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Effect of a Physiotherapist-Led School-Based Postural Education Programme on Knowledge of Healthy Postural Habits Among Nigerian Adolescents: A Controlled Quasi- Experimental Study

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Abstract

Background

Poor postural habits established during adolescence increase the risk of musculoskeletal disorders and may persist into adulthood. However, evidence on the effectiveness of school-based postural education in low- and middle-income countries remains limited.

Objective

To evaluate the effectiveness of a physiotherapist-led school-based postural education programme on postural knowledge, postural behaviours, and musculoskeletal symptoms among adolescents in Enugu, Nigeria.

Methods

A controlled quasi-experimental study employing a two-group pretest–posttest design was conducted among 200 adolescents attending lesson centres in Enugu State, Nigeria. Participants from different lesson centres were allocated to either the intervention (n = 100) or control (n = 100) group using a non-randomized allocation procedure to minimise contamination. The intervention group received a physiotherapist-led school-based postural education programme comprising fifteen sessions over three weeks, while the control group continued their usual academic activities. Outcomes were assessed using the HEBACAKNOW-DL, HEBACAKNOW-PAE, BackPEI, and NMQ-E questionnaires. Analysis of covariance (ANCOVA) was used to compare post-intervention outcomes after adjusting for baseline values.

Results

The intervention significantly improved HEBACAKNOW-DL (adjusted mean difference = 9.39, 95% CI: 8.54–10.24; $p < 0.001$) and HEBACAKNOW-PAE (adjusted mean difference = 11.16, 95% CI: 10.20–12.12; $p < 0.001$) scores, with large effect sizes. Significant improvements were observed in correct sitting posture while writing ($p = 0.034$) and computer use ($p = 0.048$), whereas reductions in musculoskeletal symptoms were not statistically significant.

Conclusion

A physiotherapist-led school-based postural education programme significantly improved adolescents' postural knowledge and selected postural behaviours but did not produce significant short-term

reductions in musculoskeletal symptoms. These findings provide preliminary evidence supporting the integration of structured postural education into school health programmes.

Background of the Study

Musculoskeletal disorders (MSDs) are among the leading causes of disability worldwide, affecting an estimated 1.71 billion people and accounting for a substantial proportion of years lived with disability (YLDs) globally [1, 2]. Although MSDs are commonly regarded as conditions of adulthood, accumulating evidence indicates that many musculoskeletal problems originate during childhood and adolescence, when rapid skeletal growth, behavioural habits, and movement patterns are established [3–5]. Contemporary educational and lifestyle practices, including prolonged sitting, reduced physical activity, and extensive use of digital technologies, have substantially altered adolescents' postural behaviours, contributing to growing concerns regarding spinal health worldwide [3, 4, 6]. In one of the largest epidemiological studies conducted to date, Yang et al. reported that 65.3% of 595,057 Chinese schoolchildren demonstrated incorrect postural alignment during routine classroom activities [7]. Similarly, neck, shoulder, and low back pain are increasingly reported among adolescents, with poor ergonomics, prolonged screen exposure, and sedentary lifestyles consistently identified as important contributing factors [8, 9]. In Nigeria, Ayanniyi et al. reported a substantial prevalence of back pain among secondary school students, underscoring adolescent musculoskeletal health as an important public health concern in low- and middle-income settings [10]. Furthermore, longitudinal evidence suggests that musculoskeletal pain experienced during childhood and adolescence often persists into adulthood, highlighting the importance of early preventive interventions targeting modifiable behavioural risk factors [5].

Poor postural behaviour is increasingly recognised as a modifiable health behaviour influenced by knowledge, environmental influences, and behavioural reinforcement rather than merely a biomechanical problem [11–14]. Despite spending considerable time sitting in classrooms and using digital devices, many adolescents receive little or no structured education on spinal health, ergonomics, and healthy body mechanics [12–15]. Prolonged smartphone use, poor classroom ergonomics, inappropriate school furniture, and excessive screen exposure have been associated with altered spinal posture and musculoskeletal discomfort among school-aged children [6, 7, 11]. Consequently, improving adolescents' knowledge of healthy postural habits is increasingly recognised as an important strategy for promoting musculoskeletal health and preventing posture-related disorders [13–15]. Although knowledge alone may not ensure behavioural change, school-based postural education programmes have consistently demonstrated significant improvements in adolescents' knowledge of back care and healthy postural practices [13–15].

Schools are widely recognised as effective settings for health promotion because they provide sustained opportunities to influence health behaviours during critical stages of physical, cognitive, and social development [16]. Within this context, physiotherapists possess specialised expertise in biomechanics, ergonomics, movement analysis, exercise prescription, and musculoskeletal health promotion, making

them well positioned to design and deliver evidence-based postural education programmes [17]. The present study was conceptually informed by Bandura's Social Cognitive Theory (SCT), which proposes that health behaviours develop through reciprocal interactions between personal, behavioural, and environmental factors. The intervention was designed to incorporate key SCT constructs, including observational learning through live demonstrations, behavioural capability through structured teaching, guided practice with corrective feedback, reinforcement through repeated educational sessions, and self-efficacy by encouraging participants to practise healthy postural behaviours during daily activities. These strategies are recognised as important mechanisms for promoting knowledge acquisition and facilitating sustainable behaviour change, making SCT an appropriate theoretical framework for school-based postural education interventions [18]. Evidence supporting school-based postural education has grown considerably over the past decade. Randomised controlled trials and quasi-experimental studies consistently demonstrate improvements in adolescents' knowledge of posture, back care, and ergonomic practices following structured educational programmes [13–15]. A recent systematic review further concluded that school-based back care education effectively improves back care knowledge and related preventive behaviours, although evidence for reducing back pain prevalence remains inconclusive [19]. Nevertheless, the review also highlighted methodological limitations across existing studies, including heterogeneous intervention protocols, short follow-up periods, inconsistent outcome measures, and reliance on self-reported outcomes, underscoring the need for more rigorously designed educational intervention studies with transparent reporting and robust analytical methods [19].

