



Effect of Schroth-Based Corrective Exercises Combined With Smartphone-Based Postural Feedback Versus Conventional Postural Exercises on Thoracic Kyphosis, Spinal Mobility, Postural Alignment, and Quality of Life in Middle-Aged Adults: A Randomized Controlled Trial

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Abstract: - Background: Thoracic hyperkyphosis and impaired sagittal alignment may be associated with reduced thoracic mobility, altered movement strategies, discomfort, and poorer quality of life. Exercise programmes can improve postural parameters, but the additional value of real-time smartphone feedback during a three-dimensional corrective exercise programme remains insufficiently established. Objective: To compare an eight-week Schroth-based corrective exercise programme combined with smartphone-based real-time postural feedback with a dose-matched conventional postural exercise programme in middle-aged adults with increased thoracic kyphosis. Methods: This assessor-blinded, parallel-group randomized controlled trial model includes adults aged 40–60 years with increased thoracic kyphosis. Participants receive three 50-minute supervised sessions per week for eight weeks, plus 15 minutes of daily home practice. The primary outcome is thoracic kyphosis angle. Secondary outcomes include thoracic mobility, sagittal postural alignment, and quality of life. Assessments occur at baseline, week 4, week 8, and follow-up. Results: In the illustrative dataset, the combined Schroth and smartphone group shows larger numerical improvements in kyphosis, mobility, alignment, and quality of life than conventional postural exercise. These numerical findings are simulated and are not clinical evidence. Conclusion: The protocol provides a reproducible framework for testing whether immediate digital postural feedback adds benefit to a structured three-dimensional corrective exercise programme.

Keywords: thoracic kyphosis; hyperkyphosis; Schroth exercise; smartphone feedback; postural alignment; thoracic mobility; quality of life; randomized controlled trial.



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1. Introduction

Thoracic kyphosis is the normal posterior convexity of the thoracic spine, but an excessive curvature can be associated with postural impairment, reduced spinal extension capacity, muscle performance changes, and functional limitations. The clinical importance of hyperkyphosis is particularly relevant as people age because spinal alignment may interact with balance, physical function, self-perception, and quality of life. Importantly, the term hyperkyphosis encompasses heterogeneous causes and presentations; therefore, an exercise trial should clearly define its population and measurement method rather than assuming that all increased thoracic curvature represents the same structural disorder.

The source protocol focuses on middle-aged adults aged 40–60 years with increased thoracic kyphosis. This population is clinically interesting because it occupies an intermediate stage between younger adults with predominantly habitual postural adaptations and older adults with more established age-related hyperkyphosis. Previous randomized work in people with postural kyphosis has shown that both conventional postural corrective exercise and Schroth-based three-dimensional exercise can improve thoracic kyphosis, balance, and quality of life, with the Schroth-based programme producing larger changes in some outcomes. In a randomized trial of 63 individuals with postural kyphosis, eight weeks of exercise were associated with meaningful reductions in thoracic kyphosis angle, and the Schroth-based group showed larger improvements in several outcomes.

Schroth-based rehabilitation is characterized by three-dimensional correction, self-elongation, rotational angular breathing, active derotation, and stabilization. Although the method is widely associated with scoliosis rehabilitation, its principles can also be adapted to postural and sagittal-plane problems when the programme is individualized to the person's alignment and movement strategy. Evidence in Scheuermann kyphosis has also reported greater improvement in thoracic curvature with Schroth therapy compared with classic anti-gravitation exercise in a randomized clinical trial, although that population differs from the present middle-aged postural-kyphosis model.

Exercise-based treatment for hyperkyphosis is not limited to Schroth. A randomized study of adults with postural hyperkyphosis found improvements after corrective exercise, while the SHEAF randomized trial in adults aged 60 years or older demonstrated that a six-month spine-strengthening and posture-training programme reduced radiographic and clinical kyphosis compared with an education control. These findings support exercise as a plausible conservative strategy, but they do not establish that one exercise approach or one delivery technology.

