



Determination of reference values of v-sit and reach test in healthy adults aged 18–49 years

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DOI: <https://doi.org/10.66856/ijyppe.2026.11.4.11101>

Abstract

Objective: To determine age- and sex-specific reference values for the V-Sit and Reach test among healthy adults aged 18–49 years.

Methods: A cross-sectional study was conducted among 306 healthy adults aged 18–49 years, equally distributed by sex across three age groups: 18–29, 30–39, and 40–49 years. The V-Sit and Reach test was performed using a standardized procedure, with three attempts recorded and the best score used for analysis. Descriptive statistics, including mean, standard deviation, median, and percentile values (P5, P10, P25, P50, P75, P90, and P95), were calculated using MS Excel.

Results: Females had a higher overall mean score (13.42 ± 4.45 inches) than males (12.43 ± 4.67 inches). The highest age-group mean was observed in participants aged 18–29 years (14.21 inches), while the lowest was observed in those aged 40–49 years (11.52 inches). The highest subgroup mean was recorded among females aged 18–29 years (14.73 inches), and the lowest among males aged 40–49 years (10.37 inches). Age- and sex-specific percentile values were established.

Conclusion: The study provides sample-based reference values for the V-Sit and Reach test in healthy adults aged 18–49 years in Indian Population. The study concludes that as the age increases flexibility decreases. These values may assist clinicians and researchers in interpreting flexibility according to age and sex.

Background: Flexibility is an important component of physical function, and reduced flexibility may affect posture, movement, and musculoskeletal health. The V-Sit and Reach test is a simple field-based measure of lower-limb and lower-back flexibility. However, age- and sex-specific reference values for healthy Indian adults are limited.

Keywords: V-sit, reach, flexibility, hamstring flexibility, reference values, healthy adults, India

Introduction

Flexibility refers to the inherent characteristic of body tissues—such as muscles and connective tissues—that influences the range of motion, a joint or group of joints can achieve safely, without causing injury.^[1] Muscle tightness occurs when the muscle's capacity to stretch or deform is reduced, leading to a limitation in the joint's range of motion.^[2] The lower extremity muscles most prone to developing tightness include the gastrocnemius-soleus complex, tibialis posterior, rectus femoris, iliopsoas, tensor fascia lata, hamstrings, and the short adductors.^[3] The occurrence of hamstring tightness is highly prevalent among normal individuals.^[2] Hamstring tightness can be seen across all age groups, and its prevalence tends to rise with advancing age.^[2]

The hamstrings play a crucial role in many daily activities, such as walking, running, jumping, and controlling some movement in the trunk. In walking, they are most important as an antagonist to the quadriceps in the deceleration of knee extension.^[4]

Reduced hamstring flexibility is linked to low back pain, postural abnormalities, gait restrictions, increased fall risk, and a higher likelihood of musculoskeletal injuries. This underscores the greater importance of maintaining hamstring flexibility.^[4]

Static flexibility is assessed using tests that record linear or angular movement of a joint or group of joints with instruments like goniometers and inclinometers.^[4] Various field tests such as the Straight Leg Raise, Passive Straight

Leg Raise, and the Mac-Rae Wright test are used to measure flexibility, along with the Sit-and-Reach test. The other methods are generally less reliable and involve more complex procedures compared to the various sit-and-reach variations.^[5]

A widely recognized and reliable field test for static flexibility is the Sit-and-Reach test, which measures the combined flexibility of the lower back and hips.^[4] The Sit-and-Reach test, originally introduced by Wells and Dillon in 1952, has become a widely used assessment tool for measuring flexibility, particularly in the lower back and hamstring muscles.^[6]

