[Environmental Health and Preventive Medicine 3, 130-140, October, 1998]

Original Article

An Applicability Study of the AAHPERD's Functional Fitness Test for Elderly American Adults to Elderly Japanese Adults

Koichi YAGUCHI[*1] and Manabu FURUTANI[*2]

[*1]*Department of Hygiene, Kagoshima University Faculty of Medicine, Kagoshima*
[*2] *Osaka Resort and Sports College, Osaka*

Abstract

In 1990 a functional fitness test for the elderly was proposed by the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD). This study was undertaken to determine the applicability of that test for elderly Japanese adults. The fitness parameters of the test were "total body flexibility", "agility and dynamic balance", "coordination of eye, arm and hand movements", "strength and endurance", and "aerobic capacity". The sample consisted of five hundred thirty-four healthy normal elderly adults between the ages of 60 and 90.

The results indicated that each test item possessed relatively high reliability and validity. It would be useful to give this test to the elderly Japanese adults in order to determine their functional fitness levels measured by each test item individually and also to assess the relationships between their functional fitness levels and their activities of daily living, particularly those involving cognitive and social abilities.

Key words: elderly Japanese, functional fitness test, ADL, application study

Introduction

The population of Japan has been rapidly aging over the last two decades. In 1997 the aged comprised 15.4% of the population[1], a figure that included an unprecedented number of frail and handicapped persons, often bed-ridden and suffering from senile dementia. Under such circumstances, enhancement of the functional fitness capacity of the elderly through participating in lifelong integrated sports and maintaining regular physical activities as elements of a healthy lifestyle contributing to the prevention of geriatric diseases become essential [2,3]. This has been recognized in rapidly-aging societies such as those of Western Europe, the United States and Japan[4-6]. It is essential to determine current physical fitness levels of the elderly in order to maintain their physical health status and ability to live independently. These, in turn, are related to their Activities of Daily Living (ADL) [7-9] and mental health status[6,10-12]. Several kinds of fitness tests for the elderly have been developed in the past ten years in Japan and the United States[13-17]. These have been standardized to be used in clinical settings. However, the health practitioners dealing with older people in institutional and community settings are not always familiar with these fitness tests. Owing to the factors mentioned above, the authors administered the functional fitness test for adults over 60 years of age, proposed by the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) in 1990[7], to elderly Japanese adults living at home. Furthermore, the reliability and validity of the AAHPERD's test battery were examined by analyzing the relationships between the functional fitness test items and other sets of physical fitness test items, confirmed to be well validated for elderly Japanese adults[13-15].

Received Jul. 6, 1997 /Accepted Jul.6, 1998
Reprint requests to: Koichi YAGUCHI
Department of Social Work, School of Health Sciences
Tokai University
Bohseidai, Isehara, Kanagawa 259-1143, Japan
TEL: +81(463)90-2010
FAX: +81(463)90-2073

Materials and Methods

1. Subjects

About two hundred elderly adults participated in validity and reliability studies for the functional fitness test. The total number of elderly adults who participated as a population of data analyses of this test was 534: 186 male and 348 female Japanese from 60 to 90 years of age. They were living in their own homes, of which there were three family types: 42% were living alone; 36% were living only with a spouse and 22% were living with a spouse and children. About 80% of the subjects had graduated from a junior high school or a high school, whereas 20% of them had graduated from a college or university. All were in the completely independent level of the physical ADL, but some were in the partly dependent level of the instrumental ADL. They underwent a simple physical examination, which involved measurement of blood pressure, a self-rated health evaluation, determination of the degree of physical activities involving exercise and sports and the completion of a checklist of general health complaints by health practitioners before the test. The final condition of participation in the study was the absence of any condition which might prevent them from exercise. They voluntarily consented to participate after being informed of both the content of the functional fitness test and the results of the physical examination.

2. Design and procedures

The AAHPERD functional fitness test for the elderly consisted of five fitness parameters and their corresponding test items. The parameters included trunk and leg flexibility (sit and reach test), agility and dynamic balance (agility and dynamic balance test),coordination (soda pop coordination test), strength and endurance (strength and endurance test),and endurance (880-yard walk test). Functional fitness for the elderly[17] was defined as "the physical capacity of the individual to meet ordinary and unexpected demands of daily life safely and effectively". This definition indicated the need for a test that was practical and related closely to activities normally encountered by individuals over 60 years of age. The reliability and validity of the original test for elderly Americans were demonstrated in the results of several published papers[18-21].

The reliability for each test item of the AAHPERD's test battery was examined by analyzing the correlations between the scores measured at an one-week interval (test- retest reliability). The three kinds of validity for each test item were examined by analyzing the relationships between each test item of the functional fitness test battery and other sets of physical fitness test items[13-15], confirmed to be well validated for elderly Japanese adults (content validity), and by analyzing the intercorrelations between the five functional test items for the elderly (content validity),and also by analyzing the relationships between each test item of the test battery and chronological age,which is noticed to be an effective index of the normal aging process[23] (criterion-related validity), and furthermore,by assessing the relationships between each item of the AAHPERD's test battery and the activity scales[25,26], particularly those involving cognitive and social abilities of eldely Japanese adults (construct validity).

These test items were given, in order, to the elderly Japanese sample after measuring both body weight and standing height. The equipment, set up, and procedure of each test item was described in AAHPERD's published protocol[7,22]. The main procedure for the conduct of each test was as follows: Body weight in kilogram with increments of 0.1 kg was measured on a calibrated scale, which was placed on a firm, flat, horizontal surface. Standing height in centimeter was measured using the graduated scale of length with increments of 0.1 cm. The ponderal index, the degree of leanness, was obtained based on both the body weight and the standing height of each person.

Flexibility: The main procedure for conducting the sit and reach test was as follows: A measurement sheet was prepared. It contained a long straight line of 90 cm with increments of 0.1 cm and also a shorter straight line of 50 cm,perpendicular to the long line. Two marks were drawn on the short line, each 15 cm away from th intersection of the two lines. The subject must remove his or her shoes for this test and sit on the floor with legs extended, 30 cm apart, toes pointing straight up, and heels right up against the line. The hands were placed one directly on top of the other. The subject then reached forward slowly, sliding the hands along the measuring stick as far as possible, and must hold the final position for at least 2 seconds. The tester administering the test must place one hand on top of one of the subject's knees to ensure that the subject's knees were not raised during the test. Two test trials were given to a subject after two practice trials to allow him or her to understand test instructions and procedures. The best trial was recorded as the score.

