Special project

Studying the bio mechanical characteristics in elderly

Guide
Prof. G G Ray

Submitted by :

Pragati Kapur
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Industrial Design Centre, IIT Bombay
08613804

Approval sheet

The Special Project titled “Studying bio mechanical characteristics in elderly” by Pragati Kapur, 08613804 is approved as a partial fulfilment of the requirements for Post Graduate Degree in Industrial Design.

Project Guide.....
Date.....

Acknowledgement

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My regards to all my friends whose invisible hands have helped me during the different stages of my project.
To my Parents who are always by my side.

Abstract

The purpose of this survey was to study the biomechanical characteristics in elderly above 60 years of age.

A sample of 27 elderly, 11 males and 17 females, in the age range of 60 years to 88 years from elderly homes in Delhi and Mumbai were tested using standardized instruments.

Various bio mechanical characteristics were studied and recorded.

Elderly in India

India is in a phase of demographic transition. As per the 1991 census, the population of the elderly in India was 57 million as compared with 20 million in 1951. There has been a sharp increase in the number of elderly persons between 1991 and 2001 and it has been projected that by the year 2050, the number of elderly people would rise to about 324 million.

India has thus acquired the label of “an ageing nation” with 7.7% of its population being more than 60 years old. The demographic transition is attributed to the decreasing fertility and mortality rates due to the availability of better health care services. It has been observed that the reduction in mortality is higher as compared with fertility. There has been a sharp decline in the crude death rate from 28.5 % during 1951-1961 to 8.4 % in 1996; while the crude birth rate for the same time period fell from 47.3 % to 22.8 % in 1996.

Over the past decades, India’s health program and policies have been focusing on issues like population stabilization, maternal and child health, and disease control. However, current statistics for the elderly in India gives a prelude to a new set of medical, social, and economic problems that could arise if a timely initiative in this direction is not taken by the program managers and policy makers. There is a need to highlight the medical and socio-economic problems that are being faced by the elderly people in India, and strategies for bringing about an improvement in their quality of life also need to be explored. [1]

[1] http://www.ijcm.org.in/article.asp?issn=0970-0218;year=2008;volume=33;issue=4;spage=214;epage=218;aulast=Ingle

Biomechanics

Biomechanics is a science of application of principle of mechanics in biological system
Biomechanics studies helps us to understand on what happens inside the body mechanism when we walk, we sit, we move, we lift load and how the engineering forces that work in the body.

The study of biomechanics ranges from the inner workings of a cell to the movement and development of limbs, to the mechanical properties of soft tissue, and bones

The discipline of biomechanics integrates the laws of physics and the working concepts of engineering to describe the motion of various body segments and the forces acting on these segments.

Human biomechanics research addresses a broad range of topics related to human mechanics. Studies include examining the mechanical function of muscles, connective tissue, cartilage, skin, nerves, bones, joints, and internal organs. Biomechanics research also includes research that is focused on human movement and performance, muscle force development, joint motion study, actuation of the internal and external forces, moments/torques that produce movement and so on.[2]

[2] http://colleenkelly.net/ArticlesandInfo/Sports/BIOMECHANICS/whatisbiomechanics.htm

Methodology

Instruments used

1. Anthropometric kit
2. Grip strength dynamometer
3. Grip diameter
4. Pinch strength
5. Goniometer
6. Weighing machine
7. Wrist dynamometer

- The anthropometric kit was used to take the linear measurement (stature of subjects).
- Body weight was ascertained using a frequently checked and calibrated physician s scale.
- Grip strength dynamometres - A Jamar® Hydraulic Hand Dynamometer was used for this purpose
- Pinch force was measured using - A JAMAR Hydraulic Pinch Gauge was used for this purpose
- Range of joint motion was measured using BASELINE goniometer. In this study, range of joint motion for elbow and wrist joints were measured
- Wrist strength was measured using Jamar BASELINE wrist dynamometer
- The grip diameter was determined using a calibrated cone which is locally manufactured.

Measurements were done in standing and sitting positions. All subjects were clothed lightly as possible and were bare-foot. The sitting posture was so arranged that the feet rested flat on the floor, and an angle of 90 degrees was formed at knee and hip joint.