The Sit-and-Reach test and its various modifications—such as the Unilateral Seated Sit-and-Reach, Chair Sit-and-Reach, Modified Sit-and-Reach, Back-Saver Sit-and-Reach, Toe-Touch Test, and V-Sit and Reach. These are widely included in health-related physical fitness assessment batteries like EUROFIT, FITNESSGRAM, President's Challenge, and Unifit test (6–60).^[7] Although the Sit-and-Reach test and its variations are commonly used due to their ease of administration, understandable procedures, and low skill requirements, they are often impractical for self-use because of limited access to necessary equipment (e.g., test box).^[7]

Cailliet (1988) noted that stretching both hamstrings at once in the traditional Sit-and-Reach test could cause excessive posterior disc compression, as the front parts of the vertebrae are forced together, thus the Back Saver Sit-and-Reach was introduced. Hoeger *et al.* (1990) pointed out that

the traditional Sit-and-Reach test may be influenced by differences in limb length. To address this, they developed a modified version that measures flexibility by calculating the difference between the starting reach position and the final reach position viz. the Modified Sit-and-Reach test. The classical Sit-and-Reach test was later adapted to be performed without a box, a variation known as the V-Sit and Reach test.^[8] Therefore, the V-Sit and Reach test, was proposed by the North American association "President's Challenge" to measure the flexibility of the lower back and hamstring muscles. Its advantage is that not requiring a test box, which is essential in the original Sit-and-Reach test also convenient in alter spine posture.^[1]

There is evidence suggesting that the V-Sit and Reach test is a valid and reliable tool for assessing hamstring and lower back flexibility. There exists a significant research gap in the Indian population with respect to reference studies thus in this study, the V-Sit and Reach test is used to determine reference values in healthy Indian adults aged 18 to 49 years.

Materials and Methods

1. Study Design and Setting

A cross-sectional survey was conducted among healthy community-dwelling adults in Navi Mumbai, Maharashtra. Ethical approval was obtained from the Institutional Ethics Committee of TMV's Lokmanya Tilak College of Physiotherapy, Kharghar. The purpose and procedure of the study were explained to participants, and written informed consent was obtained before assessment.

2. Participants and Sampling

A total of 306 participants were recruited using purposive sampling. The sample was equally distributed across three age groups: 18–29 years, 30–39 years, and 40–49 years. Each age group comprised 102 participants, including 51 females and 51 males. The sample size of 306 was calculated using OpenEpi Version 3, with a type I error of 0.05 and 95% power, using the reported population estimate for adults aged 18–49 years in Navi Mumbai.

3. Eligibility Criteria

Participants were eligible if they were healthy males or females aged 18–49 years and were community dwelling. Exclusion criteria included lower-limb or spinal deformity, lower-limb fracture, known neurological, cardiovascular, or musculoskeletal conditions or complaints, severe mobility impairment due to physical injury, spinal cord injury or amputation, spinal or lower-limb implants, recent trauma or surgery, participation in yoga or gym activities, and unwillingness to participate.

4. V-Sit and Reach Procedure

A measuring tape was placed on the floor at a right angle to the 15-inch mark. The participant sat with the measuring tape positioned between the legs, with the legs extended along the taped line. The heels touched the edge of the marked line and were positioned approximately 10–12 inches apart. The participant placed both hands together with the elbows extended, bent forward, reached toward the measuring tape, and held the final position for 2 seconds. Three attempts were performed, and the best score was recorded for analysis.

5. Statistical Analysis

Data collected from 306 healthy adults aged 18–49 years were entered and analyzed statistically using MS-Excel. Continuous variables were expressed as mean and standard deviation (SD), and median, values.

Percentile values were calculated at the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles to describe the distribution of V-Sit and Reach scores and to derive sample-based reference values.

Results

This study results in Age- and sex-wise descriptive and percentile values obtained for the V-Sit and Reach test. Mean V-Sit and Reach performance was highest in the 18–29-year group and lowest in the 40–49-year group. The age- and sex-specific percentile table constitutes the principal reference-value output of the study.

