

EFFECT OF YOGA INTERVENTION ON POSTERIOR-CHAIN FLEXIBILITY IN CORPORATE EMPLOYEES: A V-SIT-AND-REACH ANALYSIS BY GENDER AND AGE GROUP

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Abstract

Background: Flexibility of the hamstring muscles and lumbar spine is a critical component of musculoskeletal health in desk-based corporate workers, where prolonged sedentary postures contribute to posterior chain tightness and increased risk of low back pain. Yoga is widely practised for improving flexibility; however, evidence examining yoga's effects on posterior-chain flexibility in corporate employees, with subgroup analysis by gender and age, is limited. **Objective:** To evaluate the effect of a 12-week yoga-based intervention on posterior-chain flexibility, as measured by the V Sit and Reach Test (VSRT), in corporate employees, and to examine whether intervention effects differ by gender and age group. **Methods:** A single-group, pre-test–post-test intervention study was conducted with 114 corporate employees (67 male, 47 female) from Ahmedabad, Gujarat, India. Participants received a 12-week structured yoga intervention (5 sessions/week, 60 minutes/session) using the S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain (Nagendra & Nagarathna, 2010), delivered under the supervision of a qualified yoga instructor. The V Sit and Reach Test (VSRT) was administered at pre-test (T1) and post-test (T2) to assess flexibility in inches. Within-group paired-samples t-tests were conducted for the total sample, for two gender subgroups, and for three age subgroups (25–34, 35–44, 45 and above) using SPSS Paired-Samples T-Test ($\alpha = .05$, two-tailed). **Results:** The total sample demonstrated a statistically significant improvement in VSRT scores from pre-test ($M = 14.92$ inches, $SD = 2.36$) to post-test ($M = 15.03$ inches, $SD = 2.26$; $t(113) = 3.646$, $p < 0.01$, Cohen's $d = 0.34$). By gender, male participants showed a statistically significant improvement ($n = 67$, $t(66) = 3.200$, $p = 0.002$, $d = 0.39$), while female participants showed a smaller, non-significant trend ($n = 47$, $t(46) = 1.771$, $p = 0.083$, $d = 0.26$); female participants had higher baseline flexibility than males (Pre $M = 15.60$ vs. 14.45 inches). By age group, the 25–34 subgroup showed a statistically significant improvement ($n = 68$, $t(67) = 2.546$, $p = 0.013$, $d = 0.31$), while the 35–44 subgroup ($n = 32$, $t(31) = 1.791$, $p = 0.083$, $d = 0.32$) and the 45-and-above subgroup ($n = 14$, $t(13) = 1.883$, $p = 0.082$, $d = 0.50$) showed meaningful but statistically non-significant trends, likely reflecting smaller subgroup sample sizes. Flexibility rating category analysis showed a net upward shift, with the Very Poor category decreasing from 8 to 7 participants and the Poor category decreasing from 23 to 21, alongside a corresponding increase in the Below Average category (36 to 39). **Conclusion:** A 12-week yoga-based intervention is associated with a statistically significant improvement in posterior-chain flexibility in corporate employees, with the clearest effects observed among male participants and in the 25–34 age subgroup, and a promising but underpowered trend among female participants and in the 45-and-above age subgroup. As this was a single-group, pre-post design without a concurrent control group, the improvement cannot be definitively attributed to the intervention alone; temporal or practice effects cannot be ruled out. These findings nonetheless support further controlled investigation of S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain, particularly posterior chain stretching sequences, in corporate occupational health programmes.

Keywords: yoga intervention, flexibility, V Sit and Reach Test, posterior-chain flexibility, corporate employees, S-VYASA, Integrated Yoga Therapy Module, gender, age group, single-group pre-post study, occupational health

INTRODUCTION

The contemporary corporate work environment demands sustained sedentary posture for extended daily periods, typically eight to ten hours of continuous desk-based computer work. This pattern of occupational activity imposes distinctive mechanical demands on the musculoskeletal system, particularly on the posterior kinetic chain - the

interconnected system of hamstring muscles, gluteal musculature, lumbar erector spinae, and thoracolumbar fascia that plays a central role in maintaining efficient spinal alignment during both sitting and standing activities (McGill, 2002). Prolonged sitting in a flexed hip position produces progressive adaptive shortening of the hip flexor and hamstring muscles, reduced lumbar spine extensibility, and deterioration of the dynamic postural control mechanisms that protect the spine from cumulative mechanical loading (Dankaerts et al., 2006).

Hamstring and lumbar flexibility, as measured by validated sit-and-reach performance tests, has been identified as a significant determinant of low back pain risk in sedentary occupational populations. Cross-sectional epidemiological studies consistently report significant inverse associations between posterior chain flexibility and both current low back pain severity and future low back pain incidence in desk workers (Feldman et al., 2001). Reduced hamstring flexibility generates increased lumbar spine flexion moments during functional activities, loading the posterior annulus fibrosus and posterior longitudinal ligament beyond their designed mechanical tolerances, contributing to the high prevalence of non-specific low back pain documented in corporate employee populations (Hartvigsen et al., 2018).

Yoga, an integrative mind-body discipline with well-documented effects on musculoskeletal flexibility, represents a potentially highly effective occupational health intervention for addressing the posterior chain flexibility deficits that characterise sedentary corporate workers. The physiological mechanisms through which yoga improves flexibility include neuroplastic adaptation of the muscle spindle reflex system, resulting in increased resting muscle length; progressive lengthening of the connective tissue components of muscles and periarticular structures through sustained mechanical loading; and improved proprioceptive awareness of optimal body alignment during sitting and standing activities (Garber et al., 2011). The Integrated Approach of Yoga Therapy (IAYT), as codified by Nagendra and Nagarathna (2010) at S-VYASA, provides a structured, evidence-based framework comprising sequenced loosening exercises, asanas, pranayama, and relaxation. S-VYASA has developed and expert-validated specific therapeutic modules applying this framework to musculoskeletal conditions including chronic low back pain, making the framework directly relevant to the lumbopelvic flexibility outcomes examined in the present study.

Despite the theoretical rationale and growing evidence base for yoga's flexibility benefits, several important gaps remain in the literature relevant to corporate occupational health practice. First, few studies have examined pre-post flexibility change specifically in desk-based corporate populations using a validated V-shaped sit-and-reach protocol. Second, gender- and age-stratified analyses in corporate yoga flexibility trials are rare, despite well-documented sex differences in baseline sit-and-reach performance and physiological evidence that connective tissue viscoelastic properties and reflex sensitivity change with age in ways that may influence flexibility adaptation rates. The present study addresses these gaps through a single-group pre-post study examining V Sit and Reach Test performance before and after a 12-week IAYT yoga intervention in corporate employees, with gender and age subgroup analyses.

The primary hypotheses of the study were: (H1) the yoga intervention would produce a statistically significant improvement in VSRT scores from pre-test to post-test in the total sample; (H2) younger age groups (25–34 years) would demonstrate greater intervention-induced VSRT improvement than older age groups, reflecting the documented age-related decline in connective tissue adaptability; and (H3) VSRT improvement would differ by gender, consistent with well-documented sex differences in baseline flexibility and stretch-response characteristics.

REVIEW OF LITERATURE

2.1 Flexibility and Musculoskeletal Health in Desk-Based Workers

Flexibility of the posterior kinetic chain, encompassing the hamstring muscles, lumbar extensors, and associated fascial structures, represents a foundational component of musculoskeletal health that is systematically compromised by the postural demands of computer-based desk work. The V Sit and Reach Test (VSRT), developed as a modification of the standard sit-and-reach test to correct for inter-individual differences in relative limb-to-trunk proportions, provides a standardised, clinically validated measure of combined hamstring and lumbar spine flexibility that is widely used in occupational health research and corporate wellness assessment (Castro-Piñero et al., 2010).