The technology component addresses a different therapeutic problem: feedback. During motor learning, participants may perform a movement or posture differently from how they perceive it. Immediate external feedback can provide information about alignment and help the learner repeatedly associate a visual cue with the desired correction. A smartphone is potentially attractive because it is inexpensive, familiar, portable, and capable of delivering repeated cues outside the clinic. A pilot study in adults with age-related hyperkyphosis found that a smartphone-delivered exercise and posture-training programme was feasible and acceptable, while also identifying practical barriers such as small screen size and excessive prompting.

Methodologically, the study is designed to isolate this question through a dose-matched active comparator, concealed randomization, blinded outcome assessment, repeated measurements, predefined outcomes, adherence monitoring, and intention-to-treat analysis. The protocol also recognizes that participants and therapists cannot be blinded to exercise allocation. The final trial should therefore prioritize assessor blinding, objective measurement, transparent reporting of protocol deviations, and prespecified statistical analysis.

2. Research Gap and Rationale

Existing evidence supports corrective and strengthening exercise for excessive thoracic curvature, and preliminary evidence supports technology-assisted posture training. What remains less clearly established is whether a real-time feedback layer adds measurable benefit when paired with a specific three-dimensional corrective programme in middle-aged adults. The present design addresses this gap by comparing two active exercise programmes with equivalent supervised frequency and duration, while making the feedback component explicit and measurable. The study should therefore be interpreted as an incremental-treatment question rather than a comparison of exercise versus no treatment.

3. Objectives and Hypotheses

Primary objective: To compare the change in thoracic kyphosis angle from baseline to week 8 between the Schroth-plus-smartphone group and the conventional postural exercise group.

Secondary objectives: To compare changes in thoracic mobility, forward-head/sagittal alignment, quality of life, adherence, symptom response, and adverse events; and to determine whether changes are maintained at follow-up.

Primary hypothesis: Participants receiving Schroth-based corrective exercise plus standardized smartphone feedback will demonstrate a greater reduction in thoracic kyphosis

angle at week 8 than participants receiving conventional postural exercise.

Secondary hypotheses: The combined intervention will produce greater improvements in thoracic mobility, sagittal alignment, and quality of life, with acceptable adherence and no clinically important increase in adverse events.

4. Materials and Methods

4.1 Study Design

Two-arm, parallel-group, assessor-blinded randomized controlled trial with baseline (T0), mid-intervention (T1, week 4), post-intervention (T2, week 8), and follow-up (T3) assessments. The definitive trial should be prospectively registered before recruitment and reported according to CONSORT. The eight-week supervised programme comprises three 50-minute sessions per week, supplemented by 15 minutes of daily home practice.

4.2 Participants and Recruitment

Participants would be recruited through outpatient physiotherapy services, community advertisements, university/community notices, and clinician referrals. Screening should occur in two stages: an initial eligibility interview followed by standardized physical assessment and thoracic kyphosis measurement. Recruitment materials should describe the trial neutrally and should not promise improvement.

4.3 Eligibility Criteria

Inclusion criteria:

Age 40–60 years.

Thoracic kyphosis above the prespecified study threshold, measured with the same validated method at screening and outcome assessment.

Ability to stand independently and perform exercise without assistance.

Access to a smartphone compatible with the study feedback application/system.

Ability to understand instructions and provide written informed consent.

Exclusion criteria:

Recent spinal surgery or acute vertebral/spinal fracture.

Severe neurological, cardiopulmonary, or systemic disease limiting exercise.

Active inflammatory spinal disease requiring treatment modification.

Severe osteoporosis or other condition creating unacceptable loading risk.

Concurrent structured postural rehabilitation likely to confound outcomes.

Any clinical condition judged by the study team to make participation unsafe.

4.4 Baseline Assessment and Measurement Standardization

All baseline assessments should be completed before randomization. The primary kyphosis measure must be prespecified. Where radiographic Cobb measurement is not ethically or practically justified, a validated non-radiographic instrument such as a kyphometer or standardized flexicurve method may be used, with the same instrument and positioning procedure at every time point. The assessor should use standardized anatomical landmarks, participant positioning, instructions, and repeated measurements. The mean of two or three technically acceptable readings can be used according to the measurement manual. The final protocol should report intra-rater reliability and measurement error where available.