Table 1: demographic characteristics of participants according to age group and gender

Age group	Gender	n	Age (years), Mean $\pm$ SD
18–29	Female	51	22.61 $\pm$ 2.03
18–29	Male	51	22.94 $\pm$ 2.63
30–39	Female	51	33.65 $\pm$ 3.32
30–39	Male	51	33.27 $\pm$ 3.08
40–49	Female	51	45.35 $\pm$ 3.14
40–49	Male	51	45.47 $\pm$ 3.60

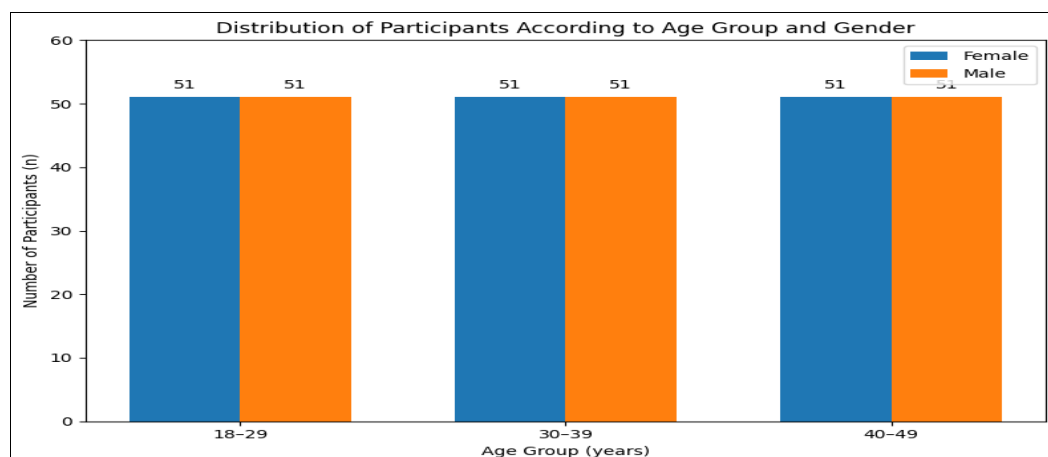


Fig 1: Demographic Characteristics of Participants According to Age Group and Gender

Interpretation: The mean age of females was 22.61 ± 2.03 years in the 18–29-year group, 33.65 ± 3.32 years in the 30–39-year group, and 45.35 ± 3.14 years in the 40–49-year group. Among males, the corresponding mean ages were 22.94 ± 2.63 , 33.27 ± 3.08 , and 45.47 ± 3.60 years, respectively.

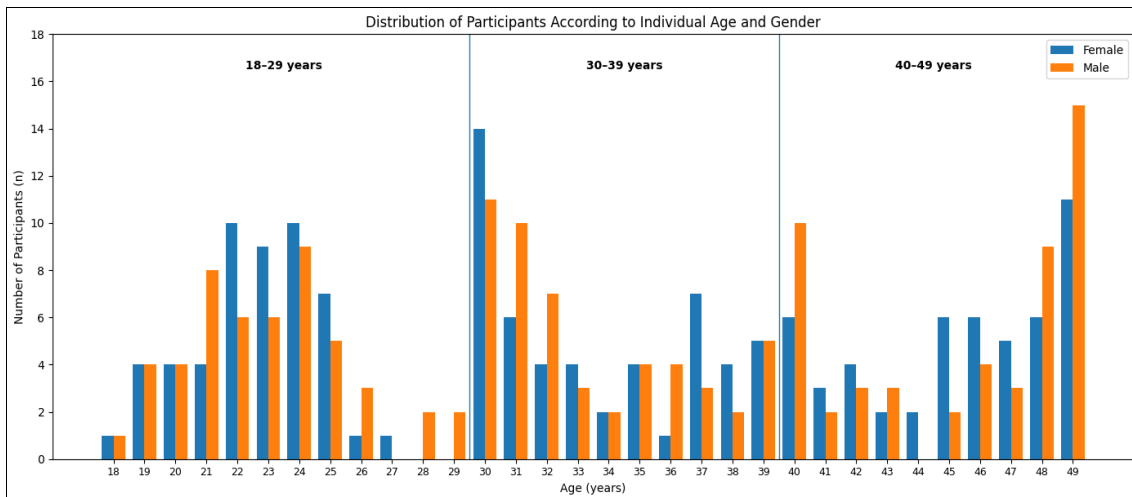


Fig 2: distribution of participants according to individual age

Interpretation: The age-wise distribution of Male and Female participants ranged from 18 to 49 years. The number of participants varied across individual ages, indicating a non-uniform age distribution.