Landmarks

The elbow (fig 1)

It is a complex structure that provides an important function as the mechanical link in the upper extremity between the hand, the wrist, and the shoulder. Its primary functions are to position the hand in the space; loss of this ability can cause significant disability for the activities of daily living. This unit provides the rotational movements of the forearm

The wrist (fig 2)

The wrist joint is a complex linkage between forearm and hand which is capable of an impressive arc of motion yet retaining a remarkable degree of stability. Although wrist motion is not essential for most activities of daily living, the preservation of wrist motion is for some individuals essential for the performance of specific occupational or recreational activities.

The shoulder (fig 3)

The joint, or the region of the joint, by which the fore limb is connected with the body or with the shoulder girdle; the projection formed by the bones and muscles about that joint.


fig 1


fig 2


fig 3

Measurements taken

1. Range of motion

Range of motion is defined as "the measurement of the extent to which a joint can go through all of its normal spectrum of movement".

It can also be used to describe the existing amount of motion around a joint
It is expressed in degrees of joint angle or circumference (depending upon what type of joint is being measured). Each joint has an established normal range, based on what that joint does and where the two bones comprising it can move no more.[3]

Refer to fig 15, fig 16, fig 17, fig 18 [page number 26,28]

2. Grip strength

Grip strength is the force applied by the hand to pull on or suspend from objects and is a specific part of hand strength. Optimum-sized objects permit the hand to wrap around a cylindrical shape with a diameter from one to three inches.

Refer to fig 8, fig 9, fig 10 [page number 20]

3. Pinch strength

In a pinch grip, the fingers are on one side of an object, and the thumb is on the other. Typically, an object lifted in a pinch grip does not touch the palm. This is generally considered a weaker grip position.

Refer to fig 5, fig 6, fig 7 [page number 18]

4. Wrist strength

The strength of the wrist during flexion, extension, abduction and adduction is measured [4]

Refer to fig 11, fig 12, fig 13, fig 14 [page23]

http://en.wikipedia.org/wiki/Grip_strength
http://backandneck.about.com/od/r/g/rangeofmotion.htm

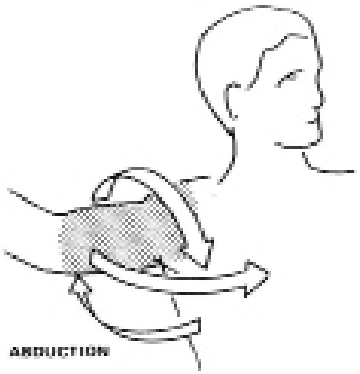
Anatomical terms of motion

Flexion - Bending movement that decreases the angle between two parts. Bending the elbow, or clenching a hand into a fist, are examples of flexion. When sitting down, the knees are flexed. Flexion of the hip or shoulder moves the limb forward (towards the anterior side of the body).

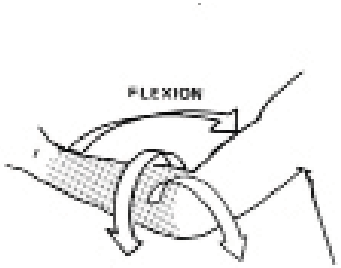
Extension - The opposite of flexion; a straightening movement that increases the angle between body parts. In a conventional handshake, the fingers are fully extended. When standing up, the knees are extended. Extension of the hip or shoulder moves the limb backward (towards the posterior side of the body).

Abduction - A motion that pulls a structure or part away from the midline of the body (or, in the case of fingers and toes, spreading the digits apart, away from the centerline of the hand or foot). Abduction of the wrist is called radial deviation. Raising the arms laterally, to the sides, is an example of abduction.

Adduction - A motion that pulls a structure or part towards the midline of the body, or towards the midline of a limb. Dropping the arms to the sides, or bringing the knees together, are examples of adduction. In the case of the fingers or toes, adduction is closing the digits together. Adduction of the wrist is called ulnar deviation. [5]



Abduction



Flexion

http://en.wikipedia.org/wiki/Anatomical_terms_of_motion
http://ajs.sagepub.com/content/34/3/423/F3.large.jpg [6]

Presentation of data

The reported statistics are as follows:

After obtaining the data, it was compiled by using microsoft excel spreadsheet and following parameters are presented

Number of subjects
The number of subjects are counted and reported. This is referred to as N in the subsequent statistics

Minimum data value
The minimum of all valid subject data is reported and is subsequently referred to as Min. value