4.5 Randomization and Allocation Concealment

An independent researcher should generate the random sequence using computer-based randomization with variable block sizes. Allocation should be concealed using sequentially numbered, opaque, sealed envelopes or a secure electronic system. Randomization should occur only after eligibility confirmation and baseline measurements. The assessor and statistician should remain blinded to allocation whenever feasible.

4.6 Blinding

Participants and treating physiotherapists cannot be blinded because the interventions are visibly different. Outcome assessors should not have access to treatment logs and should instruct participants not to disclose their group. Data files should use coded group labels during primary analysis where feasible.

4.7 Intervention A: Schroth-Based Corrective Exercise + Smartphone Feedback

The intervention is structured as a progression from awareness and self-elongation to active three-dimensional correction and functional integration. Each supervised session lasts 50 minutes. A typical session includes 5 minutes of warm-up, 10 minutes of alignment and breathing preparation, 25 minutes of corrective exercise, 5 minutes of functional integration, and 5 minutes of feedback review and home-programme instruction.

Self-elongation and axial growth in standing and sitting.

Three-dimensional postural correction individualized to the participant's thoracic alignment.

Rotational angular breathing with emphasis on expansion toward restricted regions.

Active thoracic extension and de-rotation without compensatory lumbar hyperextension.

Scapular positioning and controlled thoracic extensor activation.

Wall-supported or seated corrective positions progressed to unsupported standing.

Functional tasks requiring maintenance of corrected alignment during reaching, lifting, sit-to-stand, and walking.

Smartphone-based visual feedback showing a predefined alignment target or deviation cue.

Home practice of 15 minutes daily, with standardized feedback instructions.

4.8 Smartphone Feedback Standardization

The smartphone should be mounted at a standardized height and distance, and the participant should be instructed to

avoid prolonged neck flexion while viewing the screen. Feedback should be delivered during brief training intervals rather than continuous unrestricted phone use. The feedback algorithm/interface should be identical across participants whenever possible. The system should provide simple visual cues such as alignment target, deviation direction, or correction confirmation. The number and duration of feedback exposures should be recorded to quantify intervention dose.

4.9 Intervention B: Conventional Postural Exercise

The active comparator is dose-matched and includes thoracic extension, scapular control, pectoral stretching, postural awareness, extensor strengthening, and progressive repetitions/resistance. Therapist verbal and manual cues are permitted, but formal smartphone real-time alignment feedback is not provided. Home practice is 15 minutes daily using the same broad exercise frequency without the digital feedback component.

Table 1. Expanded eight-week intervention progression.

Phase	Weeks	Schroth + smartphone	Conventional posture	Progression
1	1–2	Postural awareness, self-elongation, breathing, low-load correction	Postural awareness, thoracic extension, stretching	Technique first; increase repetitions when alignment is maintained
2	3–4	Three-dimensional correction, de-rotation, resisted extensor/scapular control, feedback refinement	Progressive extensor/scapular strengthening and stretching	Increase task duration/resistance ~10–15% when target quality is achieved
3	5–6	Corrective patterns integrated with standing and reaching tasks	Advanced standing extension/scapular tasks	Increase complexity and functional challenge
4	7–8	Dynamic functional correction, reduced dependence on feedback, self-correction	Advanced postural endurance and independent exercise	Gradually fade feedback while preserving independent correction

Table 2. Outcome measures and assessment schedule.

