Journal of
PHYSIOLOGICAL
ANTHROPOLOGY

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

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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 males. The participants were 995 males 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 males ranged from 67.0% to 75.1%. These findings suggest that there is a relatively high relationship between the health status and physical fitness level for middle-aged and elderly males. With each individual's discriminant score calculated using the 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 age change between 30 and 69 years old was classified into five 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. *J Physiol Anthropol Appl 25(5): 311–319, 2006* http://www.jstage.jst.go.jp/browse/jpa2 [DOI: 10.2114/jpa2.25.311]

Keywords: health status, physical fitness, middle-aged and elderly males, 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). However, health status is generally evaluated as "status" based on the results of medical checkups by a medical doctor, and it is difficult to express it numerically. On the other hand, physical fitness consists of plural components (American College of Sports Medicine, 2000; World Health Organization, 1947) and can be expressed numerically. Recently, a study on the quantification of the degree of relationship between health status and physical fitness in middle-aged and elderly people was conducted (Sato et al., 2005), although quantification of the degree of the relationship is not easy because health status and physical fitness differ in character.

Sato et al. (2005) applied multiple discriminant analysis considering the character of both variables, and attempted 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 related highly to the degree of health numerically expressed using the multiple discriminant function, with the result that a relatively strong relationship was confirmed between both variables.

It is necessary to prescribe a suitable exercise program (exercise prescription) that specifies the mode, intensity, duration, frequency, etc. of exercise according to age and gender of the participants. It is necessary to pay attention to the contribution of each physical fitness component toward the degree of health which provide useful data when prescribing a suitable exercise program for improvement and maintenance of health as well as various conditions such as gender, age and so on.

This study clarified the physical fitness components that contribute to improving and maintaining health status with aging and each age group as well as quantifying the degree of the relationship between health status and physical fitness in middle-aged and elderly males.

Table 1 Sample sizes of measured and analyzed participants

Age (yrs)	Measured Ps	Analyzed Ps	
		HG	UG
30–39	260	172	25
40–49	188	71	31
50–59	231	86	80
60–69	316	81	122
Total	995	410	258

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

Methods

Participants

The participants were 995 Japanese males 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 participate in 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 according to this evaluation.

The doctor's comprehensive evaluation was made based on the criteria of the Japan Society of Ningen Dock (2005). That is, the criteria that indicated the participant was in the category "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 greater, etc. This evaluation, according to the initial criteria, was regarded 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 judged to be "Need for medical treatment" in the healthy group.

Meanwhile, the participants who were judged as "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, 4.6%, 8.5%, and 9.6% of them, respectively, had systolic pressure suggesting "Need for medical treatment", and 4.0%, 5.1%, and 4.8% of them, respectively, had diastolic blood pressure indicating "Need for medical treatment". The latter two groups were classified as the unhealthy group.

