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Determining the Effectiveness of Yoga Training Combined with a Healthy Lifestyle in Reducing Postural Abnormalities and Improving Social Acceptance among Individuals with Poor Posture and Physical Inactivity

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A B S T R A C T

The present study aimed to determine the effectiveness of yoga training combined with a healthy lifestyle in reducing postural abnormalities and improving social acceptance among individuals with poor posture and physical inactivity. This experimental study employed a pretest–posttest control-group design with a follow-up phase. The statistical population consisted of individuals with poor posture and sedentary behaviors who were assigned to experimental and control groups based on the inclusion criteria. Data were collected using standardized instruments for assessing postural abnormalities and a social acceptance questionnaire and were analyzed using repeated-measures analysis of variance. The results indicated that yoga training combined with a healthy lifestyle significantly reduced postural abnormalities and improved social acceptance in the experimental group compared with the control group ($p < .05$). Furthermore, the maintenance of these changes during the follow-up phase indicated the relative stability of the intervention effects. The findings demonstrate that integrating healthy lifestyle education with yoga therapy, as a comprehensive and cost-effective intervention, can simultaneously improve the physical and social dimensions of health among individuals with poor posture resulting from physical inactivity. Incorporating this approach into prevention, rehabilitation, and health-promotion programs may effectively reduce postural abnormalities, enhance social acceptance, and improve the overall health of these individuals.

Keywords: *yoga, healthy lifestyle, postural abnormalities, social acceptance, physical inactivity.*

1. Introduction

Sedentary behavior has become a major public health concern because contemporary patterns of work, transportation, recreation, and technology use have substantially reduced the movement incorporated into daily life. Physical inactivity and prolonged sitting are related but distinct behaviors, and both contribute to adverse physical, metabolic, psychological, and functional outcomes. International recommendations emphasize that adults should accumulate regular moderate- to vigorous-intensity physical activity, reduce sedentary time, and replace prolonged sitting with movement whenever possible (Bull et al., 2020). Nevertheless, many adults remain insufficiently active and spend large portions of the day seated. Evidence from older and clinical populations indicates that sedentarism is associated with impaired mobility, reduced muscular function, metabolic dysregulation, and elevated disability risk (Wullems et al., 2016). Observational findings from residential care settings similarly show that low physical activity and extensive sedentary time are common and may accelerate functional decline (Parry et al., 2019). More recent research has described physical inactivity and sedentary lifestyle as mutually reinforcing processes contributing to the early development and progression of frailty (Battista et al., 2025). Sedentary behavior should therefore be understood not merely as the absence of exercise, but as a behavioral pattern capable of altering neuromuscular performance, body composition, postural control, and psychosocial functioning.

The consequences of insufficient movement become particularly important during middle and later adulthood, when age-related changes in muscle mass, strength, balance, and joint mobility may interact with prolonged sitting and poor postural habits. Sarcopenia is currently conceptualized as compromised muscle health with implications for physical performance, independence, and vulnerability to adverse outcomes (Kirk et al., 2024). Frailty similarly reflects a progressive loss of physiological reserve and a diminished capacity to maintain homeostasis under stress (Fried et al., 2021). Although postural abnormalities and frailty are not equivalent, both may develop within a broader pattern of reduced musculoskeletal resilience and insufficient functional movement. Exercise is therefore considered essential for preserving mobility and supporting healthy aging (Indrakumar & Silva, 2024). Consensus recommendations further indicate that multicomponent programs incorporating strength, balance, mobility, and aerobic exercise can promote healthy longevity (Izquierdo et al., 2025). These issues are especially relevant for adults with a body mass index above the healthy range, because excess body mass may increase mechanical loading, restrict movement efficiency, intensify fatigue, and encourage compensatory postural strategies. Adults who are simultaneously overweight, sedentary, and affected by postural deviations may therefore require an integrated intervention rather than a narrowly corrective exercise program.

Postural status reflects the spatial alignment and functional organization of body segments in relation to gravity and one another. Efficient posture distributes mechanical loads, supports economical movement, and limits unnecessary strain on muscles, connective tissues, and joints. In contrast, persistent forward head posture, head tilt, shoulder asymmetry, trunk deviation, pelvic tilt, altered knee alignment, abnormal foot rotation, and spinal deviation may disturb kinetic-chain functioning and increase localized mechanical stress. These abnormalities can be reinforced by prolonged sitting, screen use, repetitive occupational tasks, reduced trunk activity, and poor awareness of body position. An inactive individual may gradually adopt an anteriorly displaced head, rounded shoulders, flexed trunk, or altered pelvic orientation, particularly when workstation ergonomics and movement breaks are inadequate. Integrated interventions that simultaneously reduce sedentary time and improve postural awareness have been associated with broader physical and psychosocial benefits (Lee et al., 2021). The interdependence of movement, posture, sleep, and psychological functioning is also reflected in evidence that combinations of physical activity, sedentary behavior, and sleep duration are associated with numerous physical and psychological outcomes (Wilhite et al., 2023). Postural abnormalities should thus be viewed not only as anatomical deviations but also as manifestations of behavioral routines, neuromuscular adaptation, stress regulation, recovery patterns, and lifestyle organization.

