dysfunction.

(6) Practice and effects of group health-promotion exercise programs

The group health-promotion exercise programs also take an approach to the maintenance and improvement of health-related physical-fitness items and the sociality improvement, such as communication skills necessary for social life. We will introduce the practice and effects of the group health-promotion exercise programs. The items common to all cases are shown in Table 6.

Table 6. Items common to health-promotion exercise programs for persons with higher brain dysfunctions

Item	Content	Notes
Exercise intensity	Pace with a smile	• Adjust exercise intensity • IIndividual and group items that take specificities of the disabilities and group into consideration
Exercise duration	45 minutes or longer/session	
Exercise frequency	2-3 sessions/week	
Period	About 3 months	
Exercise item	• Aerobic exercise • Muscle strengthening exercise • Recreation and sports experience	

1. Group-lesson-style exercise programs and their effects[53)]

The exercise program shown in Table 7 was performed by 20 persons with higher brain dysfunctions. The group-lesson-style program used the items of intervention guidance shown in Table 3. The participants practiced common items in the exercise. In addition, they performed muscle power training using a training sheet as a compensation method and marked the checkboxes on the sheet (Figure 40). The group-lesson-style program provided an environment that was easy for the participants to carry out the training, and the exercise program could be practiced even by a group of 20 people.

Table 7. Group-lesson-style exercise program

Item	Content	Notes
Exercise duration	45 minutes/session	• Post the content and flow of training • Present materials that describe the content of the exercise • Call out to perform the task • Support executive function using notes • Encourage action using a timer
Exercise frequency	2 sessions/week	
Period	About 3-6 months	
Number of participants	About 20 people	
Exercise item	1. Aerobic exercise Intensity: Pace with a smile Event: bicycle ergometer, treadmill	
	2. Muscle strengthening exercise Intensity: about 40-60% of maximum load Event: muscle power training machine	

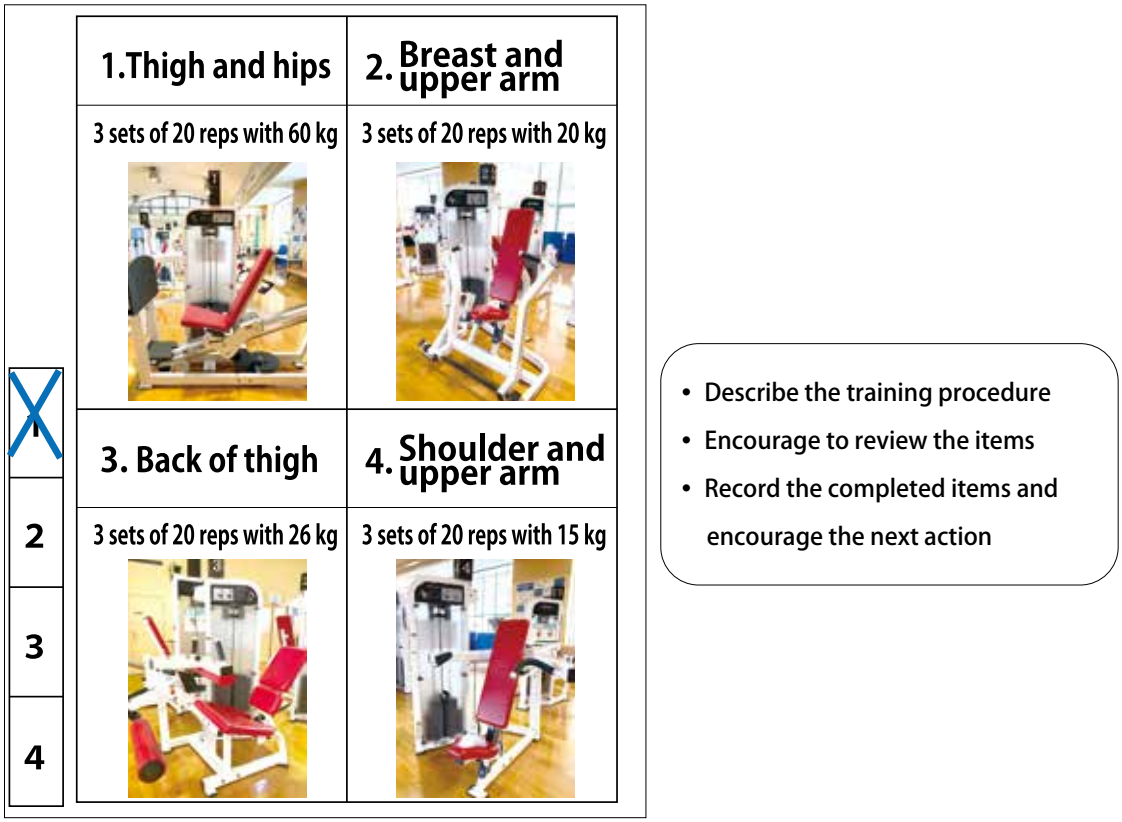


Figure 40. Memory compensation for muscle strengthening exercise (training sheet)