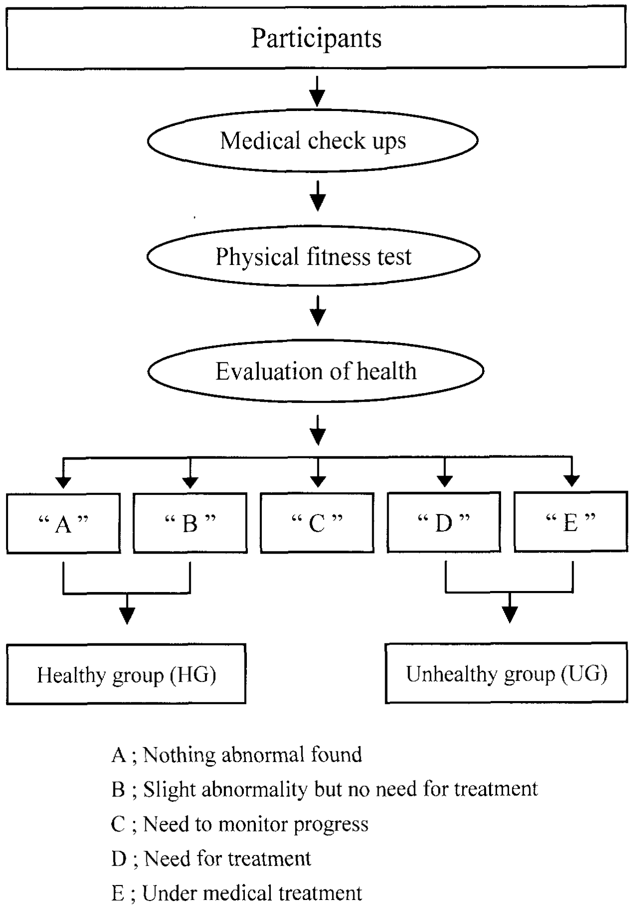

Fig. 1 Data set for multiple discriminant analysis.

There was no significant difference between the proportions of participants who were categorized as D and E. This is because the degree that they exceeded the criteria at the stage of comprehensive evaluation reflects the difference in the categories they were assigned to. Thus, the difference between the healthy group and the unhealthy group in this study may largely have depended on the existence of an abnormality in the variables of 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 the evaluation of health status is shown in Fig.1. The number of participants in the two groups of healthy and unhealthy used for the data analysis is shown on the right of Table 1.

Physical fitness tests

Anthropometrical aspects of physical fitness were evaluated using four tests of height, weight, BMI and percent body fat. Percent body fat was estimated by means of the bioelectric

Table 2 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 (times/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.

impedance method (Tanaka et al., 1992; Nakadomo et al., 1990). 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 selected to evaluate functional aspects of physical fitness. Table 2 shows the detailed methods to evaluate physical fitness. Among these six 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). The loading method to measure $\dot{V}O_2max$ was a multi-stage graded sub-maximal exercise test. $\dot{V}O_2max$ can be estimated with acceptable accuracy during conventional exercise test protocols, by considering test duration or power output on a cycle ergometer. Submaximal exercise tests are commonly used because maximal exercise testing is not a feasible method of assessing cardiorespiratory endurance for the vast majority of health/fitness practitioners (American College of Sports Medicine, 2000). In this study, the submaximal exercise test was used to secure a large sample size for multi variate analysis. Other tests were conducted using the physical fitness test system (H.I.T. System, Takei Scientific Instruments Co. Ltd., Tokyo, Japan). Table 3 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 functions were calculated with 10 physical fitness variables as an explanatory variable. Correlations among independent variables were taken into account in the process of calculation for this discriminant function. Multiple discriminant analysis was conducted using SPSS (Version 8.0.1 for Windows®, SPSS Inc.). The contribution of each physical fitness component to health status was evaluated by calculating Pearson's correlation coefficients between the score and the performance in each physical fitness test after expressing each individual's degree of health with the

Table 3 Physical characteristics of participants for the healthy group (HG) and unhealthy group (UG)