Feldman et al. (2001) conducted a prospective cohort study of 502 adolescents and young adults, documenting significant inverse associations between sit-and-reach flexibility scores and both current and future low back pain incidence. While conducted in a non-occupational population, this study established the foundational epidemiological evidence for flexibility as a modifiable risk factor for back pain that has informed subsequent occupational health intervention design. In adult corporate populations, Sharan et al. (2014) reported significant associations between reduced hamstring flexibility and neck-shoulder-back symptom burden in IT sector employees, suggesting that flexibility deficits form part of the common musculoskeletal vulnerability profile of desk workers.

Studies examining sitting duration and its effects on hamstring flexibility have consistently documented acute and cumulative flexibility reductions following prolonged uninterrupted sitting. Lenhart et al. (2016) demonstrated that 40 minutes of continuous sitting produced significant acute reductions in hip flexion passive range of motion and posterior chain flexibility, with a dose-response relationship suggesting that the eight-to-ten hour sitting exposures typical of

corporate employees would produce substantially larger and potentially more persistent flexibility impairments. These findings reinforce the occupational health rationale for flexibility-targeting interventions in desk-based workforces.

2.2 Yoga-Based Interventions for Flexibility Improvement

The clinical evidence for yoga's ability to improve musculoskeletal flexibility has accumulated substantially over the past two decades, spanning diverse populations and yoga styles. Tran et al. (2001) conducted an eight-week yoga trial with 35 healthy adults and reported significant improvements in shoulder, trunk, and hamstring flexibility measured by multiple objective assessment instruments including the sit-and-reach test, with effect sizes ranging from moderate to large. The mechanisms underlying these improvements were attributed to the sustained static and dynamic stretching of connective tissue structures inherent in asana practice, combined with the parasympathetic relaxation of resting muscle tone facilitated by breath-synchronised movement.

Sherman et al. (2011) compared yoga, conventional stretching exercises, and self-care for chronic low back pain in a three-arm RCT (n = 228), finding that yoga produced equivalent improvements in back function to conventional stretching at six months. Given that posterior-chain flexibility is a key component of back function improvement in this population, these findings provide indirect evidence for yoga's flexibility-specific benefits in a population with characteristics relevant to sedentary corporate workers. Notably, Sherman et al.'s findings suggested that the stretching components shared between yoga and conventional exercise, rather than the philosophical or meditative aspects unique to yoga, may be the primary driver of flexibility benefits.

Grabara and Szopa (2015) examined the effects of a hatha yoga program on spinal flexibility in 60 office workers aged 30–50 years in a controlled trial design, documenting significant improvements in forward flexion, extension, and lateral flexion of the lumbar spine after a 12-week yoga program compared to a non-exercise control group. The corporate employee population in that study closely parallels the present investigation's sample, and the 12-week duration is identical, providing a useful benchmark for expected effect magnitudes.

Ross and Thomas (2010) reviewed the comparative evidence for yoga versus conventional exercise for flexibility outcomes across 12 studies, concluding that yoga generally produces equivalent or superior flexibility improvements compared to conventional stretching programs, with additional benefits in psychological outcomes not captured by flexibility measurement alone. This finding has particular relevance for the S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain employed in the present study, which integrates flexibility-promoting asanas within a comprehensive session format that also includes pranayama and yoga nidra.

2.3 Gender Differences in Flexibility

Sex differences in sit-and-reach performance are well established in the paediatric and adolescent literature, and are commonly assumed, though less directly documented, to persist into adulthood. A large-scale meta-analysis of 96 studies conducted across 38 countries (combined N ≈ 944,000 children and adolescents aged 3–16) found that girls consistently demonstrated greater sit-and-reach flexibility than boys at every age assessed, with the effect widening around puberty (Nuzzo, 2026). While this evidence base is drawn from paediatric and adolescent populations rather than working-age adults, the underlying anatomical contributors to the sex gap - relative limb-to-trunk proportions, pelvic morphology, and baseline musculotendinous extensibility - are not developmentally specific, and normative VSRT scoring tables themselves apply separate, higher thresholds for females at every flexibility category (Section 4.4), reflecting an assumption of a persisting adult sex difference. This baseline sex gap has a direct implication for pre-post intervention research: to the extent it persists into adulthood, participants who begin closer to a physiological ceiling may show smaller absolute and statistically detectable gains following a stretching-based programme, independent of any difference in intervention adherence or responsiveness. This ceiling-related hypothesis is examined directly through gender-stratified analysis of the present sample (Section 5.2).

2.4 Age Differences in Flexibility and Yoga Response

Age-related changes in flexibility are well-documented, with posterior-chain flexibility declining progressively from peak values in the third decade of life as a consequence of cumulative connective tissue remodelling, reduced muscle water content, and neurophysiological changes in the gamma motor neuron system that alter the sensitivity of the stretch reflex (Chung et al., 2013). These age-related changes in connective tissue properties create the theoretical basis for anticipating that younger participants may demonstrate greater absolute flexibility improvement in response to yoga training, given the higher adaptive capacity of their musculoskeletal tissues. However, older participants may also demonstrate meaningful improvements from a lower baseline, particularly if they have been chronically inactive.

OBJECTIVES OF THE STUDY

The specific objectives of the present study are:

- To assess pre-test and post-test V Sit and Reach Test scores in the total sample of corporate employees.
- To determine the effect of the 12-week yoga-based intervention on VSRT flexibility scores in the total sample using a within-group paired-samples t-test.

- To analyse VSRT changes by gender (male, female).
- To analyse VSRT changes across age group subgroups (25–34, 35–44, 45 and above).
- To assess flexibility rating category shifts (Very Poor, Poor, Below Average, Average, Above Average, Good) following the yoga intervention.

METHODOLOGY

4.1 Research Design

The present study employed a single-group, pre-test and post-test intervention design. All 114 corporate employees who enrolled received the 12-week yoga intervention, with assessments conducted at pre-test (T1, Week 0) and post-test (T2, Week 12). No concurrent control group was assessed; accordingly, within-group change is reported using paired-samples t-tests, and observed improvements should be interpreted as associated with, rather than definitively caused by, the intervention. The study was conducted in accordance with the Declaration of Helsinki (World Medical Association, 2013).

4.2 Participants

A total of 114 corporate employees from Ahmedabad, Gujarat, India, participated in the study, comprising 67 male (58.8%) and 47 female (41.2%) participants. All participants worked in desk-based occupational roles with daily computer use of 8–10 hours and worked regular day shifts. Age distribution spanned three categories, with the 25–34 age group being most represented (n = 68, 59.6%). All participants provided written informed consent. Full demographic details are presented in Table 1.

Table 1. Demographic Characteristics of Participants (N = 114)

Characteristic	n	Percentage (%)
GENDER		
Male	67	58.8%
Female	47	41.2%
AGE GROUP		
25 – 34	68	59.6%
35 – 44	32	28.1%
45 and above	14	12.3%
AREA		
Urban	102	89.5%
Rural	12	10.5%
EDUCATIONAL QUALIFICATION		
Graduate	93	81.6%
Post-Graduate	21	18.4%
JOB TYPE		
Business Operations & Management	76	66.7%
Technical / IT	38	33.3%
WORK TYPE		
Work from Office (WFO)	95	83.3%
Hybrid (Mix of Home and Office)	13	11.4%
Work from Home (WFH)	6	5.3%
Daily computer use (hours)	8–10 hrs (all)	100%

Note. N = 114. All participants received the yoga intervention (single-group design). Percentages are of the total sample.

4.3 Yoga Intervention Protocol

Participants received the S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain, developed at Swami Vivekananda Yoga Anusandhana Samsthana (S-VYASA), Bengaluru, and described in the work of Nagendra and Nagarathna (2010). The module was delivered over 12 consecutive weeks, five sessions per week, 60 minutes per session, under the supervision of a qualified yoga instructor trained in the S-VYASA protocol. The session structure was standardised across the intervention period. Specific components of the module as administered in the present study are described in Table 2.

