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# Contribution of Physical Fitness Component to Health Status in Middle-aged and Elderly Females

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**Abstract** This study determined the physical fitness component that contributes to improving and maintaining health status for each age group as well as quantifying the degree of the relationship between health status and physical fitness in middle-aged and elderly females. The participants were 2,371 females aged 30 to 69 years. Ten physical fitness tests and medical checkups were performed. The participants were divided into a healthy group and an unhealthy group according to health status. Multiple discriminant analysis was applied to the multivariate data. Correct discriminant probabilities of the multiple discriminant function to discriminate the healthy and unhealthy groups for females ranged from 63.0% to 77.5%. These results suggest that there is a relatively high relationship between health status and physical fitness level for middle-aged and elderly females. With each individual's discriminant score calculated by the obtained multiple discriminant function as the index of the degree of health, the Pearson's correlation coefficient of the discriminant score and the performance in each physical fitness test were calculated. The aging change from 30 to 69 years old was classified into four patterns according to the contribution. The result of this study is considered to be useful as objective data to prepare an exercise program considering the contribution of the physical fitness component of health status.
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**Keywords:** health status, physical fitness, middle-aged and elderly females, multiple discriminant analysis, physical fitness component, exercise program

## Introduction

It has become important to improve and maintain health status and physical fitness by means of daily physical activities and exercise. Conceptually, health status can be closely related to physical fitness, as expressed by the term "health-related physical fitness" (American College of Sports Medicine, 1988; Caspersen et al., 1985). However, health status is generally evaluated as "status" based on the results of medical checkups by a medical doctor, and is difficult to express numerically. On the other hand, physical fitness consists of plural components (American College of Sports Medicine, 2000; World Health Organization, 1946), and can be expressed numerically. As mentioned above, since health status and physical fitness differ in character, quantification of the relationship is not easy, and there is little in the way of quantifying the degree of the relationship (Sato et al., 2005).

Sato et al. (2005) applied multiple discriminant analysis considering the characteristics of both concepts, and tried to quantify the degree of the relationship between health status and physical fitness in middle-aged and elderly males and females. This study suggested that the physical fitness components may be highly related to the degree of health by numerically expressing the health status using the multiple discriminant function, because a relatively strong relationship was confirmed between both variables. Although a study for middle-aged and elderly males (Sato et al., 2006) has been published, a similar study for middle-aged and elderly females has not been reported.

Middle-aged and elderly people, especially females, actively participate in various physical activities (IOC, 2004). Menopause is mentioned as one of the major features of body change of middle-aged and elderly females. A previous study reported that indefinite complaints and bone mineral density reduction by the lack of female hormones produced from the climacteric syndrome under this influence are reduced by suitable exercise (American College of Sports Medicine, 2000). It is necessary to prescribe a suitable exercise program (exercise prescription) that specifies the mode, intensity, duration, frequency, etc. of exercise according to age when doing exercise. Therefore, the contribution of each physical fitness component toward health which provides useful data when prescribing an exercise program aimed at improvement and maintenance should be determined.

This study clarified the physical fitness components that contribute to improving and maintaining health status with aging and each age grade as well as quantifying the degree of the relationship between health status and physical fitness in middle-aged and elderly females. This study result can be used when preparing an exercise program aiming at maintaining and improving health in the practical field of exercise instruction. Furthermore, it is considered that the physical fitness components can contribute to raising the quality of human life, especially health-related quality of life.

## Methods

*Participants*

The participants were 2,371 Japanese females aged 30 to 69 years. All of them had medical checkups and physical fitness tests at the Kasugai City Medical Center, Aichi, Japan. The number of participants in each 10-year age group is shown on the left of Table 1. The participants agreed to this study after a full explanation.

*Evaluation of health status*

The health status of the participants was comprehensively evaluated by a medical doctor with a five-point scale referring to height, weight, body mass index (BMI), and percent body fat in addition to results of medical checkups (blood pressure, chest X-ray, electrocardiogram, pulmonary function examination, urine test, blood test, and exercise load test). The participants were divided into two groups based on this evaluation. A doctor's comprehensive evaluation was firstly made based on the criteria of the Japan Society of Ningen Dock (2005). That is, the criteria if the participant was in the area of "Need for Medical Treatment" were systolic blood pressure of 160 mmHg or higher, diastolic blood pressure of 100 mmHg or higher, total cholesterol of 240 mm/dl or higher, neutral fat of 250 mg/dl or higher, fasting blood sugar level of 126 mg/dl or more, etc. This evaluation according to the criteria was considered as a provisional judgment. Final judgment was made using secondary data: the degree of exceeding the criteria, BMI, percent body fat, and the value of maximum oxygen uptake.