Agility and Dynamic Balance: The main procedure for conducting the agility and dynamic balance test was as follows: The equipment for this test consisted of a chair with arms (average seat height: 40 cm), duct tape, measuring tape,two cones and a stopwatch. The set up was as follows: The initial placement of the chair should be marked with the legs taped to the floor, or held to avoid moving during the test. Measuring from the spot on the floor (X) in front of the chair where the feet would be placed, the cones were set up with their farthest edge located 183 cm to the side and 152 cm behind the initial measuring spot (X). One cone was set up at either side behind the chair. The area should be well lit, and the floor even, allowing participants to walk without danger of falling. Arrows should be placed on the floor in appropriate locations to remind the subject of the correct pathway. The subject began fully seated in his or her chair with heels on the ground. On the signal "ready,go", the subject got up from the chair, moved to the right, went to the inside and around the back of the cone (counterclockwise), returned directly to the chair, sat down, and raised his or her feet 1.3cm from the floor. Without hesitating, the subject got up immediately, moved to the left, again going to the inside and around the back of the cone (clockwise), returned directly to the chair and sat down, completing one circuit. The subject got up immediately and repeated a second circuit exactly as the first. One trial consisted of two complete circuits (going around the cones four times [right, left, right, left]). During the test;after circling the cones,the subject must sit down completely in the chair. This meant that he or she must lift his or her feet 1.3 cm from the floor before getting up. The subject must use his or her hands to get in and out of the chair. He or she should move as fast as is comfortably possible without losing balance or falling. A practice "walk through" should be administered until the subject demonstrated that he or she understood the test. Two trials were given with a 30 second rest provided after each trial. The time for each trial to the nearest 0.1 second should be recorded. The best trial was recorded as the score.

Coordination: The main procedure for conducting the soda pop coordination test was as follows. The equipment for this test consisted of three unopened (360 g) cans of soda pop, a stopwatch, masking tape,a table,and a chair. Six marks were drawn exactly 12.7 cm away from each other along a line of tape on the table, starting 6.5 cm away from either edge of the tape. Then six strips of tape, each 7.6 cm long, were placed perpendicular to the 12.7 cm strips centered on the six marks previously drawn. For the purpose of this test, each little "square" formed by the crossing of the long strip of tape and the 7.6 cm strips of tape was assigned a number starting with 1 for the first square on the right to 6 for the last square on the left. In the test, the subject sat comfortably in front of the table,body centered with the diagram on the table. The preferred hand was used for this test. If the right hand was used, placed the three cans of pop on the table in the following manner: can 1 was centered on square 1 (farthest to the right), can 2 on square 3, and can 3 on square 5. To start this test, the right hand, with the thumb up, was placed on can 1 and the elbow was at a 100-120 degree to the table. When the tester gave the signal, the stopwatch was started and the subject proceeded to turn the cans of pop upside down, placing can 1 over square 2, can 2 over square 4, and can 3 over square 6. Immediately, the subject returned all three cans, starting with can 1, to their original positions. On this "returntrip", the cans were grasped with the hand in a thumb down position. This entire procedure was done twice, without stopping, and counted as one trial. In other words, two "trips" down and up were required to complete one trial. The watch was stopped when the last can of pop was returned to its original position, following the second trip back. The preferred hand was used throughout the entire task. The object of the test was to perform the task as fast as possible, making sure that the cans were always placed over the square. If a can did not cover a square at any time during the test, the trial must be repeated from the start. An error occurred if a can did not completely cover the entire square formed by the crossing of the two strips of tape. Two test trials were given to a subject after two practice trials to allow him or her to understand test instructions and procedures. The time for each trial was measured with the unit of 0.1 second. The best trial was recorded as the score.

Strength and endurance: The main procedure for conducting the strength and endurance test was as follows: The equipment for this test consisted of iron alleys of 3.6 kg for male subjects and 1.8 kg for female subjects,a stopwatch, and a chair without arms. The subject was asked to sit on a chair, back straight and against the back of the chair as much as possible. The subject's eyes should be looking straight ahead and the feet should be flat on the floor in a comfortable position. The nondominant hand should be resting in the lap with the dominant hand hanging to the side. The subject's dominant arm should be straight and relaxed. The iron alley was placed thumbs up in the dominant hand and held in the extended position. The tester should stand on the side of the subject's dominant arm and put his or her hand on the bicep of the subject's dominant arm, helping to support the weight with the other hand. The hand helping to support the iron alley was then removed and the subject was asked to contract the bicep through the full range of motion until the lower arm touched the hand of the tester on the bicep. This represented one whole trial. If the subject could not bring the weight through the full range of motion,the test was terminated with a score of zero. When the practice repetition was complete,the iron alley was placed on the floor for approximately a one-minute rest period and again placed in the hand supported by the tester. The tester then instructed the subject to repeat as many trials as possible in 30 seconds. The forearm must touch the tester's hand (on the bicep) for a complete trial. The tester counted the number of trials the subject could do in the 30-second period. The maximal number of complete trials in the 30-second interval was recorded as the score.

Endurance: The main procedure for conducting the 880-yard (804 m) walk test was as follows: The equipment for this test consisted of a stopwatch, measuring tape and cones. The test involved a continuous walk of 880-yard around a measured lap. The cones were needed to mark the inside of the lap (oval or rectangle). The lap should be designed with sufficient space to turn to reduce the effects of a quick change in direction. The subject should be instructed to walk the course as fast as he or she felt comfortable. They should walk at their own pace independent of the other participants. The subjects should not be allowed to walk in pairs or groups. It was important that they paced themselves so they were able to finish the distance and did not experience discomfort. As a special consideration,the administrator should either discourage or not allow the participants to perform this test without first consulting a physician. On the signal, "Ready, go", the subject began at a designated spot and walked the necessary laps until he or she reached the 880-yard line. A single trial was used and the time in minutes and seconds was used as the score.

Although each test item was administered according to the protocol of the original fitness test for the elderly, the equipments used for measuring each test item was constructed specifically for this test based on the AAHPERD protocol.

Other materials: Other test materials that were prepared in order to confirm the validity of the Japanese version of functional fitness test for the elderly were as follows:

One-leg stand with eyes open: This test item was one from the physical fitness test battery for adults developed by the Japan Ministry of Education,Science and Culture which consisted of the "vertical jump", the "grip strength", the "one-leg balancing", the "two step up and down",and the "repeated side step". It was recognized from published reports[13,23] that the one-leg stand with eyes open was a very useful age-related fitness test item,especially for the elderly. Two test trials by preferred leg were given to a subject according to the test manual [24]. The better trial (seconds) was recorded as the score.

Grip strength by preferred hand: This test item was one of the most common physical strength items. Two test trials by preferred hand were given to a subject according to the test manual [24]. The better trial (kg) was recorded as the score.

Reaction time to light: This test was used to measure the reaction time that was required for a subject to release his or her fingers from an electric key upon seeing a light signal. Five test trials were given to a subject after two practice trials. The score was the average time (msec) of the five experimental trials.