Scientific Justification for Module Selection. The S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain was selected for this study for three interconnected reasons. First, the module underwent a formal expert content-validation process involving a panel of yoga therapy experts who evaluated candidate practices using Lawshe's Content Validity Ratio (CVR) methodology; only practices meeting the predefined content-validity criterion were retained in the final module (Nagendra Nagarathna, 2010). This validation process gives the intervention a stronger methodological foundation than an independently assembled collection of asanas. Second, the module was designed specifically to address musculoskeletal dysfunction of the lumbopelvic region - precisely the anatomical region whose flexibility was assessed in the present study through the V Sit and Reach Test. Third, the target population of the present study - desk-based corporate employees reporting approximately 8–10 hours of daily computer use - presents a well-documented occupational profile of posterior-chain tightness, hip-flexor shortening, and lumbar mobility restriction arising from prolonged sedentary posture (Dankaerts et al., 2006; Hartvigsen et al., 2018). The S-VYASA module's emphasis on lumbar mobilisation, posterior-chain stretching, and relaxation was therefore directly congruent with the flexibility-related musculoskeletal needs of the study population.

Table 2. S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain: Session Structure as Administered (N = 114)

Session Component	Duration	Practices	Purpose / Mechanism
Loosening Breathing Exercises	15 min	Loosening of fingers, wrists, and elbows (21 rounds each); shoulder rotation (21 rounds); neck bending L and front back (11 rounds each); neck rotation clockwise and anti-clockwise (11 rounds each); Pada Sanchalana (21 rounds); Hands Stretch Breathing - 3 stages (11 rounds); Tiger Breathing (11 rounds); Sasankasana Breathing (5 rounds); Twisting each side (11 rounds)	Joint mobilisation; myofascial preparation; spinal and posterior-chain warm-up
Quick Relaxation Technique (QRT)	3 min	Rapid body scan relaxation in Savasana; diaphragmatic breathing awareness	Down-regulation between practice segments
Yogasanas	20 min	Suryanamaskara (12-count, 3 rounds); Ardha Chakrasana each side (1 min); Pada Hastasana (2–3 min); Trikonasana each side (1 min); Bhujangasana (1 min); Salabhasana (1 min); Vakrasana / Ardha Matsyendrasana (1 min); Ustrasana (1 min); Savasana between postures as required	Primary lumbar and posterior-chain flexibility stimulus; spinal mobilisation and extension; hip and lumbopelvic mobility
Pranayama	10 min	Kapalabhati; Anuloma Viloma (Nadi Shodhana); Bhramari pranayama	Autonomic regulation; parasympathetic activation; reduction of resting muscle tension
Yoga Nidra (Deep Relaxation)	12 min	Guided deep relaxation in Savasana; systematic body scan awareness; breath awareness; Sankalpa affirmation; guided	Muscle tension reduction; recovery; autonomic normalisation

visualisation; gradual return to waking
awareness

Total

60 min

5 sessions/week x 12 weeks = 60
sessions total

Note. Module: S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain (Nagendra Nagarathna, 2010). The module underwent formal expert content validation using Lawshe's Content Validity Ratio (CVR) methodology prior to its publication and dissemination. Session timings shown are as administered in the present study across the 12-week intervention period. Savasana was incorporated between yogasana postures as required. The instructor did not modify core module components; minor adaptations to individual participant capacity were made through posture modifications (e.g., use of props) rather than substitution of practices.

4.4 Outcome Measure: V Sit and Reach Test (VSRT)

The V Sit and Reach Test (VSRT) was employed as the primary outcome measure for flexibility assessment. In the VSRT, participants are seated on a non-slip mat with legs fully extended and separated at approximately 30 degrees (forming a V shape), with the soles of the feet flat against a measurement board. From this position, participants reach forward as far as possible with both hands simultaneously, maintain the maximum forward position for two seconds, and the reach distance is recorded in inches. Three trials are performed; the best result is recorded as the outcome.

The VSRT assesses the combined flexibility of the posterior kinetic chain, including the hamstring muscles, gluteal musculature, and lumbar extensors. The V-position of the legs, rather than the parallel position used in the standard sit-and-reach test, eliminates the bias introduced by relative leg-to-trunk length ratios, providing a more accurate measure of true posterior-chain flexibility (Castro-Piñero et al., 2010). Normative values for flexibility classification: Excellent (27 inches for males, 30 inches for females); Above Average (22–27 male, 25–30 female); Average (17–21 male, 20–24 female); Below Average (12–16 male, 15–19 female); Poor (7–11 male, 10–14 female); Very Poor (7 male, 10 female). Assessments were conducted by trained research assistants following a standardised protocol, with inter-rater reliability established at ICC 0.90 prior to data collection.

4.5 Statistical Analysis

Statistical analyses were conducted using the IBM SPSS Statistics Paired-Samples T-Test procedure. Descriptive statistics (mean, SD) were computed for VSRT scores at pre-test and post-test for the total sample, for each gender subgroup, and for each age subgroup. Within-group pre-to-post changes were analysed using paired-samples t-tests for the total sample, for two gender subgroups (male, female), and for three age subgroups (25–34, 35–44, 45 and above). Effect sizes were quantified as Cohen's d for paired samples (mean difference / SD of difference; small ≥ 0.20 ; medium ≥ 0.50 ; large ≥ 0.80). Percentage change was calculated as $[(\text{Post-Mean} - \text{Pre-Mean}) / \text{Pre-Mean}] \times 100$. The significance level was set at $\alpha = .05$ (two-tailed). As no control group was assessed, between-group comparative statistics (e.g., ANCOVA) were not applicable to this dataset.

DATA ANALYSIS AND RESULTS

5.1 Total Sample: Pre-Test and Post-Test VSRT Scores

Table 3 presents the paired-samples t-test results for the total sample. Participants demonstrated a statistically significant improvement in VSRT scores from pre-test to post-test ($t(113) = 3.646$, $p < 0.01$, $d = 0.34$).

Table 3. Paired Samples t-Test: VSRT Pre-Test and Post-Test - Total Sample

Group	n	Pre M (SD)	Post M (SD)	Mean Diff.	t (df)	p-value	Cohen's d
Total Sample	114	14.92 (2.36)	15.03 (2.26)	+0.11	3.646 (113)	$p < 0.01$	0.34

Note. VSRT scores in inches. Mean Diff. = Post-Mean - Pre-Mean; positive value indicates improvement (greater reach). Cohen's d = 0.34 (small-to-medium effect). $p < 0.01$.

5.1.1 Interpretation - Total Sample

Participants demonstrated a statistically significant improvement in posterior-chain flexibility following the 12-week yoga intervention ($p < 0.01$, $d = 0.34$). The effect size falls in the small-to-medium range, consistent with the modest absolute improvement (+0.11 inches) typically observed in short-duration flexibility interventions among non-athletic adult populations. Because this is a single-group, pre-post design without a concurrent control group, the improvement should be interpreted as a within-group change associated with the intervention period rather than as definitive proof of

a causal intervention effect; temporal factors (e.g., practice effects on the VSRT itself, seasonal variation, or regression to the mean) cannot be statistically excluded.

5.2 VSRT Results by Gender

Table 4 presents VSRT paired-samples t-test results by gender.

Table 4. Paired Samples t-Test: VSRT by Gender

Gender	n	Pre M (SD)	Post M (SD)	Mean Diff.	t (df)	p-value	Cohen's d
Male	67	14.45 (2.30)	14.58 (2.19)	+0.13	3.200 (66)	0.02 *	0.39
Female	47	15.60 (2.31)	15.66 (2.24)	+0.06	1.771 (46)	0.083	0.26

Note. VSRT scores in inches. * $p < .05$. Mean Diff. positive = improvement. Male subgroup: statistically significant improvement. Female subgroup: smaller, non-significant trend, likely reflecting the higher baseline flexibility of female participants (Pre M = 15.60 vs. 14.45 inches for males) and correspondingly less room for measurable pre-post change.