With the judgment according to the criteria, the participants who were categorized as "No need for medical treatment", or were judged as "A. Nothing abnormal" or "B. Slight abnormality but no need for treatment" were classified as the healthy group. Accordingly there was no one who was in the area of "Need for medical treatment" in the healthy group.

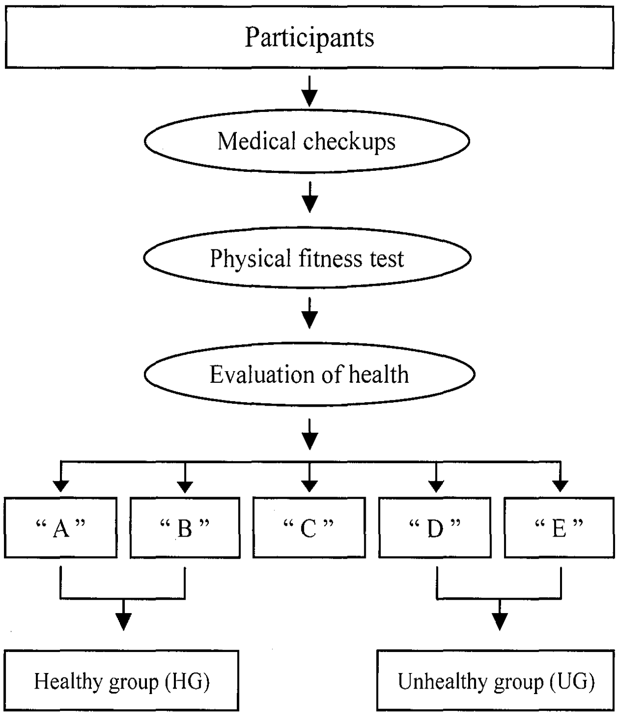
Meanwhile, the participants who came under the area of "Need for medical treatment", were categorized as "C. Need to monitor progress", "D. Need for treatment", and "E. Under treatment" mainly according to the degree that they exceeded the criteria of the Japan Society of Ningen Dock. Incidentally, 2.6%, 0.5% and 2.7%, of them, respectively, had systolic pressures falling under the area of "Need for medical treatment", and 1.4%, 0.3%, and 1.1% of them, respectively, had diastolic blood pressures falling under the area of "Need for medical treatment". The latter two groups were classified as the unhealthy group.

This is because the degree that they exceeded the criteria at the stage of comprehensive evaluation reflects on differences in judgment. The difference between the healthy group and the unhealthy group in this study may largely depend on the existence of an abnormality in the items for medical checkups. Multiple discriminant analysis (Cooley et al., 1971; Betz, 1987) was applied to the two groups. Those judged as "Need to Monitor Progress" (the middle of the five-point scale) were excluded from the data analysis. The procedure for evaluation

**Table 1** Sample sizes of measured and analyzed participants

| Age (yrs) | Measured Ps | Analyzed Ps | |
|---|---|---|---|
| | | HG | UG |
| 30–39 | 290 | 178 | 22 |
| 40–49 | 477 | 230 | 79 |
| 50–59 | 990 | 345 | 209 |
| 60–69 | 614 | 166 | 199 |
| Total | 2,371 | 919 | 509 |

Note 1) Ps: participants, HG: healthy group, UG: unhealthy group.




A: Nothing abnormal found
B: Slight abnormality but no need for treatment
C: Need to monitor progress
D: Need for treatment
E: Under medical treatment

**Fig. 1** Data set for multiple discriminant analysis.

**Table 2** Medical checkups

| Examination | Variables |
|---|---|
| Sphygmomanometry | systolic blood pressure, diastolic blood pressure |
| Urine | protein, glucose, urobilinogen, occult blood, ketones, bilirubin, pH, specific gravity, nitrites, leukocytes |
| Pulmonary function | vital capacity, % vital capacity, forced vital capacity, forced expiratory volume $_1$, % forced expiratory volume $_1$ |
| Blood | fasting blood sugar, hemoglobin A1c, total protein, albumin, albumin-globulin ratio, glutamic oxaloacetic transaminase, glutamic pyruvic transaminase, alkaline phosphatase, $\gamma$-glutamyl transpeptidase, total cholesterol, low density lipoprotein, high density lipoprotein, triglyceride, urea nitrogen, creatinine, uric acid, Fe white blood cell, red blood cell, hemoglobin, hematocrit, platelet, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration |
| Chest X-ray | X-ray photography, C/T ratio |
| Electrocardiogram | rest electrocardiogram |
| Exercise | load electrocardiogram, $\dot{V}O_2max$ |