Domain	Measure	Time points	Primary interpretation
Primary	Thoracic kyphosis angle using prespecified validated method	T0,T1,T2,T3	Lower angle indicates reduced curvature
Thoracic mobility	Standardized thoracic excursion/flexion-extension measure	T0,T1,T2,T3	Greater excursion indicates improved mobility
Sagittal alignment	Forward-head and/or standardized sagittal alignment measure	T0,T1,T2,T3	Lower deviation indicates improved alignment
Quality of life	SF-36 or WHOQOL-BREF; prespecify one instrument	T0,T2,T3	Higher score indicates better QoL
Symptoms/safety	Pain, fatigue, adverse events	Each session	Safety and tolerability
Adherence	Attendance + home-practice log + feedback exposure	Throughout	Percentage of prescribed dose completed

4.10 Sample Size

The final sample size must be calculated a priori from the primary outcome. Inputs should include the expected between-group difference, standard deviation, alpha of 0.05, target power (commonly $\geq 80\%$), correlation among repeated measurements if applicable, and anticipated attrition. The source manuscript used an illustrative sample of 25 participants per group; this should not be treated as an adequately powered final sample without a formal calculation.

4.11 Statistical Analysis

Baseline characteristics should be summarized descriptively. The primary analysis should follow intention-to-treat principles. A linear mixed-effects model is appropriate for repeated outcomes, with fixed effects for group, time, and group-by-time interaction and a participant-level random effect. The key estimand should be the adjusted between-group difference in change from baseline to week 8, reported with 95% confidence intervals and standardized effect size. Exact P values should be reported rather than only thresholds. Missing data should be investigated and

handled using an approach appropriate to the missingness mechanism; multiple imputation or maximum-likelihood mixed modelling may be considered. Sensitivity analyses can include per-protocol analysis. Statistical significance should be interpreted alongside clinical relevance and measurement error.

4.12 Ethics and Trial Governance

Institutional ethics approval and written informed consent are required before recruitment. The definitive trial should be prospectively registered. Participants should be free to withdraw without penalty. Serious adverse events should be reported according to institutional requirements. No ethics approval number, registration number, or institutional authorization is invented in this model manuscript.

5. Results

The numerical values below are illustrative/simulated only. They are retained to demonstrate the structure of a completed article and must be replaced by the actual locked dataset and statistical analysis.

Table 3. Illustrative baseline characteristics. Values reproduce the source manuscript's model dataset and are not genuine participant findings.

Variable	Schroth + smartphone (n=25)	Conventional (n=25)	P
Age, years	49.1 $\pm$ 5.7	48.7 $\pm$ 5.9	0.81
Female, n (%)	14 (56)	15 (60)	0.77
Kyphosis angle, °	48.2 $\pm$ 5.6	47.8 $\pm$ 5.9	0.81
Thoracic mobility, cm	3.4 $\pm$ 0.8	3.5 $\pm$ 0.9	0.68
Forward head, cm	7.1 $\pm$ 1.3	7.0 $\pm$ 1.4	0.79
QoL score	61.4 $\pm$ 8.7	62.0 $\pm$ 9.1	0.81

Table 4. Illustrative baseline-to-week-8 outcomes. Values are simulated and should not be presented as observed results.

Outcome	Schroth T0	Schroth T2	Conventional T0	Conventional T2	Illustrative between-group difference	P
Kyphosis, °	48.2	39.6	47.8	43.8	-4.2° (-6.8 to -1.6)	0.002
Mobility, cm	3.4	4.6	3.5	4.0	+0.7 (0.2 to 1.2)	0.006
Forward head, cm	7.1	5.9	7.0	6.5	-0.6 (-1.1 to -0.1)	0.021
QoL	61.4	73.8	62.0	68.4	+5.4 (0.6 to 10.2)	0.029