Despite growing international interest in school-based postural education, evidence from sub-Saharan Africa remains limited. Differences in educational environments, classroom ergonomics, and school environments may limit the applicability of findings from high-income countries to Nigerian adolescents. Furthermore, although previous Nigerian studies have documented the prevalence of adolescent musculoskeletal pain, few have evaluated structured school-based educational interventions to improve knowledge of healthy postural habits. Generating context-specific evidence is therefore essential for informing school health practice and strengthening physiotherapy-led musculoskeletal health promotion in Nigerian schools. Addressing this evidence gap may support the integration of physiotherapist-led postural education into school health programmes aimed at promoting lifelong musculoskeletal health.

Therefore, this study aimed to evaluate the effectiveness of a physiotherapist-led school-based postural education programme in improving knowledge of healthy postural habits among Nigerian adolescents. We hypothesised that adolescents who received the intervention would demonstrate significantly greater post-intervention knowledge than those in the control group.

Methods

Study design

This controlled quasi-experimental study employed a two-group pretest–posttest design to evaluate the effectiveness of a physiotherapist-led school-based postural education programme on adolescents'

knowledge of healthy postural habits in Enugu State, Nigeria. Two lesson centres received the educational intervention, while two comparable lesson centres served as controls. Outcome assessments were conducted at baseline and three weeks after completion of the intervention. The study was reported in accordance with the Transparent Reporting of Evaluations with Non-randomized Designs (TREND) Statement for non-randomized intervention studies [20]. Ethical approval was obtained from the Health Research Ethics Committee of the University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu, Nigeria (Approval No.: NHREC/05/01/2008B-FWA00002458-1RB00002323).

Study setting

The study was conducted in Enugu metropolis, Enugu State, Nigeria, between (May) and (August). Enugu is a major urban centre in southeastern Nigeria with numerous private lesson centres that provide supplementary academic instruction for secondary school students preparing for national examinations. Four lesson centres participated in the study: Faraday Academy and His Grace Lesson Centre comprised the intervention group, whereas Prizewinner Remedial College and Ivy-League Tutorial College served as the control group. Separate lesson centres were used to minimise contamination between participants.

Participants

The study population comprised apparently healthy adolescents aged 12–17 years attending four selected lesson centres in Enugu metropolis, Nigeria, during the study period.

Participants were eligible if they: (i) were aged 12–17 years; (ii) were enrolled in one of the participating lesson centres; (iii) were able to understand and complete the study questionnaires; and (iv) provided written assent with written informed consent obtained from a parent or legal guardian.

Participants were excluded if they: (i) had neurological, musculoskeletal, or cognitive disorders that could affect participation; (ii) had previously received structured postural education within the preceding 12 months; or (iii) returned incomplete questionnaires or withdrew before completion of the study.

Sample size determination

The minimum sample size was determined using Cochran's formula for estimating sample size for large populations: $n = \frac{Z^2 p(1-p)}{d^2}$ where n is the required sample size, Z = 1.96 corresponding to a 95% confidence level, p = 0.653 based on the reported prevalence of poor postural habits among schoolchildren by Yang et al. [7], and d = 0.05 representing the desired precision. The calculated minimum sample size was 348 participants. However, data collection was conducted during the school holiday period, when attendance at lesson centres was substantially reduced. Consequently, only 200 eligible adolescents were available and recruited into the study. Although the target sample size was not

achieved, all eligible participants who met the inclusion criteria and provided informed consent/assent were enrolled. No interim analyses or stopping rules were planned or implemented.

Patient and Public Involvement

Patients and members of the public were not involved in the design, conduct, reporting, or dissemination of this study. The intervention and outcome measures were informed by published evidence and validated assessment instruments.

Sampling and Group Allocation

A multistage sampling approach was employed. Four eligible lesson centres in Enugu metropolis were selected using cluster sampling. Subsequently, eligible adolescents within each centre were recruited consecutively using convenience sampling until the required sample size was achieved. Because the intervention was delivered at the lesson-centre level, individual randomisation was not feasible. Following selection, two lesson centres were purposively assigned to the intervention group and two to the control group based on logistical feasibility while ensuring comparable student populations, consistent with recommendations for educational intervention studies and non-randomized designs [20, 21]. The lesson centre was the unit of assignment to study condition, whereas the individual adolescent was the unit of analysis. Because only four lesson centres participated and outcome measurements were obtained at the individual level, analyses were performed at the participant level with adjustment for important baseline covariates. Due to the nature of the educational intervention, blinding of participants and the physiotherapist delivering the intervention was not feasible. However, standardized outcome assessment procedures were applied across both groups to minimise assessment bias.

Intervention

The intervention comprised a physiotherapist-led school-based postural education programme designed to improve adolescents' knowledge of healthy postural habits. The programme was developed from previously published school-based back care education programmes and current recommendations on spinal health, ergonomics, and posture education for adolescents [13–19]. A licensed physiotherapist with experience in musculoskeletal rehabilitation and health promotion delivered the intervention. To minimise variability attributable to differences in educator experience or teaching style, the same physiotherapist conducted all intervention sessions using a standardized protocol.