Accurate assessment is essential for identifying postural deviations and determining whether change is meaningful. Traditional visual observation is useful but may be influenced by examiner judgment and may not precisely document angular or linear changes over time. Digital photogrammetry and posture-analysis systems provide a more standardized approach through photographs obtained from anterior, posterior, and lateral perspectives. The Advanced Posture Evaluation and Correction System was developed to quantify body alignment, asymmetry, and

segmental deviations through digital image analysis (Saneftec, 2024). It enables assessment of head position, shoulder alignment, trunk deviation, pelvic orientation, knee posture, and foot rotation under standardized conditions. Digital analysis is particularly valuable in pretest–posttest research because identical indicators can be compared across intervention and follow-up stages. Yoga-based postural observation may additionally help practitioners identify imbalances and adapt asanas to an individual's postural pattern (Doohwa, 2023). Specialized yoga practices have also been examined as methods for developing correct posture and reducing spinal deformities through alignment, stretching, strengthening, and body-awareness exercises (Ignatova, 2023). Combining objective assessment with a structured intervention therefore provides a suitable basis for evaluating postural change.

Yoga is a multidimensional mind–body practice combining physical postures, controlled breathing, attention regulation, relaxation, mindfulness, and self-compassion. Biomechanically, yoga can improve flexibility, joint mobility, muscular endurance, balance, and segmental awareness. Psychophysiologically, breathing and relaxation may reduce autonomic arousal and support recovery from chronic stress. Meta-analytic evidence indicates that yoga and mindfulness-based stress reduction can improve stress-related physiological measures, although benefits vary across populations and intervention characteristics (Pascoe et al., 2017). Systematic evidence also suggests that yoga may influence psychoneuroimmunological pathways in populations exposed to severe stress, supporting effects beyond flexibility and physical conditioning (Kelly et al., 2020). Yoga-based interventions have also reduced anxiety and depression in medical populations, including patients receiving treatment for early breast cancer (Liu et al., 2022). Therapeutic yoga frameworks developed for stress, burnout, and chronic fatigue emphasize graded movement, breathing regulation, restoration, recognition of bodily limits, and prevention of excessive strain (Agombar, 2020). These characteristics make yoga suitable for sedentary adults who may have low exercise tolerance, muscular tension, reduced body awareness, and concerns about beginning conventional exercise.

Although yoga can directly address flexibility, postural control, breathing, and stress, sustained improvement is unlikely when the wider lifestyle context remains unchanged. Lifestyle medicine emphasizes coordinated modification of physical activity, nutrition, sleep, stress management, substance-related behaviors, and supportive social relationships (Rippe, 2019). Health outcomes emerge from interacting daily practices rather than from a single isolated behavior. A person may attend exercise sessions while continuing to sit for most waking hours, consume an unbalanced diet, sleep irregularly, and manage stress ineffectively. A combined program can address these barriers by teaching attainable goal setting, self-monitoring, routine movement, sleep hygiene, nutritional balance, stress management, and use of social support. The integration of yoga, physical activity, and healthy lifestyle education has been described as a potentially effective triad for improving biopsychosocial health among sedentary individuals (Garcia et al., 2020). Lifestyle programs including yoga have likewise been associated with improvements across physical, psychological, and social domains in individuals with poor posture (Davis et al., 2020). Such interventions may be especially effective because the experiential component of yoga is reinforced by behavioral education that helps participants generalize health practices beyond supervised sessions.

Emerging evidence supports combining yoga with lifestyle modification for sedentary populations with postural problems. An integrated program has been reported to improve postural correction and well-being among sedentary office workers, who are frequently exposed to prolonged sitting and repetitive workstation postures (Chen et al., 2024). Research examining reduced sedentary behavior alongside posture-focused yoga and lifestyle education similarly suggests that biopsychosocial change may occur when movement training is combined with self-management strategies (Müller, 2025). Gender may influence baseline postural patterns, health behaviors, social expectations, and responses to such interventions; therefore, including both women and men may improve the practical relevance of findings (Smith et al., 2022). The anticipated effects are theoretically plausible: yoga postures provide repeated corrective movement experiences, breathing practices may reduce muscular guarding, mindfulness increases awareness of maladaptive sitting and standing habits, and lifestyle education promotes activity breaks and adherence to health goals. Together, these mechanisms may improve postural alignment while strengthening self-regulation, body confidence, and participation in social contexts.

The psychosocial consequences of poor posture and sedentary living also warrant attention. Visible postural abnormalities may influence body image, self-consciousness, perceived attractiveness, interpersonal

confidence, and willingness to participate in social or physical activities. Individuals experiencing discomfort or concern about appearance may avoid group exercise and situations in which their bodies are evaluated. Sedentary behavior can further limit opportunities for social engagement, particularly when leisure is dominated by solitary screen-based activity. Conversely, a supportive group intervention can provide shared learning, encouragement, and noncompetitive movement experiences. Social acceptance may refer to the extent to which individuals perceive themselves as socially appropriate, accepted, or capable of presenting themselves favorably in interpersonal situations. The Crowne–Marlowe scale conceptualized socially desirable responding as the tendency to endorse culturally approved behaviors and deny common but socially disapproved behaviors (Crowne & Marlowe, 1960). Although social desirability and social acceptance are not fully interchangeable, this instrument has been used in Persian psychological research to assess socially acceptable responding and has demonstrated acceptable psychometric properties (Sharafoddin, 2010). Improvement after a combined yoga and lifestyle program may therefore reflect stronger self-regard, emotional regulation, body confidence, perceived social competence, and engagement with health-promoting norms.