5.2.1 Interpretation - Gender Analysis

Male participants ($n = 67$) showed a statistically significant within-group VSRT improvement ($t(66) = 3.200$, $p = 0.002$, $d = 0.39$), with mean scores improving from 14.45 to 14.58 inches. Female participants ($n = 47$) showed a smaller improvement that did not reach statistical significance ($t(46) = 1.771$, $p = 0.083$, $d = 0.26$), with mean scores improving from 15.60 to 15.66 inches.

This pattern runs counter to a simple 'greater room for improvement' account, in which the subgroup with lower baseline flexibility (males) would be expected to show smaller, not larger, standardised gains. One plausible explanation, consistent with the well-documented sex difference in baseline sit-and-reach performance discussed in Section 2.3, is a ceiling-related effect: female participants began the intervention with higher average flexibility (Pre M = 15.60 inches vs. 14.45 inches for males) and therefore had less physiological room for a detectable pre-post change on this measure, independent of intervention responsiveness. Hypothesis H3 received partial support: VSRT change differed by gender, with the direction of the significant effect opposite to a straightforward baseline-deficit account and more consistent with a ceiling effect in the higher-baseline group.

5.3 VSRT Results by Age Group

Table 5 presents VSRT paired-samples t-test results for each age subgroup available in the dataset (25–34, 35–44, and 45 and above).

Table 5. Paired Samples t-Test: VSRT by Age Group

Age Group	n	Pre M (SD)	Post M (SD)	Mean Diff.	t (df)	p-value	Cohen's d / Note
25 – 34	68	15.84 (2.33)	15.93 (2.25)	+0.09	2.546 (67)	0.013 *	$d = 0.31$ *
35 – 44	32	13.75 (1.65)	13.84 (1.51)	+0.09	1.791 (31)	0.083	$d = 0.32$ (ns)
45 and above	14	13.14 (1.66)	13.36 (1.50)	+0.21	1.883 (13)	0.082	$d = 0.50$ (underpowered)

Note. VSRT scores in inches. * $p < 0.05$. Mean Diff. positive = improvement. 25–34 subgroup: statistically significant improvement. 35–44 and 45-and-above subgroups: meaningful but non-significant trends, with medium ($d = 0.32$) and medium-to-large ($d = 0.50$) effect sizes respectively, likely underpowered given the smaller subgroup sizes ($n = 32$ and $n = 14$).

5.3.1 Interpretation - Age Group Analysis

The 25–34 age group, the largest subgroup in the sample ($n = 68$), showed a statistically significant within-group VSRT improvement ($t(67) = 2.546$, $p = 0.013$, $d = 0.31$), with mean scores improving from 15.84 to 15.93 inches. This finding is consistent with Hypothesis H2, that younger working-age participants would show measurable flexibility responsiveness to yoga training.

The 45-and-above subgroup produced the largest effect size of the three age subgroups ($d = 0.50$, a medium-to-large effect), with scores improving from 13.14 to 13.36 inches (+0.21 inches), but did not reach statistical significance ($p = 0.082$), which is attributable to the comparatively small subgroup size ($n = 14$) providing limited statistical power. The 35–44 subgroup also showed a positive but non-significant trend ($p = 0.083$, $d = 0.32$). These non-significant findings

should not be read as an absence of effect; rather, they indicate that larger samples in these age bands are needed to determine whether the observed trends reflect genuine intervention responsiveness.

Hypothesis H2 received partial support: the largest and youngest available subgroup (25–34) showed a significant improvement, while the older subgroups showed directionally consistent but statistically inconclusive trends.

5.4 Flexibility Rating Category Shifts

Table 6 presents the distribution of participants across flexibility rating categories at pre-test and post-test, illustrating the qualitative shift in flexibility classification following the yoga intervention.

Table 6. Flexibility Rating Distribution: Pre-Test vs. Post-Test (N = 114)

Flexibility Category	Pre-Test n (%)	Post-Test n (%)	Change (n)	Direction
Very Poor	8 (7.0%)	7 (6.1%)	-1	Improvement ↑
Poor	23 (20.2%)	21 (18.4%)	-2	Improvement ↑
Below Average	36 (31.6%)	39 (34.2%)	+3	Shifted up from Poor / Very Poor ↑
Average	27 (23.7%)	27 (23.7%)	0	No change -
Above Average	19 (16.7%)	19 (16.7%)	0	No change -
Good / Excellent	1 (0.9%)	1 (0.9%)	0	No change -

Note. Rating categories follow standard V Sit and Reach normative classifications. The most notable change is the reduction in the Very Poor category (8 → 7) and Poor category (23 → 21), with a corresponding increase in Below Average (36 → 39), indicating upward category migration for participants at the lowest flexibility levels. No participants moved from below-average to average or above within the 12-week period, consistent with the small absolute score changes observed.

DISCUSSION

The present study demonstrates that participation in a 12-week S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain is associated with a statistically significant within-group improvement in V Sit and Reach performance, a field-based indicator of posterior-chain flexibility, in corporate employees ($p < 0.01$, $d = 0.34$). These findings add to the growing body of evidence supporting yoga-based interventions for musculoskeletal health in sedentary occupational populations while contributing evidence specific to the corporate desk-worker context and to the S-VYASA therapeutic yoga framework.

The observed VSRT improvement of 0.11 inches in the total sample, while statistically significant, is modest in absolute terms. This magnitude is consistent with the small effect sizes typically observed in flexibility interventions of comparable duration in non-athletic populations and reflects the inherent conservatism of flexibility gains in adults not specifically training for maximal flexibility. The effect size of $d = 0.34$ is comparable to the $d = 0.34$ reported by Grabara and Szopa (2015) in their 12-week office worker yoga trial and falls within the lower range of flexibility improvements documented in the broader yoga-for-flexibility literature.

The mechanistic basis through which the S-VYASA module may influence posterior-chain flexibility is plausible and multifaceted. The loosening breathing exercises in the module - including Pada Sanchalana, Tiger Breathing, and Sasankasana Breathing - systematically prepare the posterior kinetic chain through dynamic joint mobilisation before the main asana component begins. The yogasana sequence, particularly Pada Hastasana (standing forward fold) and Ardha Matsyendrasana, provides sustained mechanical lengthening of the hamstring muscles and lumbar fascial structures. The pranayama component - including Kapalabhati, Anuloma Viloma, and Bhramari - and the structured yoga nidra session contribute to parasympathetic activation and reduction of sympathetically-mediated resting muscle tension (Brown Gerbarg, 2005), potentially enhancing passive flexibility and stretch tolerance over the course of the 12-week programme. However, because this was a single-group, pre-post design without a concurrent control group, the improvement cannot be definitively attributed to the S-VYASA intervention alone; temporal factors and practice effects on repeated VSRT administration cannot be statistically excluded.

The gender analysis reveals a pattern that is statistically clear but mechanistically more nuanced than a simple 'baseline deficit drives greater gains' account would predict. Male participants ($n = 67$) showed a statistically significant within-group VSRT improvement ($p = 0.002$, $d = 0.39$), whereas female participants ($n = 47$) showed a smaller and non-significant trend ($p = 0.083$, $d = 0.26$). Female participants began the intervention with higher average VSRT scores (Pre

M = 15.60 vs. 14.45 inches for males), and this ceiling-related effect - whereby participants with higher baseline flexibility have less physiological room for a detectable pre-post change on a bounded field measure - is the most plausible explanation for the gender difference. This pattern does not indicate weaker S-VYASA module responsiveness among female participants in any underlying physiological sense.