**Table 3** Assessments of physical fitness

| Element | Test (unit) | Method |
|---|---|---|
| Physique | Height (cm) | Height was a linear measurement of the distance from the floor or standing surface to the top (vertex) of the skull. |
| | Weight (kg) | The weight of the clothes was measured and subtracted from the overall weight. |
| | BMI: body mass index | Weight (kg)/Height (m)$^2$ |
| Body composition | Body fat (%) | The participant rested on the bed looking up. A pole was put at the wrist and the ankle for measurement by the bioelectric impedance method. |
| Muscular strength | Grip strength (kg) | The participant held a handgrip dynamometer in the preferred hand with the arm by the side and squeezed it using maximal force. The best result of two trials determined the score. |
| Flexibility | Sit and reach (cm) | The participant sat on the floor with legs outstretched toward a box. The participant then bent forward and pushed the slide bar on the box with the fingertips as far as possible. The distance the slide bar moved was recorded. The best trial determined the score. |
| Balance | One leg balance with eyes closed (s) | The participant stood on one leg with eyes closed. The standing time was recorded. The best of two trials determined the score. |
| Agility | Reaction time (s) | The participant stood in front of a signal box. The subject jumped toward the light signal on the signal box as quickly as possible. The reaction time to the light signal was recorded. The average time of five trials determined the score. |
| Muscular endurance | Sit-ups (time/30s) | The participant lay face up on a bench with both ankles fixed, and then drew up the knees to a right angle with both hands crossed behind the head. The participant lifted the upper part of the body to the knees at the signal of buzzer and lay back on the bench as quickly as possible. The frequency of this action determined the score. |
| Cardio respiratory endurance | $\dot{V}O_2max$ (ml/kg/min) | A bicycle ergometer was used for this purpose. The load was gradually added in three or four stages (three minutes per stage). The measurement value is the value per weight indirectly estimated due to the heart rate monitored with an electrocardiogram during pedaling. |

of health status is shown in Fig. 1. The number of participants in the two groups of healthy and unhealthy subjects used for analysis is shown on the right of Table 1. Health status was evaluated in this study using the results of the medical checkup carried out at the Kasugai City Medical Center, Aichi, Japan,. Table 2 shows the items in the main medical checkups and the method. The equipment was calibrated by an engineer before each measurement period. All subjects were measured by skilful testers with identical equipment.

The percentages of subjects who smoked were 15.6% for males and 2.2% for females, and of those with a drinking habit, 59.1% for males and 20.7% for females. Those percentages are lower than the Japanese standard data (Health and Welfare Statistics Association, 2006).

*Physical fitness tests*

Anthropometrical aspects of physical fitness were evaluated by four tests of height, weight, BMI, and percent body fat. Percent body fat was measured by the bioelectric impedance method (Tanaka et al., 1992; Nakadomo et al., 1990). Six tests of grip strength, sit and reach, one leg balance with eyes closed, reaction time (light stimulus), sit-ups, and maximal oxygen uptake ($\dot{V}O_2max$) were used to evaluate functional aspects of physical fitness. Table 3 and Fig. 2 show the detailed methods used to evaluate physical fitness. Among these tests, $\dot{V}O_2max$ was indirectly measured from the heart rate during exercise with a cycle ergometer using an exercise load system (STU-1100, Nihon Kohden Co. Ltd., Tokyo, Japan). Other tests were conducted using a physical fitness test system (H.I.T. System, Takei Scientific Instruments Co. Ltd., Tokyo, Japan)