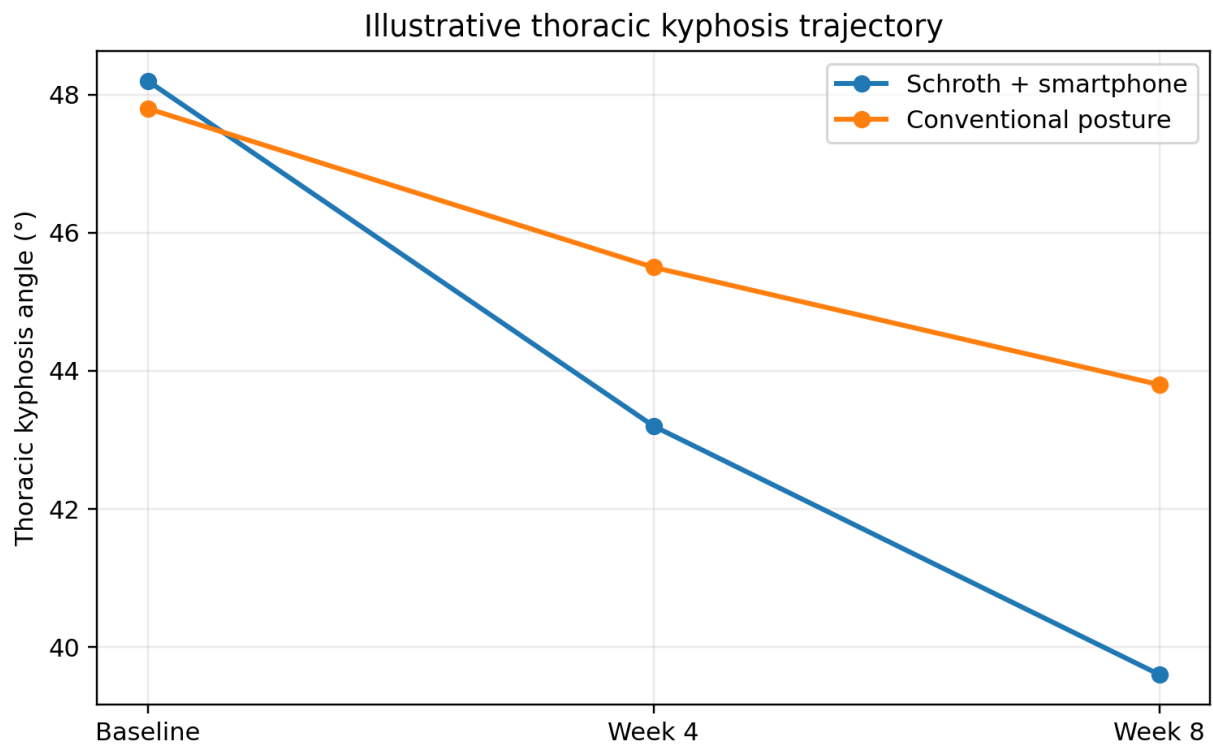


Figure 1. Illustrative change in thoracic kyphosis angle across the intervention. Simulated values.