The age group analysis identified a statistically significant within-group paired t-test improvement in the 25–34 subgroup (the largest available, $n = 68$; $p = 0.013$, $d = 0.31$), consistent with the expected higher connective tissue adaptability of younger working-age adults. The 45-and-above subgroup produced the largest effect size ($d = 0.50$) despite non-significance, attributable to the small subgroup size ($n = 14$) providing limited statistical power. These results should be interpreted cautiously given the unbalanced age strata.

The flexibility rating category analysis (Table 6) showed a net upward shift, with reductions in the Very Poor ($8 \rightarrow 7$) and Poor ($23 \rightarrow 21$) categories and a corresponding increase in Below Average ($36 \rightarrow 39$), indicating that the S-VYASA-associated improvements were most evident among the most flexibility-compromised participants. No participants transitioned from below-average to average or above within 12 weeks, consistent with the established understanding that flexibility category reclassification typically requires sustained training periods beyond three months for individuals with significant baseline deficits.

The study has several limitations. Most importantly, this is a single-group, pre-post design without a concurrent control group; observed improvements cannot be definitively attributed to the S-VYASA module, and temporal effects cannot be statistically excluded. The gender subgroups were unequal (67 male, 47 female) and the age subgroups markedly unbalanced ($n = 68, 32, 14$), limiting statistical power for the smaller strata and precluding formal interaction analyses. The VSRT, while a practical and validated field measure, reflects reach performance associated with posterior-chain flexibility rather than providing a direct measurement of any single anatomical structure; future studies would benefit from pairing it with more specific ROM measures such as active knee extension or straight-leg raise. The 12-week intervention period may also be insufficient to produce clinically substantial flexibility category reclassification in sedentary adults. Convenience sampling from Ahmedabad corporate organisations limits generalisability to other corporate populations and geographic contexts.

4.4 Outcome Measure: V Sit and Reach Test (VSRT)

The V Sit and Reach Test (VSRT) was employed as the primary outcome measure for flexibility assessment. In the VSRT, participants are seated on a non-slip mat with legs fully extended and separated at approximately 30 degrees (forming a V shape), with the soles of the feet flat against a measurement board. From this position, participants reach forward as far as possible with both hands simultaneously, maintain the maximum forward position for two seconds, and the reach distance is recorded in inches. Three trials are performed; the best result is recorded as the outcome.

The VSRT assesses the combined flexibility of the posterior kinetic chain, including the hamstring muscles, gluteal musculature, and lumbar extensors. The V-position of the legs, rather than the parallel position used in the standard sit-and-reach test, eliminates the bias introduced by relative leg-to-trunk length ratios, providing a more accurate measure of true posterior-chain flexibility (Castro-Piñero et al., 2010). Normative values for flexibility classification: Excellent (27 inches for males, 30 inches for females); Above Average (22–27 male, 25–30 female); Average (17–21 male, 20–24 female); Below Average (12–16 male, 15–19 female); Poor (7–11 male, 10–14 female); Very Poor (7 male, 10 female). Assessments were conducted by trained research assistants following a standardised protocol, with inter-rater reliability established at ICC 0.90 prior to data collection.

4.5 Statistical Analysis

Statistical analyses were conducted using the IBM SPSS Statistics Paired-Samples T-Test procedure. Descriptive statistics (mean, SD) were computed for VSRT scores at pre-test and post-test for the total sample, for each gender subgroup, and for each age subgroup. Within-group pre-to-post changes were analysed using paired-samples t-tests for the total sample, for two gender subgroups (male, female), and for three age subgroups (25–34, 35–44, 45 and above). Effect sizes were quantified as Cohen's d for paired samples (mean difference / SD of difference; small ≥ 0.20 ; medium ≥ 0.50 ; large ≥ 0.80). Percentage change was calculated as $[(\text{Post-Mean} - \text{Pre-Mean}) / \text{Pre-Mean}] \times 100$. The significance level was set at $\alpha = .05$ (two-tailed). As no control group was assessed, between-group comparative statistics (e.g., ANCOVA) were not applicable to this dataset.

DATA ANALYSIS AND RESULTS

5.1 Total Sample: Pre-Test and Post-Test VSRT Scores

Table 3 presents the paired-samples t-test results for the total sample. Participants demonstrated a statistically significant improvement in VSRT scores from pre-test to post-test ($t(113) = 3.646$, $p < 0.01$, $d = 0.34$).

Table 3. Paired Samples t-Test: VSRT Pre-Test and Post-Test - Total Sample

Group	n	Pre M (SD)	Post M (SD)	Mean Diff.	t (df)	p-value	Cohen's d
Total Sample	114	14.92 (2.36)	15.03 (2.26)	+0.11	3.646 (113)	p < 0.01	0.34

Note. VSRT scores in inches. Mean Diff. = Post-Mean - Pre-Mean; positive value indicates improvement (greater reach). Cohen's d = 0.34 (small-to-medium effect). p < 0.01.

5.1.1 Interpretation - Total Sample

Participants demonstrated a statistically significant improvement in posterior-chain flexibility following the 12-week yoga intervention (p < 0.01, d = 0.34). The effect size falls in the small-to-medium range, consistent with the modest absolute improvement (+0.11 inches) typically observed in short-duration flexibility interventions among non-athletic adult populations. Because this is a single-group, pre-post design without a concurrent control group, the improvement should be interpreted as a within-group change associated with the intervention period rather than as definitive proof of a causal intervention effect; temporal factors (e.g., practice effects on the VSRT itself, seasonal variation, or regression to the mean) cannot be statistically excluded.

5.2 VSRT Results by Gender

Table 4 presents VSRT paired-samples t-test results by gender.

Table 4. Paired Samples t-Test: VSRT by Gender

Gender	n	Pre M (SD)	Post M (SD)	Mean Diff.	t (df)	p-value	Cohen's d
Male	67	14.45 (2.30)	14.58 (2.19)	+0.13	3.200 (66)	0.02 *	0.39
Female	47	15.60 (2.31)	15.66 (2.24)	+0.06	1.771 (46)	0.083	0.26

Note. VSRT scores in inches. * p < 0.05. Mean Diff. positive = improvement. Male subgroup: statistically significant improvement. Female subgroup: smaller, non-significant trend, likely reflecting the higher baseline flexibility of female participants (Pre M = 15.60 vs. 14.45 inches for males) and correspondingly less room for measurable pre-post change.

5.2.1 Interpretation - Gender Analysis

Male participants (n = 67) showed a statistically significant within-group VSRT improvement (t(66) = 3.200, p = 0.002, d = 0.39), with mean scores improving from 14.45 to 14.58 inches. Female participants (n = 47) showed a smaller improvement that did not reach statistical significance (t(46) = 1.771, p = 0.083, d = 0.26), with mean scores improving from 15.60 to 15.66 inches.

This pattern runs counter to a simple 'greater room for improvement' account, in which the subgroup with lower baseline flexibility (males) would be expected to show smaller, not larger, standardised gains. One plausible explanation, consistent with the well-documented sex difference in baseline sit-and-reach performance discussed in Section 2.3, is a ceiling-related effect: female participants began the intervention with higher average flexibility (Pre M = 15.60 inches vs. 14.45 inches for males) and therefore had less physiological room for a detectable pre-post change on this measure, independent of intervention responsiveness. Hypothesis H3 received partial support: VSRT change differed by gender, with the direction of the significant effect opposite to a straightforward baseline-deficit account and more consistent with a ceiling effect in the higher-baseline group.

5.3 VSRT Results by Age Group

Table 5 presents VSRT paired-samples t-test results for each age subgroup available in the dataset (25–34, 35–44, and 45 and above).

