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RESEARCH ARTICLE

Construction of A Physical Fitness Test Battery for Middle-Aged Women

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Abstract

Proper measuring tools can provide the exact information about an individual's fitness level. The purpose of the study was to construct a suitable physical fitness test battery and to develop norms for middle-aged women in the Indian population. A total number of 405 middle-aged Indian women of 40-59 years were selected from three basic occupations of homemaking, office job, and manual labor. They were divided into two groups 40-49 years (n=230) and 50-59 years (n=175). The selected physical fitness variables for the construction of the physical fitness test battery were strength, strength endurance, agility, flexibility, balance, coordination, gait velocity, and cardiovascular endurance, which were measured by the standard and valid tests such as hand grip dynamometer, wall squat test, figure of eight-run test, sit and reach test, one leg stand test, plate tape test, and 6 min walk test respectively. Descriptive statistics, normality of the data, Pearson product-moment correlation, and Percentile score were calculated by SPSS version 21. Cajori's 5-grade evaluation norms were applied. The External validity of the newly constructed test battery was examined by using Eviews software version 9. Results revealed that the obtained data was normal and the selected variables were highly correlated. The Percentile scale revealed that the score from P_0 -P_{100} for each variable for both the groups and grading was expressed in five grades such as excellent, good, average, below average, and poor. External validity confirmed the validity of the physical fitness test battery for middle-aged women across the world.

Keywords
Physical Fitness, Middle-aged women, Percentile scale, Grading

INTRODUCTION

Women are the basic unit of the society and they are pioneers of the nation. They play significant roles in families as well as in society (**Mojumder, 2020**). Notwithstanding, the role of women in social, political, economic, religious, and cultural spheres is not recognized and their contribution is not counted as significant **(Bayeh, 2016**). In India, most of them are confined to family work and they seldom take care of their health and fitness with respect to their daily work. In many cases, they have no ample scope to pay attention adequately to their physical fitness. But it is worth noting that women live longer than men and are more likely than men to experience disabilities at a younger age (**Baum et al., 2021**). It has also been noticed from various studies that health status declines with aging and women experience a more rapid decline of health issues than men **(Crimmins et al., 2019**) consequently, they require assistance in their older age.

Middle age is the most important period in women's lives that is associated with different changes. During this period middle-aged women have to face many problems such as financial, family, job, and health issues **(Krantz & Ostergren, 2000**). Among these, health problems are the most vital in women's lives. In India generally, middle-aged women are involved in primary occupations like homemaking, office job, and physical work or manual work. Homemakers

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usually perform all kinds of household work such as cooking, sweeping, cleaning utensils, washing clothes, and caring for children, whereas Office going women perform office jobs, and Physical laborers perform cultivation, construction work, work in bricks field, and coal mines. Despite their occupations involving a certain amount of physical work still technological advancement discourages homemakers and office-going women to perform the optimum amount of physical activity. During this middle age period, women suffer from many non-communicable diseases such as heart disease, stroke, diabetes, obesity, osteoporosis, anxiety, hypertension, and Alzheimer's disease (**Bandyopadhyay & Das, 2022**). It was observed from different studies that physical fitness may help to prevent those noncommunicable diseases to a great extent (**Lin et al., 2020**). Therefore, the optimum level of physical fitness of a woman is an important prerequisite for enabling themselves to accomplish their daily living as well as satisfactorily contribute to the family and society.

Physical fitness plays an important role in all aspects of health which can also ensure the health status of an individual in every phase of life. The ability to perform daily living activities greatly depends on an individual's level of physical fitness. Physical fitness may be defined as the capacity to perform daily physical activities safely and independently without fatigue. Physical fitness may be expressed through various bio motor abilities such as strength, endurance, flexibility, agility, balance, and coordination. Strength is the ability to exert maximum force by a muscle or a group of muscles during a single control action to overcome resistance. Hand grip strength is an indicator of individual overall strength and can serve as a predictor of morbidity and mortality **(Labott & Donath, 2023**). Endurance is the physiological capacity of a person by which he or she can sustain a movement over a period of time. Many studies showed that endurance training improved cardiac output, and sleep quality, and result in lower heart rate, and reduced blood pressure **(Canpolat, 2023; Skrypnik et al., 2015**). Flexibility can be defined as the ability to execute movements with greater amplitude or range (**Geremia et al., 2015**). It is affected by muscle strength of the joint, tendons, ligaments, and other factors. From various studies, it has been proved that a person who has a good degree of flexibility can perform daily tasks efficiently and effectively (**Martins et al., 2023**). Agility is defined as a rapid whole-body movement with a change of velocity or direction in response to an external stimulus (**Labott & Donath, 2023**). It has been noticed from previous studies that the characteristics of agility such as tactile sensitivity, joint proprioception, leg strength, and power begin to decline gradually after 40 years of age **(Manderoos et al., 2017**). Balance is the ability to adjust the position in space. The ability of postural control is influenced by the sensory system (vestibular, visual, somatosensory), the cognitive system (central nervous system), and the Musculo skeletal system (**Dunsky, 2019; Ertürk et al., 2023**). Coordination is the ability to execute various movements smoothly with efficiency and accuracy.

Physical fitness is measured by valid tests and test batteries (**Han & Lee, 2022**). In developed countries, there are so many valid test batteries by which a particular age group of men and women can measure their total physical fitness level. The literature reveals that many test batteries have been constructed in many countries such as Groningen Fitness Test (**Lemmink et al., 2001**), Functional Fitness Test (**Rikli & Jones, 1999**), Euro Fit Test battery (**Tsigilis et al., 2002**), Alpha Fit Test Battery for Adults (**Suni et al., 2009**) on different population and also they have included strength, endurance, agility, flexibility, balance, coordination parameters in their test battery. But, in Indian society, there is no availability of a recognized test battery for middle-aged women by which women can evaluate their physical fitness level. Even researchers who are conducting research on middle-aged women related to their physical fitness, don't get any standard test battery from an Indian perspective rather they use the test battery and norms constructed on other population. Norms on a particular population is indispensible to identify an individual's status or position. Therefore, the purpose of the present study was to construct a suitable physical fitness test battery for middle-aged women in the Indian population and to develop pertinent norms.