Variables [unit]	Group	Age [yrs] 30–39	40–49	50–59	60–69
Height [cm]	HG	170.9 (5.7)	169.7 (4.4)	165.7 (5.8)	165.1 (5.6)
	UG	168.9 (7.0)	168.4 (4.6)	164.5 (5.1)	163.7 (6.0)
Weight [kg]	HG	64.7 (8.9)	64.6 (6.4)	62.4 (6.4)	61.1 (7.9)
	UG	72.0 (12.4)	67.0 (9.0)	64.0 (7.4)	63.3 (7.7)
BMI; body mass index	HG	22.2 (2.7)	22.5 (1.9)	22.7 (1.9)	22.4 (2.5)
	UG	25.2 (3.5)	23.8 (3.0)	23.7 (2.7)	23.6 (2.4)
Percent body fat [%]	HG	19.1 (3.9)	18.7 (3.4)	19.5 (3.6)	19.8 (4.2)
	UG	22.4 (6.3)	20.9 (3.9)	20.7 (4.9)	21.5 (3.5)
Grip strength [kg]	HG	50.5 (6.5)	47.6 (5.4)	43.8 (6.8)	39.6 (5.2)
	UG	50.0(7.1)	46.4 (4.9)	42.5 (6.4)	38.5 (5.5)
Sit and reach [cm]	HG	8.2 (8.1)	7.6 (7.2)	7.2 (9.3)	3.9 (8.1)
	UG	4.1 (9.3)	4.8 (7.2)	5.9 (10.1)	1.4 (9.7)
One leg balance with eyes closed [s]	HG	79.4 (69.7)	54.9 (52.5)	32.1 (32.2)	12.7 (12.1)
	UG	43.0 (55.3)	34.9 (30.8)	20.3 (17.8)	13.5 (22.1)
Reaction time [s]	HG	.344 (038)	.366 (047)	.376 (052)	.414 (054)
	UG	.357 (040)	.373 (049)	.385 (060)	.420 (087)
Sit-ups [times/30s]	HG	21.2 (4.9)	17.4 (5.9)	16.1 (5.0)	13.6 (3.8)
	UG	20.5 (4.0)	17.2 (4.9)	14.5 (5.4)	11.6 (4.6)
$\dot{V}O_2max$ [ml/kg/min]	HG	42.3 (10.6)	39.6 (10.3)	36.1 (7.2)	31.7 (7.1)
	UG	35.6 (10.0)	34.6 (8.7)	31.4 (8.6)	30.0 (8.1)

Note 1) Mean (SD)

Table 4 Multiple discriminant functions to discriminate the healthy and unhealthy groups for each age group

30–39 yrs

$$Y = +0.26478X_1 - 0.294827X_2 + 0.59941X_3 + 0.11184X_4 + 0.0166X_5 + 0.03759X_6 + 0.00384X_7 - 1.66792X_8 - 0.01818X_9 + 0.03818X_{10} - 41.57136$$

40–49 yrs

$$Y = -0.07941X_1 + 0.19217X_2 - 0.76831X_3 - 0.07981X_4 + 0.06758X_5 + 0.05611X_6 + 0.00442X_7 + 1.42426X_8 - 0.01750X_9 + 0.01684X_{10} + 15.35799$$

50–59 yrs

$$Y = -0.94608X_1 + 1.29141X_2 - 3.80648X_3 + 0.02117X_4 + 0.01920X_5 - 0.01170X_6 + 0.01408X_7 - 1.13971X_8 + 0.04233X_9 + 0.06685X_{10} + 158.82985$$

60–69 yrs

$$Y = +0.26289X_1 - 0.28798X_2 + 0.51899X_3 - 0.03680X_4 + 0.01293X_5 + 0.00946X_6 - 0.00764X_7 + 1.21467X_8 + 0.16842X_9 + 0.01934X_{10} - 40.05146$$

Note 1) Y: Discriminant score representing health status, X_1: Height (cm), X_2: Weight (kg), X_3: 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)

discriminant score. Significance was tested at $p<0.05$, and absolute values of the correlations of 0.4 or more were interpreted as medium correlation coefficients in the evaluation. The physical fitness components highly contributing to health status are presented on the basis of the absolute values of the correlations of 0.4 at each age group.

Results

Multiple discriminant functions and correct discriminant probabilities

Table 4 shows the multiple discriminant functions obtained by multiple discriminant analysis by each age group. 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 these 10 variables. Figure 2 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, the correct discriminant probability, and the percentage correctly discriminated. The correct discriminant probabilities ranged from 67.0% to 75.1% and the test of proportion revealed no significant tendency with age ($p>0.05$).

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

Pearson's correlation coefficients between the discriminant score and the performance in each physical fitness test were calculated using each individual's discriminant score representing the degree of health status, determined by the multiple discriminant functions. The results of significance are shown in Table 5. Significant correlation coefficients ($p<0.05$) were obtained for 8 items for 30 to 39 year olds, 8 items for 40 to 49 year olds, all items for 50 to 59 year olds, and 8 items for 60 to 69 year olds.