Social and cognitive activity scale: This scale was developed by Koyano et al.[25] to measure the higher level competence of the elderly living at home which could not be adequately assessed by existing scales of ADL. It consisted of thirteen items related to both instrumental and functional ADL for the elderly. The score was the total number of the appropriate responses.

Instrumental ADL scale: This scale was developed by Lawton et al.[7]. It consisted of seven items for measuring the degree of independence of the ADL items such as dialing a telephone, going shopping, doing housework, preparing meals, using various means of transportation,taking medicine as prescribed, managing home economics and saving money. The score was the total number of appropriate responses.

Simple intellectual scale for the elderly: This scale was a revised version of Hasegawa's dementia scale (HDS-R) developed by Kato et al.[26]. It was also one of the most effective brief screening tests for age-associated dementia. It consisted of nine items which contained such features as "orientation of time, place and person","short term memory","general information", etc.. The score was the total number of appropriate responses.

3. Data analyses

In order to confirm the applicability of the AAHPERD's test battery for elderly Americans to elderly Japanese, the reliability and validity of each item of this test was examined by using the data obtained in this study. The reliability of each test item was examined by using the test-retest reliability method as outlined in the research[19,20] involving the American samples. The validity of each item of the test was examined using four methods to determine validity, which included content validity, criterion-related validity, construct validity and predictive validity. The Pearson's correlation coefficients between each item of the functional fitness test battery and other sets of test items, selected from the same fitness parameters[13-15] were obtained as an index for content validity. The results of this correlation analysis were evaluated from the statistically significant levels of P<0.05 and over of r values. Furthermore,one more index of the content validity for Japanese adults was obtained by using the correlation matrix of the five functional fitness items. The results of this correlation analysis were evaluated from the statistically significant levels of P<0.05 and over of r values, which were anticipated to be in the values ranging from low r to modest r because each item of the test was designed to be a measure of different dimensions for each functional fitness parameter. The Pearson's correlation coefficients between chronological age and each test item were obtained as an index of the criterion-related validity. The results of this correlation analysis were evaluated from the statistically significant levels of P<0.05 and over of r values,which were anticipated to be in the values ranging from the modest r to high r because each item score of the test was designed to be concurrent with age as indicated by the validity studies[20,30] of the American samples. Furthermore,in addition to the concurrent validity of each test item mentioned above,the Multiple Classification Analysis (MCA)[27], a type of multivariate analysis, was performed for each item of the test in order to evaluate the influence of chronological age, sex, standing height and body weight on each test score as an index of the criterion-related validity. The results of the MCA for each test item were evaluated from the rates (%) of attribution, in which chronological age was anticipated to indicate the highest attribution rate of each item score of the test relative to the other three independent variables. The MCA analysis for each test item was performed by using only the elderly Japanese sample in this study. The intercorrelation coefficients between the five functional fitness items and both the physical and cognitive scales for the elderly adults were obtained as an index of the construct validity. The results of this correlation analysis were evaluated from the statistically significant levels of P<0.05 and over of r values, which were anticipated to be in the values ranging from the modest r to high r because each item score of the test was designed for inferring the degree of both social and intellectual abilities[7-9,26] of the elderly adults. As an index of predictive validity,the follow-up data measured at three one-year intervals for each item of the functional fitness test was obtained by gender from the healthy elderly Japanese adults who were in the age class of the "young old"[2]. The results of this follow-up data were evaluated from the differences of the mean scores of each test item over the test period, which meant no statistically significant difference between the three mean scores in each test item because it was anticipated the "young old" adults would maintain almost the same levels of physical and functional fitness as indicated by the results of the WHO study[2].

In order to confirm the reliability and the validity of the test items for the elderly mentioned above, the statistical test methods of the correlation analysis,the multivariate analysis and the t-test method were used. The standard score for each test item was calculated by using the percentile ranking of 7, 31, 69 and 93 according to the previous studies[13,17], which was ultimately divided into the five stages in order to show the functional fitness level for the elderly Japanese adults. The data analyses were conducted using the Statistical Package for Social Sciences computer program (SPSS for Windows Release 6.1.3.) at the Computation Center of Tokai University.

4. Period of the test administration

The collection period of test data was from September 1992 to August 1995. The fitness test and its related inquiries were administered in Kyushu,Japan.

Results

1. Test participation rate and data distribution

According to the test procedures mentioned above, 95% or more of the elderly volunteers could participate in four of the five items of the AAHPERD's test battery for the elderly. Fifteen volunteers agreed not to participate in the measurements of the test according to the results of their physical examination. The 880-yard walk test had only a 75% participation rate mainly because of some participants' difficulty in walking. The number of subjects used in the final scoring of this test is shown in Table 1. The ratios (%) of the number of subjects,classified by age group into five-year intervals from 60-64 to over 85 years of age,were respectively 18%, 27%, 26%, 16%, 7% and 6% in the male sample and 13%, 18%, 20%, 24%, 17% and 8% in the female sample.

Table 1.Number of subjects by gender and age class.

	Male		Female	
Age class	N	%	N	%
60~64 yrs	34	18.3	45	12.9
65~69 yrs	51	27.4	64	18.4
70~74 yrs	49	26.3	71	20.4
75~79 yrs	30	16.1	83	23.9
80~84 yrs	12	6.5	58	16.7
85 yrs ~	10	5.4	27	7.7
Total	186	100.0	348	100.0

The data distribution of each test item by gender was statistically tested for the values of skewness and kurtosis. The distribution of all test data by gender indicated no large discrepancy from the normal distribution for each test item. The mean,standard deviation (SD) and number of subjects for each test item were calculated by gender. The data are shown in Table 2. The test items for which there were significant differences between the means by gender were the sit and reach test (t=6.249,P<0.001), the agility and dynamic balance test (t= 4.466, P<0.001), the soda pop coordination test (t=2.716, P<0.01) and the 880-yard walk test (t=6.200, P<0.001). The mean score of the sit and reach test in the female sample was higher than that of the male sample; whereas, for the other three tests,the mean scores of the male sample were higher than those of the female sample as shown in Table 2. Consequently,the percentile values of 7%, 31%, 69% and 93% were tentatively calculated by gender as a criterion for scoring for each test item, based on the data of each test item as shown in Table 3.

Table 2. The mean scores and standard deviation (SD) of the five functional fitness test items for healthy elderly Japanese adults over 60 years of age living in their own homes.