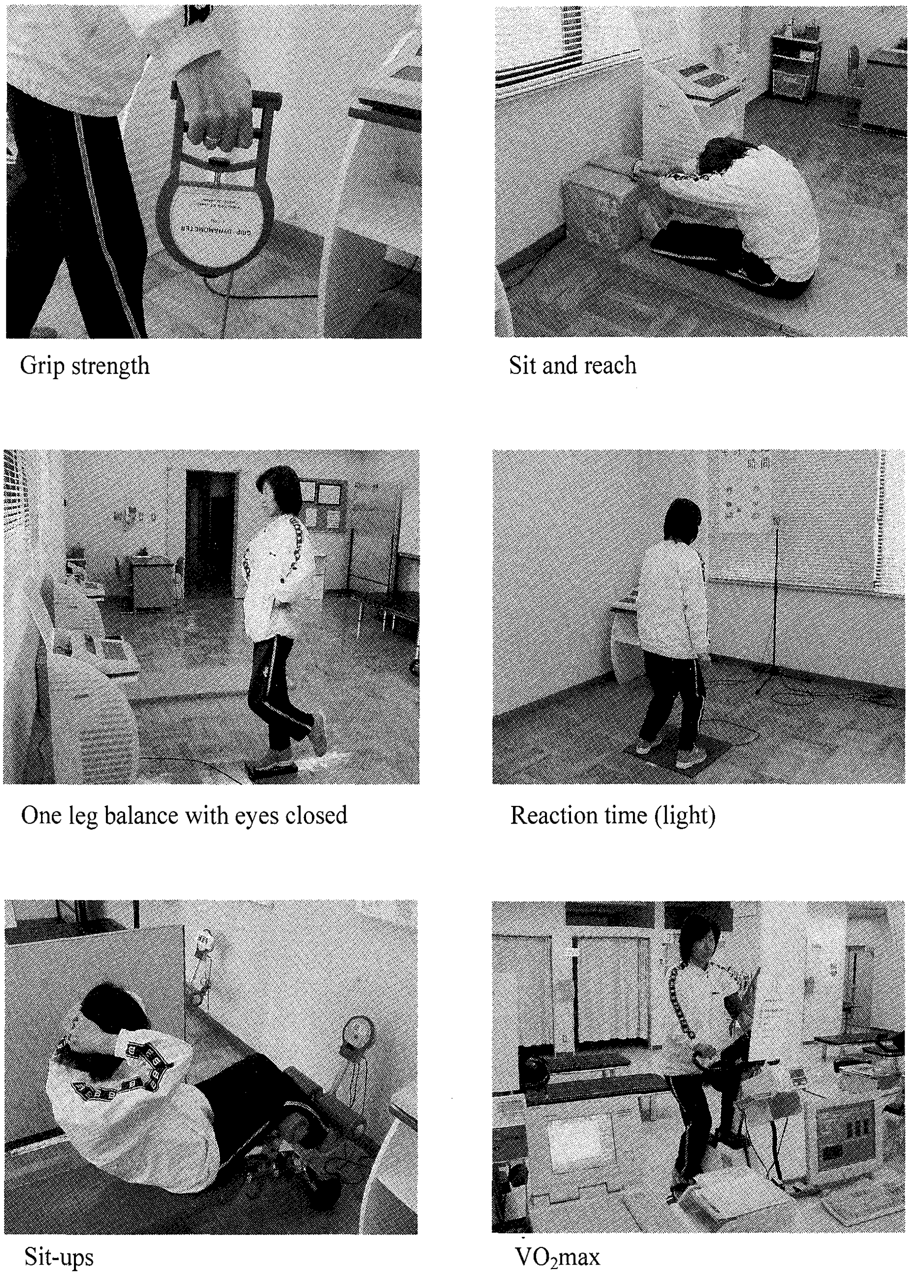



**Fig. 2** Physical fitness test (function).

as shown in Fig. 2 (Takei Scientific Instruments Co., Ltd, 1999). Table 4 shows the means and standard deviations of physical fitness tests in the healthy and unhealthy groups for each age group.

*Data analysis*

Multiple discriminant analysis (Cooley et al., 1971; Betz, 1987) was used because a previous study (Sato et al., 2005) suggested that the relationship between health status and performance of a physical fitness test can be quantified. Multiple discriminant analysis can determine the degree of the relationship between both variables by using qualitative data as a dependent variable and plural quantitative data as independent variables. Multiple discriminant functions that can appropriately discriminate the two groups of healthy and unhealthy were calculated based on the results of physical fitness tests. The correct discriminant probabilities with the functions were used to evaluate the degree of the relationship between health status and physical fitness. The multiple discriminant function was calculated with 10 physical fitness variables as an explanatory variable. The healthy and unhealthy groups were classified by a medical doctor based on the results of medical checkups. The contribution of each physical fitness component to health status was evaluated by expressing each individual's degree of health with the discriminant score, and calculating Pearson's correlation coefficient between that score and the performance in each physical fitness test. In evaluating the correlation coefficients, significance was tested at $p<0.05$, and absolute values of the correlations of 0.4 or more were interpreted as the medium correlation coefficient. The physical fitness components highly contributing to health status were presented on the basis of a correlation coefficient of 0.4 at each