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MATERIALS AND METHODS

Participants and Sample Size Determination

Before conducting the study, the sample size was determined with the help of Cochran's formula which indicates the minimum sample size n = 384 for the infinite population (Garret & Woodworth, 1981). As daily living highly involves physical

activities, so keeping in mind the participant's daily activities the three basic occupations of middle-aged Indian women such as Homemaking, Office job, and Manual labor were considered to select the true representative of the population. As per the National Sample Survey Organization (NSSO), in India 62% of women are engaged in home management, 18.5% are engaged in office work and 19.5% of women are engaged in manual labor. To get the targeted number of participants, they were chosen from middle-aged elderly women of three basic occupations as per the NSO ratio. Initially, a total number of 703 women were reached. Finally, on the basis of inclusion criteria, 405 middle-aged women [(n=405); Homemakers (HM)=251, Office goers (OG)=75, Physical worker (PW)=79] were selected for the present study. 298 subjects were excluded because they did not fit into inclusion criteria The adopted inclusion criteria were: i) middle-aged women between 40-59 years (**Adams et al., 2023**). ii) medically fit iii) physically healthy and iv) willing to participate in this study. The participants were divided into two groups 40-49 years age group (n=230,) and 50-59 years age group (n=175) of middle-aged women.

Selection of variables for construction of physical fitness test battery and their assessment protocol

Based on the literature and as per the feasibility, relevancy, and convenience the physical fitness variables such as strength, strength endurance, agility, flexibility, balance, coordination, gait velocity, and cardiovascular endurance have been incorporated for constructing a physical fitness test battery of middle-aged women.

Hand grip Strength Test-Hand grip strength (GS) was measured on the dominant hand by using a Grip dynamometer (Labdeal, Lab-226). The arm of the dominant hand was placed at a 90-degree angle and the elbow was placed by the side of the body. Each participant was given two trials with at least 15 seconds of recovery between each effort. The best result was recorded in kilograms (kg) (**Suni et al., 2009; Bandyopadhyay, 2020**).

Wall Squat Test-The strength endurance (SE) was measured by using the wall squat test. The back of the upper body was kept in touch with the wall with maintaining the position 90-degree angle between knees and hips. The total duration of time participants could hold the position was the score. Two trials were given and the best score was recorded in seconds (**Lea et al., 2021; McIntosh et al., 1998**).

Figure of Eight run Test-Agility (AG) was measured by using the Figure of Eight run test. Two cones were placed at a distance of 10 m. At the command 'go', each subject started from one cone and covered a 10 m distance to another cone and then went around the cone like a figure of eight and ran back to the starting cone. The time taken to complete the task was measured in seconds and tenths of seconds. The best of two trials was considered as a score (**Suni et al., 2009; Wood, 2018**).

Sit and Reach Test-Flexibility (Flex) was measured by using sit and reach test. The participants were asked to place the soles of their feet against the sit and reach box. Both knees were locked and pressed flat to the floor, then the participants placed their both palms side by side and moved the hand forward as far as possible on the measuring line, without any jerking. The best score was recorded among two trials to the nearest centimeter (**Abate Daga et al., 2021; Ponce-González et al., 2020**).

One Leg Stand Test-For measuring Balance (Bal) one leg stand test was used where participants placed their one foot at knee level along with the inner side of the supporting leg and rotate the thigh outwards. Participants were advised to stand as still as possible. Sixty seconds were the upper limit for the test. The Longest correct position maintenance time by the participants was recorded in seconds as a score. Two trials were performed and the best one was recorded **(Malmberg et al., 2002; Suni et al. 2009**).

Plate tape Test-The plate tape test was implemented to assess hand-eye coordination (Coord). The participants were asked to stand in front of the table where a blue rectangle of paper disc was placed at the center of the table and two yellow paper circles were placed at the side of the rectangle, one, on each side at a 30 cm distance. The participants were asked to place their non-active hand in on blue rectangle. They move their active hand over the non-active hand and touch the center of the two yellow discs. When the participants touch two yellow circles with their active hands complete one cycle. The time taken to complete 25 cycles was the score. The testing procedure was carried out twice, the better one result was recorded (**Jopkiewicz et al., 2015; Mack-Inocentio et al., 2020**).

10-meter walk Test-Gait velocity (GV) was assessed by a 10-meter walking test that measured the functional ability of an individual. Participants were instructed to walk 1.2 m before and after a 10-meter walking course, at their normal speed. The time taken for covering 10 meters was the score. Two trials were performed and to reduce the learning effects, the average of two trials was documented in m/s as gait speed **(Bohannon, 1997; Novaes et al., 2011**).

6-minute Walk Test-Cardiovascular Endurance (CVE) was assessed by a 6-minute Walk test. 30m long distance was marked by two cones in the open area. A warming-up period was provided and the participants were asked to walk the 30 m distance without assistance. The objective of the test was to cover as much distance in meters as possible in six minutes which was recorded as a score. (**Alameri et al., 2009; Jalili et al., 2018; Troosters et al., 1999**)

Design of the study

The study was conducted in West Bengal, the eastern state of India, from July 2021 to February 2022. The participants were chosen through local clubs and community centers from different places in West Bengal. Prior to the test, the participants underwent a medical examination by a registered medical practitioner to ensure that they were in good health. Healthy women were selected on the basis of basic information such as age, height, weight, occupation, etc. The detail about the study and its pros and cons were informed to all participants verbally and in written form. The participants reported in a group of an average of fifteen at the test centers and for the collection of data, the selected physical fitness tests were administered by the investigators along with the assistance of qualified expert members. Before appearing in the physical fitness test every participant underwent a warming session of 7 to 10 minutes consisting of walking, slow jogging, stretching, and bending exercises. On the first day the participants' age, height, weight, grip strength, strength endurance, gait velocity, and flexibility were measured. On the second day, the tests for balance, agility, hand-eye coordination, and cardiovascular endurance were conducted to measure the said abilities. The study was approved and supervised by the departmental research committee, Physical Education, the University of Kalyani (Reg No 110050 of 2017-2018 Ref No. Ph.D./Phy.Edu./Ak/484 (30)/2022, dated 17 November 2022).The detail of study design is presented in Figure 1. Informed consent was obtained from the participants before their inclusion in the study. In accordance with Articles 19 and 20 of the WMA Declaration of Helsinki, the authors took into account the needs and priorities of the groups/individuals in which the study was conducted and the situation in which the study could not be carried out outside these groups, and individuals were taken into account. "Additional precautions were taken by the investigator(s) to protect the volunteers in this study."