Table 3: v-sit and reach scores according to age group for both males and females

Age group	n	Mean (Inches)	SD (Inches)
18–29	102	14.21	4.09
30–39	102	13.06	4.75
40–49	102	11.52	4.51

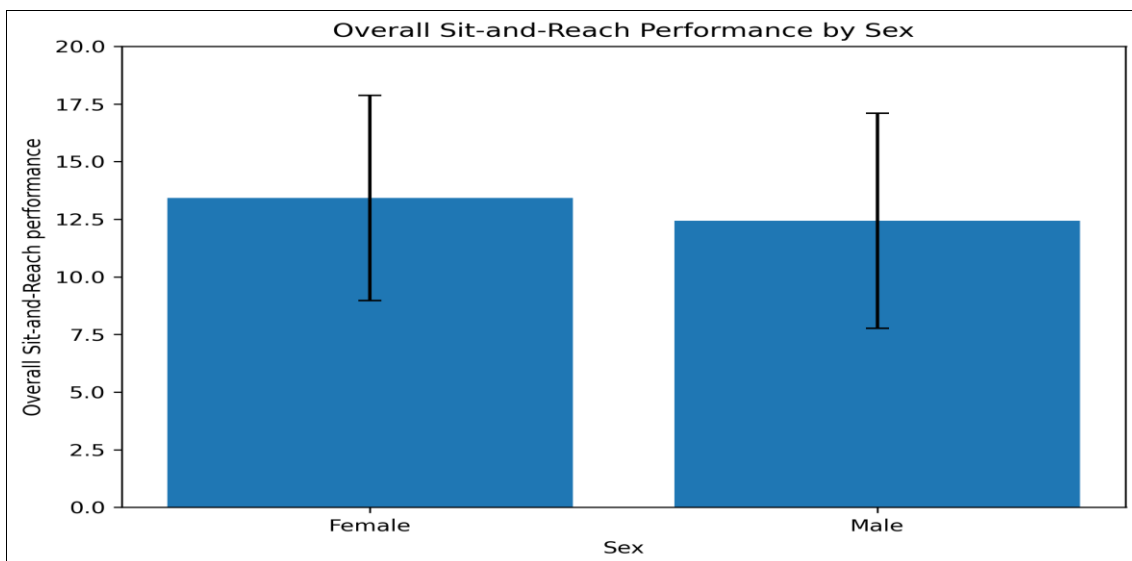


Fig 3: v-sit and reach scores according to age group for both males and females

Interpretation: The overall Sit-and-Reach performance was slightly higher among females compared with males. Females had a mean score of 13.42 ± 4.45 inches, with a median of 14.00 inches, whereas males had a mean score of 12.43 ± 4.67 inches, with a median of 13.00 inches. The sample consisted of 153 females and 153 males.

Table 4: percentile reference values of v- sit and reach test

Age group	Sex	n	Mean (Inches)	SD (Inches)	P5	P10	P25	P50	P75	P90	P95
18–29	Female	51	14.73	4.04	8.35	9.50	12.05	15.00	16.95	20.00	22.00
18–29	Male	51	13.68	4.11	8.17	8.50	10.22	13.55	16.27	19.84	20.84
30–39	Female	51	12.86	4.67	4.20	6.50	10.15	12.80	15.90	18.00	20.60
30–39	Male	51	13.26	4.87	3.90	5.90	10.40	14.50	16.45	19.00	19.80
40–49	Female	51	12.67	4.41	5.30	5.90	10.50	13.00	16.10	17.80	18.60
40–49	Male	51	10.37	4.37	3.65	4.90	7.15	10.50	14.25	16.40	16.85