Maximum data value
The maximum of all valid subject data is reported and is subsequently referred to as Max. value

Mean
It is the sum of the values divided by the number of values , which is referred to as Average or arithmetic mean

Standard deviation
It is the basic measure of variability. If most of the data cluster close to their mean value, the standard deviation will be small. If on the other hand, many of the data are either much smaller or much larger than the mean, the standard deviation will be large

$$s_n = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2}.$$

x1,x2..... xn are values of sample items

$\overline{x}$ mean of the observations

GENERAL INFORMATION

Subject No.	NAME	AGE	SEX
1	Rasilaben Andariya	68 years	F
2	Aanandi Desai	70 years	F
3	Janardhan S. Arolkar	79 years	M
4	N Acharya	60 years	M
5	Dheera Bose	60 years	F
6	S Laxmi Narayan	70 years	M
7	D' Silva	85 years	M
8	Banu Kumari	63 years	F
9	Kokila	61 years	F
10	Govindi Devi	75 years	F
11	Kanwal Kishore Mehra	65 years	M
12	Savita Sen	65 years	F
13	Rajee Subhramaniyam	88 years	F
14	Ira Mukherjee	70 years	F
15	Amritraj	68 years	M
16	Prem Bhatnagar	81 years	F
17	Roshan Lal Chaufla	81 years	M
18	Bimla Puri	79 years	F
19	Urmila Chaturvedi	74 years	F
20	Saroj Bala	70 years	F
21	Tara	62 years	F
22	Kamala	75 years	F
23	Maniben	80 years	F
24	Gopal	78 years	M
25	Surekha Mhatre	82 years	F
26	G.M. Bapat	85 years	M
27	R.V. Tanna	65 years	M

The general physical condition of most of the subjects was good with mild degeneration due to ageing
They could move around on their own and could carry out most of their activities of daily living themselves

Age

Statistics

Number of subjects	27
Number of males	10
Number of females	17
Range of age	60 years to 88 years

	Min. value	Max. value	Average	Standard deviation
Males	60	88	76.09	11.37
Female	61	82	71.94	8.02
Combined	60	88	73.57	9.69

WEIGHT (kg)

Subject No.		Sex
1	60 kg	F
2	70 kg	F
3	65 kg	M
4	60 kg	M
5	48 kg	F
6	65 kg	M
7	54 kg	M
8	48 kg	F
9	45 kg	F
10	44 kg	F
11	45 kg	M
12	38 kg	F
13	54 kg	F
14	35 kg	F
15	56 kg	M
16	55 kg	F
17	72 kg	M
18	42 kg	F
19	70 kg	F
20	85 kg	F
21	40 kg	F
22	60 kg	F
23	45 kg	F
24	49 kg	M
25	40 kg	F
26	45 kg	M
27	67 kg	M

Weight

Statistics

Number of subjects	27
Number of males	10
Number of females	17
Range of age	60 years to 88 years

	Min. value	Max. value	Average	Standard deviation
Males	45	72	57.81	8.62
Female	38	85	51.70	13.15
Combined	38	85	54.10	11.96

Definition
Body weight as measured on physician s scale. The subject stands upright with hands on sides, on the physician's scale and the reading is noted

STATURE (cm)

Subject No.	
1	148.8 cm
2	127.5 cm
3	160.5 cm
4	159.5 cm
5	141.5 cm
6	170.5 cm
7	152.5 cm
8	142.8 cm
9	135.5 cm
10	152.5 cm
11	165.2 cm
12	140.4 cm
13	150.5 cm
14	147.5 cm
15	160.7 cm
16	155.3 cm
17	160.5 cm
18	157.5 cm
19	155.6 cm
20	162.5 cm
21	153.6 cm
22	149.6 cm
23	145.0 cm
24	164.0 cm
25	153.2 cm
26	155.1 cm
27	169.6 cm

fig 4

Stature

Statistics

Number of subjects	27
Number of males	10
Number of females	17
Range of age	60 years to 88 years

	Min. value	Max. value	Average	Standard deviation
Males	152.5	170.5	162.4	5.49
Females	127.5	162.5	148.19	8.44
Combined	127.5	170 .5	153.77	10.16

Definition

Subject stands straight, head in the Frankfort plane, heels together and weight distributed equally on both feet. With the arm of the anthropometer firmly touching the scalp, measure the vertical distance from the standing surface to the top of the head.