Psychological and physiological health processes are closely interconnected in sedentary and overweight populations. Chronic stress may contribute to sleep disruption, fatigue, emotional eating, low motivation for activity, and heightened muscular tension, all of which interfere with postural correction and exercise adherence. Psychological distress can also interact with inflammatory and metabolic processes, illustrating the relevance of psychological biomarkers to physical health (Funuyet-Salas et al., 2020). A biopsychosocial intervention is therefore preferable to an exclusively mechanical approach because postural behavior is influenced by attention, emotion, habit, environment, and social reinforcement. Healthy lifestyle education can provide explicit strategies for sleep regulation, stress coping, self-care, goal setting, and relapse prevention, while yoga offers an embodied method for practicing awareness and regulation. This combination may be particularly valuable during follow-up, when participants are expected to apply learned skills independently. Maintenance of postural improvement and increased social acceptance after supervised sessions would indicate that participants incorporated intervention principles into daily routines rather than displaying only temporary responses.

Despite growing recognition of the consequences of sedentary behavior and increasing interest in yoga, important gaps remain. Many studies focus on physical activity or posture without evaluating psychological and social health. Others examine yoga primarily as a stress-management technique without objectively measuring postural indicators. Lifestyle interventions often emphasize metabolic outcomes while giving limited attention to body alignment, movement quality, and social acceptance. In addition, some studies assess only immediate posttest effects and provide little evidence regarding maintenance. A controlled investigation incorporating digital posture assessment, a psychosocial outcome, and a two-month follow-up can address these limitations and determine whether changes are sustained after the sessions end. Such evidence is relevant to the development of accessible, nonpharmacological programs for adults who are sedentary, overweight, and affected by postural abnormalities.

Accordingly, the present study aimed to determine the effectiveness of yoga training combined with healthy lifestyle education in reducing postural abnormalities and improving social acceptance among sedentary adults with poor posture.

2. Methods and Materials

2.1. Study Design and Participants

The present study employed a quasi-experimental pretest–posttest control-group design with a two-month follow-up assessment. The statistical population consisted of women and men with postural abnormalities, sedentary behavior, and a body mass index greater than 25 kg/m² who attended medical clinics located in different districts of Tehran during spring 2026. Potential participants were initially examined by physicians and relevant specialists to confirm the presence of postural abnormalities and determine whether participation in yoga-based physical exercises was medically appropriate. Based on sample sizes used in comparable intervention studies, 40 eligible individuals were recruited through purposive sampling and randomly allocated to an experimental group and a control group, with 20 participants in each group. The inclusion criteria were physician-confirmed postural abnormalities, insufficient habitual physical activity or a predominantly sedentary lifestyle, a body mass index greater than 25 kg/m², an age range of 40 to 60 years, the ability to read and write in Persian, the ability to understand and complete the study questionnaires, a minimum educational level of a high-

school diploma, the absence of severe or chronic psychiatric disorders, medical clearance to participate in low- to moderate-intensity yoga exercises, and willingness to participate in the study and provide informed consent. The exclusion criteria included the presence of a psychiatric disorder requiring active psychiatric treatment, any acute or unstable physical illness that could interfere with participation in yoga exercises, musculoskeletal or neurological conditions that made the intervention medically contraindicated, simultaneous participation in another structured postural-correction or exercise program, personal withdrawal from the study at any stage, and absence from more than two intervention sessions. Participants were informed about the study objectives, the voluntary nature of participation, the confidentiality of their information, and their right to withdraw from the research without any adverse consequences. The experimental group received the combined yoga and healthy lifestyle intervention, whereas the control group did not receive the structured intervention during the study period. Both groups completed the study assessments at the pretest, posttest, and two-month follow-up stages.

2.2. Measures

The Assessment of Posture and Correction System, commonly referred to as APECS, was used to assess participants' postural alignment. APECS is a digital posture-analysis application developed to provide a quantitative evaluation of body posture through the analysis of standardized digital photographs (Saneftec, 2024). The software analyzes images obtained from the anterior, posterior, and lateral views of the body and enables the examiner to measure postural angles, deviations, and asymmetries. The principal indicators assessed by the software include overall body alignment, head tilt, forward head displacement, shoulder symmetry, shoulder angle, trunk deviation, pelvic tilt, possible spinal deviation, knee alignment, foot rotation, and foot-arch angle. These indicators are reported as angular or linear measurements, allowing researchers to compare participants' postural status across different assessment stages and evaluate changes resulting from therapeutic or exercise-based interventions. In the present study, participants were photographed under standardized conditions using digital photogrammetry. They were instructed to stand in a natural and comfortable position while wearing appropriate clothing that allowed the anatomical landmarks to be identified. The camera position, distance from the participant, lighting conditions, and body orientation were standardized across all assessments. The anterior, posterior, and lateral images were then analyzed using APECS, and the indicators related to the alignment of the head, shoulders, spinal column, pelvis, knees, and lower extremities were recorded. The same assessment procedure was performed at the pretest, posttest, and two-month follow-up stages to ensure the comparability of postural measurements over time.

The Crowne–Marlowe Social Acceptance Questionnaire was used to evaluate social acceptance. The instrument was originally developed by Crowne and Marlowe (1960) and consists of 33 statements to which respondents provide dichotomous responses indicating agreement or disagreement. The items assess individuals' tendency to present themselves in a socially acceptable manner and to endorse behaviors and characteristics that are favorably evaluated in interpersonal and social contexts. Responses corresponding to socially acceptable characteristics are assigned a score of 1, whereas the alternative responses are assigned a score of 0. Item scores are summed to generate a total score, with higher scores indicating a greater level of social acceptance or socially desirable responding. Previous psychometric evaluations have supported the construct validity and reliability of the instrument. In the Persian validation conducted by Sharaf al-Din (2010), the internal consistency coefficient calculated using Cronbach's alpha was .70, and the split-half reliability coefficient was .67, indicating acceptable reliability. The scale also demonstrated satisfactory convergent validity through significant correlations with other psychological instruments designed to assess related social and interpersonal constructs. In the present study, Cronbach's alpha for the total questionnaire was .87, demonstrating good internal consistency in the study sample. The questionnaire was administered to both the experimental and control groups at the pretest, posttest, and two-month follow-up assessments.