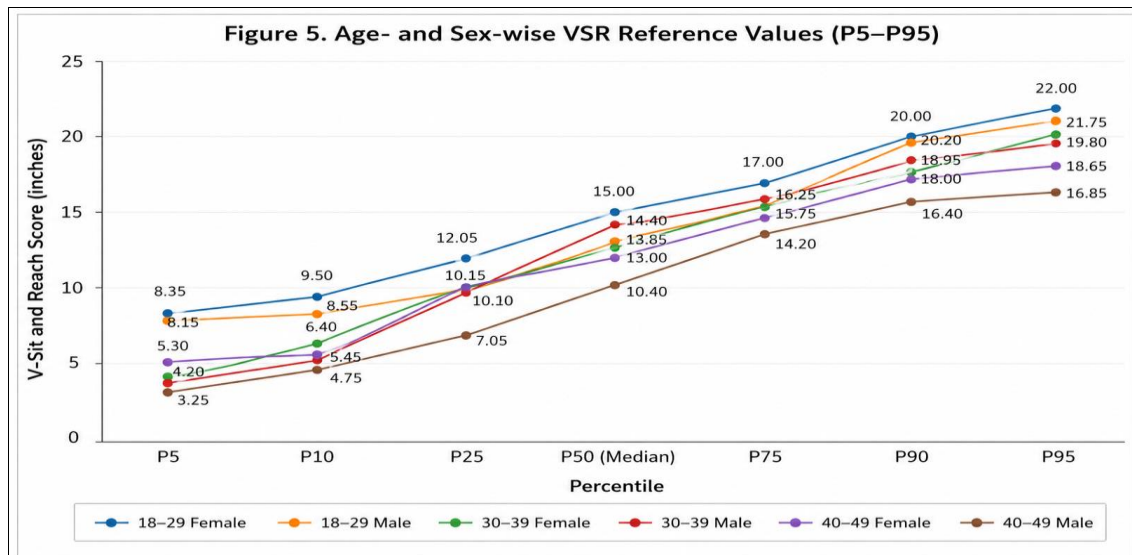


Fig 4: percentile reference values of v- sit and reach test

Interpretation: Presents P10, P25, P50, P75 and P90 for each age-sex subgroup. P50 represents the median, while P10 and P90 describe the lower and upper ends of the central 80% of the observed distribution. Females showed higher Sit-and-Reach performance in the 18–29 group, while males scored slightly higher in the 30–39-year group. The highest mean was seen in 18–29-year females (14.73 inches) and the lowest in 40–49-year males (10.37 inches).

The P5–P95 values represent the reference range for approximately 90% of participants.

Discussion

The present study was conducted to determine age- and sex-specific reference values for the V-Sit and Reach test among healthy adults aged 18–49 years. A total of 306 healthy adults were included in the study, with equal representation of males and females across the three age groups. The V-Sit and Reach test has the advantage of being simple and inexpensive and can be performed using a measuring rule without requiring the specialised box used for the conventional Sit-and-Reach test.^[5] This makes it practical for use in clinical, educational and fitness settings where sophisticated equipment may not be available.

The development of reference values is particularly relevant because previous Indian research has mainly focused on specific age groups and has used the conventional Sit-and-Reach test. A study conducted among healthy young adults aged 18–25 years developed reference values for the Sit-and-Reach test, demonstrating the usefulness of normative data for interpreting flexibility performance in young adults.^[10] In comparison, the present study included adults from 18 to 49 years and generated separate percentile values for males and females across three age groups. Thus, the present study extends the available reference information to a wider adult age range using the V-Sit and Reach test. The main finding of the study was that V-Sit and Reach performance showed a decreasing trend with increasing age. The mean score was highest in the 18–29-year age group (14.21 inches) whereas the 40–49-year group demonstrated the lowest mean V-Sit and Reach score.