Test item	Gender	N	Mean score	SD	Value of t-test*
Sit and reach test (cm)	Male	186	4.6	11.0	6.249 ***
	Female	345	10.6	9.6	
Agility and dynamic balance test (sec)	Male	179	29.5	8.4	4.466 ***
	Female	339	33.2	9.9	
Soda pop coordination test (sec)	Male	186	15.0	4.6	2.716 **
	Female	347	16.3	6.3	
Strength and endurance test (reps)	Male	185	23.8	5.6	N.S.
	Female	341	24.2	6.1	
880 yard walk test (sec)	Male	158	553.0	82.0	6.200 ***
	Female	250	612.0	109.0	

Number of subjects : 534 (female=348,male=186), age range: 60~90 years old.
reps: repetitions per 30 seconds.
* : The t-test values which showed significant differences between the means by gender in each test item.
N.S.: not significant
*** : Level of significance for t-test: P<0.001.
** : Level of significance for t-test: P<0.01.

Table 3.The criterion of scoring based on the data distributions of the five functional fitness test items for adults over 60 years of age.

	percentile	~7~		~31~	~69~	~93~
Test item	Gender	I	II	III	IV	V
Sit and reach test (cm)	Male	~-12.5	-12.4~ 0.0	0.1~8.5	8.6~19.0	19.1~
	Female	~- 4.0	- 3.9~ 6.0	6.1~15.0	15.1~24.0	24.1~
Agility and dynamic balance test (sec)	Male	~ 38.0	37.9~30.4	30.3~25.0	24.9~22.4	22.3~
	Female	~ 46.0	45.9~35.4	35.3~27.7	27.6~23.0	22.9~
Soda pop coordination test (sec)	Male	~ 21.8	21.7~15.7	15.6~12.5	12.4~10.7	10.6~
	Female	~ 25.3	25.2~16.6	16.5~13.3	13.2~11.0	10.9~
Strength and endurance test (reps)	Male	~ 16.0	17.0~21.0	22.0~26.0	27.0~31.0	32.0~
	Female	~ 15.0	16.0~22.0	23.0~27.0	28.0~32.0	33.0~
880-yard walk test (sec)	Male	~ 656	655~580	579 ~509	508 ~472	471 ~
	Female	~ 791	790~645	644 ~554	553 ~490	489 ~

Number of subjects: 534 (female=348; male=186), age range: 60~90 years old.
reps: repetitions per 30 seconds.

2. Reliability of the test

Test-retest reliability:

In order to confirm the reliability of the AAHPERD's functional fitness test items for elderly Japanese adults, a small sample consisting of eight male and twelve female elderly subjects of 60-85 years of age was selected. They were healthy adults living in the same city and consented voluntarily to participate in the test-retest plan. A retest was given to the same sample one week after the first test. The results of the test-retest reliability of each test item are shown in Table 4. The Pearson's correlation coefficients (r) for each test were 0.805 (P<0.01) for the sit and reach test,0.884 (P<0.01) for the agility and dynamic balance test,0.815 (P<0.01) for the soda pop coordination test,0.752 (P<0.01) for the strength and endurance test,and 0.890 (P<0.01) for the 880-yard walk test.

Table 4. The Pearson's correlation coefficients (r) between the two test scores measured at a one-week interval for the functional fitness assessment for adults over 60 years of age as a test-retest reliability study.

Test item	r
Sit and reach test (cm)	.805**
Agility and dynamic balance test (sec)	.884**
Soda pop coordination test (sec)	.815**
Strength and endurance test (reps)	.752**
880 yard-walk test (sec)	.890**

Number of subjects : 20,age range: 60~85 years of age.
** : P<0.01.
reps: repetitions per 30 seconds.
Test-retest interval: one week.
The functional fitness assessment consists of five test items: sit and reach test; agility and dynamic balance test; soda pop coordination test; strength and endurance test and 880 yard-walk test for adults over 60 years of age. These were originally developed by AAHPERD in 1990.

3.Validity of the test

Content validity:

The correlation coefficients between each test item of the functional fitness test for the elderly and other sets of test items, selected from the same fitness parameters and used in Japan for purposes of test administration security[13-15], were obtained for content validity. The results are shown in Table 5. The fitness test items for elderly Japanese adults did not always correspond to the functional fitness test items. However,the three kinds of test items,which are recognized to be very useful age-related fitness indices[23].as shown in Table 5, corresponded to the AAHPERD's test items for the elderly in the study using 63 elderly subjects (22 men,41 women) between the ages of 60 and 74.

Table 5.The Pearson's correlation coefficients between the functional fitness test and other physical fitness tests obtained from the healthy elderly sample living in their own homes as a content validity study.

Test item	Test item: One-leg stand with eyes open (sec)	Grip strength by preferred hand (kg)	Reaction time to light (msec)
Sit and reach test (cm)	.120	-.026	-.116
Agility and dynamic balance test (sec)	-.481***	-.269*	.212
Soda pop coordination test (sec)	-.399**	-.405**	.760***
Strength and endurance test (reps)	.204	.154	-.215
880 yard-walk test (sec)	-.341**	-.271*	.208

Number of subjects: 63 (female=41,male=22),age range: 60～90 years old.
Level of significance for Pearson's correlation coefficients: * ; P<0.05, **; P<0.01, *** ; P<0.001.
reps: repetitions per 30 seconds.

As the results show: there was a significant correlation between the one-leg stand test and three of the test items of the AAHPERD: the agility and dynamic balance test [r= -0.481 (P<0.001)]; the soda pop coordination test [r= -0.399 (P<0.01)]; the 880-yard walk test [r= -0.341 (P<0.01)]. There was a significant correlation between the grip strength test and the same three test items: the agility and dynamic balance test [r=-0.269 (P<0.05)]; the soda pop coordination test [r= -0.405 (P<0.01)]; and the 880-yard walk test [r= -0.271 (P<0.05)]. There was a significant correlation between the reaction time test and only one of the test items: the soda pop coordination test [r=0.760 (P<0.001)]. These findings showed a significant correlation between three items of the AAHPERD's functional fitness test battery and the other sets of fitness test items[13-15]for elderly Japanese adults over 60 years.

The correlation matrix of the five functional fitness items was obtained by using thetotal number of subjects (n=534) in order to determine the content validity. The results are shown in Table 6. The correlation coefficients of the test items ranged from r= -0.053 to r=0.724 (P<0.01). The correlation coefficients for three of the items,the agility and dynamic balance test,the soda pop coordination test and the 880-yard walk test,showed significantly modest values (r=0.59 to r= 0.72). Similar results were also obtained from a gender-specific correlation matrix.

Table 6.The correlation matrix (Pearson's simple correlation coefficients) of the five functional fitness test items for adults over 60 years of age obtained from healthy residents (n=534) living in their own homes as a content validity study.