2. Example of group program that had a positive effect on cognitive function[54)]

The exercise program shown in Table 8 was performed by 9 persons with higher brain dysfunctions. To determine the training effect, 10m walking speed, Functional Independence Measure (FIM), and Revised Hasegawa Dementia Scale (HDS-R) were measured before and after the training, and improvement in 10m walking speed, FIM, and HDS-R were observed. Group exercise and sports require activity selection and communication according to the situation, in addition to physical activity. Thus, it is thought that they had a positive effect on physical fitness and cognitive function.

Table 8. Group exercise program that showed a positive effect on cognitive function

Item	Content	Notes
Exercise intensity	Pace with a smile	• Adjust exercise intensity • Break down tasks into small steps • Call out to perform tasks • Divide roles • Plan a game strategy • Encourage communication between participants and instructors
Exercise duration	45-90 minutes/session	
Exercise frequency	2-3 session/week	
Period	About 2 months	
Number of participants	About 10 people	
Individual events	• Running in the gymnastic hall • Slalom running	
Group events	• Shuffleboard • Basketball	

3. Example of group program that improved physical fitness and mood state[55)]

The exercise program shown in Table 9 was performed by 20 persons with higher brain dysfunctions. To determine the training effect, Profile of Mood States (POMS) and physical fitness measurements were performed. It resulted in improved POMS, and physical fitness was also improved in all items. It is thought that the practice of the group exercise program had a positive effect on the improvement of physical ability and mood state.

Table 9. Group exercise program that improved physical fitness and mood state

Item	Content	Notes
Exercise intensity	Pace with a smile	• Support for executive function using notes • Execution of greetings and division of roles • Provision of opportunities to talk and express opinions • Practice of preparation and tidying up • Obeying the rules • Introduction of events of interest
Exercise duration	45 minutes/session	
Exercise frequency	3 sessions/week	
Period	About 2 months	
Individual events	• Bicycle ergometer • Muscle strengthening exercise	
Group events	• Shuffleboard • Takkyu	

4. Example of a group event for persons with declined information processing ability[52)]

The exercise program shown in Table 10 was performed by a male in his 40s who had decreased general intellectual function, attention disabilities, and lack of visual information processing ability due to higher brain dysfunction, and in terms of physical fitness, his agility and balance ability were greatly reduced.

It resulted in an improvement in overall physical fitness, and the tasks were completed in time with simple instructions given during activities. The group event involved many points of contact between the participants, and it was effective likely because of its exercise environment that required information processing under various situations.

Table 10. Group exercise program for improving information processing ability

Item	Content	Notes
Exercise intensity	Pace with a smile	• Create contact between the participants • Support participants to be considerate of others • Make the movement a habit by repeating it • Support to build confidence
Exercise duration	60 minutes/session	
Exercise frequency	2 sessions/week	
Period	About 6 months	
Individual event	Re-learning of how to use the body	
Group event	Recreation type	

As in the previous studies, examples 1-4 demonstrate the positive effects of health-promotion exercise programs on the prevention of life-related disease and higher brain dysfunctions, mainly by improving physical fitness. In particular, when practicing an individual or group exercise program, it needs to take the points of attention shown in Table 2 into consideration.

In addition, when conducting a group health-promotion exercise program, the selection of item is important. In the next section, we will describe the events of the health-promotion exercise programs that are practiced in a group.

(7) Events of group exercise

We will describe the use methods of health-promotion exercise programs by giving examples of events that persons with higher brain dysfunctions can perform in a group according to the specificity of the disabilities for a certain period of time while adjusting exercise intensity.

○ Takkyu Volley[56] (Figure 41)

Target persons (example): Those with low physical fitness due to disabilities in general cognitive function.

Overview: Using a table - tennis table, 6 people from each team sit on chairs on one side of the net, roll a ball with a wooden board racket, and return it to the opponent's court through the bottom of the net within 3 hits.