Correlation coefficients higher than a medium degree ($|r|\geq 0.4$) were obtained for the 30 to 39 year olds (−0.593) for weight, all age levels of BMI (−0.466 to −0.787), 30 to 39 year olds (−0.590), 40 to 49 year olds (−0.664) and 60 to 69 year olds (−0.567) for percent body fat, 40 to 49 year olds (0.433) for sit and reach, 30 to 39 year olds (0.416), 40 to 49 year olds (0.461) and 50 to 59 year olds (0.496) for one leg balance with eyes closed, 60 to 69 year olds (0.582) for sit-ups, 30 to 39 year olds (0.494), 40 to 49 year olds (0.546) and 50 to 59 year olds (0.643) for $\dot{V}O_2$max. The aging change from 30 to 69 year olds can be classified into five patterns.

Among age groups, medium or higher correlation coefficients were obtained for ages 30 to 39 years on five items of weight, BMI, percent body fat, one leg balance with eyes closed and $\dot{V}O_2$max, for ages 40 to 49 years on five items of BMI, percent body fat, sit and reach, one leg balance with eyes closed and $\dot{V}O_2$max, for ages 50 to 59 years on three items of BMI, one leg balance with eyes closed and $\dot{V}O_2$max, and for ages 60 to 69 years on three items of BMI, percent body fat and sit-ups.

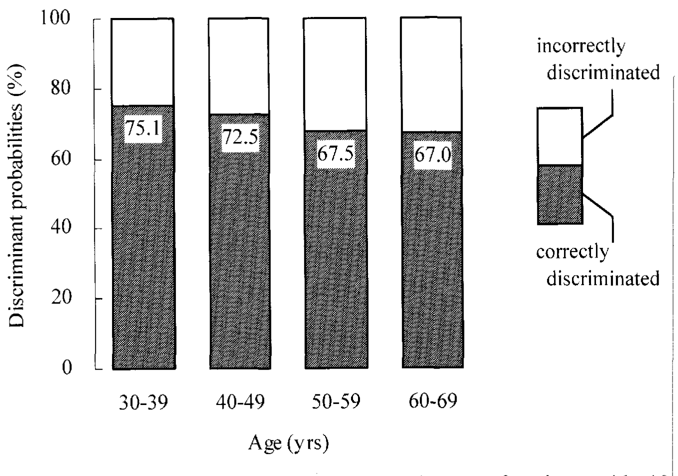

Fig. 2 Discriminant probabilities for discriminant functions with 10 physical fitness variables.

Discussion

Relationships between health status and physical fitness in middle-aged and elderly males

To maintain and improve health status, 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 the interest in the degree of relationship between health status and physical fitness has been growing. However, studies for quantitative data have still been limited (Sato et al., 2005), although the degree of their relationship is widely recognized conceptually.

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 that study, the correct discriminant probability by each age group was calculated with one multiple discriminant function obtained from participants aged between 30 and 69 years old using physical fitness variables and age for the independent variables. In this study, the variable of age was eliminated from the function to analyze for each age group and only physical fitness variables were used. That is, after participants aged between 30 and 69 years old 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 the physical fitness tests. The correct discriminant probabilities of these multiple discriminant functions were 67.0 to 75.1%. The correct discriminant probability was a relatively high value as shown in the previous study (85.8% for 30 to 39 year olds, 75.0% for 40 to 49 year olds, 65.6% for 50 to 59 year olds, 66.1% for 60 to 69 year olds) (Sato et al., 2005), with a similar tendency of age change. This suggested that discrimination of health status

Table 5 Correlation coefficients between discriminant score representing health status and physical fitness variables