Test item	A	B	C	D	E
A.Sit and reach test (cm)	1.000				
B.Agility and dynamic balance test (sec)	-.172** (515)Δ	1.000			
C.Soda pop coordination test (sec)	-.151** (530)	.594** (518)	1.000		
D.Strength and endurance test (reps)	.265** (523)	-.470** (512)	-.497** (525)	1.000	
E.880 yard-walk test (sec)	-.053 (406)	.724** (406)	.387** (408)	-.366** (404)	1.000

**: P<0.01.
Δ : numbers in brackets are number of subjects being used in calculations of correlation coefficients.
reps: repetitions per 30 seconds.

Table 7. The age class comparisons of each test item of the AAHPERD's functional fitness assessment for the elderly consisting of 186 male and 348 female Japanese subjects.

Test item		Age class (yrs): 60～64	65～69	70～74	75～79	80～84	85～	F value	Multiple t test (Ryan method)	r
Sit and reach	N	79	115	119	112	70	36			
test (cm)	M	10.38	9.67	7.87	8.12	7.15	6.44	1.511	N.S.*	-.116**
	SD	10.29	9.41	11.12	10.83	10.65	9.82			
Agility and	N	78	115	114	111	68	32			
dynamic balance	M	25.19	27.39	30.41	35.22	38.80	44.30	58.803***	60,65>70>75>80>85	.583**
test (sec)	SD	3.20	4.16	6.27	10.19	10.40	13.87			
Soda pop	N	79	115	120	113	70	36		60,65>70>75>80>85	
coordination	M	12.53	14.02	15.43	16.68	18.52	22.21	32.013***	65,70>75>80>85	
test (sec)	SD	2.21	2.74	4.54	6.79	5.00	10.49		70,75>80>85	.440**
Strength and	N	77	115	117	112	71	34		60,65>70>75>80>85	
endurance	M	27.44	26.27	24.32	22.20	21.32	19.26	23.671***	75,80>85 ; 80,85	-.420**
test (reps)	SD	5.30	4.55	5.09	5.89	5.46	7.32			
880-yard walk	N	78	110	90	86	33	11		60,65>70>75>80>85	
test (sec)	M	531.24	555.65	572.39	645.71	700.39	765.18	46.949***	65,70>75>80>85 ;	.593**
	SD	55.65	56.08	77.95	107.16	93.39	133.44		80,85	

r: Pearson's correlation coefficients between age of subject and each test score.
* N.S.: not significant.
** Level of significance for Pearson's correlation coefficients and F test: P<0.01
*** Level of significance for Pearson's correlation coefficients and F test: P<0.001
reps: repetitions per 30 seconds.
N: number of subjects, M: mean, SD:standard deviation.

Criterion-related validity:

In order to examine the concurrent validity of the test,the correlation coefficients between the score of each test and chronological age were obtained by using the total number of subjects. As shown in Table 7,the Pearson's correlation coefficients between the five fitness test items and chronological age were r= -0.116 (P<0.01) for the sit and reach test,r=0.583 (P<0.01) for the agility and dynamic balance test,r=0.440 (P<0.01) for the soda pop coordination test,r=-0.420 (P<0.01) for the strength and endurance test,and r=0.593 (P<0.01) for the endurance test. These results showed that performance levels on each test item of the AAHPERD's test battery decreased significantly with advancing age.

In order to evaluate the influence of sex,age,standing height and body weight on each test score of the functional fitness test for the elderly,the Multiple Classification Analysis (MCA)[27],a type of multivariate analysis,was used. Each score of the functional fitness test items for the elderly was used as a dependent variable of the MCA and the four variables of sex,age,height and weight were used as independent variables. As shown in Table 8,the number of categories for each independent variable was as follows: two for sex; six for age; five for height; and five for weight. The coefficients calculated by the MCA were Eta (η : magnitude of influence of each independent variable on each test score),Beta (β : magnitude of influence of each independent variable only on each test score with the influence of other independent variables controlled) and Multiple correlation coefficient (R: magnitude of total influence of all independent variables on each test score). The results showed that the "age class" was the most important independent variable contributing to each test score,except in the case of the sit and reach test. On two of the test items,the agility and dynamic balance and the 880-yard walk,the rates (%) of attribution of age on the test scores were relatively higher than those of the other three test scores: 29% on the agility and dynamic balance test; 31% on the 880-yard walk test. The independent variables of male,younger age classes,taller height and lighter weight tended to contribute to better performances of these two test items. The attribution rates (%) of both body weight and standing height on each item score of the test showed low values which ranged from 2% to 6% respectively. The results of the MCA for the dynamic balance test item are shown in Table 8. The value of Beta (β) for each independent variable was statistically significant: gender=0.08 (P<0.01); age class=0.51 (P<0.01); standing height=0.18 (P< 0.01); and body weight=0.12 (P<0.01). The multiple R of the test item was 0.607 (P<0.01). Particularly,the results of the MCA for the soda pop coordination item showed similar trends with those of the MCA for both the agility and dynamic balance item and the 880-yard walk test item. The rate (%) of attribution of age on the test score was 17.2% (multiple R=0.447,P<0.01).

Tabule 8.Multiple Classification Analysis (MCA) for the test item of "agility and dynamic balanse" using elderly Japanese aduluts: Influence of gender , age , height and weight on the test scre.

Inderpendent variable	Category	Number of subjects	Unadjusted deviation	Eta(η)	Adjusted for independence deviation	Beta(β)	Rate (%) of attribution
Gender	1.male	179	-2.39		-0.99		
	2.female	339	1.26	.18	0.52	.08**	1.4
Age class (yrs)	1.60-64	78	-6.75		-5.90		
	2.65-69	115	-4.55		-4.02		
	3.70-74	114	-1.53		-1.45		
	4.75-79	111	3.28		2.85		
	5.80-84	68	6.85		6.07		
	6.85-	32	12.36	.57	11.19	.51**	29.0
+ Height (cm)	1.level 1	65	6.51		3.52		
	2.level 2	143	2.03		0.85		
	3.level 3	189	-1.42		-0.48		
	4.level 4	85	-3.83		-2.33		
	5.level 5	36	-3.35	.34	-1.71	.18**	6.1
++ Weight (kg)	1.level 1	66	2.95		0.31		
	2.level 2	125	1.74		-0.63		
	3.level 3	201	-1.81		-0.85		
	4.level 4	90	-0.97		1.56		
	5.level 5	36	1.10	.19	2.45	.12**	2.2
Multiple R squared						.368	
Multiple R						.607**	

+The categories of height for both sexes are as follows : level 1 = 153cm and below ;level 2 = 154-158cm ; level 3 = 159-163cm ; level 4 = 164-168cm ; level 5 = 169cm and over for men and level 1 =140cm and below ; level 2 = 141-145cm ; level 3 = 146-150cm ; level 4 = 151-155cm ; level 5 =156cm and over for women.