The intervention was delivered over a three-week period, during which participants attended one 45-minute face-to-face educational session each weekday (Monday to Friday), resulting in a total of 15 supervised sessions. Each session combined didactic lectures, practical demonstrations, guided discussions, supervised practice, and reinforcement of previously taught concepts. Educational content included the anatomy and function of the spine, characteristics of good and poor posture, consequences

of prolonged poor postural habits, ergonomic principles for sitting, standing, reading, writing, lifting, carrying schoolbags, and using smartphones and computers, as well as simple posture-corrective stretching exercises appropriate for adolescents. Teaching was supported with illustrated posters, live demonstrations, and printed educational pamphlets summarising the key messages. Participants were actively engaged throughout the programme by identifying incorrect postures, practising recommended postural techniques, participating in interactive discussions, and asking questions to reinforce learning.

Intervention fidelity was maintained by delivering all sessions using the same physiotherapist, a standardized lesson plan, identical educational materials, a consistent teaching sequence, and uniform session duration across both intervention centres. The same educational content was delivered throughout the intervention period to ensure that all planned learning objectives were achieved consistently. Participant engagement was promoted through repeated supervised practice, interactive questioning, reinforcement of key concepts, and opportunities for feedback during each session.

Participants allocated to the control group continued their usual academic activities without receiving postural education during the study period. To ensure ethical fairness, the educational programme and accompanying educational pamphlets were offered to the control group after completion of post-intervention data collection. Participants received the intervention in groups within their respective lesson centres during scheduled educational sessions. Attendance was recorded at each of the 15 intervention sessions, and adherence to the intervention schedule was monitored throughout the study. All participants allocated to the intervention group completed the educational programme. No intervention-related adverse events were reported.

Outcome measures

The primary outcome was adolescents' knowledge of healthy postural habits, assessed at baseline and three weeks after the intervention using the Health and Back Care Knowledge Related to Daily Life (HEBACAKNOW-DL) and Health and Back Care Knowledge Related to Physical Activity and Exercise (HEBACAKNOW-PAE) questionnaires. These questionnaires are components of the validated HEBACAKNOW instrument, which assesses adolescents' knowledge of appropriate spinal posture, ergonomic principles during daily activities, and posture-related physical activity and exercise. The HEBACAKNOW instrument demonstrated good psychometric properties, including good internal consistency (Cronbach's $\alpha = 0.82$), satisfactory test–retest reliability (ICC = 0.76), and acceptable construct validity among adolescent populations [21].

Secondary outcomes included self-reported postural habits, musculoskeletal symptoms, and anthropometric characteristics. Self-reported postural habits were assessed using the Back Pain and Body Posture Evaluation Instrument (BackPEI), which demonstrated good content validity and good to very good test–retest reproducibility ($\kappa = 0.60$ to > 0.80), with the pain intensity item showing excellent reliability (ICC = 0.937) [22]. Musculoskeletal symptoms were assessed using the Extended Nordic

Musculoskeletal Questionnaire (NMQ-E), a standardized instrument with excellent test–retest reliability (ICC = 0.90–0.97) for epidemiological assessment of musculoskeletal disorders [23].

Anthropometric measurements included height, weight, and body mass index (BMI). Height was measured to the nearest 0.1 cm using a calibrated portable stadiometer, while body weight was measured to the nearest 0.1 kg using a calibrated digital weighing scale, with participants wearing light clothing and no shoes. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2).

Data collection procedures

Data were collected over a four-week period following a standardized protocol across all participating lesson centres. Prior to data collection, permission was obtained from the management of each participating lesson centre. Written informed consent was obtained from parents or legal guardians, and written assent was obtained from all participating adolescents.

At baseline (Week 0), participants completed a structured questionnaire comprising demographic information, the Extended Nordic Musculoskeletal Questionnaire (NMQ-E), the Back Pain and Body Posture Evaluation Instrument (BackPEI), the Health and Back Care Knowledge Related to Daily Life (HEBACAKNOW-DL) questionnaire, and the Health and Back Care Knowledge Related to Physical Activity and Exercise (HEBACAKNOW-PAE) questionnaire. Height and body weight were subsequently measured using standardized anthropometric procedures. All baseline and follow-up assessments were conducted by trained members of the research team using standardized procedures to ensure consistency in data collection.

Following completion of the baseline assessment, participants in the intervention group received the physiotherapist-led school-based postural education programme over a three-week period (Weeks 1–3). The programme comprised one 45-minute supervised educational session each weekday (Monday to Friday), resulting in a total of 15 sessions. Participants in the control group continued their usual academic activities without receiving postural education during the study period. To minimise contamination, intervention and control participants were recruited from different lesson centres.

At the end of the intervention period (Week 4), participants in both groups completed the NMQ-E, BackPEI, HEBACAKNOW-DL, and HEBACAKNOW-PAE questionnaires using the same standardized procedures employed at baseline. All questionnaires were administered under researcher supervision to minimise missing data and provide clarification where necessary without influencing participants' responses. Completed questionnaires were checked immediately for completeness and consistency before data entry. Participants with missing post-intervention outcome data were excluded from the primary analysis using a complete-case approach because the proportion of missing data was minimal.