Variables	Age (yrs)			
	30–39	40–49	50–59	60–69
Height	0.259**	0.327**	0.231**	0.297**
Weight	−0.593**	−0.349**	−0.273**	−0.356**
BMI; body mass index	−0.787**	−0.587**	−0.466**	−0.598**
Percent body fat	−0.590**	−0.664**	−0.306**	−0.567**
Grip strength	0.066	0.248*	0.214**	0.249**
Sit and reach	0.386**	0.433**	0.152*	0.344**
One leg balance with eyes closed	0.416**	0.461**	0.496**	−0.053
Reaction time	−0.289**	−0.155	−0.190*	−0.105
Sit-ups	0.121	0.049	0.360**	0.582**
$\dot{V}O_2$max	0.494**	0.546**	0.643**	0.284**

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

of middle-aged and elderly males had relatively high accuracy, even using only the physical fitness data and excluding the variable of age.

Health status can be preliminarily estimated if physical fitness data similar to that used in this study are collected. When the discriminant score, which is obtained by substituting physical fitness data for each individual in the multiple discriminant function (Table 4) in this study, is 0 or more, it is discriminated as a "healthy group" and if less than 0, it is discriminated as an "unhealthy group". This multiple discriminant function can deal with continuous variables by representing the health status of each individual with a discriminant score. In general, a relatively high relationship existed between health status and physical fitness of middle-aged and elderly males. This enabled health status, expressed as status, to be converted into a numerical value using a multiple discriminant function. The relationship with each physical fitness component was evaluated using the correlation coefficients.

Age change in the contribution of each physical fitness component to the degree of health

The degree of 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 coefficients between the score and the performance in a physical fitness test. The strong correlation between degree of health status and the measured value representing each physical fitness component suggested that the changes in both variables were highly correlated with each other.

Such findings are helpful as quantitative data when used in creating exercise programs according to gender, age, health status, physical fitness level, etc. It is, therefore, meaningful to elucidate the physical fitness component that highly contributes to the degree of health status.

In the test of the significance of a correlation coefficient, significance ($p<0.05$) was obtained in at least 8 of 10 items in each age group. These physical fitness components contribute to the degree of health status. Furthermore, observing the change for each component in detail with the correlations, BMI indicated relatively high correlation coefficients in all age groups. Tests of height, grip strength, and reaction time had low correlation coefficients in all age groups. As for one leg balance with eyes closed and $\dot{V}O_2max$, medium and higher correlation coefficients were obtained for ages 30 to 59 years old. For weight, they were obtained only for ages 30 to 39 years old, sit and reach only for ages 40 to 49 years old, and sit-ups only for ages 60 to 69 years old. From the above, the changes with age can be classified into the following five patterns shown in Fig. 3.

1. Components indicating medium and higher correlations consistently throughout in all age groups [BMI] (Fig. 3A)

BMI indicated medium and higher correlations consistently throughout in all age groups. Obesity is considered to have a bad influence on health status because a negative correlation coefficient was obtained. Obesity is the factor that raises the prevalence of hypertension, hyperlipemia, diabetes and so on, and careful attention should be paid in health care (National Institutes of Health, 1985). Although the appropriate range exists in BMI, a negative correlation coefficient suggests the necessity of case when a value becomes especially large, exceeding the appropriate range. In a study on the relationship between BMI and a disease (McGee, 2005), it was reported that BMI exceeding the standard is not healthy, and it is suggested that BMI is effective as characterizing the degree of health regardless of age. From the above, for all age groups of middle-aged and elderly males, the maintenance of BMI within an appropriate range would contribute greatly to maintaining a good health status. Accordingly, in guiding exercise, it is effective to maintain a correct BMI within the appropriate range.

2. Components indicating a peak at ages 30 to 50 years old and a medium and higher correlation [Balance, Cardiorespiratory endurance] (Fig. 3B)

Components of balance and cardiorespiratory endurance showed that these contributions were relatively high for ages 30 to 59 years old, but were mostly low for 60 to 69 years old. The balance function will also improve if there is training during the period of growth because the nervous system is closely involved. On the other hand, it is reported to recover slower compared with other physical fitness components once balance fails with aging. It is, therefore, suggested that exercise to improve and maintain balance should be adopted in an exercise program for 30 to 59 year-old males.