++The categories of weight for both sexes are as follows : level 1 = 49kg and below ;level 2 = 50-55kg ; level 3 = 56-65kg ; level 4 = 66-73kg ; level 5 = 74kg and over for men and level 1 =41kg and below ; level 2 = 42-48kg ; level 3 = 49-57kg ; level 4 = 58-64kg ; level 5 =65kg and over for women.

**Level of signficance : P < 0.01.

Predictive validity:

In comparing the follow-up data for each test item measured in 1993, 1994 and 1995 as shown in Tables 9 and 10, it was found that the mean score of each test item indicated no significant difference by gender (12 men,14 women) for the two age-classes of 65-69 and 70-74 (M=70.5 years of age for men, M=70.9 years of age for women). It was noted from the results that the functional fitness level of each test item was stable in the healthy "young old" samples[2] for the three-year period. The Pearson's correlation coefficients for the scores of the test items,including the follow-up data measured at three one-year intervals,showed significantly modest and high values (r=0.663 to r=0.946) during the period of test administration.

Table 9. The data comparisons of the AAHPERD's functional fitness assessment for the elderly which were measured three times for the same male sample (n=12).

Test item		Years (A.D.) of test 1993 (first)	1994 (second)	1995 (third)	F-value	Multiple t-test (Ryan method)	r
Sit and reach	M	10.79	9.17	7.63	0.355	N.S.[a]	0.824**
test (cm)	S D	7.64	7.69	10.44			0.718 **0.835**
Agility and							
dynamic balance	M	25.66	25.61	24.73	0.213	N.S.	0.627*
test (sec)	S D	2.78	4.31	4.01			0.672 * 0.927**
Soda pop							
coordination	M	14.38	13.93	13.23	0.771	N.S.	0.712**
test (sec)	S D	2.67	1.99	1.77			0.747 **0.725**
Strength and							
endurance	M	27.00	26.17	27.00	0.130	N.S.	0.778**
test (reps)	S D	5.79	3.74	4.71			0.505 △ 0.663*
880-yard walk	M	496.17	498.92	507.25	0.158	N.S.	0.914**
test (sec)	S D	49.73	36.20	56.38			0.714 **0.766**

r: the intercorrelation coefficients between the test scores measured three times for the same sample.
The measurement of each test was undertaken once a year from 1993 to 1995.
[a] N.S.: not significant.
△ : Level of significance for Pearson's correlation coefficient: P<0.10.
* : Level of significance for Pearson's correlation coefficient: P<0.05.
** : Level of significance for Pearson's correlation coefficient: P<0.01.
reps: repetitions per 30 seconds.
M: mean; SD: standard deviation.

Table 10.The data comparisons of the AAHPERD's functional fitness assessment for the elderly which were measured three times for the same female sample (n=14).

Test item		Years (A.D.) of test 1993 (first)	1994 (second)	1995 (third)	F-value	Multiple t-test (Ryan method)	r
Sit and reach	M	12.46	9.57	11.07	0.457	N.S.[a]	0.860**
test (cm)	S D	7.70	7.57	8.03			0.725 ** 0.702**
Agility and							
dynamic balance	M	27.44	27.44	27.61	0.009	N.S.	0.859*
test (sec)	S D	4.37	4.14	4.60			0.822 ** 0.946**
Soda pop							
coordination	M	14.69	13.85	14.06	0.351	N.S.	0.789**
test (sec)	S D	2.62	2.55	2.55			0.697 ** 0.747**
Strength and							
endurance	M	26.86	25.29	25.43	0.365	N.S.	0.661**
test (reps)	S D	4.94	5.24	5.50			0.738 ** 0.784*
880-yard walk	M	557.14	554.29	543.36	0.154	N.S.	0.617*
test (sec)	S D	68.72	67.55	63.81			0.589 *0.850**

r: the intercorrelation coefficients between the test scores measured three times for the same sample. The measurement of each test was undertaken once a year from 1993 to 1995.
[a] N.S.: not significant.
* : Level of significance for Pearson's correlation coefficient: P<0.05
** : Level of significance for Pearson's correlation coefficient: P<0.01
reps: repetitions per 30 seconds.
M: mean; SD: standard deviation.

Construct validity:

Table 11 indicates that the correlation coefficients between the functional fitness test items and the physical and cognitive variables consisting of the social and cognitive activity scale,the instrumental ADL scale,and the simple intellectual scale for the elderly were all statistically significant in the female sample,except for the correlations (r) among the sit and reach test and the three cognitive scales for the elderly. The sample consisted of one hundred twenty-four elderly female adults living at home. Of particular importance were the Pearson's correlation coefficients between the soda pop coordination test and the three cognitive scales: -0.455 (P<0.001) with the social and cognitive activity scale,-0.502 (P<0.001) with the instrumental ADL scale, and -0.660(P<0.001) with the simple intellectual scale for the elderly.

Table 11.The Pearson's correlation coefficients between test items of the functional fitness Assessment for adults over 60 years of age and the scales for both physical and cognitive functions for the elderly obtained from the female sample (n=124) as a validity study.

	Test item		
Test item	Social and congnitive activity scale[a] (point)	Instrumental ADL scale[b] (point)	Simple intellectual scale for the elderly[c] (point)
Sit and reach	. 012	-. 001	. 010
test (cm)	(123)△	(123)	(120)
Agility and dynamic balance	-. 208*	-. 315**	-. 347***
test (sec)	(115)	(115)	(114)
Soda pop coordination	-. 455***	-. 502***	-. 660***
test (sec)	(124)	(124)	(122)
Strength and	. 302**	. 391***	. 395***
endurance test (reps	(122)	(122)	(120)
880-yard walk test sec)	-. 338**	-. 463***	-. 339**
	(71)	(71)	(71)

△ ; numbers in brackeks indicate number of subjects for each test.
Level of significance for Pearson's correlation coefficients: * ; P<0.05, ** ; P<0.01. *** ; P<0.001.
a ; Social and cognitive activity scale is a measure of competence of older people and was developed for elderly Japanese adults by Koyano and Shibata et al. in 1987.
b ; Instrumental ADL scale was originally developed by Lawton and Brody (1968) and then adapted for elderly Japanese adults by Shichida,Shibata et al. in 1977.
c ; Simple intellectual scale for the elderly was developed by Hasegawa et al. in 1974 and then revised by Kato and Hasegawa et al. in 1991 for demented patients and frail elderly adults.
reps ; repetitions per 30 seconds.

Discussion

Those who ultimately participated in this study were healthy and in the independent level of the physical ADL and also consented voluntarily to participate after they had been informed about the content of both the test and the results of the simple physical examination. Similarly the elderly Americans who participated in the original testing were healthy residents living at home and consented voluntarily to participate after being well-informed of the benefits of both medical and exercise assessments for elderly adults[18-20]. Accordingly the health and living conditions of the elderly Japanese adults used in this study were thought to be similar to those of the American samples.