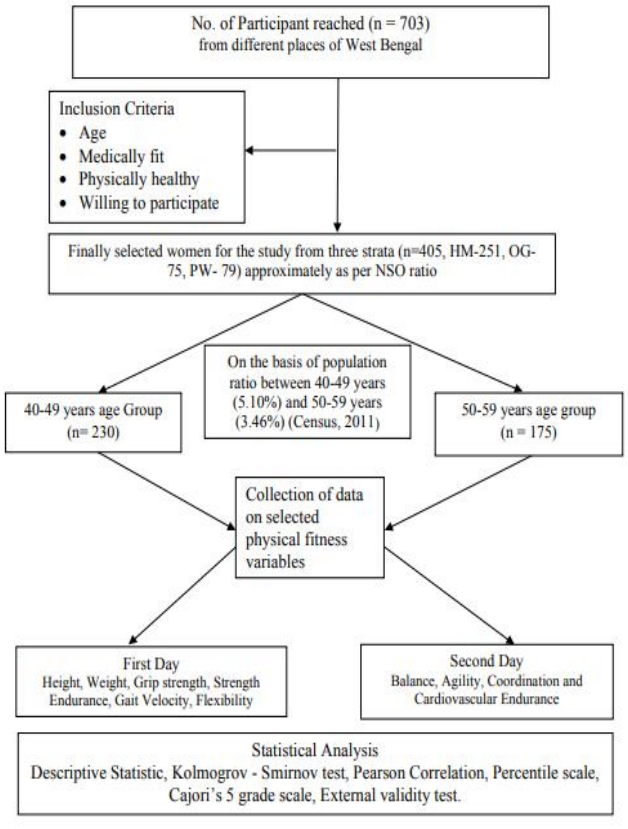

Figure 1. Flow chart of the study design

Statistical Procedure

The collected data were analyzed by using the SPSS-21 version. The mean and standard deviation were computed on each selected physical fitness variable. The normality of each variable was ascertained by the Kolmogorov-Smirnov test. Pearson Product moment correlation was applied to find out the relation among the physical fitness variables. Percentile scale was used to convert all raw data of each variable into percentile scores for both groups separately. Cajori's 5-grade evaluation norms i.e. poor, below average, average, good, and excellent were applied for grading each variable. The external validity of the test battery was

examined through the Unbiased Test, Efficiency Test, Sufficiency Test, and Consistency Test by using Eviews software version 9.

RESULTS

General Characteristics of the Participants

The general characteristics of the participants were expressed through descriptive statistics on Age, Weight, Height, and BMI which are presented in Table 1. The mean and SD of age, weight, height and BMI of 40-49 years middle-aged women group were 44.03±3.03 years, 59.53±10.57 kg, 151.25±6.54 cm and 25.97±4.08 kg/m2 respectively and the mean and SD of age, weight, height and BMI of 50-59 years middle-aged women group were 54.71±2.76 years, 55.05 ±9.62 kg, 148.53±5.51 cm and 24.93±4.09 kg/m^2 respectively.

Descriptive Statistics of Physical fitness variables of middle aged women

The mean, SD, range, and normality of the data of the selected physical fitness variables for both the middle-aged women groups of 40-49 years and 50-59 years are presented in Table 2.

Table 1. General characteristics of the participants

Group		Age (year)	Weight (kg)	Height (cm)	BMI (kg/m^2)
40-49 years	Mean±SD	44.03±3.03	59.53±10.57	151.25 ±6.54	25.97±4.08
50-59 years	Mean±SD	54.71±2.76	55.05±9.62	148.53±5.51	24.93±4.09

Note. SD= Standard Deviation, kg= Kilogram, cm= Centimetre, kg/m^2= Kilogram/Meter^2, BMI=Body Mass Index

Table 2. Descriptive statistics of physical fitness variables for 40-49 years and 50-59 years age group of middle-aged women

Ag Gr.	40-49 years					50-59 years				
	Mean±SD	SEM	Range (Min-Max)	Normality: KS stat		Mean±SD	SEM	Range (Min-Max)	Normality: KS stat	
				Stat	sig				Stat	Sig
GS (kg)	17.61±5.56	0.36	25.00 (4-29)	.047	.200*	12.40±5.28	0.39	23.00 (1-24)	.050	.200*
SE (sec)	50.22±23.78	1.56	96.00 (4-100)	.038	.200*	45.33±21.62	1.63	88.00 (2-90)	.031	.200*
Bal (sec)	31.50±14.02	0.92	55.00 (5-60)	.056	.081*	26.47±10.72	0.81	58.00 (2-60)	.049	.200*
AG (sec)	12.26 ±2.93	0.19	12.80 (6.2-19.00)	.030	.200*	14.26±3.51	0.26	15.77 (6.60-22.37)	.037	.200*
Coord (sec)	17.50 ±3.51	0.23	18.24 (10.71-28.95)	.047	.200*	20.68 ±3.79	0.28	18.31 (12.14-30.45)	.037	.200*
Flex (cm)	17.87 ±5.32	0.35	25.00 (5-30)	.049	.200*	14.57±5.47	0.41	26.00 (1-27)	.041	.200*
GV (m/sec)	1.42 ±0.35	0.02	1.60 (0.6-2.20)	.037	.200*	1.25±0.35	0.02	1.68 (0.42-2.10)	.022	.200*
CVE (m)	503.60±69.36	4.57	350.00 (320-670)	.148	.200*	475.80±69.89	5.28	339.00 (310-649)	.030	.200*