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 depends on the respiratory system, the cardio-vascular system, and the skeletal muscle function, which is reported to be a useful component 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 and 59 years. From these findings, as for balance and cardiorespiratory endurance, it would be effective to prepare an exercise program for the relatively young age group by emphasizing these two components.

3. Components indicating medium and higher correlations in one age group [Weight, Flexibility, Muscular endurance] (Fig. 3C)

A weight change similar to BMI was observed with age, and the ages that showed a medium and higher contribution were only ages 30 to 39 years. Accordingly, the exercise instruction especially for males aged 30 to 39 years old should take into

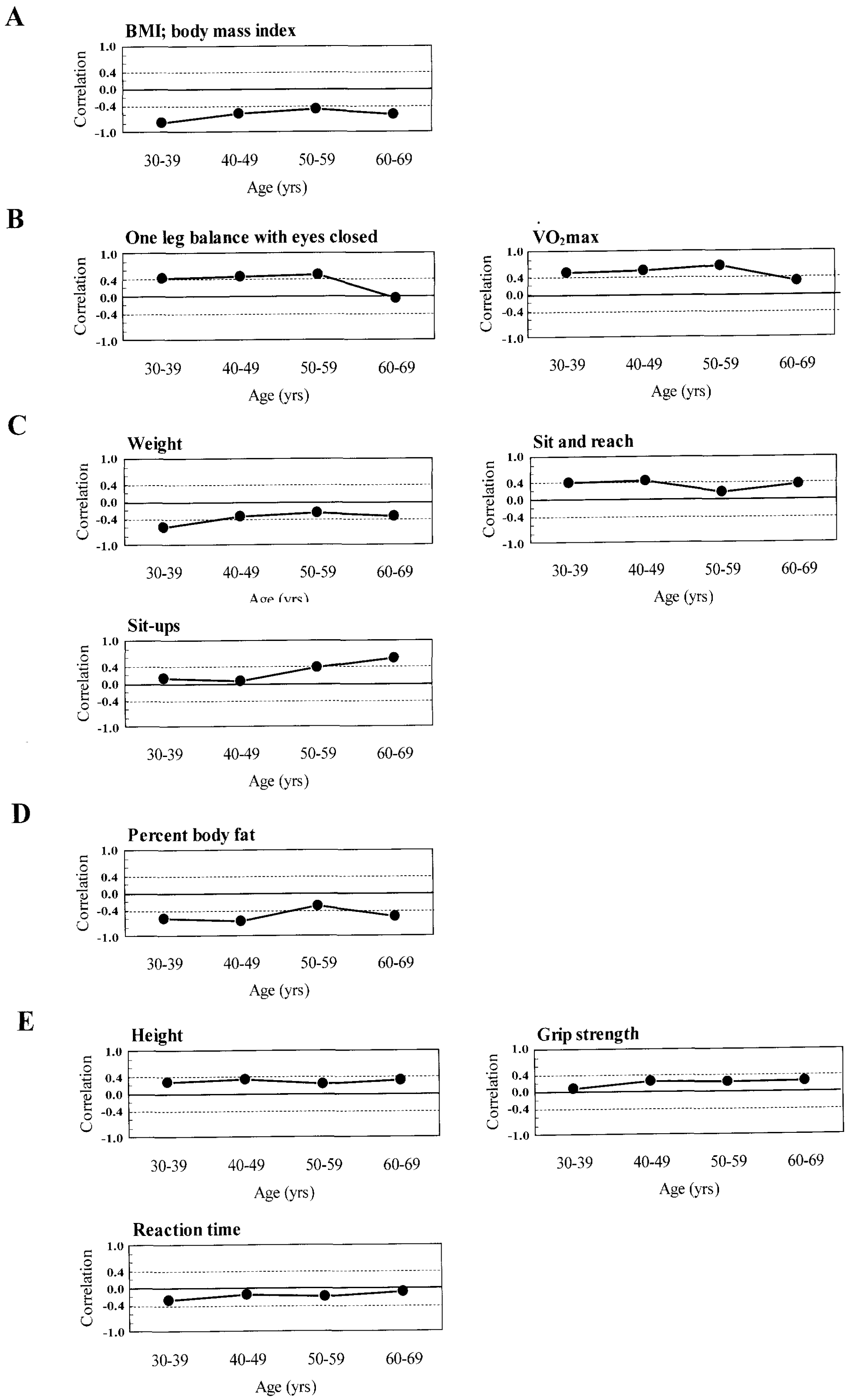

Fig. 3 Age-related changes in the contributions of physical fitness variables to health status.

consideration changes not only in BMI (physique) but also in weight.

Flexibility showed age change had the highest contribution to health in ages 40 to 49 years. In many cases, a deficiency in flexibility is considered to be the cause of some diseases such as internal diseases and lumbago, and affects health status indirectly. Therefore, exercise instruction paying attention to flexibility in 40 to 49 year olds is suggested.

The test of sit-ups selected in this study is a way to evaluate muscular endurance, with the dynamic muscular endurance of abdominal muscles as a main factor (Diener et al., 1995; Faulkner et al., 1989). It is conjectured that the capability for continuous work accompanied by muscle contraction of the trunk for a long time can be related to the degree of health status for ages 60 to 69 years. It is, therefore, suggested that exercise to improve and maintain muscular endurance of the trunk should be adopted in an exercise program for ages 60 to 69 years.

4. Components indicating medium and higher correlation in other age groups except for one age group [Percent body fat] (Fig. 3D)