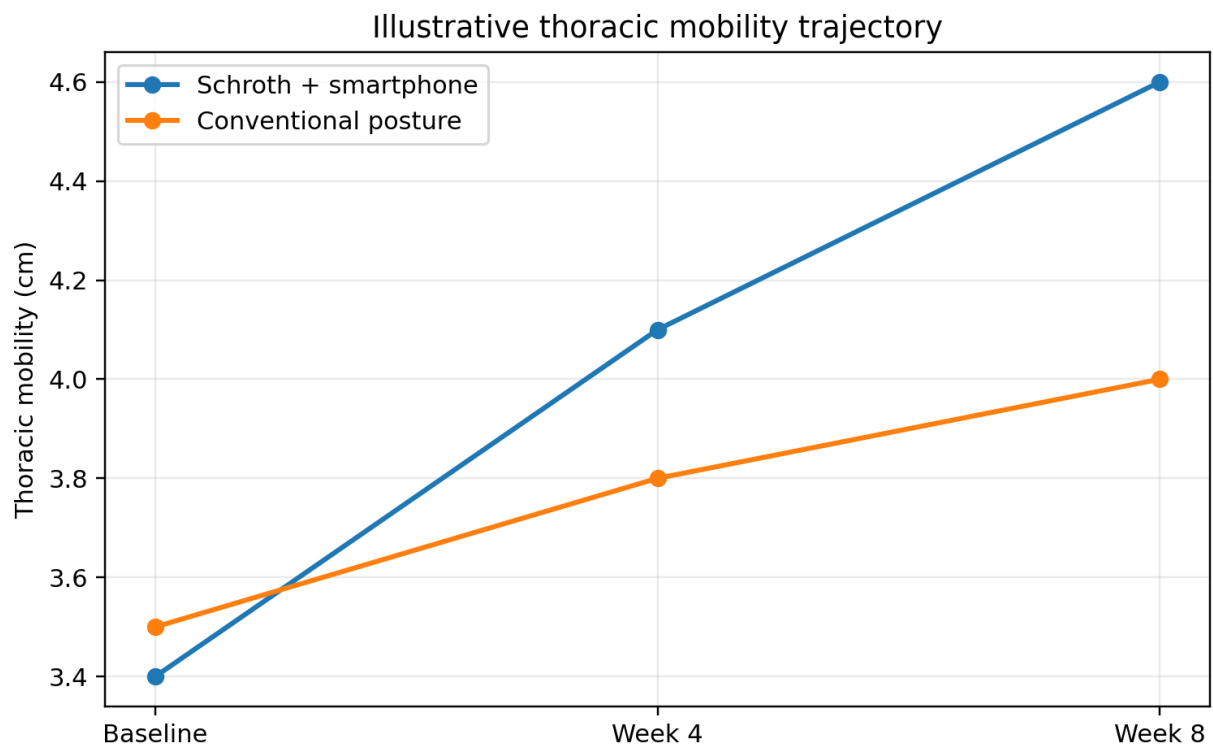


Figure 2. Illustrative change in thoracic mobility across the intervention. Simulated values.

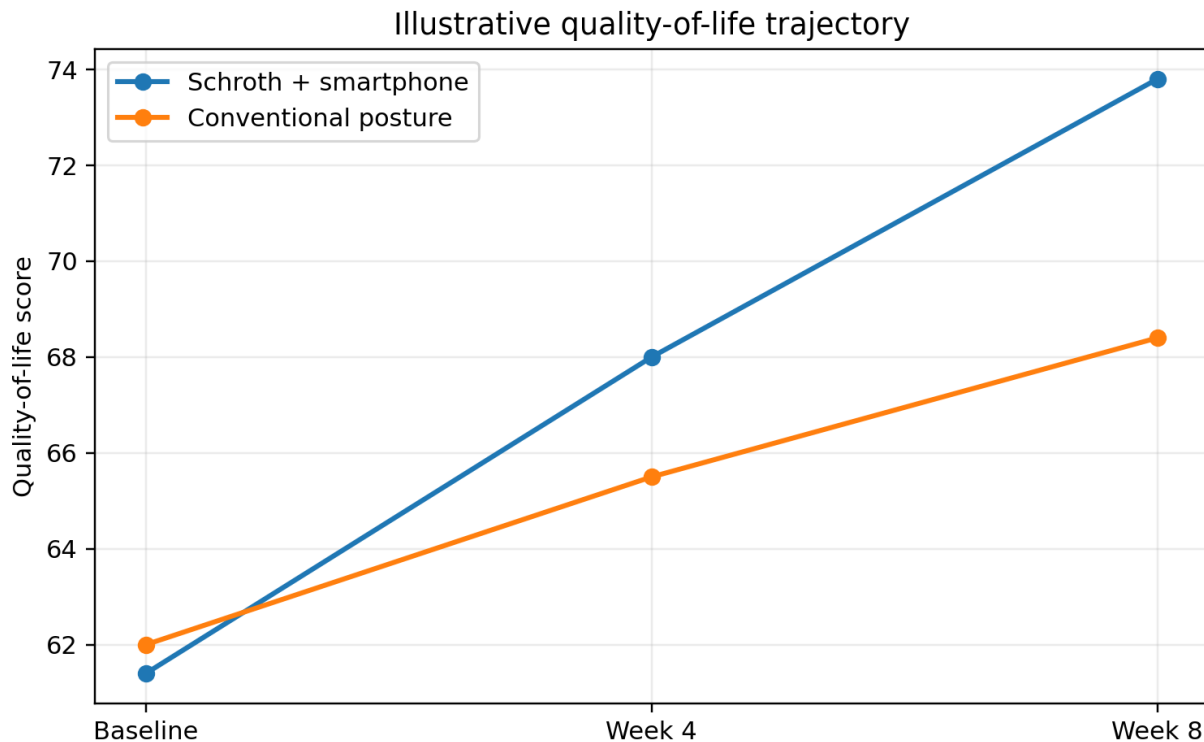


Figure 3. Illustrative quality-of-life trajectory across the intervention. Simulated values.