Note. GS=Grip strength, SE=Strength Endurance, Bal=Balance, AG=Agility, Coord=Coordination, Flex=Flexibility, GV=Gait Velocity, CVE=Cardiovascular Endurance, Gr.=Group, kg= Kilogram, sec=Second, cm= Centimetre, m/sec= Meter/second, , m=Meter, SEM=Standard Error of Mean *p> 0.05

Table 2 reveals that the mean and SD of physical fitness variables such as GS was 17.61±5.56 kg, SE was 50.22±23.78 sec, Bal was 31.50±14.02 sec, AG was 12.26±2.93 sec, Coord was 17.50±3.51 sec, Flex was 17.87±5.32 cm, GV was 1.42±0.35 m/sec and CVE was 503.60±69.36 m for 40-49 years middle-aged women group. Similarly, the mean and SD physical fitness variables for age group 50-59 years for GS was 12.40±5.28 kg, SE was 45.33 ±21.62 sec, Bal was 26.47±10.7 sec, AG was 14.26±3.51 sec, Coord was 20.68 ±3.79 sec, Flex was 14.57±5.47 cm, GV was 1.25±0.35 m/sec and CVE was 475.80±69.89 m. Further, Table 2 reveals that the obtained scores for each variable for both groups were normal.

Correlation among the physical fitness variables

Though tests for the physical fitness variables were chosen from standard test batteries or valid tests used in other experimental research for middle-aged women still Pearson Product moment correlation was computed on obtained data of the whole sample (n=405, age 40-59 years) to find out the relation among the selected physical fitness variables.

The Table 3 reveals that the variables were highly correlated with each other (r = 0.996 – 0.949). Hence the selection of a physical fitness variables for constructing a physical fitness test battery is justified and valid.

Percentile scores of the physical fitness variables

Percentile scores of all variables were computed on obtained field test data for the newly constructed physical fitness test battery of 40-49 years and 50-59 years of middle-aged women group by using the percentile score, which are presented in Table 4 (40-49 years) and table 5 (50-59 years).

From Table 4 it can be seen that in the 40-49 years of middle-aged women, the P_{100} score of GS, SE, Bal, AG, Coord, Flex, GV, and CVE variables were 29.00 kg, 100.00 sec, 60.00 sec, 6.20 sec, 10.71 sec, 30.00 cm, 2.20 m/s, and 670.00 m respectively. On the other hand, the P_0 score of selected variables were 4.00 kg, 4.00 sec, 5.00 sec, 19.00 sec, 28.95 sec, 6.00 cm, 0.60 m/s and 320.00 m respectively.

Table 3. Correlation among grip strength, strength endurance, balance, agility, coordination, flexibility, gait velocity, and cardiovascular endurance of 40-59 years of middle-aged women

Variables	GS	SE	Bal	AG	Coord	Flex	GV	CVE
GS	1							
SE	.979** (.000)	1						
Bal	.993** (.000)	.983** (.000)	1					
AG	.994** (.000)	.982** (.000)	.996** (.000)	1				
Coord	.988** (.000)	.967** (.000)	.990** (.000)	.992** (.000)	1			
Flex	.965** (.000)	.965** (.000)	.966** (.000)	.964** (.000)	.949** (.000)	1		
GV	.993** (.000)	.976** (.000)	.994** (.000)	.994** (.000)	.990** (.000)	.964** .000	1	
CVE	.991** (.000)	.973** (.000)	.988** (.000)	.990** (.000)	.986** (.000)	.959** (.000)	.992** (.000)	1

Note. GS=Grip strength, SE=Strength Endurance, Bal=Balance, AG=Agility, Coord=Coordination, Flex=Flexibility, GV=Gait Velocity, CVE=Cardiovascular Endurance

**p< 0.01

Table 4 reveals that if a participant of 40-49 years of middle-aged women group scores 4 kg and below in GS then the participant would be given 0 points. If the participant scores 10 kg in GS, then the participant would be given 10 points. In the same way, if a participant scores 12.20 kg, 13.75 kg,

14.30 kg, 16.00 kg, 18.00 kg, 19.00 kg, 21.00 kg, 22.00 kg, 23.00 kg, 25.00 kg and 29.00 kg in GS then the participant would be given 20, 25, 30, 40, 50, 60, 70, 75, 80, 90, and 100 points respectively. In the same manner, participants of the 40-49 years of middle-aged women group score according to the percentile norms on other variables. The frequency of the percentile scores for 40-49 years of middle-aged women group scores GS, SE, Bal, and AG are presented in Figure 2, and Coord, Flex, GV, and CVE are presented in Figure 3.

Table 4. Percentile scores of all selected physical fitness variables for physical fitness test battery of 40-49 years of middle-aged women group

Percentile	40-49 years								Percentile
	GS (kg)	SE (sec)	Bal (sec)	AG (sec)	Coord (sec)	Flex (cm)	GV (m/sec)	CVE (m)	
P_0	4	4	5	19	28.95	6	0.6	320	P_0
P_{10}	10	17.1	11.1	16.39	22.34	11	0.94	410	P_{10}
P_{20}	12.2	28.2	20	15.04	20.70	13	1.12	443.20	P_{20}
P_{25}	13.75	32.75	22	14.33	19.98	14	1.17	465	P_{25}
P_{30}	14.3	37	24	13.78	19.31	15	1.23	480	P_{30}
P_{40}	16	44	27	12.94	18.43	16	1.33	490	P_{40}
P_{50}	18	49	30	12.17	17.43	18	1.41	510	P_{50}
P_{60}	19	56	34	11.34	16.41	19	1.52	525	P_{60}
P_{70}	21	63	39	10.61	15.34	21	1.63	544.10	P_{70}
P_{75}	22	67.25	42	10.15	14.89	22	1.69	550.50	P_{75}
P_{80}	23	73	45	9.57	14.33	23	1.76	560	P_{80}
P_{90}	25	84	52	8.35	13.05	25	1.90	593.60	P_{90}
P_{100}	29	100	60	6.20	10.71	30	2.20	670	P_{100}