Percent body fat indicated medium and higher correlations in age groups except for ages 50 to 59 years. Accordingly, the percent body fat is not as important to the degree of health for ages 50 to 59. In general, the percent body fat for middle-aged and elderly males is important for the degree of health as well as BMI, although it was confirmed as low importance only for ages 50 to 59. The maintenance of percent body fat as well as BMI within an appropriate range would contribute greatly to maintaining good health status. That is, in guiding exercise, it is effective to maintain a desirable percent body fat.

5. Components not indicating medium and higher correlations consistently throughout all age groups [Height, Muscular strength, Agility] (Fig. 3E)

The variable of height is used as a the basis to calculate 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 significantly once adult status is reached although there is a difference in the growth period. It is suggested that the degree of the relationship between both variables is low because the living environment easily influences health status. The physique index selected in this study was evaluated from a ratio of weight to height, so the degree was highly related to weight. From the observation that medium and higher correlation coefficients with health are obtained for BMI, evaluation with similar accuracy may be possible even using two variables of BMI and percent body fat instead of these 4 variables when estimating health status with fewer variables.

Low contributions to health in muscular strength and agility suggest that it is not necessary to give special consideration to these components when preparing an exercise program for middle-aged and elderly males to improve and maintain health status.

Physical fitness components with a high contribution useful to prepare exercise programs for each age group

Although a close relationship between health status and physical fitness is conceptually recognized, data based on an objective numerical value is required when preparing an exercise program in the field of exercise instruction. The age change for 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.

Figure 4 shows the physical fitness components indicating medium and higher correlation coefficients ($|r| \geq 0.4$) for each age group. These quantitative data would be useful when preparing an exercise program according to the age of participants. Referring to a general exercise program for middle-aged and elderly males (American College of Sports Medicine, 2000), and taking the change in BMI into