**Table 4** Physical characteristics of participants for healthy group (HG) and unhealthy group (UG)

| Variables [unit] | Group | Age [yrs] 30–39 | 40–49 | 50–59 | 60–69 |
|---|---|---|---|---|---|
| Height [cm] | HG | 158.0 ( 5.4) | 155.4 ( 4.7) | 154.7 ( 4.9) | 151.9 ( 4.9) |
| | UG | 158.7 ( 3.8) | 155.0 ( 4.9) | 153.7 ( 5.1) | 151.8 ( 4.7) |
| Weight [kg] | HG | 51.2 ( 6.0) | 52.4 ( 5.5) | 51.8 ( 5.8) | 50.1 ( 6.2) |
| | UG | 55.7 ( 7.7) | 58.7 ( 9.7) | 55.8 ( 8.1) | 54.7 ( 6.7) |
| BMI: body mass index | HG | 20.5 ( 2.2) | 21.7 ( 2.0) | 21.7 ( 2.1) | 21.7 ( 2.5) |
| | UG | 22.1 ( 3.0) | 24.4 ( 3.6) | 23.6 ( 3.2) | 23.7 ( 2.9) |
| Percent body fat [%] | HG | 25.5 ( 4.6) | 26.0 ( 5.3) | 26.7 ( 4.4) | 27.7 ( 5.7) |
| | UG | 25.1 ( 5.7) | 27.8 ( 6.8) | 29.1 ( 5.7) | 30.4 ( 6.3) |
| Grip strength [kg] | HG | 30.6 ( 3.9) | 29.5 ( 3.8) | 27.1 ( 3.8) | 24.6 ( 3.7) |
| | UG | 31.2 ( 5.0) | 29.4 ( 4.6) | 26.7 ( 4.1) | 24.8 ( 3.7) |
| Sit and reach [cm] | HG | 10.9 ( 7.1) | 11.6 ( 7.5) | 11.7 ( 6.9) | 10.7 ( 7.4) |
| | UG | 12.2 ( 7.1) | 9.7 ( 7.4) | 10.2 ( 7.2) | 10.4 ( 7.2) |
| One leg balance | HG | 55.6 (52.8) | 48.2 (48.8) | 28.6 (39.8) | 15.6 (27.0) |
| with eyes closed [s] | UG | 40.9 (28.4) | 45.9 (56.3) | 19.8 (23.9) | 10.0 (11.7) |
| Reaction time (light) [s] | HG | .378 (.040) | .387 (.049) | .411 (.054) | .447 (.074) |
| | UG | .397 (.053) | .409 (.062) | .422 (.059) | .455 (.081) |
| Sit-ups [times/30s] | HG | 15.1 ( 4.0) | 11.4 ( 5.4) | 7.5 ( 5.5) | 5.3 ( 5.1) |
| | UG | 12.8 ( 5.6) | 9.5 ( 5.1) | 6.4 ( 6.0) | 4.4 ( 4.9) |
| $\dot{V}O_2max$ [ml/kg/min] | HG | 30.7 ( 5.6) | 23.2 ( 6.0) | 25.6 ( 5.6) | 24.1 ( 4.8) |
| | UG | 27.5 ( 6.7) | 25.2 ( 5.5) | 24.7 ( 6.1) | 22.8 ( 6.2) |

Note 1) Mean (SD)

**Table 5** Multiple discriminant functions to discriminate the healthy and unhealthy groups for each age group

30–39 yrs

$$Y=+0.23826X_1-0.41867X_2+0.63892X_3+0.15775X_4-0.01027X_5-0.02113X_6+0.00252X_7-5.41849X_8+0.07682X_9+0.07437X_{10}-34.19552$$

40–49 yrs

$$Y=-0.13863X_1+0.18191X_2-0.92458X_3+0.12472X_4+0.03485X_5+0.01832X_6-0.00368X_7-4.63381X_8-0.00041X_9+0.05862X_{10}+28.25317$$

50–59 yrs

$$Y=+0.09798X_1-0.11661X_2-0.09164X_3+0.03622X_4+0.04328X_5+0.02320X_6+0.00578X_7-0.74774X_8+0.00409X_9+0.05896X_{10}-10.66094$$

60–69 yrs

$$Y=-0.07541X_1+0.04039X_2-0.52606X_3+0.05278X_4+0.04693X_5-0.00515X_6+0.01150X_7+1.06550X_8+0.00200X_9+0.03026X_{10}+17.32266$$

Note 1) Y: Discriminant score representing health status, $X_1$: Height (cm), $X_2$: Weight (kg), X3: BMI: body mass index, $X_4$: Percent body fat (%), $X_5$: Grip strength (kg), $X_6$: Sit and reach (cm), $X_7$: One leg balance with eyes closed (s), $X_8$: Reaction time (s), $X_9$: Sit-ups (times/30s), $X_{10}$: $\dot{V}O_2max$ (ml/kg/min)

age level. These components are useful when preparing an exercise program. Multiple discriminant analysis was conducted using SPSS (Version 8.0.1 for Windows®, SPSS Inc.).