Studies examining sit-and-reach performance across different age groups have demonstrated that flexibility tends to be lower in older adults compared with younger adults, with age-related reductions also observed in sit-and-reach scores.^{[3] [11]} However, flexibility is not determined by age alone. Factors such as muscle stiffness and reduced flexibility of the hamstrings and hip musculature, including

the psoas major, may limit pelvic and trunk movement during forward bending.^{[3] [4]} Variations in the physical properties of muscles and connective tissues may also contribute to differences in flexibility. In addition, body proportions, particularly differences in limb and trunk length, can influence the distance achieved during the sit-and-reach test.^{[6] [8]} Similar age-related patterns have been reported in studies using sit-and-reach-based flexibility assessments, where older participants generally demonstrated lower flexibility scores than younger participants.^{[3] [11]}

In the present study, females demonstrated a higher overall mean V-Sit and Reach score than males. The mean score was 13.42 inches among females and 12.43 inches among males. Although females showed a slightly higher mean score, the overall difference between males and females was not statistically significant ($p = 0.0857$). Previous research involving young adults has reported that females may obtain higher scores on flexibility tests than males.^[12] Similar differences have also been observed in studies using age- and sex-specific flexibility measurements.^[1]

When stratified by age and sex, females had higher mean V-Sit and Reach scores than males in the 18–29 and 40–49-year groups, while males scored slightly higher in the 30–39-year group. A statistically significant sex difference was observed only in the 40–49-year group ($p = 0.01$). These findings indicate that sex-related differences in V-Sit and Reach performance were not uniform across all age groups. Age- and sex-specific sit-and-reach studies have similarly demonstrated variation in the magnitude and direction of sex differences across age groups.^[13] The present study established age- and sex-specific percentile values from percentile 5 to percentile 95. The highest mean score was observed among 18–29-year-old females (14.73 inches), while the lowest was observed among 40–49-year-old males (10.37 inches).

The previous study established normative values for the Sit-and-Reach test among healthy adults aged 18–25 years, demonstrating the usefulness of normative data for

interpretation of flexibility performance. ^[10] This study extends this approach to a wider age range of 18–49 years using the V-Sit and Reach test and provides separate reference values according to age and sex. This may help physiotherapists identify individuals who demonstrate relatively low flexibility and may also provide a baseline for monitoring changes following flexibility or exercise interventions.

Conclusion

The study established age- and sex-specific reference values for the V-Sit and Reach test in healthy adults aged 18–49 years. It concludes that flexibility decreased with increasing age, with the highest scores seen in the 18–29-year group and the lowest in the 40–49-year group. Females had slightly better overall scores than males, although the overall difference was not statistically significant. Overall, the percentile values obtained can be used as reference standards for assessing flexibility in healthy adults.

Limitations

- Convenience sampling may limit generalizability of the reference values.
- The study included only adults aged 18–49 years; therefore, findings cannot be generalized to older age groups.
- The study was conducted within a limited geographical setting and may not represent all Indian populations.

Clinical Implications

- The V-Sit and Reach test is simple, low-cost, and easy to perform.
- The age- and sex-specific reference values from this study can help physiotherapists judge an individual's flexibility more appropriately.
- They can also be used to identify low flexibility, set a baseline, and monitor changes after stretching or exercise programmes.

Future Scope

- Larger sample sizes can be used to develop more robust reference values.
- Multicentric studies involving participants from different regions of India can be conducted to improve generalizability.
- Future studies can examine the influence of anthropometric factors such as height, limb length and BMI on V-Sit and Reach performance

Ethical Considerations

Approval was obtained from the Institutional Ethics Committee of TMV's Lokmanya Tilak College of Physiotherapy, Kharghar. Participants were informed about the purpose and procedure of the study and written informed consent was obtained.

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