Exercise intensity: about 2.5 METs

Playing Takkyu volley in cooperation

Tools

Figure 41. Group exercise event (Takkyu Volley)

Event tasks:

1. Understand the role to return the ball in cooperation within a certain number of hits (memory).
2. Remember the number of hits (memory).
3. Concentrate and act (attention).
4. Improve the rules to extend exercise duration and lead to a Pace with a happy face exercise.

Changing of rules (examples):

1. Count the number of hits with everyone.
2. Increase the limit of the number of hits.
3. Play within the length of time players can concentrate, with a reduced limit of the number of hits.

○ Ground Golf [57] (Figure 42)

Target persons (example): Those with memory and executive function disabilities who are not able to continue exercise for a long period of time.

Overview: Players hit a ball with a dedicated wooden club and compete for the smaller number of strokes from the start to the hole post.

Exercise intensity: about 3 METs.

Playing ground golf indoors
(it can also be played outdoors)

Tools

Figure 42. Group exercise event (Ground Golf)

Event tasks:

1. Act proactively to achieve the minimum number of strokes (executive function).
2. Record the number of strokes in each course (memory).
3. Approach memory and executive function and lead to a Pace with a smile exercise.

Changing of rules (example):

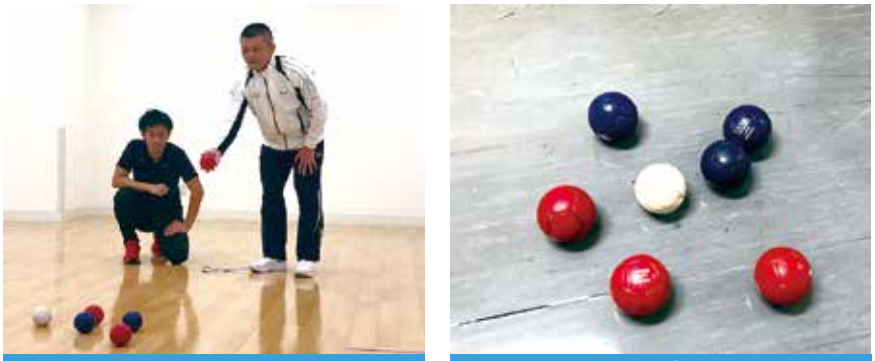
1. Use notes to describe the order of the course and the target number of strokes.
2. Count the number of strokes with a few people.
3. Adjust the length of the course and extend the distance of movement.

○Boccia[58] (Figure 43)

Target persons (example): Those with executive function disorders (unable to prioritize things).

Overview: Two opponents pitch 6 red and blue balls at the white jack ball (target ball), and the team or individual who is closer to the jack ball wins.

Exercise intensity: about 3 METs.



Pitching in turns　　Tools

Figure 43. Group exercise event (Boccia)

Event tasks:

1. Understand the situation for each pitch to get closer to the jack ball with a fixed number of pitches (attention).
2. Make a pitching location and future plans for problem-solving approaches (executive function).
3. Approach executive function disorders and encourage a Pace with a happy face exercise.

Changing of rules (examples):

1. Pitch alternately in a fixed order.
2. Describe and present the procedure and pitching order.

○ Balloon Volleyball[59] (Figure 44)

Target persons (example): Those with disturbance of attention (unable to stay focused).

Overview: Six players from each team enter the court that is divided by a net, and both teams hit a ball over the net. All team members touch the ball and return it to the opponent's court within 10 hits.

Exercise intensity: about 4 METs.

Figure 44. Group exercise event (Balloon Volleyball)

Event tasks:

1. Understand who touched the ball and return it with a fixed number of hits (memory).
2. Remember the number of hits (memory).
3. Concentrate and act (attention).
4. Approach disturbance of attention and lead to a Pace with a smile exercise.

Changing rules (examples):

(a) Decide the playing time according to physical fitness and degree of disability.

(b) Count the number of hits together.

(c) Change the size of the balloon to adjust the hangtime.

References

1) Munehiro Shindo, Hiroaki Tanaka, Mamoru Tanaka (ed): Health promotion training handbook. Asakura Shoten. Tokyo. 2010: P3-19. P22-26. P34-39. P40-54. P165-173. (Japanese).
2) Shigeho Tanaka (ed): Move and lose weight! Calorie consumption dictionary. 2010, Seibido Shuppan. Tokyo. P11, P86-135. (Japanese).
3) Sakamoto Masaaki and Chinami Sugiyama (translation): Exercise guidance textbook for persons with chronic disease -From diagnosis and treatment to fitness. Nap Co. Ltd. 2004: P2-14. P15-26. P46-66. (Japanese).

