

Effectiveness of a School-Based Exercise Intervention for Forward Head Posture and Neck Functional Disability among Adolescents: A Randomized Controlled Trial

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ABSTRACT

Background: Forward head posture (FHP) is common among adolescents and may affect cervical alignment and neck function. Early intervention may help prevent potential functional consequences. As adolescents spend much of their time at school, the school setting provides a practical opportunity to deliver accessible and structured interventions. Therefore, school-based exercise may be a feasible approach to improving cervical posture and neck function among adolescents with FHP.

Subjects and Method: This randomized controlled trial included 70 adolescents aged 15–17 years with FHP, comprising 35 participants in the school-based exercise group (intervention group) and 35 participants in the ergonomic education group (control group). The outcome variables were cervical posture and neck functional status, assessed using the craniovertebral angle (CVA) and Neck Disability Index (NDI), respectively. The intervention was conducted for three weeks, with assessments performed at four time points: baseline, week 1, week 2, week 3. Longitudinal changes in CVA and NDI were analyzed separately using linear mixed-effects models including treatment group, time, and group $\times$ time interaction, with participant included as a random intercept.

Results: A significant group $\times$ time interaction was observed for CVA ($F = 27.450$, $p < 0.001$), indicating that the trajectory of CVA over time differed between the Intervention and Control groups. The estimated marginal mean (EMM) of CVA increased from 47.943° at baseline to 51.743° at week 3 in the intervention group, compared with an increase from 47.943° to 48.629° in the Control group, corresponding to a between-group difference in change of 3.114° (95% CI 2.35–3.88). A significant group $\times$ time interaction was also observed for NDI ($F = 13.626$, $p < 0.001$), indicating that the trajectory of NDI over time differed between the Intervention and Control groups. The EMM of NDI decreased from 5.800 to 3.400 in the Intervention group and from 5.857 to 4.857 in the Control group, corresponding to a between-group difference in change of -1.400 (95% CI -1.88 to -0.92).

Conclusion: School-based exercise was associated with greater improvements in cervical posture and reductions in neck disability than ergonomic education among adolescents with FHP. These findings indicate that school-based exercise may be a feasible approach for addressing postural and neck-related problems in school settings, although the short follow-up period limits interpretation of longer-term effects.

Keywords: forward head posture, school-based exercise, craniovertebral angle, neck disability, adolescents

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BACKGROUND

Forward head posture (FHP) is a common postural alteration in which the head is positioned anteriorly relative to the trunk. This condition may be accompanied by changes in cervical alignment and muscle activity and may be associated with neck pain and functional limitations (Mahmoud et al., 2019; Romadhoni and Ramadhani, 2024; Amrullah et al., 2025). Musculoskeletal problems are also recognized as an important health concern during childhood and adolescence, when physical development and daily activity patterns may influence musculoskeletal health (Faienza et al., 2023). Evidence from school-based populations has shown that musculoskeletal disorders are already present among secondary-school students, musculoskeletal disorders have been reported in substantial proportions of both general and technical school populations, reaching 69.7% and 83.8%, respectively (Atia et al., 2023). Neck pain also represents an important health concern among children and adolescents. A recent GBD 2021 analysis estimated 10.32 million cases of neck pain among children and adolescents globally in 2021, with the highest prevalence rate observed in the 15–19 year age group (Sun et al., 2025). In the present study setting, preliminary screening of 12 students identified FHP accompanied by reduced neck functional ability in 8 students (66.67%), providing local context for the problem addressed in this study.

Contemporary adolescent lifestyles may increase exposure to prolonged sitting and electronic-device use. Frequent smart-phone use, prolonged screen time, sedentary behavior, and inappropriate sitting posture may expose adolescents to sustained or

unfavorable head and neck positions during studying and electronic-device activities. A systematic review and meta-analysis reported a significant association between prolonged mobile-phone use and neck pain among children and adolescents (Mahdavi et al., 2022). Research on sitting posture has also identified a relationship between sitting posture and neck pain, supporting the relevance of prolonged and inappropriate postural exposure as a potentially modifiable factor (Putra and Pristianto, 2023). Similar concerns regarding prolonged non-ergonomic positioning and its relationship with neck muscle tension, pain, and functional limitations have been reported in other populations (Indana et al., 2021; Pristianto et al., 2023). Studies addressing forward head posture have likewise emphasized the relevance of postural habits and corrective strategies in managing cervical postural problems (Romadhoni and Ramadhani, 2024). However, the relationship between electronic-device use and postural changes should not be interpreted as purely causal, as evidence regarding electronic screens and adolescent head and neck posture remains heterogeneous.