## Results

*Multiple discriminant functions and correct discriminant probabilities*

Table 5 shows the multiple discriminant functions for age groups obtained by multiple discriminant analysis. The multiple discriminant functions consisted of 10 variables from the physical fitness tests. This function can estimate the discriminant score representing the degree of health status for each individual by substituting the 10 variables from the physical fitness tests.

Figure 3 shows the incorrect discriminant probability, the percentage of two groups of healthy and unhealthy incorrectly discriminated from these multiple discriminant functions by each age group, and the correct discriminant probability and the percentage correctly discriminated. Correct discriminant probabilities ranged from 63.0% to 77.5%. As a result of the test of proportion, it was found that the correct discriminant probabilities decreased with age ($p<0.05$).

*Correlation coefficients between discriminant scores representing health status and physical fitness variables*

Using each individual's discriminant score representing the degree of health status, calculated by the obtained multiple discriminant function, Pearson's correlation coefficients between the discriminant score and the performance in each physical fitness test were calculated, and the results of significance are shown in Table 6. Seven significant correlation coefficients ($p<0.05$) were revealed at 30 to 39 years old, 7 variables at 40 to 49 years old, all variables at 50 to 59 years old and 7 variables at 60 to 69 years old.

In evaluating the correlation coefficients, in 50 to 59 years old (−0.594) for weight (−0.568 to −0.875), all age levels of BMI (−0.559 to −0.930), and percent body fat, 60 to 69 years old (−0.589), 30 to 39 years old (0.439) for sit-ups, 30 to 39 years old (0.447), and 40 to 49 years old (0.413) for $\dot{V}O_2$max, correlation coefficients higher than a medium degree were obtained. The aging change from 30 to 69 years old could be classified into four patterns.

By age group, medium or higher correlation coefficients were obtained for age 30 to 39 for the four variables of weight, BMI, $\dot{V}O_2$max, and sit-ups, for age 40 to 49 for the three variables of weight, BMI, and $\dot{V}O_2$max, and for ages 50 to 59 and 60 to 69 for the three variables of BMI, weight, and percent body fat.

## Discussion

*Relationship between health status and physical fitness in middle-aged and elderly females*

In order to maintain and improve health status, it is recognized that physical fitness should be maintained and improved through physical activity and exercise (American College of Sports Medicine, 2000; United States Department of Health and Human Services, 1996), and interest in the relationship degree between health status and physical fitness has been growing. Research for quantitative data is still restricted although the degree of their relationship is widely recognized conceptually (Sato et al., 2005).

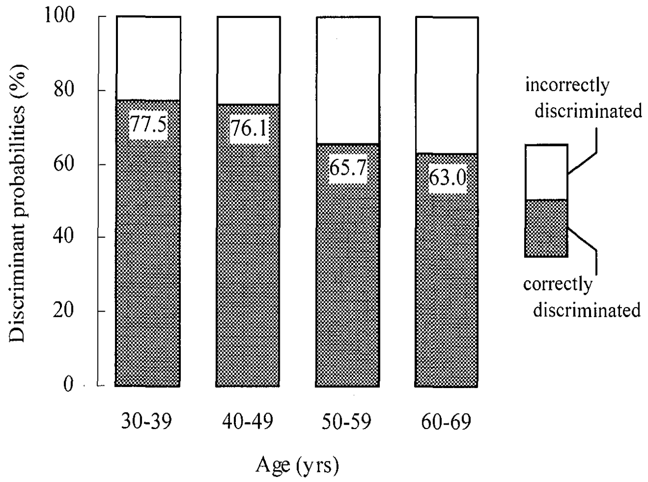



**Fig. 3** Discriminant probabilities for discriminant functions with 10 physical fitness variables.

Sato et al. (2005) quantified the degree of relationship between health status and physical fitness level for middle-aged and elderly people, applying multiple discriminant analysis suitable for the character of the status and level. In this previous study, the correct discriminant probability by each age group was calculated with one multiple discriminant function obtained from participants aged from 30 to 69 using physical fitness variables and age for the independent variables. In this study, the variable of age was eliminated from the function and the analysis was made with only physical fitness variables. That is, after participants aged from 30 to 69 were grouped at intervals of 10 years, multiple discriminant analysis was applied to each age group and the multiple discriminant function was separately calculated with 10 variables of physical fitness tests. The correct discriminant probabilities of these multiple discriminant functions were 63.0 to 77.5%. Correct discriminant probability was a relatively high value as shown in the previous study (88.5% for 30 to 39 years old, 79.9% for 40 to 49 years old, 65.7% for 50 to 59 years old, 64.7% for 60 to 69 years old), and the tendency of aging change was also similar. This suggested that discrimination of the health status of middle-aged and elderly females had relatively high accuracy, even with only the physical fitness data excluding the variable of age. As compared with the previous study, there was a difference only in age 30 to 39. It is inferred that the contribution of age may be high in this age group. If a sufficient sample size of participants is secured at this age, the correct discriminant probability becomes higher by making up a group with a smaller age range and calculating a multiple discriminant function.