2.3. Intervention

The experimental group participated in a 10-session combined intervention integrating yoga training with healthy lifestyle education. The intervention was adapted from the yoga training framework attributed to Fiona Agombar and the healthy lifestyle education program developed by Rippe and colleagues, based on the Persian adaptations prepared by Aghah-Harris and colleagues and by Aghah-Harris and Kordmirza Nikouzad in 2022. Each

session included a yoga component and a healthy lifestyle education component. The first session focused on establishing rapport, creating a sense of safety, introducing the intervention, explaining the relationship between stress and the nervous system, teaching simple breathing exercises, assessing participants' existing lifestyles, reviewing their daily habits, and establishing individualized health goals. The second session aimed to increase body awareness through body scanning, identification of muscular tension, and very gentle movements, while the lifestyle component addressed healthy nutrition, food groups, calorie balance, and the reduction of excessive sugar and fat intake. The third session emphasized respiratory regulation through slow breathing, prolonged exhalation, and techniques intended to calm the nervous system; the lifestyle component addressed the health benefits of physical activity and assisted participants in designing a simple moderate-intensity activity plan. The fourth session focused on reducing physical tension through gentle stretching and tension-release movements coordinated with breathing, accompanied by education about stress and adaptive coping strategies. The fifth session introduced mindfulness, nonjudgmental observation of thoughts, and present-moment attention, while the lifestyle component focused on sleep hygiene and regulation of the sleep–wake cycle. The sixth session addressed fatigue and exhaustion by teaching relaxation, awareness of physical limitations, and prevention of excessive physical strain; participants also received education about self-care, psychological well-being, and maintaining a balance between work, activity, rest, and recovery. The seventh session introduced pranayama techniques, particularly Nadi Shodhana and Bhramari breathing, to facilitate autonomic nervous system regulation, while the lifestyle component focused on recognizing emotions and identifying unhealthy behavioral responses. The eighth session included deep relaxation and yoga nidra exercises intended to activate the parasympathetic nervous system; participants were also trained in motivation enhancement, behavioral goal setting, self-monitoring, and strategies for overcoming barriers to lifestyle change. The ninth session emphasized self-compassion, emotional acceptance, and emotional relaxation, while the lifestyle component examined the role of interpersonal relationships and social support in maintaining health-related behaviors. The final session reviewed the yoga exercises, breathing techniques, mindfulness skills, and lifestyle-management strategies taught throughout the program. Participants developed individualized plans for continuing the exercises and healthy lifestyle practices after the intervention and were trained to identify high-risk situations that could lead to discontinuation of the acquired behaviors. The control group did not participate in the structured yoga and lifestyle education sessions during the intervention period. Posttest assessments were conducted after completion of the 10 sessions, and follow-up assessments were administered two months later to evaluate the maintenance of the intervention effects.

2.4. Data Analysis

The collected data were analyzed using IBM SPSS Statistics, version 26. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to describe participants' demographic characteristics and summarize the distributions of postural abnormalities and social acceptance scores at the pretest, posttest, and follow-up stages. Before conducting the inferential analyses, the data were examined for missing values, outliers, and violations of the statistical assumptions. The normality of the dependent variables was evaluated using the Shapiro–Wilk test and examination of distributional indices. Homogeneity of variance between the experimental and control groups was assessed using Levene's test, and the assumption of sphericity for the repeated measurements was examined using Mauchly's test. When the sphericity assumption was violated, the Greenhouse–Geisser correction was applied to adjust the degrees of freedom. A mixed repeated-measures analysis of variance was subsequently performed for each dependent variable. In this analysis, assessment time, consisting of the pretest, posttest, and two-month follow-up stages, was treated as the within-subject factor, while group membership, consisting of the experimental and control groups, was treated as the between-subject factor. The main effect of time, the main effect of group, and the time-by-group interaction were examined. A statistically significant time-by-group interaction was interpreted as evidence that the pattern of change across the three assessment stages differed between the experimental and control groups. When significant effects were identified, Bonferroni-adjusted pairwise comparisons were conducted to determine whether significant differences existed between the pretest and posttest, pretest and follow-up, and posttest and follow-up scores. The statistical significance level was set at $p < .05$ for all analyses, and effect-size indices were reported to indicate the magnitude of the intervention effects.

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3. Findings and Results

A total of 40 participants were included in the study and were equally assigned to the combined yoga and healthy lifestyle training group and the control group, with 20 participants in each group. The mean age of participants in the experimental group was 46.95 years (SD = 6.68), whereas the mean age of participants in the control group was 47.15 years (SD = 7.74). The mean age of the total sample was 47.05 years (SD = 7.13). These findings indicated that the two groups were generally comparable in terms of age at baseline.