Statistical analysis

Data were analysed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Data were screened for completeness, consistency, and accuracy before analysis. Continuous variables were summarised using means and standard deviations (SD), whereas categorical variables were presented as frequencies and percentages.

The assumptions underlying parametric analyses were assessed prior to hypothesis testing. Normality of continuous variables was evaluated using the Shapiro–Wilk test, histograms, and normal Q–Q plots. Homogeneity of variances was assessed using Levene's test, while assumptions of linearity and homogeneity of regression slopes were evaluated before performing analysis of covariance (ANCOVA). Baseline demographic, anthropometric, and clinical characteristics of the intervention and control groups were summarised descriptively to assess group comparability. Consistent with recommendations for controlled intervention studies, formal statistical significance testing of baseline characteristics was not emphasised [20, 21].

The primary analysis evaluated the effect of the intervention on post-intervention knowledge of healthy postural habits using analysis of covariance (ANCOVA). Separate ANCOVA models were fitted for the post-intervention HEBACAKNOW-DL and HEBACAKNOW-PAE scores, with study group (intervention or control) entered as the fixed factor and the corresponding baseline knowledge score included as a covariate. Age, sex, and body mass index (BMI) were included as prespecified covariates to improve the precision of treatment effect estimates and account for potential confounding. Intervention effects were reported as adjusted mean differences with 95% confidence intervals (95% CIs). Effect sizes were expressed as partial eta squared (η^2p) and interpreted according to conventional thresholds (small = 0.01, medium = 0.06, and large = 0.14). Cohen's *d* was additionally calculated to quantify the magnitude of between-group differences in post-intervention knowledge scores.

Secondary analyses evaluated post-intervention postural behaviours assessed using the Back Pain and Body Posture Evaluation Instrument (BackPEI). Binary behavioural outcomes were analysed using multivariable logistic regression, with study group entered as the independent variable and adjustment made for baseline behavioural status, age, sex, and body mass index. Results were reported as adjusted odds ratios (ORs) with 95% confidence intervals (95% CIs).

Participants with incomplete post-intervention outcome data were excluded from the primary analysis using a complete-case approach because the proportion of missing data was minimal. All statistical tests were two-tailed, and statistical significance was set at $p < 0.05$.

Ethical considerations

Ethical approval was obtained from the Health Research Ethics Committee of the University of Nigeria Teaching Hospital (UNTH), Ituku-Ozalla, Enugu, Nigeria (Approval No.: NHREC/05/01/2008B-FWA00002458-1RB00002323). Permission to conduct the study was obtained from the management of all participating lesson centres before participant recruitment.

Written informed consent was obtained from parents or legal guardians, while written assent was obtained from all participating adolescents before enrolment. Participation was voluntary, and participants were informed of their right to withdraw from the study at any stage without penalty. Participant confidentiality was maintained by anonymising all data before analysis. The study was conducted in accordance with the principles of the Declaration of Helsinki and its subsequent amendments.

Reporting guideline

This study is reported in accordance with the Transparent Reporting of Evaluations with Non-randomized Designs (TREND) Statement [20].

Results

Participant flow

A total of 245 adolescents were assessed for eligibility, of whom 38 were excluded because they did not meet the inclusion criteria (n = 26) or parental consent was not obtained (n = 12). Consequently, 207 participants were enrolled. Of these, 105 participants were allocated to the intervention group and 102 to the control group. Before baseline assessment, five participants in the intervention group and two participants in the control group did not report to their respective lesson centres and were therefore not included in the study. A total of 200 adolescents (100 intervention and 100 control) completed the study and were included in the final analysis. No participants were lost to follow-up after baseline assessment, and no participants were excluded from the final analysis (Figure 1).

Baseline demographic and anthropometric characteristics of participants

The baseline demographic and anthropometric characteristics of the participants are presented in Table 1. A total of 200 adolescents were included in the analysis, comprising 100 participants in the intervention group and 100 participants in the control group. The overall mean age of the participants was 13.71 ± 1.59 years, and 101 (50.5%) were male. Overall, the intervention and control groups were broadly comparable with respect to age, sex distribution, height, weight, and body mass index at baseline.

Table 1. Baseline demographic and anthropometric characteristics of participants

Characteristic	Intervention (n = 100)	Control (n = 100)	Total (N = 200)
Age (years), mean ± SD	13.77 ± 1.65	13.64 ± 1.53	13.71 ± 1.59
Male, n (%)	42 (42.0)	59 (59.0)	101 (50.5)
Female, n (%)	58 (58.0)	41 (41.0)	99 (49.5)
Height (m), mean ± SD	1.62 ± 0.11	1.62 ± 0.09	1.62 ± 0.10
Weight (kg), mean ± SD	47.15 ± 12.23	51.00 ± 12.22	49.08 ± 12.35
Body mass index (kg/m²), mean ± SD	17.84 ± 3.30	19.17 ± 3.71	18.51 ± 3.56

Baseline outcome measures

Baseline outcome measures are presented in Table 2, while detailed baseline behavioural characteristics assessed using the Back Pain and Body Posture Evaluation Instrument (BackPEI) and baseline musculoskeletal symptom profiles assessed using the Extended Nordic Musculoskeletal Questionnaire (NMQ-E) are provided in Supplementary Tables S1 and S2, respectively. At baseline, the intervention and control groups demonstrated broadly comparable knowledge scores for healthy postural habits, with mean HEBACAKNOW-DL scores of 15.82 ± 3.21 and 15.47 ± 3.34, respectively, and mean HEBACAKNOW-PAE scores of 17.36 ± 3.58 and 17.09 ± 3.71, respectively (Table 2). Baseline behavioural characteristics were also generally comparable between the two groups. Across the study population, 62.0% of participants reported engaging in regular physical exercise, 62.0% carried their school backpack on both shoulders, and only 27.5% demonstrated correct sitting posture while using a computer (Supplementary Table S1). Musculoskeletal symptoms were most frequently reported in the lower back (40.0%), followed by the neck (29.0%) and shoulders (23.0%) (Supplementary Table S2).