For middle-aged and elderly females, changes in their health status under the influence of female hormones must also be

**Table 6** Correlation coefficients between discriminant score representing health status and physical fitness variables

| Variables | Age (yrs) | | | |
|---|---|---|---|---|
| | 30–39 | 40–49 | 50–59 | 60–69 |
| Height | −0.102 | 0.074 | 0.242** | 0.032 |
| Weight | −0.568** | −0.723** | −0.701** | −0.875** |
| BMI: body mass index | −0.559** | −0.827** | −0.881** | −0.930** |
| Percent body fat | 0.069 | −0.265** | −0.594** | −0.589** |
| Grip strength | −0.123 | 0.016 | 0.127** | −0.056 |
| Sit and reach | −0.141* | 0.220** | 0.263** | 0.053 |
| One leg balance with eyes closed | 0.233** | 0.039 | 0.314** | 0.362** |
| Reaction time (light) | −0.376** | −0.347** | −0.252** | −0.138** |
| Sit-ups | 0.439** | 0.286** | 0.254** | 0.239** |
| $\dot{V}O_2$max | 0.447** | 0.413** | 0.380** | 0.302** |

Note 1) * $p<0.05$, ** $p<0.01$

taken into consideration. It is pointed out that female hormones may have important functions required for human physiology, especially for cardiovascular system functions (Sanada et al., 2003; Collins et al., 1995). That is, female hormones may influence the degree of relationship between health status and physical fitness level that fall with aging.

It was reconfirmed that a relatively high relationship generally exists between health status and physical fitness in middle-aged and elderly females. This enabled the health status expressed as status to be converted into a numerical value by using a multiple discriminant function, and the relationship with each physical fitness component is examined with the correlation coefficient.

Although the close relationship between health status and physical fitness is conceptually recognized, data based on the objective numerical value is required when preparing an exercise program in the field of exercise instruction. The aging change in the contribution of each physical fitness component to the degree of health and the physical fitness components that highly contribute to the degree of health in each age group should be determined.

*Aging change of the contribution of each physical fitness component to the degree of health*

Expressing each individual's degree of health with the discriminant score, and calculating Pearson's correlation coefficient between the score and the performance in a physical fitness test, the degree of the contribution of each physical fitness component to health status was evaluated. In the test of the significance of a correlation coefficient, significance ($p<0.05$) was obtained in at least 7 of 10 variables in each age group. These physical fitness components are indicated to be related to the degree of health. Furthermore, observing the change for each variable in detail with the correlation coefficient, BMI and percent body fat showed a tendency for the correlation to become higher with age. Tests of grip strength, sit and reach, one leg balance with eyes closed, and reaction time had low correlation coefficients in all age groups. As for sit-ups, medium and higher correlation coefficients were obtained only for age 30 to 39. For $\dot{V}O_2$max they were obtained only for ages 30 to 39 and 40 to 49, and thereafter, a tendency for the correlation to become lower with age was observed. From the above, the change with age into the following four patterns was classified as shown in Table 6.

*1. The components indicating medium and higher correlations consistently throughout in all age groups*
[Weight, BMI]

For weight and BMI, the degree of relation to the degree of health becomes high with age. A negative correlation coefficient was obtained, because obesity is considered to have a bad influence on health status. Obesity is the factor that raises the prevalence of hypertension, hyperlipemia, diabetes, and so on, and careful attention should be paid to health care (National Institute of Health, 1985). However, care is necessary also when the value becomes smaller than the appropriate range, because the range exists in weight and BMI. In a study on the relationship between BMI and a disease, it was reported (McGee, 2005) that BMI exceeding the standard is not healthy, and it is considered that weight and BMI are effective as characteristic of the degree of health regardless of age. Furthermore, an obese person's rate is high in middle-aged and elderly females (Kehayias, 1997; Roubenoff et al., 1995). From the above, it is considered that for all age groups of middle-aged and elderly females, the maintenance of weight and BMI within an appropriate range would contribute greatly to keeping a good health status. Accordingly, in guiding exercise, it is effective to maintain a correct weight and BMI within the appropriate range.