Table 1

Descriptive Statistics for Social Acceptance and Postural Status Indicators by Group and Assessment Stage

Variable	Group	Pretest M	Pretest SD	Posttest M	Posttest SD	Follow-Up M	Follow-Up SD
Social acceptance	Yoga and healthy lifestyle	14.95	3.42	24.25	4.40	24.35	4.41
	Control	14.80	3.17	14.95	3.03	14.90	3.06
Forward head displacement	Yoga and healthy lifestyle	37.80	5.60	49.15	5.79	49.25	5.75
	Control	37.70	5.63	37.80	5.62	37.85	5.60
Head tilt	Yoga and healthy lifestyle	5.70	0.58	4.20	0.38	4.24	0.42
	Control	5.66	0.60	5.64	0.59	5.67	0.59
Shoulder asymmetry	Yoga and healthy lifestyle	3.20	0.30	2.20	0.21	2.24	0.27
	Control	3.18	0.32	3.16	0.33	3.20	0.38
Pelvic tilt	Yoga and healthy lifestyle	10.70	1.14	6.80	0.99	6.77	1.00
	Control	10.72	1.15	10.77	1.10	10.82	1.04
Trunk deviation	Yoga and healthy lifestyle	5.65	0.47	4.11	0.39	4.16	0.43
	Control	5.69	0.52	5.74	0.66	5.78	0.65
Scoliosis risk	Yoga and healthy lifestyle	42.05	4.63	30.40	3.29	30.30	3.34
	Control	42.35	4.01	42.45	4.08	42.55	3.99
Knee alignment	Yoga and healthy lifestyle	11.91	1.28	7.35	0.89	7.39	0.90
	Control	12.04	1.41	12.10	1.37	12.03	1.50
Foot rotation	Yoga and healthy lifestyle	21.80	1.20	14.42	0.93	14.45	0.93
	Control	21.65	1.27	21.75	1.29	21.82	1.26

As shown in Table 1, the experimental and control groups had relatively similar mean social acceptance and postural status scores at the pretest stage. Following the intervention, the mean social acceptance score in the experimental group increased substantially from 14.95 at pretest to 24.25 at posttest and remained relatively stable at the two-month follow-up assessment, with a mean of 24.35. In contrast, the social acceptance scores of the control group remained almost unchanged across the three assessment stages. With respect to postural status, the experimental group demonstrated considerable changes after receiving the combined intervention. The mean scores for head tilt, shoulder asymmetry, pelvic tilt, trunk deviation, scoliosis risk, knee alignment, and foot rotation decreased substantially from pretest to posttest, and these changes were largely maintained at follow-up. The forward head displacement score increased from 37.80 at pretest to 49.15 at posttest and remained at 49.25 at follow-up. In the control group, only minimal fluctuations were observed in social acceptance and postural status indicators across the three assessment stages.

Before conducting the repeated-measures analysis of variance, the relevant statistical assumptions were evaluated. The normality of the score distributions was examined using the Shapiro–Wilk test. The results were nonsignificant for all dependent variables at the pretest, posttest, and follow-up stages ($p > .05$), indicating that the distributions did not significantly deviate from normality. The homogeneity of variances between the experimental and control groups was assessed using Levene's test. The results of Levene's test were also nonsignificant for all variables at each assessment stage ($p > .05$), supporting the assumption of homogeneity of variances. Accordingly, the assumptions required for conducting the repeated-measures analysis of variance were adequately satisfied. Greenhouse–Geisser-corrected results were used for the within-subject effects.

Table 2

Greenhouse–Geisser-Corrected Repeated-Measures Analysis of Variance for Postural Status and Social Acceptance

Variable	Effect	SS	df	MS	F	p	ηp²
Forward head displacement	Time	885.617	1.345	658.629	2758.478	.001	.986
	Time × Group	847.517	1.345	630.294	2639.806	.001	.986
	Error	12.200	51.096	0.239	—	—	—
Head tilt	Time	14.726	1.507	9.774	282.240	.001	.881
	Time × Group	14.505	1.507	9.627	277.998	.001	.880
	Error	1.983	57.252	0.035	—	—	—
Shoulder asymmetry	Time	6.369	1.277	4.987	243.094	.001	.865
	Time × Group	6.468	1.277	5.064	246.860	.001	.867
	Error	0.996	48.532	0.021	—	—	—
Pelvic tilt	Time	98.179	1.462	67.160	1421.260	.001	.974
	Time × Group	106.029	1.462	72.529	1534.898	.001	.976
	Error	2.625	55.551	0.047	—	—	—
Trunk deviation	Time	13.908	1.668	8.340	325.638	.001	.896
	Time × Group	16.695	1.668	10.011	390.899	.001	.911
	Error	1.623	63.374	0.026	—	—	—
Scoliosis risk	Time	889.350	1.225	726.023	966.500	.001	.962
	Time × Group	936.350	1.225	764.392	1017.578	.001	.964
	Error	34.967	46.549	0.751	—	—	—
Knee alignment	Time	136.058	1.570	86.677	1086.255	.001	.966
	Time × Group	138.842	1.570	88.451	1108.481	.001	.967
	Error	4.760	59.649	0.080	—	—	—
Foot rotation	Time	348.054	1.496	232.645	2576.505	.001	.985
	Time × Group	375.012	1.496	250.664	2776.067	.001	.986
	Error	5.133	56.851	0.090	—	—	—
Social acceptance	Time	598.517	1.005	595.733	22.518	.001	.372
	Time × Group	567.450	1.005	564.811	21.349	.001	.360
	Error	1010.033	38.178	26.456	—	—	—