4) Japanese Society of Physical Fitness and Sports Medicine Editorial Committee (translation): Exercise prescription guidelines/exercise load test and exercise program, original 8th edition. Tokyo. 2014: P18-38. (Japanese).
5) Ministry of Foreign Affairs: Japan SDGs action platform: (Accessed September 23, 2020) https://www.mofa.go.jp/mofaj/gaiko/oda/sdgs/about/index.html. (Japanese).
6) Planning Division, Disability Health and Welfare Department, Social and Assistance Bureau: Posting of "International Classification of Functioning, Disability and Health, Revised Edition" (Japanese version) on the website of the Ministry of Health, Labour and Welfare. August 5, 2002. (Accessed September 23, 2020) https://www.mhlw.go.jp/houdou/2002/08/h0805-1.html. (Japanese).
7) Michio Ikai: Introduction to Exercise Physiology. Kyorin Shoin. 1963: P144. (Japanese).
8) Japanese Orthopaedic Association: Locomotive Syndrome Prevention Awareness Official Website: Locomo ONLINE. https://locomo-joa.jp/locomo/. (Japanese).
9) Takeshi Nakamura: Interleukin-6 responses in persons with spinal cord injury during arm exercise and wheelchair sports. Yokohama medical journal. 67. 2016. 103-107. (Japanese).
10) Kyonosuke Yabe, Katsuhiko Kusano, Hideo Nakata (ed): Adapted Sports Science -Theory for Sports Practice for Persons with Disabilities and the Elderly-. Ichimura Publishing. Tokyo. 2004: P50-51. (Japanese).
11) ※ Ryuichi Nihei et al. (ed): Rehabilitation for Persons with Cervical Spinal Cord Injury, Revised 3rd Edition. Tokyo. 2016: P143-148. P274-275. (Japanese).
12) Kuno Shinya et al.: Effect of strength training on aging muscles of elderly people. Japanese Journal of Physical Fitness and Sports Medicine. 2003. 52 Suppl:17-30. (Japanese).
13) Yukiharu Higuchi et al.: The influence of exercise intervention for spinal-cord-injury persons with metabolic syndrome. J. Physical Medicine. 2009. 20(3): 269-274. (Japanese).
14) Sato Yuzo: Treatment of diabetes -Focusing on diet and exercise therapy-, Clinical medicine in tomorrow. 2003. 15(2):11-20. (Japanese).
15) Yukiharu Higuchi et al.: The trial of the multi-center task to popularize and establish the health promotion program for the persons with disabilities: a draft of the exercise program. J. Musculoskeletal Medicine. 2017. 28(1): 82-88. (Japanese).
16) Yukiharu Higuchi et al.: The trial of the multi-center task to popularize and establish the health promotion program for the persons with disabilities. J. Musculoskeletal Medicine. 2015. 26(1): 71-77. (Japanese).
17) Takeshi Nakamura et al.: The actual condition survey for the prevention of elbow injury in wheelchair marathon athletes (first report). Descente Sports Science. 2016. 37: 43-48. (Japanese).
18) Yukiharu Higuchi et al: Health, Labor and Welfare Science Research Grant/Disability Health and Welfare Comprehensive Research Project "Research on proper exercise prescription and lifestyle guidance for the prevention of lifestyle-related diseases and secondary disabilities in persons with spinal cord injury" (2005-19 Fiscal Year General Report) March 2008. (Japanese).