The relevance of FHP and neck-related functional limitations extends beyond individual postural or pain complaints. Neck problems may interfere with activities that require sustained sitting, reading, studying, and the use of electronic devices, potentially affecting physical functioning and participation in everyday and school-related activities. These limitations may also influence quality of life when neck problems interfere with routine academic and daily activities. In adolescents with FHP, postural awareness and physiotherapy-based interventions

have also been investigated in relation to neck pain, suggesting that postural problems may have functional implications during the school years (Amrullah et al., 2025). Neck-related functional limitations are also commonly evaluated using the Neck Disability Index (NDI), which captures the extent to which cervical problems affect daily activities and functional status (Vetiani et al., 2022; Abdullah and Pristianto, 2024). More broadly, maintaining musculoskeletal health during childhood and adolescence is important because musculoskeletal problems may influence physical activity and everyday functioning across this developmental period (Faenza et al., 2023). Addressing modifiable musculoskeletal problems during adolescence may therefore be relevant to early prevention and to reducing the potential burden of musculoskeletal problems later in life.

From a public health perspective, schools provide an accessible setting for reaching adolescents through health promotion and early intervention. School-based programs can support adolescent health by addressing health-related behaviors and the school environment (Xu et al., 2020). Classroom-based interventions have also been explored to reduce sedentary behavior and support spinal health among school-children (Fisher and Louw, 2022). In addition, the relationship between sitting posture and neck pain highlights the importance of addressing modifiable postural and ergonomic factors (Putra and Pristianto, 2023).

Compared with clinic-based rehabilitation, school-based approaches may allow adolescents to receive preventive and early interventions within their routine environment, potentially improving feasibility and reach. Their delivery through schools may also facilitate the implementation of scalable strategies for adolescent musculoskeletal

health. Therefore, school-based exercise and ergonomic education may provide a practical approach to promoting musculoskeletal health and addressing postural problems during adolescence.

Although previous studies have examined McKenzie Exercise, Neck Calliet Exercise, postural awareness, and other physiotherapy approaches for FHP and neck-related problems (Kim et al., 2019; Wulan et al., 2023; Chaiyawijit and Kanlayanaphotporn, 2024; Laksmi et al., 2024; Yani and Gani, 2024), evidence on their use as a combined, structured intervention in school-based adolescent populations remains limited. In particular, few studies have evaluated an intervention that addresses both cervical posture and neck functional ability within a school setting. Addressing this gap may contribute to the development of accessible approaches for early management and promotion of adolescent musculoskeletal health. Therefore, the present study examined the effectiveness of School-based Exercise, combining McKenzie Exercise and Neck Calliet Exercise, on cervical posture and neck functional ability among adolescents with FHP.

SUBJECTS AND METHOD

1. Study Design

This was a randomized controlled trial (RCT). The study was conducted at Islamic Senior High School 1 Surakarta, Central Java, Indonesia, from June to July 2026. All eligible participants were recruited before random allocation. Participants were assigned to the school-based exercise or ergonomic education group using random numbers generated in Microsoft Excel. The allocation was determined only after completion of the randomization procedure and was not known or predictable by the researcher before assignment. Both interventions were delivered by the researcher.

Due to the nature of the interventions, participants and the intervention provider were not blinded to group allocation. Outcome assessors (enumerators) were aware of the two study groups but were blinded to the group assignment of individual participants throughout all CVA and NDI assessments. Data analysis was conducted with knowledge of group allocation.