PINCH STRENGTH (kilogram force)

Subject No.	Pinch force	Forward	Vert down	Overhead
1	5	5	5.5	5.5
2				
3	7	8	6.5	8
4	6.5	5	5	5.5
5	4	3	3	4
6	4	4	4	3
7	5	4.5	4	3
8	4	4	4	4
9	3	3.5	3.5	3
10	2	2	3	0.5
11	3.5	3.5	2.5	4
12	3.5	3	3	2.5
13	3	2	2.5	2.5
14	2.5	2.5	2	2
15	11	9	8	11
16	2	4	3	3
17	5.5	6	3	6
18	2.5	2.5	3	3
19	5	4	4	5.5
20	3	3	3	3
21	2	1.5	1.5	1.5
22	3	2.5	2.5	2.5
23	4	3	2.5	3
24	4	4	3	4
25	3	3	3	3
26	5	3	3	3
27	6.5	9.5	5	5.5

fig 5 Forward

fig 6 Vertical down

fig 7 Overhead

Pinch strength

Statistics

Number of subjects	27
Number of males	10
Number of females	17
Range of age	60 years to 88 years

PINCH GRIP	Min. value	Max. value	Average	Standard deviation
Males	3.5	11	5.77	1.76
Female	2	5	3.21	0.93
Combined	2	11	4.19	1.91

FORWARD	Min. value	Max. value	Average	Standard deviation
Males	3	9	5.04	1.85
Females	1.5	5	3	0.88
Combined	1.5	9	3.83	1.69

VERTICAL DOWN	Min. value	Max. value	Average	Standard deviation
Males	2.5	8	4.45	1.60
Females	1.5	5.5	3.66	0.88
Combined	1.5	8	3.62	1.40

OVERHEAD	Min. value	Max. value	Average	Standard deviation
Males	3	11	5.22	2.33
Females	0.5	5.5	3.03	1.24
Combined	0.5	5.5	3.92	2.07

Definition

Subject holds the pinch gauge in the right hand and presses the button with the index finger and thumb, provided below the indicator. While taking the reading, the fingers are on one side of an pinch, and the thumb is on the other and the pinch grip does not touch the palm. The pinch gauge allows accurate development of a true pinch pattern. The red indicator needle remains at maximum reading until reset. [Refer fig 5,6,7]

GRIP STRENGTH (kilogram force)

Sub No.	slot 1	slot 2	slot 3	slot 4	slot 5	Forward	Vert down	Overhead
1	7.5	10	2.5	0	0	8	8	6
2	-	-	-	-	-	-	-	-
3	20	30	28	26	22	18	16	20
4	7.5	10	10	12	8	6	4	8
5	2	1	1	1	1	2	0	2
6	0	0	2.5	1	1	1	0	2
7	2	10	6	4	4	10	8	8
8	2	3	1	1	2	3	1	2
9	1	6	2	0	0	3	1	1
10	1	2	1	1	1	1	1	1
11	10	16	12	8	5	14	10	14
12	2	6	2	3	1	5	4	2
13	0	2	1	1	0	2	0	2
14	0	2	3	2	0	3	2	3
15	26	28	22	18	16	20	18	20
16	1	8	8	6	2	8	8	7
17	4	17	14	12	9	10	10	8
18	3	3	2	2	1	4	3	6
19	2	10	10	6	2	10	5	14
20	2	5	8	6	4	6	6	4
21	-	-	-	-	-	-	-	-
22	0	1	0	0	0	2	0	0
23	0	2	2	0	0	2	0	2
24	2	6	4	4	4	2	6	4
25	6	10	14	6	4	6	6	14
26	4	8	6	6	4	8	6	10
27	12	14	12	6	8	20	11	12

fig 8 Overhead

fig 9 Forward

fig 10 Vertical down

Grip strength

Statistics

Number of subjects	25
Number of males	10
Number of females	15
Range of age	60 years to 88 years

1 st slot	Min. value	Max. value	Average	Standard deviation
Males	0	26	8.86	7.69
Female	0	7.5	1.96	2.10
Combined	0	7.5	4.88	6.26