Note. GS=Grip strength, SE=Strength Endurance, Bal=Balance, AG=Agility, Coord=Coordination, Flex=Flexibility, GV=Gait Velocity, CVE=Cardiovascular Endurance, kg= Kilogram, sec=Second, cm= Centimetre, m/sec= Meter/second, , m=Meter

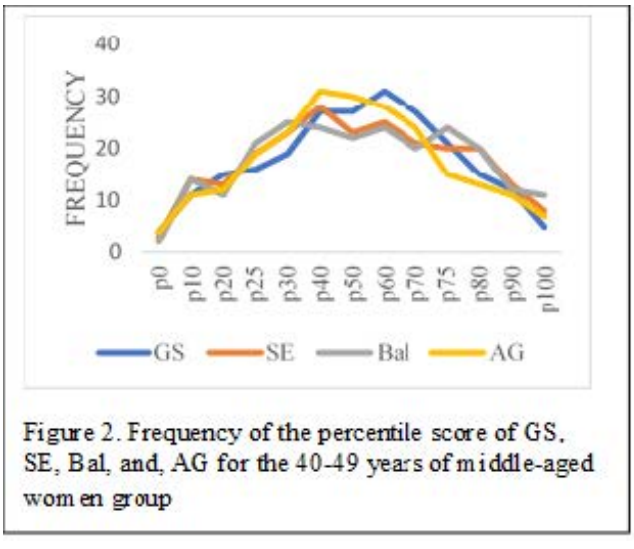

Figure 2. Frequency of the percentile score of GS, SE, Bal, and, AG for the 40-49 years of middle-aged women group

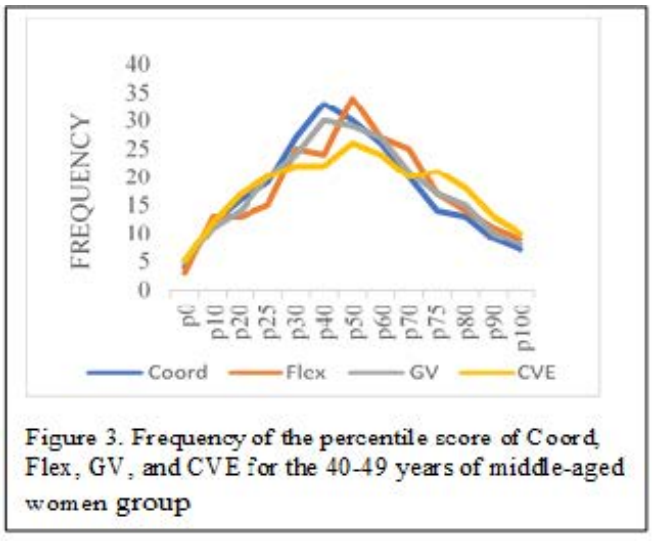

Figure 3. Frequency of the percentile score of Coord, Flex, GV, and CVE for the 40-49 years of middle-aged women group

From Table 5 it can be seen that in the 50-59 years of middle-aged women group, the P_{100} score of GS, SE, Bal, AG, Coord, Flex, GV, and CVE were 24.00 kg, 90.00 sec, 60.00 sec, 6.60 sec, 12.14 sec, 27.00 cm, 2.10 m/s, and 649.00 m respectively. On the other hand, the P_0 score of selected variables were 1.00 kg, 2.00 sec, 2.00 sec, 22.37 sec, 30.45 sec, 1.00 cm, 0.42 m/s and 310.00 m respectively. Table 5 reveals that if a participant scores 1 kg and below in GS then the participant would be given 0 points.

If the participant scores 5 kg in GS, then the participant would be given 10 points. In the same way, if a participant scores 8.00 kg, 9.00 kg, 9.80 kg, 11.00 kg, 12.00 kg, 14.00 kg, 15.00 kg, 16.00 kg, 17.00 kg, 20.00 kg, and 24 kg in GS then the participants would be given 20, 25, 30, 40, 50, 60, 70, 75, 80, 90, and 100 points respectively. In the same manner, the participants' raw scores of any

physical fitness variables based on the same test would be converted into percentile scores as mentioned in Table 5. The frequency of the percentile scores for 50-59 years middle-aged women group of GS, SE, Bal, and AG are presented in Figure 4, and Coord, Flex, GV, and CVE are presented in Figure 5.

Table 5. Percentile scores of all selected physical fitness variables for physical fitness test battery of 50-59 years of middle-aged women group

Percentile	50-59 years								Percentile
	GS (kg)	SE (sec)	Bal (sec)	AG (sec)	Coord (sec)	Flex (cm)	GV (m/sec)	CVE (m)	
P_0	1	2	2	22.37	30.45	1	0.42	310	P_0
P_{10}	5	15	13	18.84	25.95	7	0.77	380.8	P_{10}
P_{20}	8	25.2	17.2	17.33	23.84	10	0.95	417.2	P_{20}
P_{25}	9	30	19	16.57	23.19	11	1.01	429	P_{25}
P_{30}	9.8	33	20	16.21	22.45	12	1.05	441.8	P_{30}
P_{40}	11	39	24	15.17	21.46	13	1.17	458.4	P_{40}
P_{50}	12	45	26	14.33	20.68	15	1.25	472	P_{50}
P_{60}	14	50.6	28	13.52	19.58	16	1.33	490.6	P_{60}
P_{70}	15	57.2	32	12.5	18.49	17.2	1.43	510.2	P_{70}
P_{75}	16	61	34	11.94	18.06	18	1.5	523	P_{75}
P_{80}	17	65.8	35	11.24	17.34	19	1.56	535.8	P_{80}
P_{90}	20	76.4	40	9.37	15.79	22	1.75	571.4	P_{90}
P_{100}	24	90	60	6.6	12.14	27	2.1	649	P_{100}