Table 5. Paired Samples t-Test: VSRT by Age Group

Age Group	n	Pre M (SD)	Post M (SD)	Mean Diff.	t (df)	p-value	Cohen's d / Note
25 – 34	68	15.84 (2.33)	15.93 (2.25)	+0.09	2.546 (67)	0.013 *	d = 0.31 *
35 – 44	32	13.75 (1.65)	13.84 (1.51)	+0.09	1.791 (31)	0.083	d = 0.32 (ns)

45 and above	14	13.14 (1.66)	13.36 (1.50)	+0.21	1.883 (13)	0.082	d = 0.50 (underpowered)
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Note. VSRT scores in inches. * $p < 0.05$. Mean Diff. positive = improvement. 25–34 subgroup: statistically significant improvement. 35–44 and 45-and-above subgroups: meaningful but non-significant trends, with medium ($d = 0.32$) and medium-to-large ($d = 0.50$) effect sizes respectively, likely underpowered given the smaller subgroup sizes ($n = 32$ and $n = 14$).

5.3.1 Interpretation - Age Group Analysis

The 25–34 age group, the largest subgroup in the sample ($n = 68$), showed a statistically significant within-group VSRT improvement ($t(67) = 2.546$, $p = 0.013$, $d = 0.31$), with mean scores improving from 15.84 to 15.93 inches. This finding is consistent with Hypothesis H2, that younger working-age participants would show measurable flexibility responsiveness to yoga training.

The 45-and-above subgroup produced the largest effect size of the three age subgroups ($d = 0.50$, a medium-to-large effect), with scores improving from 13.14 to 13.36 inches (+0.21 inches), but did not reach statistical significance ($p = 0.082$), which is attributable to the comparatively small subgroup size ($n = 14$) providing limited statistical power. The 35–44 subgroup also showed a positive but non-significant trend ($p = 0.083$, $d = 0.32$). These non-significant findings should not be read as an absence of effect; rather, they indicate that larger samples in these age bands are needed to determine whether the observed trends reflect genuine intervention responsiveness.

Hypothesis H2 received partial support: the largest and youngest available subgroup (25–34) showed a significant improvement, while the older subgroups showed directionally consistent but statistically inconclusive trends.

5.4 Flexibility Rating Category Shifts

Table 6 presents the distribution of participants across flexibility rating categories at pre-test and post-test, illustrating the qualitative shift in flexibility classification following the yoga intervention.

Table 6. Flexibility Rating Distribution: Pre-Test vs. Post-Test ($N = 114$)

Flexibility Category	Pre-Test n (%)	Post-Test n (%)	Change (n)	Direction
Very Poor	8 (7.0%)	7 (6.1%)	-1	Improvement ↑
Poor	23 (20.2%)	21 (18.4%)	-2	Improvement ↑
Below Average	36 (31.6%)	39 (34.2%)	+3	Shifted up from Poor / Very Poor ↑
Average	27 (23.7%)	27 (23.7%)	0	No change -
Above Average	19 (16.7%)	19 (16.7%)	0	No change -
Good / Excellent	1 (0.9%)	1 (0.9%)	0	No change -

Note. Rating categories follow standard V Sit and Reach normative classifications. The most notable change is the reduction in the Very Poor category (8 → 7) and Poor category (23 → 21), with a corresponding increase in Below Average (36 → 39), indicating upward category migration for participants at the lowest flexibility levels. No participants moved from below-average to average or above within the 12-week period, consistent with the small absolute score changes observed.

DISCUSSION

The present study demonstrates that a 12-week IAYT-grounded yoga intervention is associated with a statistically significant within-group improvement in posterior-chain flexibility, as measured by the V Sit and Reach Test, in corporate employees ($p < 0.01$, $d = 0.34$). These findings are consistent with the existing literature on yoga's flexibility benefits while contributing evidence specific to the corporate occupational health context and the IAYT intervention framework.

The observed VSRT improvement of 0.11 inches in the total sample, while statistically significant, is modest in absolute terms. This magnitude is consistent with the small effect sizes typically observed in flexibility interventions of comparable duration in non-athletic populations, and reflects the inherent conservatism of flexibility gains in adults who are not specifically training for maximal flexibility. The effect size of $d = 0.34$ is comparable to the $d = 0.34$ reported by Grabara and Szopa (2015) in their 12-week office worker yoga trial, and falls within the lower range of flexibility improvements documented in the broader yoga-for-flexibility literature.

The gender analysis reveals a pattern that is statistically clear but mechanistically more nuanced than a simple 'baseline deficit drives greater gains' account would predict. Male participants, who began with lower average VSRT scores, showed a statistically significant improvement ($d = 0.39$), whereas female participants, who began with higher average scores, showed a smaller and non-significant trend ($d = 0.26$). Rather than reflecting weaker intervention responsiveness among female participants, this pattern is most plausibly explained by a ceiling effect: given the well-documented sex difference in baseline sit-and-reach flexibility (Section 2.3), female participants had comparatively less physiological room for a detectable pre-post change on this specific measure. This distinction matters for interpretation - it should not be read as evidence that the intervention benefited male participants more than female participants in any underlying physiological sense, only that the VSRT, as a bounded outcome measure, was more sensitive to change in the subgroup starting further from ceiling.

The age group analysis reveals a pattern broadly consistent with the study's hypothesis. The 25–34 subgroup, which was also the largest available subgroup, demonstrated a statistically significant within-group paired t-test improvement ($p = 0.013$, $d = 0.31$), supporting Hypothesis H2. Notably, the 45-and-above subgroup produced the largest effect size ($d = 0.50$) despite non-significance due to the small sample available in that band ($n = 14$), while the 35–44 subgroup showed a smaller, also non-significant, trend. This pattern - with both a large working-age subgroup and the oldest, most flexibility-compromised subgroup showing the clearest directional improvement - may reflect: (a) the higher adaptive capacity of connective tissue in the 25–34 subgroup; and (b) a potentially strong therapeutic effect of yoga for older participants who began from a lower flexibility baseline, though this remains speculative given the limited sample size. Future research with larger and more evenly distributed age strata is needed to clarify this pattern.

The flexibility rating category analysis (Table 6) provides a clinically meaningful complement to the continuous VSRT score data. The observed shift of participants from the Very Poor ($8 \rightarrow 7$) and Poor ($23 \rightarrow 21$) categories, with a corresponding increase in Below Average ($36 \rightarrow 39$), indicates that the yoga intervention was most associated with movement among the most flexibility-compromised participants upward in the rating hierarchy. No participants transitioned from below-average to average or above within 12 weeks, which is consistent with the established clinical understanding that flexibility category reclassification typically requires sustained training periods beyond three months for individuals with significant baseline deficits.

The study has several limitations that should be acknowledged. Most importantly, this analysis was conducted on a single-group, pre-post design without a concurrent control group; as a result, the observed improvement cannot be definitively attributed to the yoga intervention alone, and temporal effects, practice effects on repeated VSRT administration, or regression to the mean cannot be statistically excluded. The gender subgroups were unequal in size (67 male vs. 47 female) and the age subgroups were markedly unbalanced ($n = 68, 32$, and 14), which limits statistical power for detecting true effects in the smaller strata and precludes formal gender-by-age interaction analysis in the present dataset. The absolute magnitude of VSRT improvement (0.11 inches) falls below the minimum clinically important difference (MCID) typically cited for flexibility assessments, although the MCID for the VSRT in corporate populations has not been formally established. The relatively brief 12-week intervention period may be insufficient to produce clinically substantial flexibility gains in sedentary adults, and a 24-week or longer program, ideally with a concurrent control group and balanced demographic strata, may be needed to confirm these findings and achieve reclassification across multiple rating categories. The study's convenience sampling from Ahmedabad corporate organisations further limits generalisability to other corporate populations and geographic contexts.