19) Japanese Association of Rehabilitation Medicine, Cerebral Palsy Rehabilitation Guidelines Development Committee (ed): Cerebral Palsy Rehabilitation Guidelines (2nd Edition). Kanehara Shuppan. Tokyo. 2014: P207-208. (Japanese).
20) Mayumi Nagano et al.: Effect of exercise at ventilatory threshold on magnitude and duration of excess post-exercise O2 consumption. Japanese Journal of Physical Fitness and Sports Medicine. 1992. 41: 436-446. (Japanese).
21) Yukiharu Higuchi: Special feature - Health promotion approach for persons with disabilities II. Detailed explanation on exercise and health management in the chronic stage of spinal cord injury. MB Med Reha. 2020. No.253:37-42. (Japanese).
22) World Health Organization: Noncommunicable diseases. 1 June 2018. https://www. who.int/news-room/fact-sheets/detail/noncommunicable-diseases
23) Saltin B, et al: Response to Exercise after Bed Rest and after Training: A Longitudinal Study of Adaptive Changes in Oxygen Transport and Body Composition. Circulation. 1968.38(5 Suppl). VII :1-78
24) Lee et. Al.: Effect of Regular Exercise on Cardiopulmonary Fitness in Males with Spinal Cord Injury. Ann Rehabil Med. 2015. 39(1): 91-99.
25) Burkett L. N. et al.: Exercise Capacity of Untrained Spinal Cord Injured Individuals and the Relationship of Peak Oxygen Uptake to Level of Injury. Paraplegia. 1990. 28: 512-521.
26) Hannan A L et al: High-intensity interval training versus moderate intensity continuous training within cardiac rehabilitation: a systematic review and meta-analysis. Open Access J Sports Med Actions. 2018. Jan 26;9: 1-17.
27) Martin Ginis KA. et al.: Evidence-based scientific exercise guidelines for adults with spinal cord injury: an update and a new guideline. Spinal Cord. 2018. 56: 308-321.
28) Schneider D. A. et al.: Plasma catecholamine and blood lactate responses to incremental arm and leg exercise. Med. Sci. Sports Exerc. 2000. 32(3): 608-613.
29) Araki M. et al.: “Slow walking with turns” increases quadriceps and erector spinae muscle activity. J. Phys. Ther. Sci. 2017. 29: 419-424.
30) Higuchi Y et al.: Cardiorespiratory responses during passive walking-like exercise in quadriplegics. Spinal Cord. 2006. 44: 480-486.
31) Washburn RA and Figoni SF: High density lipoprotein cholesterol in individuals with spinal cord injury: The potential role of physical activity. Spinal Cord. 1999. 37: 685-695.
32) Hata J et al.: Ten year recurrence after first ever stroke in a Japanese community: the Hisayama study. J Neurol Neurosurg Psychiatry 2005. 76: 368-372.
33) Partha Dutta et al.: Myocardial infarction accelerates atherosclerosis: Nature 2012. 487: 325-329.
34) Akira Umeno et al.: Exercise intensity in the movements of hemiplegic patients. The 27th Tokai Hokuriku Physical Therapy Academic Conference. 2011. Session ID: P-089. (Japanese).
35) Sandra A. et al.: Physical Activity and Exercise Recommendations for Stroke Survivors-A Statement for Healthcare Professionals From the American Heart Association/American Stroke

Association-. Stroke. 2014; 45: 2532-2553.
36) Cabinet Office: 2018 White Paper on Aging Society (2019) (Accessed September 23, 2020) https://www8.cao.go.jp/kourei/whitepaper/w-2018/zenbun/30pdf_index.html. (Japanese).
37) Ministry of Health, Labour and Welfare. Household Statistics Office with Policy Director and Counselor: Comprehensive Survey of Living Conditions (2019) (Accessed September 23, 2020) https://www.mhlw.go.jp/toukei/saikin/hw/k-tyosa/k-tyosa19/index.html. (Japanese).
38) Health and Sports Division at Japan Sports Agency. Outline and report of the results of the 2018 survey on physical fitness and athletic ability (2019) (Accessed September 23, 2020) https://www.mext.go.jp/sports/b_menu/toukei/chousa04/tairyoku/kekka/k_detail/1421920.htm. (Japanese).
39) Hiroaki Tanaka: Book to read before running - Scientific training that produces results in the shortest time. Kodansha. Tokyo. 2017. P62-70. (Japanese).
40) Satoshi Muraki, Noriaki Tsunawake, Yasuaki Tahara, Masahiro Yamasaki: Effect of Pedal Rotation Speed of Passive Cycling on Respiratory and Circulatory Response. Japanese Journal of Physical Fitness and Sports Medicine. 2001. 50(6): 801. (Japanese).
41) Yukiharu Higuchi et al: “Research on proper exercise prescription and lifestyle guidance for the prevention of lifestyle-related diseases and secondary disabilities in persons with disabilities” – Questionnaire survey on the health status of persons with disabilities: Targeting persons with cerebral palsy-. The journal of Japanese Society of Clinical Sports Medicine. 2012. 20(4): S169-S169. (Japanese).
42) Yukiharu Higuchi et al: Practice of improving metabolic syndrome in persons with disabilities -Limiting factors for improvement through cases-. Abstracts of the Japanese Society of Exercise Therapy. 2010. 35: 58-58. (Japanese).
43) Yukiharu Higuchi: Rehabilitation and Sports Persons with Disabilities. The 4th Development of Rehabilitation and Sports according to Life Stage -Efforts of the National Rehabilitation Center for Persons with Disabilities-. Japanese Journal of Rehabilitation. 2016. No.168. P40-431. (Japanese).
44) Hideo Nakata. Endurance Training for the Persons with Visual Disabilities. The Journal of Clinical Sports Medicine. 1995. 11: 1244-1247. (Japanese).
45) Clark-Carter, D.D., Heyes, A.D., & Howarth, C.I.: The efficiency and walking speed of visually impaired people. Ergonomics. 1986. 29(6): 779-789.
46) Survey commissioned by the Japan Sports Agency. Sports promotion project for persons with disabilities in the community (Research on the promotion of sports participation of persons with disabilities) Report. II Survey report. Survey on sports life of children and persons with disabilities. pp17-59. 2016. (Japanese).
47) Fumiya Yamashita. Health Questionnaire Survey for Persons with Disabilities: Persons with Visual Disabilities. Research Sharing Report on Health Promotion, Sports Support, and Dissemination for Persons with Disabilities. 2014. (Japanese).
48) Ryuichi Nakamura (ed). Rehabilitation Manual 4 - Guide Help for the Persons with Visual