Note. GS=Grip strength, SE=Strength Endurance, Bal=Balance, AG=Agility, Coord=Coordination, Flex=Flexibility, GV=Gait Velocity, CVE=Cardiovascular Endurance, kg= Kilogram, sec=Second, cm= Centimetre, m/sec= Meter/second, m=metre

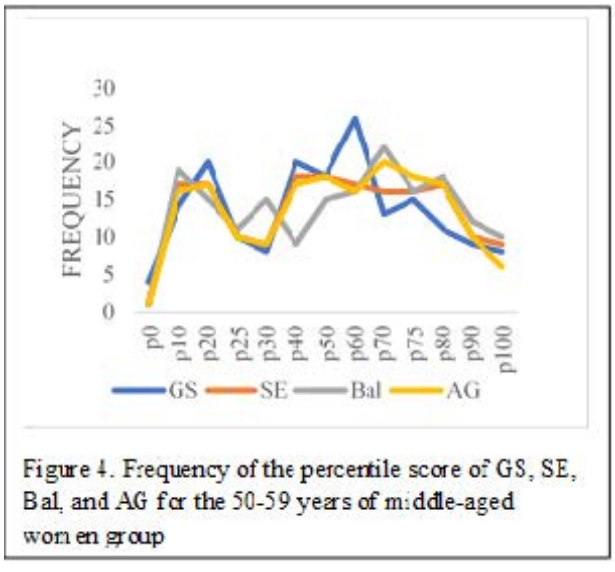

Figure 4. Frequency of the percentile score of GS, SE, Bal, and AG for the 50-59 years of middle-aged women group

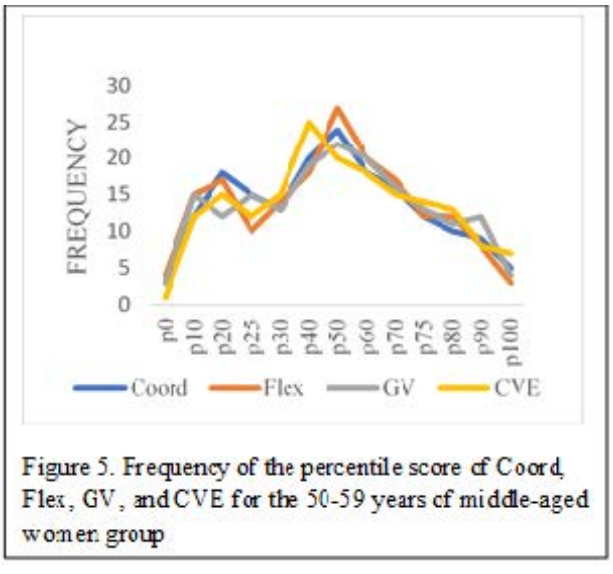

Figure 5. Frequency of the percentile score of Coord, Flex, GV, and CVE for the 50-59 years of middle-aged women group

Grading of all selected physical fitness variables for both groups.

Grading of all variables was computed by using Cajori's 5-grade evaluation norms, which are presented in Table 6 and Table-7. Cajori's 5-grade evaluation norms represent the five grades that are excellent, good, average, below average, and poor. An excellent grade was given when a score of a variable lies between the means with +1.5 SD and above, good grade was given when a score of a variable lies between the means with +0.5 SD and above. It was average when a score lies between below the means with +0.5 SD and above the means with -0.5 SD. The below-average grade was given when a score of a variable lies between the means with -0.5 SD and below. Whereas the poor grade was given when a score of a variable lies between the means with -1.5 SD and below.

Table 6 reveals that the excellent score of GS, SE, Bal, AG, Coord, Flex, GV, and CVE in the 40-49 years middle-aged women group were ≤26.05 kg, ≤85.90 sec, ≤52.53 sec, ≤7.86 sec, ≤12.23 sec, ≤25.85 cm, ≤1.94 m/sec, and ≤609.72 m respectively. The poor score of the same group for

GS, SE, Bal, AG, Coord, Flex, GV, and CVE were ≥9.24 kg, ≥14.56 sec, ≥10.47sec, ≥16.66 sec, ≥22.77 sec, ≥9.89 cm, ≥0.95 m/sec and ≥397.48 m respectively.

Table 7 also reveals that in the 50-59 years middle-aged women group the excellent score of GS, SE, Bal, AG, Coord, Flex, GV, and CVE were ≤20.03 kg, ≤77.76 sec, ≤ 42.55 sec, ≤9.00 sec, ≤15.00 sec, ≤ 22.77 cm ≤ 1.77 m/sec, ≤580.66 m respectively, whereas a poor score of the same group for GS, SE, Bal, AG, Coord, Flex, GV, and CVE were ≥4.49 kg, ≥12.89 sec, ≥10.39 sec, ≥19.53 sec, ≥26.38 sec, ≥6.37 cm, ≥0.73 m/sec and ≥370.96 m respectively.