*2. The components not indicating medium and higher correlations consistently throughout all age groups*
[Height, Muscular strength, Flexibility, Balance, Agility]

The variable of height becomes the basis in the case of calculating various physique indices, as well as its use as a representative index of body length (American College of Sports Medicine, 2000). However, height does not change a lot once we are grown up, although the differences in the growing period, nutrients, etc. affect growth. It is inferred that the degree of the relationship with health status is low because it is easily influenced by the living environment. The physique index used in this study was evaluated from a ratio of weight to height, and the degree very much relates to weight. From the fact that medium and higher correlation coefficients with health are obtained for weight and BMI, evaluation with similar accuracy is possible even from the two variables of BMI and percent body fat instead of these 4 variables when estimating health with fewer variables.

The contribution to health of muscular strength, flexibility, balance, and agility was low, suggesting that it is not necessary to give special consideration to these components when preparing and exercise program for middle-aged and elderly females in order to improve and maintain health status.

*3. The components indicating a peak at ages 30 to 40 and a medium and higher correlation*
[Muscular endurance, Cardiorespiratory endurance]

The test of sit-ups selected in this study is a way to evaluate muscular endurance, and the dynamic muscular endurance of abdominal muscles is a main factor (Diener et al., 1995; Faulkner et al., 1989). It is a matter of conjecture whether the continuous work accompanied by muscle contraction of the trunk performed for a long time should be related to the degree of health for females aged 30 to 39. It is, therefore, considered that exercise to improve and maintain the muscular endurance of the trunk should be adopted in an exercise program for females aged 30 to 39.

Cardiorespiratory endurance is dynamic exercise using various muscular groups and reflects the ability to continue an exercise with medium and high intensity for a long time.

Performance of this exercise is dependent on the respiratory system, the cardiovascular system, and the skeletal muscles, and it is pointed out to be a component useful as an index of health status, in comparison with other physical fitness components, in common with both middle-aged and elderly males and females (American College of Sports Medicine, 2000; Kumagai et al., 1993). However, the ages that showed a medium and higher contribution were between ages 30 to 39 and 40 to 49.

As for muscular endurance and cardiorespiratory endurance, from the fact that the pattern of the contribution to health declines with age was observed, it is suggested that it would be effective to prepare an exercise program for a relatively young age group by emphasizing these two components.

*4. The components indicating a peak at ages 50 to 60 and a medium and higher correlation*

[Percent body fat]

For percent body fat with age, the same change as weight and BMI was observed, and the ages that showed a medium and higher contribution were between 50 to 59 and 60 to 69. It was suggested that the contribution to body composition increases with age.

In addition, investigating this change with aging, the aging pattern of percent body fat disagreed with that of cardiorespiratory endurance. The increase in weight or body fat is considered to be a secondary cause for the decline of the $\dot{V}O_2$max largely used as an index of cardiorespiratory endurance with age (Pollock et al., 1987). It is observed that there is a turning point in the contribution to health in ages 40 to 49 and 50 to 59. This may indicate that attention should be paid to setting the exercise intensity in the endurance exercise for the program to improve and maintain health. Accordingly, although it is desirable that for ages 30 to 39 and 40 to 49 that the exercises are performed with a relatively high intensity to improve and maintain cardiorespiratory endurance, it is considered to be effective to correct to a relatively low intensity to improve and maintain health and to decrease body fat in ages 50 to 59 and 60 to 69.

*The physical fitness components with a high contribution useful to prepare exercise programs for each age group*

By age group, medium or higher correlation coefficients were obtained for age 30 to 39 for the four variables of weight, BMI, $\dot{V}O_2$max, and sit-ups, for age 40 to 49 for the three variables of weight, BMI, and $\dot{V}O_2$max, and for ages 50 to 59 and 60 to 69 for the three variables of BMI, weight, and percent body fat (Table 6). It is considered that such data would be useful when preparing an exercise program according to age group. Referring to the general exercise program for middle-aged and elderly females (American College of Sports Medicine, 2000), and taking the change of weight and BMI into consideration in all age groups, endurance for age 30 to 39 should be improved by exercise with a relatively high intensity in cardiorespiratory endurance. In addition, exercise such as sit-ups for muscular endurance of the trunk are preferentially adopted in an exercise program. For age 30 to 39 and 40 to 49, exercise to improve and maintain cardiorespiratory endurance is appropriate. Exercise with a relatively low intensity to maintain percent body fat at an appropriate range for endurance is effective for ages 50 to 59 and 60 to 69.

The result of this study is considered to be useful as objective data when preparing an exercise program considering the contribution of physical fitness components to health, although when preparing an exercise program, mode, intensity, duration, and frequency of exercise must be set up according to individual conditions (health status, physical fitness level, age, gender, etc.) and individual purpose (American College of Sports Medicine, 2000).

All the conclusions in this study were generalized under the limitations in participants, evaluation and assessment of health status and physical fitness, and data analysis.

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