Reliability: As stated previously,this present study examined the test-retest reliability of each item in the AAHPERD test battery. The reliability data for each test item was obtained from a sample of twenty elderly Japanese subjects. After a one-week interval following the functional fitness test battery for the elderly,it was confirmed that the test-retest reliability (Pearson's correlation coefficient) was high (r=0.8 and over) for all of the test items except for the strength and endurance test (r=0.752). Thus,the reliability data of the strength and endurance test seemed to be slightly lower than those of the other four test items although it was statistically significant. The test-retest reliability study for the sample of twenty-five elderly Americans indicated that the Pearson's correlation coefficients were 0.56 to 0.93 for each test item of the same functional fitness test battery for the elderly. Relatively modest correlations (r) were shown for the strength and endurance test item (r= 0.56) and the soda pop coordination test item (r=0.57) [20]. In consideration of this point,it was appropriately indicated that the score for each item of the test battery did not change after a one-week interval following the formal measuring conditions based on the protocol of the test[17].

Content validity: There were significant correlation coefficients (r) between the AAHPERD functional fitness test items and the other set of fitness test items,consisting of the one-leg stand with eyes open,the grip strength and the reaction time to light. The soda pop coordination test was found to be a very useful test item to examine the relationship between the fitness parameters of strength and agility. From these results,the content validity of the functional fitness test was confirmed. Furthermore,it was confirmed from the intercorrelation analysis of the functional fitness test items that the individual items of the AAHPERD test seemed to capture the different fitness dimensions because of relatively low correlations. However,the correlation coefficient (r) between the agility and dynamic balance test and the 880-yard walk test showed a significantly modest value (r=0.72). Furthermore,it would be necessary to examine the relationships between the individual items of this test and the other set of test items[13-15] whose usefulness as a physical fitness test for the elderly has already been confirmed.

Criterion-related validity: In order to examine the concurrent validity of the test,the correlation coefficients between the score of each test and the chronological age of participants were examined (Table 7). The Pearson's correlation coefficients (r) for the four test items with respect to age showed significantly modest values (absolute r's=0.42 and over),except for the value (absolute r=0.116) for the flexibility test item. In order to evaluate the degree of influence of sex,age,standing height and body weight on each test score of the functional fitness test,the MCA was administered for each test score as a dependent variable. The results showed that the most important variable of the four independent variables contributing to each test score,except in the case of the sit and reach test,was "age class". Particularly for the agility and dynamic balance test and the 880-yard walk test,the rates (%) of attribution of age class on each test score were higher than those for the other three tests. The independent variables of male,younger age classes,taller height and lighter weight for these two items tended to contribute to the higher scores. The MCA for the soda pop coordination test showed similar results. As mentioned above,the effect of age class on the functional fitness level of the elderly was confirmed by both the correlation analysis and the results of the MCA. The Pearson's correlation coefficient between age and the sit and reach test item showed a significant low value ($r=-0.116, P<0.01$). From the results,it was thought that the individual differences tended to exceed the age differences in the ability of the "total body flexibility" measured by the sit and reach test for adults over 60 years of age as stated in the discussion of a study[23].

Predictive validity: The test items were measured at three one-year intervals as a longitudinal study (Tables 9 and 10). Comparisons of the three mean scores of each test item for both male and female samples indicated no significant differences on the multiple t-test,although they tended to deteriorate with subsequent years of the test administration. Conversely,the intercorrelation coefficients (r) of the scores measured at three one-year intervals,which indicate the degree of consistency for individual scores,showed significantly modest and high values ($r's=0.50$ and over) for both sexes. The elderly adults who participated in this three-year longitudinal study were healthy and also maintained completely independent levels of both physical and instrumental ADL. The means of their ages by gender were 70 for men,and 71 for women. It should be noticed that the participants in the three age classes of the "young old" enhanced their functional fitness levels in each test item of the AAHPERD's test battery as shown in the case of the results by the MCA of the agility and dynamic balance test item in Table 8. From the results mentioned above,the participants in the "young old" classes showed no significant change of test scores over a period of the three years of test administration. These results also seem to be consistent with the hypothesis that the "young old" might continue to maintain relatively high levels of both physical and social abilities in the normal aging process[2]. From these results,it might be noted that the pattern of change of each test item score should be newly-examined with increasing age as a follow-up study by using a sample consisting of the age classes of "75-79","80-84",and "85 and over",which are designated as the "old old",and also tend to experience more serious physical disorders or illnesses than the "young old"[1,2]. As a result,it was confirmed that the performace level for each test item was relatively stable over the course of the three years of test administration. It is suggested from the follow-up study that the functional fitness test battery for "young old" adults is a useful measure of predicting functional fitness levels over a period of a few years,except in the case of illnesses or serious physical disorders.

Construct validity: All of the intercorrelation coefficients (r) of the five functional fitness items and the physical and cognitive scales for the elderly (Table 11) were statistically significant, except for the correlations between the sit and reach test and the three cognitive scales tested on a sample of 124 elderly female adults living at home. The correlation coefficients (r) of the soda pop coordination test and the three cognitive scales were particularly significant. This appears to be a useful test item for examining the relationship between cognitive abilities linked to the ADL and intelligence in elderly adults. This is due to the fact that the soda pop coordination test is designed to measure eye,arm and hand coordination,which is an indication of the relationship between the central nervous system and the peripheral nervous system of the hands[17]. The results indicated that the functional fitness test items seem to reflect the extent of an elderly person's intellectual and social abilities. The percentage of those who performed each of the AAHPERD test items completely was between 92% to 100%, except for 57.3% for the 880-yard walk test in the female sample. This group contained,in part,the subjects of the dependent level of the instrumental ADL,some of whom resisted participating in the 880-yard walk test (Table 11). These results show that it was not always easy for elderly female adults living independently to perform the 880-yard walk test as a total body endurance item.

The distribution of data by gender for each test item indicated no significant discrepancy from the normal distribution. Following original test protocol[17] and the studies[13,14],the percentile values were calculated by gender as a criterion for scoring each test item,tentatively based on the data of each functional fitness test item,which was collected from the sample of 534 healthy elderly adults living at home. Taken as a whole,the raw data for each test item was divided into five categories (I - V) by using a percentile ranking,which established the position of a given individual along a continuum using the norms related to a given population,as shown in Table 3. It is possible to use the categories of I and II as "lower level in each functional fitness item" and also to use the categories of IV and V as "higher level in each functional fitness item",compared with the category of III as "average level in each functional fitness item". However,the norms of data on the five fitness test items of the AAHPERD's test battery for elderly Japanese were obtained from a relatively smaller sample than the original test sample consisting of a thousand people[17]. In the future,it is recommended that a much larger population, comprised of both males and females,would be studied in order to more effectively evaluate the functional fitness data for elderly Japanese adults.