Table 2. Baseline postural knowledge scores of participants

Outcome	Intervention (n = 100)	Control (n = 100)	Total (N = 200)
HEBACAKNOW-DL score, mean ± SD	15.82 ± 3.21	15.47 ± 3.34	15.65 ± 3.27
HEBACAKNOW-PAE score, mean ± SD	17.36 ± 3.58	17.09 ± 3.71	17.23 ± 3.6

Effect of the intervention on postural knowledge

The effects of the physiotherapist-led postural education programme on postural knowledge are presented in Table 3. After adjustment for baseline knowledge scores, age, sex, and body mass index using analysis of covariance (ANCOVA), adolescents in the intervention group demonstrated significantly higher post-intervention knowledge scores than those in the control group for both outcome measures. For the HEBACAKNOW-DL questionnaire, the adjusted mean difference was 9.39 points (95%

CI 8.54 to 10.24; $p < 0.001$), with the intervention accounting for 58.2% of the variance in post-intervention scores (partial $\eta^2 = 0.582$) and a large standardized effect size (Cohen's $d = 1.96$). Similarly, for the HEBACAKNOW-PAE questionnaire, the adjusted mean difference was 11.16 points (95% CI 10.20 to 12.12; $p < 0.001$), with the intervention explaining 64.8% of the variance in post-intervention scores (partial $\eta^2 = 0.648$) and a large standardized effect size (Cohen's $d = 2.18$).

Table 3. Adjusted post-intervention knowledge scores following the physiotherapist-led postural education programme

Outcome measure	Intervention (Adjusted Mean ± SE)	Control (Adjusted Mean ± SE)	Adjusted Mean Difference (95% CI)	*p*-value	Partial η^2	Cohen's *d*
HEBACAKNOW-DL	26.81 ± 0.31	17.42 ± 0.31	9.39 (8.54 to 10.24)	<0.001	0.582	1.96
HEBACAKNOW-PAE	29.47 ± 0.35	18.31 ± 0.35	11.16 (10.20 to 12.12)	<0.001	0.648	2.18

Abbreviations: CI, confidence interval; SE, standard error; ANCOVA, analysis of covariance.

Note: Adjusted means were estimated using ANCOVA after controlling for baseline knowledge score, age, sex, and body mass index.

Effect of the intervention on postural behaviours

The association between the physiotherapist-led postural education programme and healthy postural behaviours at the three-week follow-up is presented in Table 4. Compared with participants in the control group, adolescents who received the intervention were significantly more likely to demonstrate correct sitting posture while writing (adjusted OR = 1.87, 95% CI 1.05–3.34; $p = 0.034$) and correct sitting posture while using a computer (adjusted OR = 1.76, 95% CI 1.00–3.11; $p = 0.048$). Improvements were also observed in other healthy postural behaviours, including regular physical exercise, reading or studying outside bed, limiting television and computer use to less than 2 hours per day, obtaining at least 8 hours of sleep per night, correct lifting technique, carrying the school backpack on both shoulders, and adopting a correct sleeping posture. However, these differences did not reach statistical significance after adjustment for baseline behaviour, age, sex, and body mass index ($p > 0.05$) (Table 4).

Table 4. Association between the physiotherapist-led postural education programme and healthy postural behaviours at three-week follow-up

Behaviour	Intervention, n (%)	Control, n (%)	Adjusted OR (95% CI)	*p*-value
Regular physical exercise	67 (67.0)	62 (62.0)	1.24 (0.68–2.25)	0.48
Reading/studying outside bed†	60 (60.0)	55 (55.0)	1.23 (0.69–2.20)	0.49
Television viewing <2 h/day	49 (49.0)	45 (45.0)	1.18 (0.66–2.09)	0.58
Computer use <2 h/day	51 (51.0)	47 (47.0)	1.17 (0.66–2.07)	0.59
Sleep duration ≥8 h/night	58 (58.0)	56 (56.0)	1.09 (0.61–1.94)	0.77
Correct sitting posture while writing	48 (48.0)	33 (33.0)	1.87 (1.05–3.34)	0.034
Correct sitting posture while using a computer	42 (42.0)	29 (29.0)	1.76 (1.00–3.11)	0.048
Correct sitting posture while talking	43 (43.0)	35 (35.0)	1.40 (0.79–2.49)	0.24
Correct lifting technique	49 (49.0)	39 (39.0)	1.50 (0.85–2.66)	0.17
Backpack carried on both shoulders	67 (67.0)	62 (62.0)	1.25 (0.69–2.25)	0.46
Correct sleeping posture	41 (41.0)	37 (37.0)	1.18 (0.66–2.10)	0.58

Abbreviations: OR, odds ratio; CI, confidence interval.