Disabilities. National Rehabilitation Center for Persons with Disabilities. P2-9. 2000. (Japanese).
49) Fumiya Yamashita et al. The exercise program necessary for weight loss of the visually impaired in tendency to the obesity. The journal of musculoskeletal medicine. 28(4). P428-433. 2017. (Japanese).
50) Phadke, C.P., Vierira L., Mathur S., Cipriano G. Jr, Ismail F., Boulias, C.: Impact of Passive Leg Cycling in Persons with Spinal Cord Injury: A Systematic Review. Top Spinal Cord Inj Rehabil 2019. 25(1): 83-96.
51) (Incorporated Administrative Agency) National Institute of Health and Nutrition. Revised "Metabolic Equivalents (METs) Table of Physical Activity." p. 3,4,28,49. 2012. (Japanese).
52) Yoshiko Tobimatsu and YukoUrakami (ed). National Rehabilitation Center for Persons with Disabilities, Rehabilitation of persons with higher brain dysfunction aiming for social reintegration. Nankodo. 2016: p.2-22. p.171-179. (Japanese).
53) Fumiya Yamashita et al. Introduction of exercise guidance for persons with higher brain dysfunction. No.66. The 36th Achievement Presentation at the National Rehabilitation Center for Persons with Disabilities. 2019. http://www.rehab.go.jp/application/files/3315/8503/2444/66.pdf. (Japanese).
54) Iwabuchi Norihisa et al. The Effect of Rehabilitation Sport on Cognitive Recovery of the Patients with Acquired Brain Injury. The journal of rehabilitation sports Iryo Taiiku. 2012. 31(2): 64-69. (Japanese).
55) Iwabuchi Norihisa et al. The Effect of Rehabilitation Sport on Mood States and Physical Fitness of the Patients with Acquired Brain Injury. The journal of rehabilitation sports Iryo Taiiku. 2013. 32(1): 2-7. (Japanese).
56) Ibaraki Takkyu Valley Association. Explanation of Takkyu Volley Competition and Rules (Accessed September 19, 2020). http://ibatvk.blog.fc2.com/blog-entry-135.html. (Japanese).
57) Japan Ground Golf Association. About Ground Golf. (Accessed September 19, 2020). http://www.groundgolf.or.jp/about/tabid/62/Default.aspx. (Japanese).
58) Japan Boccia Association. About Boccia. (Accessed September 19, 2020) . https://japan-boccia.com/about. (Japanese).
59) Japan Fusen Volleyball Association. Rules. (Accessed September 19, 2020) .https://nihon-fusen.jimdofree.com/%E3%83%AB%E3%83%BC%E3%83%AB/. (Japanese).
60) Ryoichi Nagatomi: Special Feature - Science on Physical Activity of COPD. Topics 6. Myokine and biology of skeletal muscle adaptation. Annals of the Japanese Respiratory Society, 4(1): P41-46, 2015. (Japanese).
61) Masayoshi Yamamoto, Izumi Tabata: Muscle energy output and physical exercise energetics. P113-205. 1989. Kobundo Shuppan. (Japanese).