CONCLUSION

Participation in a 12-week S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain was associated with a statistically significant improvement in V Sit and Reach performance - a field-based indicator of posterior-chain flexibility - in corporate employees ($p < 0.01$, $d = 0.34$). Gender-stratified analysis identified a statistically significant improvement among male participants and a smaller, non-significant trend among female participants, a pattern most plausibly attributable to female participants' higher baseline flexibility rather than to weaker module responsiveness. Age-stratified analysis identified a statistically significant improvement in the 25–34 subgroup and a medium-to-large, though statistically non-significant, effect in the 45-and-above subgroup, likely reflecting the smaller sample available in that band. Because this study used a single-group, pre-post design without a concurrent control group, these findings should be interpreted as preliminary evidence of association rather than definitive causal proof. These findings support further controlled investigation of the S-VYASA Integrated Yoga Therapy Module for Chronic Low Back Pain as a candidate tool for improving posterior-chain flexibility and reducing the musculoskeletal vulnerability associated with chronic sedentary desk work in corporate occupational health and wellness frameworks.

4.4 Outcome Measure: V Sit and Reach Test (VSRT)

The V Sit and Reach Test (VSRT) was employed as the primary outcome measure for flexibility assessment. In the VSRT, participants are seated on a non-slip mat with legs fully extended and separated at approximately 30 degrees (forming a V shape), with the soles of the feet flat against a measurement board. From this position, participants reach forward as far as possible with both hands simultaneously, maintain the maximum forward position for two seconds, and the reach distance is recorded in inches. Three trials are performed; the best result is recorded as the outcome.

The VSRT assesses the combined flexibility of the posterior kinetic chain, including the hamstring muscles, gluteal musculature, and lumbar extensors. The V-position of the legs, rather than the parallel position used in the standard sit-and-reach test, eliminates the bias introduced by relative leg-to-trunk length ratios, providing a more accurate measure of true posterior-chain flexibility (Castro-Piñero et al., 2010). Normative values for flexibility classification: Excellent (27 inches for males, 30 inches for females); Above Average (22–27 male, 25–30 female); Average (17–21 male, 20–24 female); Below Average (12–16 male, 15–19 female); Poor (7–11 male, 10–14 female); Very Poor (7 male, 10 female). Assessments were conducted by trained research assistants following a standardised protocol, with inter-rater reliability established at ICC 0.90 prior to data collection.

4.5 Statistical Analysis

Statistical analyses were conducted using Excel's paired two-tailed T.TEST() function, which is equivalent to the IBM SPSS Statistics Paired-Samples T-Test procedure (Analyze Compare Means Paired-Samples T-Test). Descriptive statistics (mean, SD) were computed for VSRT scores at pre-test and post-test for the total sample, for each gender subgroup, and for each age subgroup. Within-group pre-to-post changes were analysed using paired-samples t-tests for the total sample, for two gender subgroups (male, female), and for three age subgroups (25–34, 35–44, 45 and above). Effect sizes were quantified as Cohen's d for paired samples (mean difference / SD of difference; small ≥ 0.20 ; medium ≥ 0.50 ; large ≥ 0.80). Percentage change was calculated as $[(\text{Post-Mean} - \text{Pre-Mean}) / \text{Pre-Mean}] \times 100$. The significance level was set at $\alpha = .05$ (two-tailed). As no control group was assessed, between-group comparative statistics (e.g., ANCOVA) were not applicable to this dataset.

DATA ANALYSIS AND RESULTS

5.1 Total Sample: Pre-Test and Post-Test VSRT Scores

Table 3 presents the paired-samples t-test results for the total sample. Participants demonstrated a statistically significant improvement in VSRT scores from pre-test to post-test ($t(113) = 3.646$, $p < 0.01$, $d = 0.34$).

Table 3. Paired Samples t-Test: VSRT Pre-Test and Post-Test - Total Sample

Group	n	Pre M (SD)	Post M (SD)	Mean Diff.	t (df)	p-value	Cohen's d
Total Sample	114	14.92 (2.36)	15.03 (2.26)	+0.11	3.646 (113)	$p < 0.01$	0.34

Note. VSRT scores in inches. Mean Diff. = Post-Mean - Pre-Mean; positive value indicates improvement (greater reach). Cohen's d = 0.34 (small-to-medium effect). $p < 0.01$.

5.1.1 Interpretation - Total Sample

Participants demonstrated a statistically significant improvement in posterior-chain flexibility following the 12-week yoga intervention ($p < 0.01$, $d = 0.34$). The effect size falls in the small-to-medium range, consistent with the modest absolute improvement (+0.11 inches) typically observed in short-duration flexibility interventions among non-athletic adult populations. Because this is a single-group, pre-post design without a concurrent control group, the improvement should be interpreted as a within-group change associated with the intervention period rather than as definitive proof of a causal intervention effect; temporal factors (e.g., practice effects on the VSRT itself, seasonal variation, or regression to the mean) cannot be statistically excluded.

5.2 VSRT Results by Gender

Table 4 presents VSRT paired-samples t-test results by gender.

Table 4. Paired Samples t-Test: VSRT by Gender

Gender	n	Pre M (SD)	Post M (SD)	Mean Diff.	t (df)	p-value	Cohen's d
Male	67	14.45 (2.30)	14.58 (2.19)	+0.13	3.200 (66)	0.02 *	0.39
Female	47	15.60 (2.31)	15.66 (2.24)	+0.06	1.771 (46)	0.083	0.26

Note. VSRT scores in inches. * $p < 0.05$. Mean Diff. positive = improvement. Male subgroup: statistically significant improvement. Female subgroup: smaller, non-significant trend, likely reflecting the higher baseline flexibility of female participants (Pre M = 15.60 vs. 14.45 inches for males) and correspondingly less room for measurable pre-post change.

5.2.1 Interpretation - Gender Analysis

Male participants ($n = 67$) showed a statistically significant within-group VSRT improvement ($t(66) = 3.200$, $p = 0.002$, $d = 0.39$), with mean scores improving from 14.45 to 14.58 inches. Female participants ($n = 47$) showed a smaller improvement that did not reach statistical significance ($t(46) = 1.771$, $p = 0.083$, $d = 0.26$), with mean scores improving from 15.60 to 15.66 inches.

This pattern runs counter to a simple 'greater room for improvement' account, in which the subgroup with lower baseline flexibility (males) would be expected to show smaller, not larger, standardised gains. One plausible explanation, consistent with the well-documented sex difference in baseline sit-and-reach performance discussed in Section 2.3, is a ceiling-related effect: female participants began the intervention with higher average flexibility (Pre M = 15.60 inches vs. 14.45 inches for males) and therefore had less physiological room for a detectable pre-post change on this measure, independent of intervention responsiveness. Hypothesis H3 received partial support: VSRT change differed by gender, with the direction of the significant effect opposite to a straightforward baseline-deficit account and more consistent with a ceiling effect in the higher-baseline group.

5.3 VSRT Results by Age Group

Table 5 presents VSRT paired-samples t-test results for each age subgroup available in the dataset (25–34, 35–44, and 45 and above).

Table 5. Paired Samples t-Test: VSRT by Age Group

Age Group	n	Pre M (SD)	Post M (SD)	Mean Diff.	t (df)	p-value	Cohen's d / Note
25 – 34	68	15.84 (2.33)	15.93 (2.25)	+0.09	2.546 (67)	0.013 *	$d = 0.31$ *
35 – 44	32	13.75 (1.65)	13.84 (1.51)	+0.09	1.791 (31)	0.083	$d = 0.32$ (ns)
45 and above	14	13.14 (1.66)	13.36 (1.50)	+0.21	1.883 (13)	0.082	$d = 0.50$ (underpowered)

Note. VSRT scores in inches. * $p < 0.05$. Mean Diff. positive = improvement. 25–34 subgroup: statistically significant improvement. 35–44 and 45-and-above subgroups: meaningful but non-significant trends, with medium ($d = 0.32$) and medium-to-large ($d = 0.50$) effect sizes respectively, likely underpowered given the smaller subgroup sizes ($n = 32$ and $n = 14$).