Effect of the intervention on musculoskeletal symptoms

The association between the physiotherapist-led postural education programme and musculoskeletal symptoms at the three-week follow-up is presented in Table 5. Compared with the control group, participants in the intervention group demonstrated modest reductions in the prevalence of musculoskeletal symptoms across most anatomical regions. The largest reductions were observed for lower back symptoms (41.0% to 36.0%), neck symptoms (30.0% to 27.0%), and upper back symptoms (18.0% to 16.0%). However, after adjustment for baseline symptom status, age, sex, and body mass index, none of the between-group differences reached statistical significance (all $p > 0.05$).

Table 5. Association between the physiotherapist-led postural education programme and musculoskeletal symptoms at the three-week follow-up

Body region	Baseline Intervention, n (%)	Follow-up Intervention, n (%)	Baseline Control, n (%)	Follow-up Control, n (%)	Adjusted OR (95% CI)	*p*-value
Neck	30 (30.0)	27 (27.0)	28 (28.0)	28 (28.0)	0.86 (0.46–1.62)	0.64
Shoulders	24 (24.0)	22 (22.0)	22 (22.0)	22 (22.0)	0.91 (0.45–1.84)	0.79
Upper back	18 (18.0)	16 (16.0)	20 (20.0)	20 (20.0)	0.76 (0.34–1.68)	0.50
Lower back	41 (41.0)	36 (36.0)	39 (39.0)	38 (38.0)	0.80 (0.45–1.42)	0.44
Elbows	7 (7.0)	6 (6.0)	6 (6.0)	6 (6.0)	0.86 (0.26–2.88)	0.81
Wrists/Hands	16 (16.0)	14 (14.0)	15 (15.0)	15 (15.0)	0.90 (0.39–2.05)	0.80
Hips/Thighs	12 (12.0)	10 (10.0)	11 (11.0)	11 (11.0)	0.89 (0.34–2.31)	0.81
Knees	20 (20.0)	18 (18.0)	18 (18.0)	18 (18.0)	0.89 (0.42–1.89)	0.76
Ankles/Feet	14 (14.0)	13 (13.0)	13 (13.0)	13 (13.0)	0.92 (0.38–2.22)	0.85

Abbreviations: OR, odds ratio; CI, confidence interval.

Note: Adjusted odds ratios were estimated using multivariable logistic regression after adjustment for baseline musculoskeletal symptoms, age, sex, and body mass index. Odds ratios <1 indicate lower odds of reporting musculoskeletal symptoms in the intervention group at follow-up.

Intervention fidelity and adverse events

The physiotherapist-led postural education programme was delivered according to the planned intervention protocol over the three-week study period. Attendance was recorded at each of the 15 educational sessions, and intervention adherence was monitored throughout the programme. All scheduled educational sessions were delivered by the same licensed physiotherapist using the standardized lesson plan and identical educational materials to ensure intervention fidelity. No

deviations from the intervention protocol were recorded during the study period. Furthermore, no intervention-related adverse events or unintended effects were reported.

Discussion

This study demonstrated that a physiotherapist-led school-based postural education programme markedly improved adolescents' knowledge of healthy postural habits and produced modest improvements in selected postural behaviours. However, these early behavioural changes were not accompanied by statistically significant reductions in musculoskeletal symptoms over the three-week follow-up period. This pattern is consistent with behavioural learning theory, whereby educational interventions typically produce rapid gains in knowledge, followed by gradual behaviour change and, over time, measurable improvements in health outcomes. Consequently, the absence of significant changes in musculoskeletal symptoms after three weeks should not be interpreted as evidence of intervention ineffectiveness but rather as reflecting the temporal sequence through which behaviour change influences clinical outcomes.

Effect of the intervention on postural knowledge

The intervention markedly improved adolescents' knowledge of healthy postural habits, demonstrating that structured physiotherapist-led postural education is an effective strategy for enhancing spinal health literacy. Similar findings have been reported by Miñana-Signes et al. [14], who observed significant improvements in back-care knowledge following school-based educational programmes, and by Akbari-Chehrehbargh et al. [13], whose theory-based intervention improved pupils' knowledge of spine care. Likewise, the systematic review by Anyachukwu et al. [19] concluded that school-based back-care education consistently improves spinal health knowledge among children and adolescents. More recent evidence also supports the effectiveness of school-based educational interventions for improving knowledge of back health and ergonomics, although the quality of evidence remains moderate because of methodological heterogeneity and the limited number of high-quality studies available [19,24].

The substantial improvement observed in this study is unsurprising because educational interventions primarily target cognitive outcomes, which are generally more responsive to structured teaching than behavioural or clinical outcomes. Participants received fifteen supervised sessions over three weeks, allowing repeated exposure to key concepts, practical demonstrations, supervised practice, feedback, and reinforcement. These educational strategies are consistent with Bandura's Social Cognitive Theory, which proposes that observational learning, guided practice, reinforcement, and self-efficacy facilitate knowledge acquisition and subsequent behaviour change [18]. Furthermore, the large effect sizes observed for both knowledge outcomes indicate that the intervention had substantial educational relevance beyond statistical significance, suggesting that the improvements are likely to be meaningful in school practice.

Although intervention studies from sub-Saharan Africa remain limited, the present findings extend the available regional evidence by demonstrating that a structured physiotherapist-led programme can

effectively improve postural health knowledge among Nigerian adolescents. Given differences in educational resources, classroom ergonomics, and access to school health services between many African settings and high-income countries, these findings provide important context-specific evidence supporting school-based musculoskeletal health promotion.