Further problems: Since the AAHPERD's functional fitness test battery for the elderly was proposed[17,18],the number of clinical validity studies focusing on each test item has increased[18-20]. In particular,studies have been undertaken with elderly Americans in community settings to examine relationships between their functional fitness levels and their physical and psychosocial health status by interpolating certain physical exercise programs between the first and second tests[28-30]. Hereafter,similar studies should be administered in Japan. Furthermore,the ways in which the functional fitness levels of the elderly in community and institutional settings might reflect their physical and instrumental ADL should be studied. In particular,a functional fitness test which would reflect the levels of the ADL and the cognitive abilities associated with living independently seems to be increasingly relevant as one of the objective measures for evaluating the extent of care required for the frail elderly in rapidly-aging societies.

Acknowledgements

The authors wish to acknowlege Prof. Toshio Matsushita, Department of Hygiene, Faculty of Medicine, Kagoshima University and Prof. Atsushi Ueda, Department of Hygiene, Faculty of Medicine, Kumamoto University for their supervision and valuable advice over the last decade. We also wish to thank the elderly persons who willingly consented to participate in this study. We are grateful to Mr. Takahiro Idemoto for his enthusiastic assistance. He participated as a graduate student of the National Institute of Fitness and Sports in Japan and, later, as a research staff member. We would also like to thank Ms. J. Gavan and Ms. D. Bollinger for their assistance in editing this English manuscript.

References

1) Takahashi S, Kaneko R, Ishikawa H, Ikenoue M, Mita F. Society's decreasing population: The future population of Japan inferred in September,1997. J Health Welfare Statistics 1997; **44** (5): 3-11.
2) Chodzko-Zajko WJ,editor. The WHO issues guideline for promoting physical activity among older persons. J Aging Phys Activity 1997; **5**: 1-8.
3) Morimoto K,editor. Life style and health-Health theory and demonstrable research.Tokyo: Igakusyoin,1991.
4) International Society of Sport Psychology. Physical activity and psychological benefits: A position statement. The Sport Psychologist 1992; **6**: 199-203.
5) McPherson BD. Social significance of sport and physical activity in the aging society. Jpn J Phys Edu and Sports 1992; **1**: 63-71.
6) Hackfort D. Physical exercise and psychological aspects of health. Proceedings of the International Congress of Health Psychology; 1993 July 26-30; Tokyo,Japan: Japanese Health Psychology Association, 1993.
7) Lawton MP,Brody EM. Assessment of older people: Self-maintaining and instrumental activities of daily living. Gerontologist 1969; **9**: 179-86.
8) Shibata H,Koyano W,Haga H. A review of recent research on activities of daily living especially in the community elderly. Social Gerontology 1984; **21**: 70-83.
9) Fujita T. Prevalence of disability in activities of daily living (ADL) and it's correlates among the elderly at home. Jpn J Public Health 1990; **36** (2): 76-87.
10) Berger B. The role of physical activity in the life quality of older adults. Am Acad Phys Educ Papers 1988; **5**: 42-58.
11) Yaguchi K,Furutani M. An examination of the psychosocial factors influencing the daily exercise practices of the elderly and aged people. Jpn J Phys Educ 1993; **38**: 99 -111.
12) Yaguchi K. The effect of mental health status on daily behavioral level in the healthy elderly population.In : Tokunaga M,editor.Research report on the psychological effects of exercise supported by Grants-in Aids for Scientific Research from Japan Ministry of Education,Science and Culture 1994; **57**-62.
13) Kimura M,Hirakawa K,Okuno T, et al. An analysis of physical fitness in the aged people with fitness battery test. Jpn J Phys Fitness Sports Med 1989; **38**: 175-85.
14) Oida Y, Arao T,Nishizima Y, et al.. A development of a functional fitness test for the elderly. Jpn J Public Health 1996; **43** (3): 196-208.
15) Japan Health Promotion and Fitness Foundation. The protocol of the physical fitness test for the elderly. Tokyo: The foundation,1992.
16) Osness WH. AAHPERD fitness task force: History and philosophy. J Phy Edu Rec Dance,1989 (3); 64-71.
17) Osness WH, Adrian M, Clark B, Hoeger W, Raab D, Wiswell R. Functional fitness assessment for adults over 60 years (A field based assessment): Published test protocols.American Alliance of Health, Physical Education, Recreation and Dance. Reston, VA, U. S. A 1990; 1-24.
18) Hopkins DR,Murrah B,Hoeger WWK,RC Rhodes. Effect of low-impact aerobic dance on the functional fitness of elderly women. Gerontologist 1991; **30** (2): 189-92.
19) Shaulis D,Golding LA,Tandy RD. Reliability of the AAHPERD functional fitness assessment across multiple practice sessions in older men and women. J Aging Phys Activity 1994; **2**: 273-9.
20) Bravo G,Gauthier P,Roy PM, et al. The functional fitness assessment battery: Reliability and validity data for elderly women. J Aging Phys Activity 1994; 2:67-79.
21) Osness WH. Assessment of physical function among older adults. Mature Stuff, AAHPERD Publications 1989; **8**: 93-115.
22) Yaguchi K,Furutani M,Idemoto T. An introduction of the functional fitness test for adults over 60 years by AAHPERD. Ann Fit Sports Sci 1995; **13**: 91-106.
23) Shibata H. The measurement of physical fitness for the elderly and its evaluation. J Health Phys Educ Recreat 1987; **37** (9): 658-61.
24) Japanese society of physical education editor. Method and use of physical fitness tests.1994; 1-164.
25) Koyano W,Shibata H,Nakazato K,Haga H,Suyama Y. Measurement of competence in the elderly living at home: Development of an index of competence. Jpn J Public Health 1987; **34** (3): 109-14.
26) Kato S,Hasegawa K,Shimogaki H. Development of the revised version of Hasegawa's dementia scale (HDS-R). Jpn J Geriatr Psychiatry 1991; **2**: 1339-47.
27) Koyano W. Multivariate analysis guide.ed.Tokyo: Kawashima Shoten,1988 (in Japanese).
28) Bravo G,Gauthier P,Roy PM, et al.. Impact of a 12-month exercise program on the physical and psychological health of osteopenic women. J Am Geriatr Soc 1996; **44**: 756-62.
29) Shaulis D,Golding LA,Tandy RD. Physical characteristics,physical fitness,and life- styles of senior olympic athletes and independently living cohorts. J Aging Phys Activity 1996; **4**: 1-13.
30) Evans B,Hopkins D,Toney T. Metabolic response to the half-mile AAHPERD functional fitness walk test in older adults. J Aging Phys Activity 1996; **4**: 80-9.