2 nd slot	Min. value	Max. value	Average	Standard deviation
Males	0	30	13.72	8.5
Females	1	10	4.73	3.27
Combined	0	30	8.53	7.52

3 rd slot	Min. value	Max. value	Average	Standard deviation
Males	2.5	28	11.68	7.31
Females	0	14	3.83	3.99
Combined	0	28	7.15	6.84

4 th slot	Min. value	Max. value	Average	Standard deviation
Males	1	26	9.72	6.85
Females	0	6	2.33	2.35
Combined	0	26	5.46	6.03

5 th slot	Min. value	Max. value	Average	Standard deviation
Males	1	22	7.9	5.8
Female	0	4	1.2	1.28
Combined	0	22	4.03	5.12

FORWARD	Min. value	Max. value	Average	Standard deviation
Males	1	20	10.09	6.8
Females	1	10	4.33	2.62
Combined	1	20	6.51	5.66

VERTICAL DOWN	Min. value	Max. value	Average	Standard deviation
Males	0	18	8.45	5.06
Females	0	8	3.0	2.85
Combined	0	18	5.3	4.77

OVERHEAD	Min. value	Max. value	Average	Standard deviation
Males	2	20	10	5.78
Females	0	14	4.4	4.23
Combined	0	20	6.76	5.67

Definition

The subject holds the dynamometer in the right hand, with the arm at right angles and the elbow by the side of the body. The handle of the dynamometer is adjusted if required - the base should rest on first metacarpal (heel of palm), while the handle should rest on middle of four fingers. When ready the subject squeezes the dynamometer with maximum effort, which is maintained for about 5 seconds. No other body movement is allowed. The measurement is taken in 5 different grip positions and also with hand extended forward, overhead and vertically down. The subject should be strongly encouraged to give a maximum effort. [Refer fig 8,9,10]

WRIST DYNAMOMETER (kilogram force)

Subject No.	Handle 1	Handle 2	Handle 3	Knob
1	45	45	35	30
2				
3	105	80	80	60
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26	70	85	30	30
27	70	80	45	40
28	110	95	75	70

fig 11 HANDLE 1

fig 12 HANDLE 2

fig 13 KNOB

fig 14 HANDLE 3

Wrist strength

Statistics

Number of subjects	5
Number of males	3
Number of females	2
Range of age	60 years to 88 years

HANDLE 1	Min. value	Max. value	Average	Standard deviation
Males	70	115	96.66	19.29
Female	45	70	57.5	12.5
Combined	45	115	81	25.57

HANDLE 2	Min. value	Max. value	Average	Standard deviation
Males	80	95	85	7.07
Females	45	85	65	20
Combined	45	95	77	16.91

HANDLE 3	Min. value	Max. value	Average	Standard deviation
Males	45	80	66.66	14.45
Females	30	35	32.5	2.5
Combined	30	80	53	20.63

KNOB	Min. value	Max. value	Average	Standard deviation
Males	40	70	56.66	12.47
Females	30	30	30	0
Combined	30	70	46	16.24

Definition

The appropriate grip is snapped into the body to secure unit for test. The unit is held by grasping the dynamometer body. The max indicator is set to zero. The subject twists the grip with maximum force and the reading is read. The unit is re set to zero for next test

RANGE OF MOTION- CARPALS (degrees)

Subject No.	Dorsiflexion	ROM	Ventriflexion	ROM
1	135	45	115	65
2	-	-	-	
3	121	59	104	76
4	129	51	120	60
5	129	51	123	57
6	140	40	129	51
7	158	22	134	46
8	110	70	100	80
9	-		-	
10	-		-	
11	-		-	
12	-			
13	-		-	
14	-		-	
15	-		-	
16	-		-	
17	-		-	
18	-		-	
19	-		-	
20	-		-	
21	135	45	128	52
22	145	35	120	60
23	130	50	125	55
24	127	53	101	79
25	120	60	111	69
26	125	55	115	65
27	135	45	110	70

fig 15 Dorsiflexion

fig 16 Ventriflexion

Range of motion - carpals

Statistics

Number of subjects	14
Number of males	7
Number of females	7
Range of age	60 years to 88 years

MINIMUM	Min. value	Max. value	Average	Standard deviation
Males	101	135	118.5	12.37
Female	100	128	117.42	8.92
Combined	100	135	118	10.91