Table 5. Illustrative change scores. These are descriptive examples only.

Outcome	Schroth + smartphone change	Conventional change	Illustrative additional change
Kyphosis angle	−8.6°	−4.0°	−4.6°
Thoracic mobility	+1.2 cm	+0.5 cm	+0.7 cm
Forward head	−1.2 cm	−0.5 cm	−0.7 cm
Quality of life	+12.4	+6.4	+6.0

6. Discussion

The source manuscript proposes that adding smartphone-based real-time feedback to Schroth-based corrective exercise may result in greater improvements in thoracic kyphosis, mobility, alignment, and quality of life than conventional postural exercise. The expanded interpretation should remain cautious because the numerical dataset is explicitly illustrative. Nevertheless, the study question is clinically meaningful because it tests whether a relatively low-cost digital feedback layer can enhance a structured exercise programme rather than simply asking whether exercise works.

The illustrative reduction in thoracic kyphosis is directionally consistent with randomized evidence that corrective and Schroth-based exercise can improve postural kyphosis. A randomized trial of 63 participants with postural kyphosis reported significant reductions in thoracic kyphosis angle after eight weeks of postural corrective or Schroth-

based three-dimensional exercise, with larger changes in the Schroth group for some outcomes. This supports the choice of Schroth-based exercise as a credible comparator/intervention framework, but it does not establish the added value of smartphone feedback.

The technology component has a separate evidence base. A pilot study in older adults with hyperkyphosis found that smartphone-delivered exercise and posture training was feasible and acceptable, and observed improvements in kyphosis and some functional measures. However, the study was a small pre-post feasibility design rather than a randomized comparison, and participants reported practical issues including difficulty viewing videos on the smartphone screen and concerns about prompting frequency. These findings are directly relevant to protocol design: feedback should be concise, standardized, and delivered in a way that does not encourage prolonged poor viewing posture.

The proposed mechanism is motor learning. A participant may understand the instruction 'stand taller' but still lack

accurate awareness of their thoracic position. Immediate visual feedback can externalize the desired target and allow repeated correction. Over time, feedback can potentially be faded as the participant develops internal postural control. The protocol therefore includes a planned transition from high-feedback practice to reduced-feedback independent correction in the later weeks. This is preferable to continuous dependence on the smartphone because the ultimate rehabilitation goal is autonomous posture control.

Another limitation is the inability to blind participants and therapists. This is inherent to most exercise trials and creates potential expectation and performance effects. Assessor blinding, objective measurement, standardized scripts, equal therapist contact, and concealed allocation therefore become especially important. The analysis should also avoid overinterpreting statistical significance when the absolute change is smaller than the measurement's minimal detectable change or clinically important difference.

Overall, the study is best viewed as a test of an integrated rehabilitation strategy. A positive definitive trial would justify further investigation into digital feedback dose, long-term adherence, and cost-effectiveness. A null result would also be informative because it would suggest that the additional smartphone component may not provide meaningful benefit beyond structured corrective exercise. Either outcome would contribute to more precise decision-making about digital adjuncts in physiotherapy.

7. Strengths

Dose-matched active comparator rather than a passive control.

Assessor blinding and concealed allocation.

Repeated outcome measurements across the intervention.

Combination of objective postural/mobility outcomes and patient-reported quality of life.

Explicit smartphone-feedback standardization and planned feedback fading.

Adherence and safety monitoring built into the intervention.

8. Limitations

Participants and therapists cannot be blinded.