Table 6. Grading of all selected physical fitness variables of 40-49 years of middle-aged women group

Grade	40-49 years							
	Range of Scores							
	GS (kg)	SE (sec)	Bal (sec)	AG (sec)	Coord (sec)	Flex (cm)	GV (m/sec)	CVE (sec)
Excellent	≤26.05	≤ 85.90	≤52.53	≤7.86	≤12.23	≤25.85	≤1.94	≤609.72
Good	20.45-26.04	62.12-85.89	38.51-52.52	7.87-10.79	12.24-15.74	20.54-25.84	1.59-1.93	538.98-609.71
Average	14.85-20.44	38.34-62.11	24.49-38.50	10.80-13.72	15.75-19.24	15.22-20.53	1.25-1.58	468.23-538.97
Below Average	9.25-14.84	14.57-38.33	10.48-24.48	13.73-16.65	19.25-22.76	9.90-15.21	0.96-1.24	397.49-468.22
Poor	≥9.24	≥14.56	≥10.47	≥16.66	≥22.77	≥9.89	≥0.95	≥397.48

Note. GS=Grip strength, SE=Strength Endurance, Bal=Balance, AG=Agility, Coord=Coordination, Flex=Flexibility, GV=Gait Velocity, CVE=Cardiovascular Endurance, kg= Kilogram, sec=Second, cm= Centimetre, m/sec= Meter/second, m=Meter

Table 7. Grading of all selected physical fitness variables of 50-59 years of middle-aged women group

Grade	50-59 years							
	Range of Scores							
	GS (kg)	SE (sec)	Bal (sec)	AG (sec)	Coord (sec)	Flex (cm)	GV (m/sec)	CVE (sec)
Excellent	≤20.03	≤77.76	≤42.55	≤9.00	≤15.00	≤22.77	≤1.77	≤580.66
Good	15.06-20.02	56.14-77.75	31.83-42.54	8.99-12.51	15.01-18.80	17.31-22.76	1.42-1.76	510.76-580.65
Average	9.78-15.05	34.52-56.13	21.11-31.82	12.52-16.01	18.81-22.58	11.85-17.30	1.09-1.41	440.86-510.75
Below Average	4.50-9.77	12.90-34.51	10.40-21.10	16.02-19.52	22.59-26.37	6.38-11.84	0.74-1.08	370.9-440.85
Poor	≥4.49	≥12.89	≥0.39	≥19.53	≥26.38	≥6.37	≥0.73	≥370.96

Note. GS=Grip strength, SE=Strength Endurance, Bal=Balance, AG=Agility, Coord=Coordination, Flex=Flexibility, GV=Gait Velocity, CVE=Cardiovascular Endurance, kg= Kilogram, sec=Second, cm= Centimetre, m/sec= Meter/second, m=Meter

External Validity

External Validity of the newly constructed physical fitness test battery of 40-49 years and 50-59 years groups of middle-aged women were checked through Unbiased Test, Efficiency Test, Sufficiency Test, and Consistency Test and presented in Table 8. Table 8 reveals the positive unbiased test value which indicates that there was no estimation error in both the age group and sequence of estimators was robustly unbiased in both the age group. Similarly the positive value of efficiency test, sufficiency test, and consistency test indicate that the sequence of estimators were robustly efficient,sufficient, and strongly consistent. So the positive results indicate that the newly constructed physical fitness test battery is externally valid. Hence this test battery and its percentile norms are entitled to measure physical fitness of middle-aged women across the world.

Table 8. External Validity of newly constructed physical fitness test battery of 40-49 years and 50-59 years of middle-aged women groups

External Validity	40-49 years	50-59 years
Unbiased Test	0.76	0.76
Efficiency Test	0.54	0.54
Sufficiency Test	0.499	0.499
Consistency Test	0.0001	0.0001

DISCUSSION

The aim of the study was to develop a physical fitness test battery for middle-aged women by which women can understand their health status. The present study showed that the mean of the GS, SE, Bal, AG, Coord, Flex, GV, and CVE was 17.64 kg, 50.22 sec, 31.50 sec, 12.26 sec, 17.50 sec, 17.87 cm, 1.42 m/sec and 503.60 m for women of 40-49 years age group and for women of 50-59 years age group the mean value of same variables were 12.40 kg, 45.33 sec, 26.47 sec, 14.26 sec, 20.68 sec, 14.57 sec, 1.25 m/sec, and 475.80 m respectively. The 25-percentile scale value of the 40-49 years middle-aged women group on selected physical fitness variables of GS, SE, Bal, AG, Coord, Flex, GV, and CVE were 13.75 kg, 32.75 sec, 22.00 sec, 14.33 sec, 19.98 sec, 14.00 cm, 1.17 m/sec, and 465 m respectively. For the 50-59 years age group of middle-aged women the 25-percentile scale of the same selected variables were 9.00 kg, 30.00 sec, 19.00 sec, 16.57 sec, 23.19 sec 11.00 cm, 1.01 m/sec, and 429 m respectively. Physical Fitness status is the indirect indicator of an individual's health. One can measure physical fitness status by physical fitness test battery which is made with various physical fitness components. Grip strength decreases with age for both dominant and non-dominant hands (**Adedoyin et al., 2009**). It has been recommended as an important predictor of overall muscle strength which is also recognized as a biomarker of general health status for the general population **(Bohannon, 2019**). It plays an important role in the clinical and surgical treatment, functional evaluation of people, talent identification in sports, and composition of the battery in different professional activities (**Amaral et al., 2019**). Generally, Grip strength is measured by handgrip dynamometer because it is valid, fast, inexpensive, and simple to test (**Zaccagni et al., 2020)**. Many researchers constructed reference values on GS by using the handgrip dynamometer with respect to their regional population. **Tsang** (**2005**) showed that the mean GS of 21-70 years women was 28.5±5.7 kg in Hong Kong Chinese adults. **Kamarul et al.** (**2006**) showed that the mean GS of 18-65 years women was 18.6±5.8 kg in the Malaysian Adults population. According to **Adedoyin et al.** (**2009**), the mean GS of 20-70 years women was 24.9±6.4 kg in Nigerian Adults. The obtained value of the Indian population was a little lower than the other populations mentioned above. The reasons behind this difference may have resulted from genetic factors, lifestyle, and biological changes in women (**Manoharan and Kowsalya, 2017**). **Milanović et al. (2013)** reported that strength endurance decreases due to the aging process. Muscle dysfunction is a functional impairment due to cumulative decline among multiple body systems. The deficiency of muscle strength endurance is more common in lower extremity muscles than in upper extremities. The weak muscles of the lower extremities negatively affect balance, walking performance, sit and standing ability **(Ramari et al., 2020**). Therefore, assessment of lower extremity muscles (especially quads, hamstring, and glute muscles) is an important part to understand of a person's health status. In the present study, the wall squat test was used to develop percentile norms of strength endurance for middle-aged women. **McIntosh et al**. (**1998**) mentioned that the mean SE of 40-49 years middle-aged women was 45.00 sec and 50-59 years middle-aged women was 39.00 sec on the Canadian population. The mean SE of both groups in the present study were very close to the mean SE of on the Canadian population. Balance depends on the vestibular system, cognitive system, musculoskeletal system, and the volume of physical activity. The efficiency of these systems decreases gradually when women enter at the age of 40 years (**Dunsky, 2019**). **Springer et al.** (**2007**) stated that the mean Bal for the 40-49 years of women was 42.10 sec and for the 50-59 years of women was