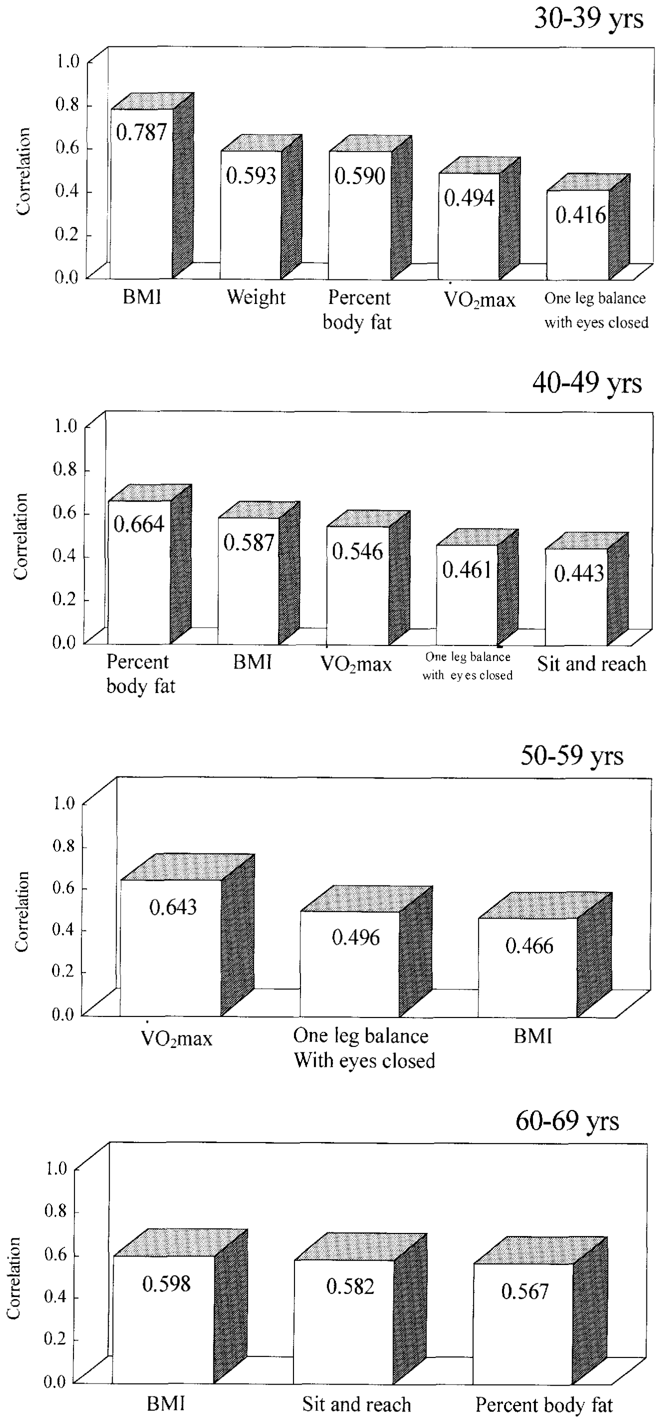

Fig. 4 Degree of contribution to health status for each age group ($|r| \geq 0.4$).

consideration in all age groups, especially for ages 30 to 39 years, care in the change of weight and percent body fat is needed and also exercise to improve and maintain cardiorespiratory endurance and balance are preferred in an exercise program. For ages 40 to 49 years, care, not only on BMI, but on percent body fat, and exercise instruction aimed at maintaining and improving cardiorespiratory endurance, balance, and flexibility should be carried out. For ages 50 to 59 years, exercise instruction for maintenance and improvement in cardiorespiratory endurance and balance paying attention to change in BMI would be effective. Moreover, for ages 60 to 69 years, it was suggested to be effective to direct exercise instruction for maintaining and improving flexibility as well as paying attention to the change of percent body fat.

The findings of the present study can be useful as objective data when preparing an exercise program with consideration of the contribution of the physical fitness components to health. However, when preparing an exercise program, mode, intensity, duration, and exercise frequency 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).

As a future research task, it may be necessary to increase the number of participants for analysis for every age, and not age levels, to clarify the contributions of each physical fitness component more closely to create exercise programs that respond more properly to age conditions. Moreover, to raise the validity of correlation coefficients, it is necessary to improve the accuracy of multiple discriminant functions, to clarify and add physical fitness variables suggested to be highly related to health status of middle-aged and elderly males.

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Received: October 11, 2005
Accepted: June 30, 2006
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