As presented in Table 2, the main effect of time was statistically significant for all postural status indicators, including forward head displacement, $F = 2758.478$, $p = .001$, $\eta p^2 = .986$; head tilt, $F = 282.240$, $p = .001$, $\eta p^2 = .881$; shoulder asymmetry, $F = 243.094$, $p = .001$, $\eta p^2 = .865$; pelvic tilt, $F = 1421.260$, $p = .001$, $\eta p^2 = .974$; trunk deviation, $F = 325.638$, $p = .001$, $\eta p^2 = .896$; scoliosis risk, $F = 966.500$, $p = .001$, $\eta p^2 = .962$; knee alignment, $F = 1086.255$, $p = .001$, $\eta p^2 = .966$; and foot rotation, $F = 2576.505$, $p = .001$, $\eta p^2 = .985$. The main effect of time was also significant for social acceptance, $F = 22.518$, $p = .001$, $\eta p^2 = .372$. These findings indicated that the outcome scores changed significantly across at least two of the three assessment stages. More importantly, the time-by-group interaction was statistically significant for forward head displacement, $F = 2639.806$, $p = .001$, $\eta p^2 = .986$; head tilt, $F = 277.998$, $p = .001$, $\eta p^2 = .880$; shoulder asymmetry, $F = 246.860$, $p = .001$, $\eta p^2 = .867$; pelvic tilt, $F = 1534.898$, $p = .001$, $\eta p^2 = .976$; trunk deviation, $F = 390.899$, $p = .001$, $\eta p^2 = .911$; scoliosis risk, $F = 1017.578$, $p = .001$, $\eta p^2 = .964$; knee alignment, $F = 1108.481$, $p = .001$, $\eta p^2 = .967$; foot rotation, $F = 2776.067$, $p = .001$, $\eta p^2 = .986$; and social acceptance, $F = 21.349$, $p = .001$, $\eta p^2 = .360$. Therefore, the pattern of change over time differed significantly between the experimental and control groups. The partial eta-squared values indicated very large intervention-related effects on the postural status indicators and moderate-to-large effects on social acceptance. Taken together with the descriptive findings, these results demonstrate that combined yoga and healthy lifestyle training produced significant changes in postural status and increased social acceptance, and that these changes were maintained during the two-month follow-up period.

4. Discussion

The present study investigated the effectiveness of yoga training combined with healthy lifestyle education in reducing postural abnormalities and improving social acceptance among sedentary adults with poor posture. The results demonstrated that the combined intervention produced significant changes in all assessed postural

indicators, including forward head displacement, head tilt, shoulder asymmetry, pelvic tilt, trunk deviation, scoliosis risk, knee alignment, and foot rotation. Significant time-by-group interactions indicated that these changes occurred primarily in the experimental group and could not be attributed merely to repeated measurement or the passage of time. The intervention also resulted in a significant increase in social acceptance, whereas the control group showed only negligible changes across the pretest, posttest, and two-month follow-up assessments. The maintenance of the postural and psychosocial improvements at follow-up suggests that the intervention effects were relatively stable and that participants were able to retain or continue applying at least some of the acquired yoga and lifestyle-management skills after the supervised sessions ended. The large effect sizes observed for most postural indicators indicate that the intervention had a substantial influence on participants' physical alignment, while the moderate-to-large effect observed for social acceptance suggests that the program also produced meaningful psychosocial benefits.

The significant improvement in postural status is consistent with studies indicating that yoga can influence body alignment through the simultaneous development of flexibility, muscular control, balance, proprioception, and postural awareness. Specialized yoga practices involve deliberate positioning of the head, shoulders, trunk, pelvis, knees, and feet, requiring participants to recognize and gradually correct habitual asymmetries (Doohwa, 2023). The findings are also aligned with research showing that yoga-based exercises can contribute to the formation of more appropriate posture and the correction of spinal and musculoskeletal deviations (Ignatova, 2023). Through repeated practice, participants may have learned to identify excessive muscular tension, unequal weight distribution, anterior or lateral displacement of body segments, and compensatory movement patterns. This enhanced kinesthetic awareness may have allowed them to modify their posture not only during formal sessions but also during standing, sitting, walking, and everyday activities. The APECS digital assessment system was particularly useful in detecting these changes because it permitted standardized evaluation of angular and linear postural indicators across the three assessment stages (Saneftec, 2024).

The reduction in head tilt, shoulder asymmetry, trunk deviation, and pelvic tilt may be explained by the corrective and neuromuscular characteristics of yoga postures. Many yoga exercises require axial elongation, balanced activation of the trunk musculature, symmetrical positioning of the shoulder girdle, and controlled movement of the pelvis. Sedentary individuals often experience shortening of anterior musculature, weakness of postural stabilizers, and reduced mobility in the thoracic spine and hip region. Yoga movements may counter these adaptations by combining stretching of shortened tissues with low-load activation of muscles responsible for maintaining alignment. The findings are consistent with the results of integrated posture-focused interventions showing that reducing sedentary time and increasing structured movement can improve both posture and broader biopsychosocial health (Lee et al., 2021). Similar improvements have been reported among sedentary office workers who participated in a combined yoga and lifestyle-modification program designed to correct posture and enhance well-being (Chen et al., 2024). The present results therefore support the proposition that postural abnormalities are modifiable when participants receive repeated corrective movement experiences accompanied by education regarding daily habits.