Effect of the intervention on postural behaviours

The intervention also resulted in significant improvements in selected postural behaviours, particularly correct sitting posture while writing and computer use. These findings suggest that improved knowledge can facilitate early behaviour change when educational activities are reinforced through practical demonstrations and supervised practice. Similar improvements have been reported by Miñana-Signes et al. [14] and Galmés-Panadés and Vidal-Conti [15], while the systematic review by Anyachukwu et al. [19] concluded that school-based back-care education generally improves posture-related behaviours among school-aged children.

Nevertheless, knowledge alone is insufficient to sustain behaviour change. Environmental opportunities, parental support, habitual practice, and self-regulation all influence whether newly acquired knowledge is translated into long-term behavioural modification. In the present study, correct writing posture and computer posture were repeatedly demonstrated and practised during the intervention sessions, making them more amenable to short-term improvement. Conversely, behaviours such as backpack carriage, lifting technique, sleeping posture, and recreational screen use are largely influenced by home environments and daily lifestyle practices, and therefore may require longer intervention periods, continued reinforcement, and active involvement of parents and teachers before meaningful behavioural changes become established.

Effect of the intervention on musculoskeletal symptoms

Although modest reductions in musculoskeletal symptoms were observed across several anatomical regions, these changes were not statistically significant after three weeks. This finding is biologically plausible because musculoskeletal symptoms generally develop following prolonged cumulative mechanical loading and repeated exposure to poor postural habits. Consequently, improvements in postural knowledge achieved over a relatively short period are unlikely to immediately reverse symptoms that may have developed over months or years. Previous systematic reviews have similarly concluded that school-based postural education consistently improves knowledge and posture-related behaviours but demonstrates less consistent effects on musculoskeletal pain outcomes, particularly over short follow-up periods [19].

The relatively short follow-up period may also explain the absence of significant symptom reduction. Adolescent musculoskeletal symptoms are multifactorial and are influenced by growth, physical activity, prolonged screen use, psychosocial factors, and environmental exposures, including ergonomic conditions at school and home [25]. These factors were not directly modified by the intervention and may have attenuated its short-term clinical impact. Therefore, while improvements in knowledge and

behaviour represent important intermediate outcomes, longer-term follow-up is required to determine whether these changes ultimately translate into sustained reductions in musculoskeletal symptoms [19, 26].

Clinical implications

The findings support the integration of physiotherapist-led postural education into school and community health programmes as a feasible strategy for promoting adolescent spinal health. Physiotherapists possess expertise in movement analysis, ergonomics, spinal biomechanics, exercise prescription, and motor learning, making them well positioned to deliver evidence-based educational programmes that combine theoretical instruction with practical skill acquisition. These findings are consistent with the preventive role of physiotherapists advocated by World Physiotherapy [17].

Given the increasing prevalence of sedentary behaviours and technology-related postural problems among adolescents, integrating structured postural education into school health programmes may strengthen musculoskeletal health literacy and establish healthy movement behaviours before maladaptive postural habits become firmly established. Although longer follow-up is required to demonstrate sustained clinical benefits, the observed improvements in knowledge and selected behaviours provide a strong rationale for incorporating physiotherapist-led postural education into existing school health promotion initiatives.

Strengths and limitations

This study has several strengths. It employed a controlled intervention design, delivered a standardized physiotherapist-led educational programme over fifteen supervised sessions, and used validated outcome measures with established psychometric properties. The intervention was delivered by the same physiotherapist using a standardized protocol, thereby enhancing intervention fidelity and facilitating reproducibility. Furthermore, the analyses adjusted for baseline outcome scores and important participant characteristics, improving the precision of treatment effect estimates and strengthening the internal validity of the findings.

Several limitations should nevertheless be acknowledged. The non-randomized design may have introduced selection bias despite statistical adjustment for potential confounders. The three-week intervention and follow-up period limited opportunities for behavioural consolidation and symptom resolution. In addition, postural behaviours and musculoskeletal symptoms were assessed using self-reported questionnaires and may therefore be subject to reporting bias. Objective assessments of posture or movement quality were not performed; therefore, improvements in self-reported postural behaviours could not be corroborated using observational or biomechanical measures. Finally, the study was conducted in lesson centres within a single metropolitan area, which may limit the generalisability of the findings to other educational settings.

Conclusion

A physiotherapist-led school-based postural education programme delivered over three weeks significantly improved adolescents' knowledge of healthy postural habits and produced modest improvements in selected postural behaviours. Although musculoskeletal symptoms showed small reductions, these changes were not statistically significant during the study period. These findings provide preliminary evidence supporting the integration of structured physiotherapist-led postural education into school health programmes to promote adolescent spinal health. Future studies should evaluate longer intervention periods, incorporate objective measures of posture, involve parents and teachers in behaviour-change strategies, and determine whether improvements in knowledge and behaviour translate into sustained reductions in musculoskeletal symptoms.

Abbreviations

ANCOVA
Analysis of Covariance
BackPEI
Back Pain and Body Posture Evaluation Instrument
BMI
Body Mass Index
CI
Confidence Interval
HEBACAKNOW
DL–Health and Back Care Knowledge Related to Daily Life
HEBACAKNOW
PAE–Health and Back Care Knowledge Related to Physical Activity and Exercise
NMQ
E–Extended Nordic Musculoskeletal Questionnaire
OR
Odds Ratio
Q
BAPHYP–Questionnaire for Back Pain and Body Posture Evaluation in Young People
RCT
Randomized Controlled Trial
SD
Standard Deviation
SPSS
Statistical Package for the Social Sciences
TREND
Transparent Reporting of Evaluations with Non–randomized Designs
UNTH
University of Nigeria Teaching Hospital

WHO
World Health Organization

Declarations

Author Contributions

AIO and CA conceived the study. KEF and JLE developed the study concept, research questions, and study design. AIO and KEF coordinated participant recruitment, data collection, intervention implementation, and data analysis. CA supervised the study and provided methodological guidance throughout the research process. CNU and JLE contributed to the interpretation of the findings and critically revised the manuscript for important intellectual content. KEF and AIO drafted the manuscript. All authors reviewed, revised, and approved the final version of the manuscript.