2. Population and Sample

The study population was students aged 15–17 years old. All 120 students at Islamic Senior High School 1 Surakarta were screened for eligibility based on the predefined inclusion and exclusion criteria. The inclusion criteria were students with CVA $<50^\circ$, had mild-to-moderate neck pain, and able to follow the exercise instructions. The exclusion criteria were a history of neck injury or surgery, neurological disorders that could affect exercise, severe postural or spinal abnormalities, and participation in other neck-related exercise programs during the study period. Of the 120 students screened, 70 met the eligibility criteria and were subsequently randomized, with 35 participants allocated to the school-based exercise group and 35 to the ergonomic education group. All participants completed the outcome assessments at baseline, week 2, week 3, and week 4, with 35 participants in each group at all assessment time points. No participants were lost to follow-up, withdrew from the study, or were excluded after randomization.

3. Study Variables

The independent variable was school-based exercise or ergonomic education. The outcome variables were cervical posture and neck functional ability.

4. Operational Definition of Variables

School-based exercise was defined as a combined exercise program consisting of McKenzie Exercise and Neck Calliet

Exercise. The program was intended to improve cervical posture and neck functional ability in adolescents with forward head posture (FHP).

Ergonomic Education referred to guidance on maintaining an appropriate sitting posture, neck position, and use of electronic devices during study and daily activities. This intervention was given to participants in the control group as a comparison condition.

Cervical posture was assessed in terms of the craniovertebral angle (CVA). A lower CVA reflects a more pronounced forward head position, while a higher CVA indicates better cervical alignment. In this study, participants with a CVA below 50° were classified as having FHP (Heydari et al., 2022). Changes in cervical posture were expressed as changes in CVA values in degrees ($^\circ$), with an increase in CVA indicating improvement.

Neck functional ability was defined based on the Neck Disability Index (NDI) score, which reflects the extent to which neck problems interfere with daily activities. Higher NDI scores indicate greater disability and poorer neck function, whereas lower scores indicate better functional status. A decrease in the NDI score was therefore considered an improvement in neck functional ability.

5. Study Instruments

Cervical posture was assessed using the craniovertebral angle (CVA). The CVA was obtained from a lateral-view photograph and analyzed using Kinovea software. The angle was determined from a horizontal line through the seventh cervical vertebra (C7) and a line connecting C7 to the tragus of the ear. Previous research has demonstrated good reliability of photometric CVA measurement, with an inter-rater ICC of 0.88 and an intra-rater ICC of 0.91 (Cote et al., 2021).

Neck functional ability was assessed using the Neck Disability Index (NDI). The NDI consists of 10 items addressing the effect of neck problems on daily activities, with a total score ranging from 0 to 50 points. Higher scores indicate greater neck-related disability, whereas lower scores indicate better functional status. The NDI has demonstrated good test-retest reliability, with a pooled ICC of 0.91 (95% CI 0.90–0.93) (Saltychev et al., 2024).

6. Data analysis

Data were analyzed using SPSS. All randomized participants were included in the primary analysis according to the intention-to-treat (ITT) principle and were analyzed according to their original group assignment. All 70 participants completed the scheduled outcome assessments, with no loss to follow-up or missing outcome data; therefore, no imputation was required.

Longitudinal changes in cranio-vertebral angle (CVA) and Neck Disability Index (NDI) were analyzed separately using linear mixed-effects models (LMM). Treatment group, time, and group × time interaction were included as fixed effects, while participant was included as a random intercept to account for within-participant

correlation across repeated measurements. The group × time interaction was considered the primary test of whether changes in CVA and NDI over time differed between the school-based exercise and ergonomic education groups. estimated marginal means (EMMs) with 95% confidence intervals (CIs) were reported for each group at each measurement time point. Statistical significance was set at $p < 0.05$.

7. Research Ethics

Ethical considerations, including confidentiality, privacy, and informed consent, were maintained throughout the study. Ethical approval was obtained from the Health Research Ethics Committee, Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Indonesia, with approval number No. 2380/KEPK-FIK/V/2026, dated May 23, 2026.