The significant changes in knee alignment and foot rotation further suggest that the intervention affected the entire kinetic chain rather than only the upper body. Postural deviations in one body region can alter loading patterns elsewhere; for example, pelvic malalignment may influence femoral rotation, knee position, and foot orientation. Yoga postures commonly involve weight-bearing activities that encourage participants to distribute pressure evenly across the feet, align the knees with the direction of movement, stabilize the pelvis, and maintain an elongated trunk. Improved alignment of the lower extremities may consequently have emerged from greater proprioceptive control and more balanced muscular activation. Exercise recommendations for healthy aging emphasize the value of multicomponent training that incorporates mobility, balance, strength, and neuromotor control rather than relying on a single form of exercise (Izquierdo et al., 2025). Yoga possesses many of these components and can be adapted to the functional capacity of middle-aged and older adults. The observed improvements are therefore compatible with evidence that appropriately prescribed physical activity supports mobility, balance, and musculoskeletal functioning across adulthood (Indrakumar & Silva, 2024).

The decrease in scoliosis risk and trunk deviation may also be related to enhanced spinal mobility and improved control of the muscles surrounding the vertebral column. Although a short-term yoga intervention cannot be assumed to produce structural correction of established spinal deformity, it may reduce functional asymmetry, muscular

imbalance, and compensatory trunk positioning. The reported reduction in the APECS scoliosis-risk indicator should therefore be interpreted primarily as an improvement in observable alignment rather than definitive anatomical correction. This distinction is important because posture is influenced by both structural and functional factors. Nevertheless, the large effect observed in the present study is consistent with evidence that yoga practices can facilitate spinal alignment and reduce postural imbalance when exercises are individualized and performed consistently (Ignatova, 2023). Therapeutic yoga frameworks also emphasize gradual movement, recognition of physical limitations, and avoidance of excessive strain, which may make them appropriate for sedentary individuals with low exercise tolerance (Agombar, 2020).

The improvement observed in the forward head indicator should be interpreted according to the scoring direction used by the APECS system. In the present data, the experimental group's mean score increased markedly after the intervention, whereas most other abnormality indicators decreased. Assuming that a higher value on this particular index represents more favorable craniovertebral alignment or a reduced degree of forward displacement, the finding indicates improvement consistent with the other postural outcomes. Forward head posture is common among individuals who spend prolonged periods using computers and mobile devices because the head gradually shifts anteriorly relative to the trunk. Yoga may improve this pattern through cervical elongation, thoracic extension, scapular stabilization, and increased awareness of head position. Integrated programs specifically targeting postural habits and sedentary behavior have similarly reported beneficial changes in head and upper-body alignment (Müller, 2025). However, because posture-analysis systems may define and calculate angles differently, the direction and clinical interpretation of the forward head score should always be reported clearly.

The effectiveness of the program may also be attributed to its combined structure. Yoga alone can improve flexibility, breathing, relaxation, and body awareness, but its benefits may be weakened when participants continue to engage in prolonged sitting, inadequate sleep, unhealthy eating, or poorly managed stress. Lifestyle medicine emphasizes that health outcomes are shaped by interacting behaviors, including physical activity, nutrition, sleep, stress regulation, and social relationships (Rippe, 2019). The intervention addressed these domains alongside yoga practice, thereby increasing the likelihood that participants would modify the conditions that contributed to their postural problems. The findings are consistent with research showing that yoga, physical activity, and healthy lifestyle education function as a complementary triad for improving biopsychosocial health in sedentary populations (Garcia et al., 2020). Comparable lifestyle programs that incorporated yoga have also yielded improvements in physical posture, psychological functioning, and social health (Davis et al., 2020). Thus, the substantial postural changes found in the present study may reflect the cumulative effects of corrective exercise, reduced sedentary time, improved self-care, and more conscious daily movement.

The findings are also meaningful in light of evidence linking inactivity with declines in muscular and functional health. Prolonged sedentary behavior can reduce energy expenditure, weaken postural musculature, impair circulation, and contribute to functional limitations (Wullems et al., 2016). Physical inactivity and sedentary lifestyle may mutually reinforce the progression of frailty and reduce physiological resilience (Battista et al., 2025). Although the participants in the present study were not necessarily frail, they displayed several risk characteristics, including inactivity, excess body weight, and postural abnormalities. Intervening during middle adulthood may help prevent these conditions from progressing toward more severe mobility impairment. This interpretation is supported by the conceptualization of frailty as a transition from coordinated physiological functioning toward reduced homeostatic capacity (Fried et al., 2021). Likewise, reductions in muscle health associated with sarcopenia can compromise stability and postural control (Kirk et al., 2024). The present intervention may therefore have value not only for correcting existing posture but also for reducing longer-term functional vulnerability.

The significant increase in social acceptance indicates that the intervention affected more than participants' physical alignment. Poor posture can influence body image, interpersonal confidence, perceived attractiveness, and willingness to engage in social situations. Individuals who feel physically uncomfortable or dissatisfied with their appearance may withdraw from group activities or become more self-conscious in social interactions. Improvement in posture may create a more upright and confident bodily presentation, which can influence both self-perception and perceived social competence. The group-based nature of the intervention may also have provided opportunities for supportive interaction, shared experience, and positive reinforcement. The Crowne–Marlowe instrument assesses

the tendency to endorse socially approved characteristics and present oneself in a favorable manner (Crowne & Marlowe, 1960). Its use in Persian psychological research has shown acceptable reliability and relationships with relevant social and psychological constructs (Sharafoddin, 2010). Accordingly, the increased scores may indicate stronger perceived social adaptation, confidence, or endorsement of socially valued behaviors after participation in the program.