40.90 sec in Washington, DC population. In the present study, the obtained mean of Bal on the Indian population is quite lower than the mean value of **Springer et al**. (**2007**) study on the Washington, DC population. The proper amount of agility of a person may help to change direction perfectly and accurately. Agility depends on strength, flexibility, and neuromuscular reaction time. **Milanovic et al**. (**2013**) also concluded that AG decreased due to the aging process. So, the inclusion of agility as a component of the physical fitness test battery is valid and justified. A certain amount of coordination is necessary to perform daily activities such as walking, cleaning, and climbing stairs. The level of coordination of middle age women decreases with aging however age is not the only thing that can cause a decline in coordination, Genetic factors, physical injury, and neurological disorders also can impair this function (**Seidler et al., 2010**). So, coordination is also a leading factor to live independently at an old age. So the inclusion of coordination as a component of test battery is worthy and justified The flexibility of hamstring and low back muscles may prevent musculoskeletal injuries, low back problems, postural deviations, gait limitations, and risk of falling (**Stathokostas et al., 2013**). Flexibility depends on muscle stiffness and stretch tolerance of an individual (**Milanovic et al., 2013**). According to Fit India Fitness Protocol and guidelines (2019) for ages 18 to 65 years, the mean Flex of 36-45 years of women was 18-19 cm and 46-55 years of women was 17-18 cm measured by the same test sit and reach. **Kordi et al**. (**2010**) expressed that the mean Flex of 40-49 years women was 25.72 cm and 50-60 years women was 25.13 cm in the Tehran population. The mean of the Flex of the present study is quite different from the result of (**Kordi et al., 2010**) study on the Tehran population but the mean of Flex of the present study is quite similar to the result of the Fit India Fitness Protocol and guidelines. The gait speed is an important element of functional ability of health which has been widely used in clinical settings as an indicator of frailty for older people. Gait speed is a reliable, inexpensive, feasible, and objective measure in a home care setting (**Mehmet et al., 2020**). Several physiological factors affect gait speed, such as the central nervous system, perceptual system, peripheral nervous system, muscle, bone, and joint (**Peel et al., 2013**). Different researchers mentioned that a gait speed below 1.0 m/s is a strong predictor for falls in elderly people **(Kyrdalen et al., 2019**). The assessment of gait speed serves several purposes, it provides an appropriate framework for the walking ability of an individual, and reference value can be provided according to sex and decade of age. **Novaes et al.** (**2011**) showed that the mean GV of the 40-49 years and 50-59 years of Brazilian women was 1.27 m/s and 1.27m/s respectively measured by the same test. **Bohannon** (**1997**) stated that the mean GS of 40-49 years of women was 1.39 m/s and 50–59 years women was 1.40 m/s in US Population. The mean GS of the 40-49 years age group of middle-aged women in the present study was quite similar to the results of **Bohannon's** (**1997**) study result in US Population. Novaes et al. (2011) recorded that the mean GV of 50-59 years of Brazilian women was 1.27 m/s which is very close to the present study of the 50-59 years of age group in the Indian population. Cardiovascular diseases are the upcoming leading cause of morbidity and mortality worldwide **(Pinckard et al., 2019**). A sedentary lifestyle is one of the major factors for cardiovascular diseases. Regular physical exercise has numerous positive effects on overall health it can also improve cardiovascular function by improving the heart and vascular system (**Nystoriak & Bhatnagar, 2018**). Therefore, the assessment of cardiovascular fitness is an important variable in research and health area. There is numerous field test by which aerobic fitness can assess, among them 6 min walk test is used because it is easy to administer. **Alameri et al.** (**2009**) showed that the mean CVE of 16-50 years women was 386m in the Arabian population. In the present study, the mean value of the CVE variables is quite different from the above study. So, the inclusion of each and every component of physical fitness in the test battery is a necessary pre-requisite for measuring physical fitness level of middle-aged women.

Strength and Practical Implication

The test battery included the tests for measuring most of the variables of the physical fitness of middle-aged women. This study provided the grading for all selected variables separately. So only selected few items can also be effectively used for a particular purpose, Moreover, the external validity was established, hence the physical fitness test battery may be used worldwide. The physical fitness battery will help to identify the physical fitness status of middle-aged women and

accordingly, health professionals, fitness trainers, and exercise scientists can design a befitting exercise protocol for a particular middle-aged women group. Further this test battery and its norms can be used in conducting various research in physical education, health science, and in medical science.

Conclusion

Based on the findings, the study may conclude that the constructed physical fitness test battery is valid and appropriate to use for measuring the physical fitness status of middle-aged women throughout the world. The particular tests and their pertinent norms will definitely indicate the status of a particular ability of middle-aged women and on the basis of that the health experts and fitness trainers can design a suitable exercise protocol for them. Moreover, the budding researchers can effectively use the test battery and norms for various research.

Conflict of interest

Authors declare that there was no conflict of interest.

Ethics Committee

The study was approved and supervised by the departmental research committee, Physical Education, the University of Kalyani, India (Reg No 110050 of 2017-2018 Ref No. Ph.D./Phy.Edu./Ak/484 (30)/2022, dated 17 November 2022).

Author Contributions

Data Collection, Statistical Calculation, and, Manuscript preparation, were done by AK; Statistical Analysis, Data Interpretation, Manuscript Preparation, and, Final review were done by NB.

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