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Competing Interests

The authors declare that they have no competing interests.

Data Availability

The datasets generated and analysed during the current study are not publicly available because they contain potentially identifiable information from participants who are minors but are available from the corresponding author on reasonable request, subject to ethical approval and institutional requirements.

Clinical Trial Registration Clinical trial number

Not applicable.

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Health Research Ethics Committee of the University of Nigeria Teaching Hospital (UNTH), Ituku-Ozalla, Enugu, Nigeria (Approval No.: Approval No.: NHREC/05/01/2008B-FWA00002458-1RB00002323). Permission to conduct the study was also obtained from the management of the participating lesson centres. Written informed consent was obtained from the parents or legal guardians of all participants, while written assent was obtained from all adolescents before enrolment. The study was conducted in accordance with the principles of the Declaration of Helsinki and its subsequent amendments.

Consent for Publication

Not applicable.

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Figures

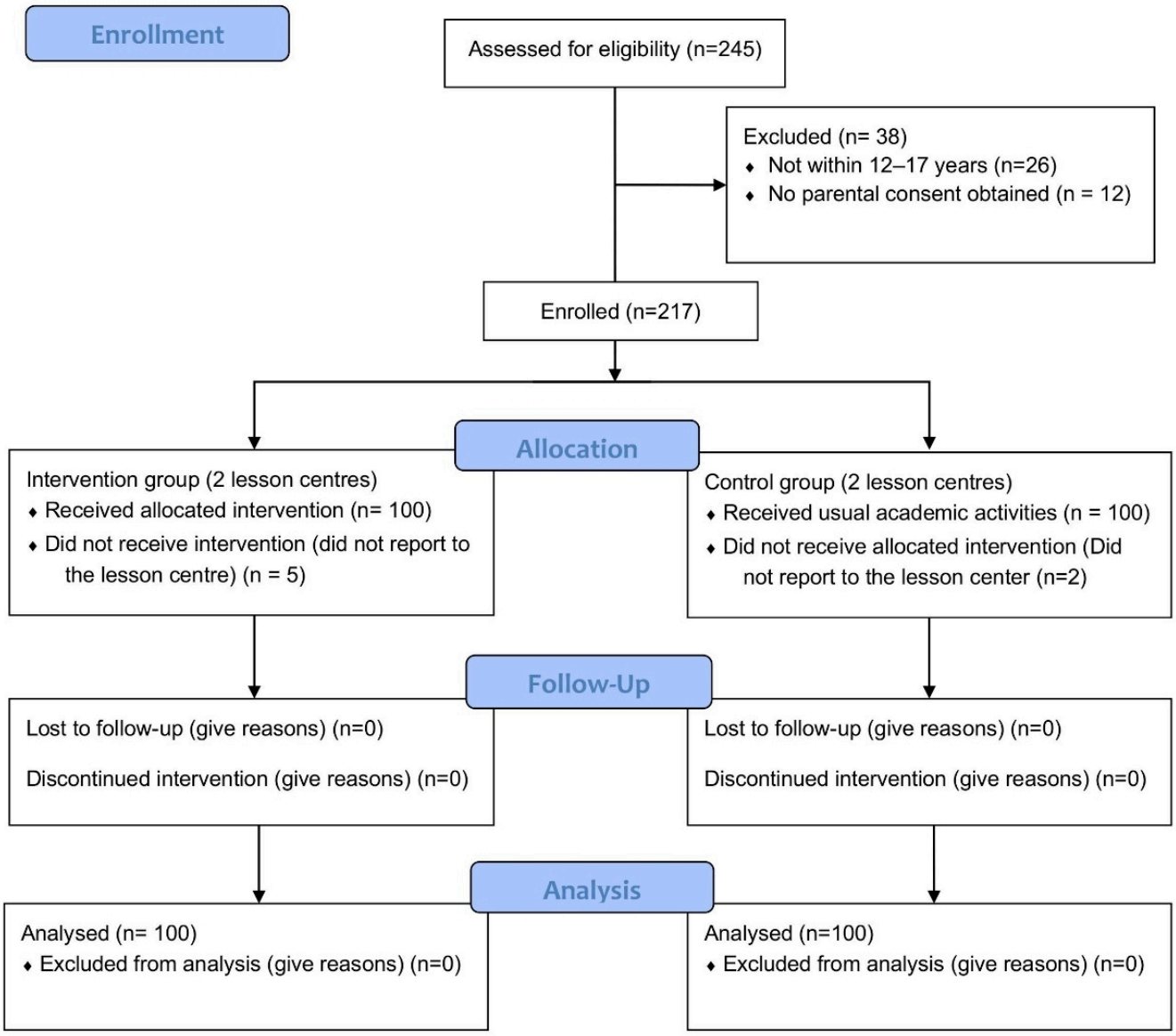


Figure 1

TREND flow diagram showing participant recruitment, allocation, follow-up, and analysis.

Supplementary Files

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