The improvement in social acceptance may also be explained through the psychological effects of yoga. Yoga integrates breathing regulation, mindfulness, emotional awareness, and self-compassion, all of which can reduce physiological arousal and improve emotional self-regulation. Meta-analytic evidence has demonstrated that yoga and mindfulness-based interventions can reduce stress-related physiological activation (Pascoe et al., 2017). Yoga has also been associated with changes in psychoneuroimmunological processes among individuals exposed to significant psychological stress (Kelly et al., 2020). Clinical studies have shown that mindfulness yoga can reduce symptoms of anxiety and depression and improve emotional functioning (Liu et al., 2022). As anxiety, negative self-evaluation, and emotional dysregulation may interfere with social participation, reductions in these experiences could contribute indirectly to greater social acceptance. In addition, the program's lifestyle component explicitly addressed emotional regulation, social support, self-care, and goal setting, providing participants with practical strategies for managing interpersonal and psychological difficulties.

The relationship between physical and psychological change is consistent with a biopsychosocial model of health. Postural abnormalities may generate discomfort and dissatisfaction, while psychological stress may increase muscular tension and reinforce maladaptive bodily positions. Chronic stress may also disrupt sleep, reduce motivation for activity, and increase reliance on sedentary coping behaviors. Research on psychological biomarkers demonstrates that emotional and physiological processes can interact with metabolic and inflammatory health conditions (Funuyet-Salas et al., 2020). Through relaxation exercises, controlled breathing, mindfulness, and lifestyle education, the intervention may have interrupted this reciprocal cycle. Participants may have experienced reduced tension and fatigue, greater confidence in movement, and more positive perceptions of their bodies, which in turn supported social engagement. These mechanisms may explain why changes were observed concurrently in physical posture and social acceptance.

5. Conclusion

The maintenance of improvements at the two-month follow-up is another important finding. Many interventions produce short-term benefits that diminish once supervised sessions end. In the present study, however, postural indicators and social acceptance remained relatively stable after treatment. This stability may be attributed to the program's emphasis on self-monitoring, individualized planning, relapse prevention, and incorporation of skills into daily routines. International physical activity guidelines emphasize that sustained health benefits depend on regular activity and reduced sedentary time rather than brief periods of exercise (Bull et al., 2020). Evidence also suggests that activity, sedentary behavior, and sleep jointly influence physical and psychological outcomes (Wilhite et al., 2023). By targeting these interrelated behaviors, the program may have provided participants with a sustainable framework for maintaining improvement. The use of both women and men also increased the practical relevance of the findings, although previous evidence suggests that gender may influence responses to yoga and lifestyle interventions (Smith et al., 2022). Overall, the findings support the effectiveness of a comprehensive intervention that combines physical practice with behavioral and psychosocial education.

Several limitations should be considered when interpreting the findings. The sample consisted of only 40 participants recruited through purposive sampling from clinics in Tehran, which limits the generalizability of the results to other geographical, cultural, occupational, and age groups. The relatively small sample may also have increased the sensitivity of effect-size estimates to sample-specific characteristics. Social acceptance was assessed through a self-report questionnaire and may have been influenced by response bias, participant expectations, or a tendency to provide socially favorable answers. The control group did not receive an active comparison intervention, making it impossible to determine whether the observed psychosocial effects resulted specifically from yoga and lifestyle education or partly from attention, group participation, and interaction with the instructor. In addition, participants' adherence to home practice and lifestyle recommendations was not objectively monitored. The two-month follow-up period was useful for examining short-term maintenance but

was insufficient for determining the long-term stability of the effects. Finally, interpretation of some digital postural indices, particularly forward head displacement, depends on the specific scoring direction and measurement algorithm of the software.

Future studies should recruit larger and more diverse samples through probability-based or multisite sampling and examine whether the intervention is equally effective across age groups, occupational categories, body mass index levels, and baseline severity of postural abnormalities. Randomized controlled trials with active comparison groups, such as corrective exercise alone, yoga alone, healthy lifestyle education alone, or general health education, would help identify the specific and combined contributions of each intervention component. Longer follow-up periods of six months or one year are recommended to determine whether improvements are maintained over time. Researchers should also assess adherence through activity monitors, practice logs, wearable devices, or digital applications and examine whether adherence mediates intervention outcomes. Future studies could include objective measures of sedentary time, muscle strength, balance, flexibility, pain, sleep quality, body image, anxiety, and quality of life. Structural or clinical assessments conducted by physiotherapists or orthopedic specialists could complement digital photogrammetry and clarify whether observed changes represent functional alignment or anatomical correction. Qualitative interviews may also help explain how participants experience changes in posture, self-confidence, and social relationships.

Healthcare providers, physiotherapists, psychologists, fitness professionals, and health educators may consider integrating yoga-based postural exercises with healthy lifestyle education for sedentary adults with poor posture. Programs should begin with medical screening and individualized assessment to ensure that exercises are safe and appropriate for each participant's physical condition. Sessions should combine gentle postures, breathing exercises, relaxation, body-awareness training, and practical instruction regarding movement breaks, nutrition, sleep, stress management, and social support. Practitioners should emphasize gradual progression, correct alignment, home practice, and adaptation of exercises for participants with pain or restricted mobility. Digital posture-analysis systems may be used to provide visual feedback and increase motivation by showing changes over time. Group delivery may be particularly beneficial because it can offer social reinforcement and improve adherence. To maintain outcomes, participants should receive personalized continuation plans, periodic follow-up sessions, and simple self-monitoring strategies that support the integration of healthy movement and lifestyle practices into everyday life.

Authors' Contributions

Authors equally contributed to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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