MAXIMUM	Min. value	Max. value	Average	Standard deviation
Males	121	158	135.12	11.56
Females	110	145	129.14	10.49
Combined	110	158	132.33	11.47

Dorsiflexion	Min. value	Max. value	Average	Standard deviation
Males	34	55	44.87	11.56
Females	35	70	50.85	10.49
Combined	34	70	47.66	11.47

Ventriflexion	Min. value	Max. value	Average	Standard deviation
Males	45	79	61.5	12.37
Females	52	80	62.57	8.92
Combined	45	80	62	10.91

Definition

Align the fulcrum of the goniometer with the fulcrum of the wrist joint of the subject. Align the stationary arm of the goniometer with the arm. hold the arms of the goniometer in place while the wrist joint is moved through its range of motion. The degree between the end points represents the range of motion.

RANGE OF MOTION- ELBOW (degrees)

Subject No.	Extension	Flexion	ROM
1	166	44	122
2	165	41	124
3	166	36	130
4	169	43	126
5	165	30	135
6	144	34	110
7	145	35	110
8	178	44	134
9	148	33	115
10	132	40	92
11	156	35	121
12	148	31	117
13	145	46	99
14	165	30	135
15	176	33	143
16	160	40	120
17	160	38	122
18	168	38	130
19	170	37	133
20	170	39	131
21	176	38	138
22	160	35	125
23	168	28	140
24	156	24	132
25	179	30	149
26	174	35	139
27	172	36	136

fig 17 Extension

fig 18 Flexion

Range of motion - elbow

Statistics

Number of subjects	27
Number of males	10
Number of females	17
Range of age	60 years to 88 years

MINIMUM	Min. value	Max. value	Average	Standard deviation
Males	24	43	34.45	4.49
Female	28	46	36.70	5.43
Combined	24	46	35.82	5.20

MAXIMUM	Min. value	Max. value	Average	Standard deviation
Males	144	176	161.63	10.42
Females	132	179	162.52	12.29
Combined	132	179	162.17	11.60

RANGE OF MOTION	Min. value	Max. value	Average	Standard deviation
Males	110	143	127.18	10.28
Females	92	149	125.82	13.99
Combined	92	149	126.35	12.68

Definition

Make the patient sit down in a chair with his arm cantilevered from his body. Place the fulcrum of the goniometer over the elbow joint. Line up the stationary arm of the goniometer along the mid line of the fore arm. Line up the moving arm with the with the front part of the arm. Then the patient was asked to flex his arm to the fullest extent to measure their greatest range of motion.

WRIST HEIGHT (cm)

Subject No.	
1	71.8
2	-
3	75.8
4	79.5
5	68.7
6	84.3
7	66.5
8	71.5
9	-
10	-
11	-
12	-
13	-
14	-
15	-
16	-
17	-
18	-
19	-
20	-
21	74.8
22	73.5
23	72.5
24	79.3
25	72.4
26	70.6
27	80.6

fig 19

Wrist height

Statistics

Number of subjects	14
Number of males	7
Number of females	7
Range of age	60 years to 88 years

	Min. value	Max. value	Average	Standard deviation
Males	66.5	84.3	76.75	5.36
Female	68.7	74.8	72.17	1.75
Combined	66.5	84.3	74.61	4.68

Definition

The subject stands erect with his arms hanging naturally at his sides. With the anthropometer, measure the vertical distance to the most distal point of the ulna.

GRIP DIAMETER (cm)

Subject No.	
1	3.6
2	3.1
3	4.5
4	4.4
5	3.8
6	3.8
7	3.7
8	4
9	3.7
10	4
11	4.2
12	3.6
13	4.2
14	3.8
15	4.2
16	3.8
17	4
18	4
19	3.8
20	4.1
21	3.7
22	3
23	3.6
24	4
25	3.5
26	4.4
27	4.52

fig 20

Grip diamater

Statistics

Number of subjects	27
Number of males	10
Number of females	17
Range of age	60 years to 88 years

	Min. value	Max. value	Average	Standard deviation
Males	3.7	4.5	4.18	0.26
Female	3.0	4.2	3.72	0.30
Combined	3.0	4.5	3.90	0.36

Definition
Subject holds a cone around the largest circumference that he can grasp with his thumb and middle finger just touching.
Record the diameter of the cone corresponding to this maximum circumference.

References

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