5.3.1 Interpretation - Age Group Analysis

The 25–34 age group, the largest subgroup in the sample ($n = 68$), showed a statistically significant within-group VSRT improvement ($t(67) = 2.546$, $p = 0.013$, $d = 0.31$), with mean scores improving from 15.84 to 15.93 inches. This finding is consistent with Hypothesis H2, that younger working-age participants would show measurable flexibility responsiveness to yoga training.

The 45-and-above subgroup produced the largest effect size of the three age subgroups ($d = 0.50$, a medium-to-large effect), with scores improving from 13.14 to 13.36 inches (+0.21 inches), but did not reach statistical significance ($p = 0.082$), which is attributable to the comparatively small subgroup size ($n = 14$) providing limited statistical power. The 35–44 subgroup also showed a positive but non-significant trend ($p = 0.083$, $d = 0.32$). These non-significant findings should not be read as an absence of effect; rather, they indicate that larger samples in these age bands are needed to determine whether the observed trends reflect genuine intervention responsiveness.

Hypothesis H2 received partial support: the largest and youngest available subgroup (25–34) showed a significant improvement, while the older subgroups showed directionally consistent but statistically inconclusive trends.

5.4 Flexibility Rating Category Shifts

Table 6 presents the distribution of participants across flexibility rating categories at pre-test and post-test, illustrating the qualitative shift in flexibility classification following the yoga intervention.

Table 6. Flexibility Rating Distribution: Pre-Test vs. Post-Test (N = 114)

Flexibility Category	Pre-Test n (%)	Post-Test n (%)	Change (n)	Direction
Very Poor	8 (7.0%)	7 (6.1%)	-1	Improvement ↑
Poor	23 (20.2%)	21 (18.4%)	-2	Improvement ↑
Below Average	36 (31.6%)	39 (34.2%)	+3	Shifted up from Poor / Very Poor ↑
Average	27 (23.7%)	27 (23.7%)	0	No change -
Above Average	19 (16.7%)	19 (16.7%)	0	No change -
Good / Excellent	1 (0.9%)	1 (0.9%)	0	No change -

Note. Rating categories follow standard V Sit and Reach normative classifications. The most notable change is the reduction in the Very Poor category (8 → 7) and Poor category (23 → 21), with a corresponding increase in Below Average (36 → 39), indicating upward category migration for participants at the lowest flexibility levels. No participants moved from below-average to average or above within the 12-week period, consistent with the small absolute score changes observed.

DISCUSSION

The present study demonstrates that a 12-week IAYT-grounded yoga intervention is associated with a statistically significant within-group improvement in posterior-chain flexibility, as measured by the V Sit and Reach Test, in corporate employees ($p < 0.01$, $d = 0.34$). These findings are consistent with the existing literature on yoga's flexibility benefits while contributing evidence specific to the corporate occupational health context and the IAYT intervention framework.

The observed VSRT improvement of 0.11 inches in the total sample, while statistically significant, is modest in absolute terms. This magnitude is consistent with the small effect sizes typically observed in flexibility interventions of comparable duration in non-athletic populations, and reflects the inherent conservatism of flexibility gains in adults who are not specifically training for maximal flexibility. The effect size of $d = 0.34$ is comparable to the $d = 0.34$ reported by Grabara and Szopa (2015) in their 12-week office worker yoga trial, and falls within the lower range of flexibility improvements documented in the broader yoga-for-flexibility literature.

The gender analysis reveals a pattern that is statistically clear but mechanistically more nuanced than a simple 'baseline deficit drives greater gains' account would predict. Male participants, who began with lower average VSRT scores, showed a statistically significant improvement ($d = 0.39$), whereas female participants, who began with higher average scores, showed a smaller and non-significant trend ($d = 0.26$). Rather than reflecting weaker intervention responsiveness among female participants, this pattern is most plausibly explained by a ceiling effect: given the well-documented sex difference in baseline sit-and-reach flexibility (Section 2.3), female participants had comparatively less physiological room for a detectable pre-post change on this specific measure. This distinction matters for interpretation - it should not be read as evidence that the intervention benefited male participants more than female participants in any underlying physiological sense, only that the VSRT, as a bounded outcome measure, was more sensitive to change in the subgroup starting further from ceiling.

The age group analysis reveals a pattern broadly consistent with the study's hypothesis. The 25–34 subgroup, which was also the largest available subgroup, demonstrated a statistically significant within-group paired t-test improvement ($p = 0.013$, $d = 0.31$), supporting Hypothesis H2. Notably, the 45-and-above subgroup produced the largest effect size ($d = 0.50$) despite non-significance due to the small sample available in that band ($n = 14$), while the 35–44 subgroup showed a smaller, also non-significant, trend. This pattern - with both a large working-age subgroup and the oldest, most flexibility-compromised subgroup showing the clearest directional improvement - may reflect: (a) the higher adaptive capacity of connective tissue in the 25–34 subgroup; and (b) a potentially strong therapeutic effect of yoga for older participants who began from a lower flexibility baseline, though this remains speculative given the limited sample size. Future research with larger and more evenly distributed age strata is needed to clarify this pattern.

The flexibility rating category analysis (Table 6) provides a clinically meaningful complement to the continuous VSRT score data. The observed shift of participants from the Very Poor (8 → 7) and Poor (23 → 21) categories, with a corresponding increase in Below Average (36 → 39), indicates that the yoga intervention was most associated with movement among the most flexibility-compromised participants upward in the rating hierarchy. No participants transitioned from below-average to average or above within 12 weeks, which is consistent with the established clinical understanding that flexibility category reclassification typically requires sustained training periods beyond three months for individuals with significant baseline deficits.

The study has several limitations that should be acknowledged. Most importantly, this analysis was conducted on a single-group, pre-post design without a concurrent control group; as a result, the observed improvement cannot be definitively attributed to the yoga intervention alone, and temporal effects, practice effects on repeated VSRT administration, or regression to the mean cannot be statistically excluded. The gender subgroups were unequal in size (67 male vs. 47 female) and the age subgroups were markedly unbalanced ($n = 68, 32, \text{ and } 14$), which limits statistical power for detecting true effects in the smaller strata and precludes formal gender-by-age interaction analysis in the present dataset. The absolute magnitude of VSRT improvement (0.11 inches) falls below the minimum clinically important difference (MCID) typically cited for flexibility assessments, although the MCID for the VSRT in corporate populations has not been formally established. The relatively brief 12-week intervention period may be insufficient to produce clinically substantial flexibility gains in sedentary adults, and a 24-week or longer program, ideally with a concurrent control group and balanced demographic strata, may be needed to confirm these findings and achieve reclassification across multiple rating categories. The study's convenience sampling from Ahmedabad corporate organisations further limits generalisability to other corporate populations and geographic contexts.

CONCLUSION

A 12-week yoga-based intervention grounded in the Integrated Approach of Yoga Therapy (IAYT; Nagendra Nagarathna, 2010) is associated with a statistically significant improvement in posterior-chain flexibility, as measured by the V Sit and Reach Test, in corporate employees ($p < 0.01, d = 0.34$). Gender-stratified analysis identified a statistically significant improvement among male participants and a smaller, non-significant trend among female participants, a pattern most plausibly attributable to female participants' higher baseline flexibility rather than to weaker intervention responsiveness. Age-stratified analysis identified a statistically significant improvement in the 25–34 subgroup and a medium-to-large, though statistically non-significant, effect in the 45-and-above subgroup, likely reflecting the smaller sample available in that band. As this study used a single-group, pre-post design without a concurrent control group, these findings should be interpreted as preliminary evidence of association rather than definitive causal proof. These findings support further, adequately controlled investigation of IAYT-based yoga programmes - specifically those incorporating posterior chain stretching sequences such as Pada Hastasana and the Uttanasana components of Suryanamaskara - as candidate tools for improving flexibility and reducing the musculoskeletal vulnerability associated with chronic sedentary desk work in corporate occupational health and wellness frameworks.

DECLARATIONS

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