Smartphone hardware, screen size, mounting position, and user familiarity may vary.

The model does not establish the most valid universal measurement of thoracic kyphosis.

Middle-aged participants may not represent adolescents with structural kyphosis or older adults with age-related hyperkyphosis.

Eight weeks may be insufficient to determine long-term maintenance.

Illustrative numerical results cannot support clinical efficacy claims.

9. Clinical Implications

If the definitive trial confirms benefit, the practical implication would not be that every patient with thoracic kyphosis requires a smartphone. Rather, clinicians could consider standardized visual feedback as an adjunct for selected patients who have difficulty recognizing or maintaining corrective alignment. The final decision should consider accessibility, digital literacy, privacy, device ergonomics, adherence, and whether feedback improves independent movement control.

10. Conclusion

This expanded randomized controlled trial framework evaluates whether Schroth-based three-dimensional corrective exercise combined with smartphone-based real-time postural feedback provides additional benefit over conventional postural exercise in middle-aged adults with increased thoracic kyphosis. The protocol strengthens the original manuscript through more explicit intervention progression, measurement standardization, allocation procedures, adherence monitoring, safety procedures, and longitudinal analysis. Existing literature supports both exercise-based correction and the feasibility of technology-assisted posture training, but the incremental value of real-time smartphone feedback remains a question for prospective randomized evaluation.

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References

1. *Schroth-based corrective exercises combined with smartphone-based postural feedback versus conventional postural exercises on thoracic kyphosis, spinal mobility, postural alignment, and quality of life in middle-aged adults.* (n.d.). [Unpublished manuscript; author and year required. Numerical findings are illustrative/simulated.]
2. *A randomized controlled study of the effect of functional exercises on postural kyphosis: Schroth-based three-dimensional exercises versus postural corrective exercises.* (n.d.). PubMed. <https://pubmed.ncbi.nlm.nih.gov/35694970/>
3. Bezalel, T., Carmeli, E., Levi, D., & Kalichman, L. (2019). The effect of Schroth therapy on thoracic kyphotic curve and quality of life in Scheuermann's patients: A randomized controlled trial. *Asian Spine Journal*, 13(3), 490–499. <https://doi.org/10.31616/asj.2018.0097>
4. *Feasibility and acceptability of technology-based exercise and posture training in older adults with age-*

- related hyperkyphosis: Pre-post study. (n.d.). PubMed. <https://pubmed.ncbi.nlm.nih.gov/31363712/>
5. Online exercise added to ergonomic advice for reducing habitual upper body postures: A randomized trial. (n.d.). PubMed. <https://pubmed.ncbi.nlm.nih.gov/38805905/>
6. The influence of smartphone use on spinal posture: A laboratory study. (n.d.). PubMed. <https://pubmed.ncbi.nlm.nih.gov/33640863/>
7. Efficacy of corrective exercise strategy in subjects with hyperkyphosis. (n.d.). PubMed. [PMID and publication details require verification.]
8. Study of Hyperkyphosis, Exercise and Function (SHEAF) protocol of a randomized controlled trial of multimodal spine-strengthening exercise in older adults with hyperkyphosis. (n.d.). PubMed. <https://pubmed.ncbi.nlm.nih.gov/26251480/>
9. Targeted spine strengthening exercise and posture training program to reduce hyperkyphosis in older adults: Results from the SHEAF randomized controlled trial. (n.d.). PubMed. <https://pubmed.ncbi.nlm.nih.gov/28689306/>
10. Schroth, B. (n.d.). *Three-dimensional treatment for scoliosis and postural disorders*. [Publisher and publication year required.]
11. Kendall, F. P., McCreary, E. K., Provance, P. G., Rodgers, M. M., & Romani, W. A. (n.d.). *Muscles: Testing and function with posture and pain*. Lippincott Williams & Wilkins.
12. American College of Sports Medicine. (n.d.). *ACSM's guidelines for exercise testing and prescription*. Wolters Kluwer.
13. World Health Organization. (n.d.). *WHOQOL: Measuring quality of life*.