RESULTS

1. Sample Characteristics

The mean age was 16.34 years old (SD= 0.64) in the intervention group and 16.2 years old (SD= 0.57) in the control group ($p = 0.285$). The sex distribution was comparable in each group (Table 1).

Table 1. Sample characteristics

Variables	n	Min.	Median	Max.	Mean (SD)	p
Outcome: modified neck exercise (n=35)						
1. Age (years)	35	15	16	17	16.34 (0.64)	0.285
2. Sex						
Male	14	N/A	N/A	N/A	N/A	-
Female	21					
3. CVA (°)	35	46	48	49	47.94 (0.91)	0.285
4. NDI	35	5	6	7	5.80 (0.72)	0.572
Outcome: ergonomic education (n=35)						
1. Age (years)	35	15	16	17	16.29 (0.57)	
2. Sex						
Male	14	N/A	N/A	N/A	N/A	
Female	21					
3. CVA (°)	35	46	48	49	47.94 (0.94)	
4. NDI	35	5	6	7	5.86 (0.69)	

The baseline craniovertebral angle (CVA) ranged from 46° to 49° in both groups, with a median of 48°. The mean CVA was 47.940 (SD= 0.91) in the school-based exercise group and 47.940 (SD= 0.94) in the ergonomic education group ($p=0.285$).

The mean Neck Disability Index (NDI) score was 5.80 (SD= 0.72) in the school-based exercise group and 5.86 (SD= 0.69) in the ergonomic education group ($p= 0.572$). All variables were comparable at baseline (Table 1).

2. Effect of school-based exercise compared with ergonomic education on craniovertebral angle and neck functional disability

A significant group $\times$ time interaction was observed for CVA ($\beta= 3.11$; $F = 27.45$, $p < 0.001$; 95% CI= 2.35 to 3.88), indicating that the trajectory of CVA over time differed between the school-based exercise and ergonomic education groups. In the school-based exercise group, the estimated marginal mean (EMM) of CVA increased from 47.94° (95% CI= 47.56 to 48.33) at baseline to 51.74° (95% CI= 51.36 to 52.13)

at week 3. In the Ergonomic Education group, the EMM increased from 47.94° (95% CI= 47.56 to 48.33) at baseline to 48.63° (95% CI= 48.24 to 49.02) at week 3.

For NDI, a significant group $\times$ time interaction was also observed ($\beta= -1.40$; $F = 13.63$; $p < 0.001$; 95% CI= -1.88 to -0.92), indicating that the trajectory of NDI over time differed between the school-based exercise and ergonomic education groups. In the school-based exercise group, the EMM of NDI decreased from 5.80 (95% CI= 5.56 to 6.04) at baseline to 3.40 (95% CI= 3.16 to 3.64) at week 3, whereas the EMM in the ergonomic education group decreased from 5.86 (95% CI= 5.62 to 6.10) to 4.86 (95% CI= 4.62 to 5.10).

The positive effect estimate for CVA indicated a greater increase in CVA over time in the school-based exercise group, while the negative effect estimate for NDI indicated a greater reduction in NDI over time compared with the ergonomic education group (Table 2). The trajectories of CVA and NDI across the four measurement time points are illustrated in (Figure 1).

Table 2. Changes in CVA and NDI over time by treatment group

Outcome	Group	Estimated Marginal Means (95% CI)				Group $\times$ Time p-value
		Baseline	Week 1	Week 2	Week 3	
CVA (°)	Intervention	47.94 (47.56 to 48.33)	48.60 (48.21 to 48.99)	50.54 (50.16 to 50.93)	51.74 (51.36 to 52.13)	<0.001
	Control	47.94 (47.56 to 48.33)	47.97 (47.58 to 48.36)	48.23 (47.84 to 48.62)	48.63 (48.24 to 49.02)	
NDI score	Intervention	5.80 (5.56 to 6.04)	5.23 (4.99 to 5.47)	4.14 (3.87 to 4.36)	3.40 (3.16 to 3.64)	<0.001
	Control	5.86 (5.62 to 6.10)	5.74 (5.50 to 5.98)	5.29 (5.05 to 5.53)	4.86 (4.62 to 5.10)	

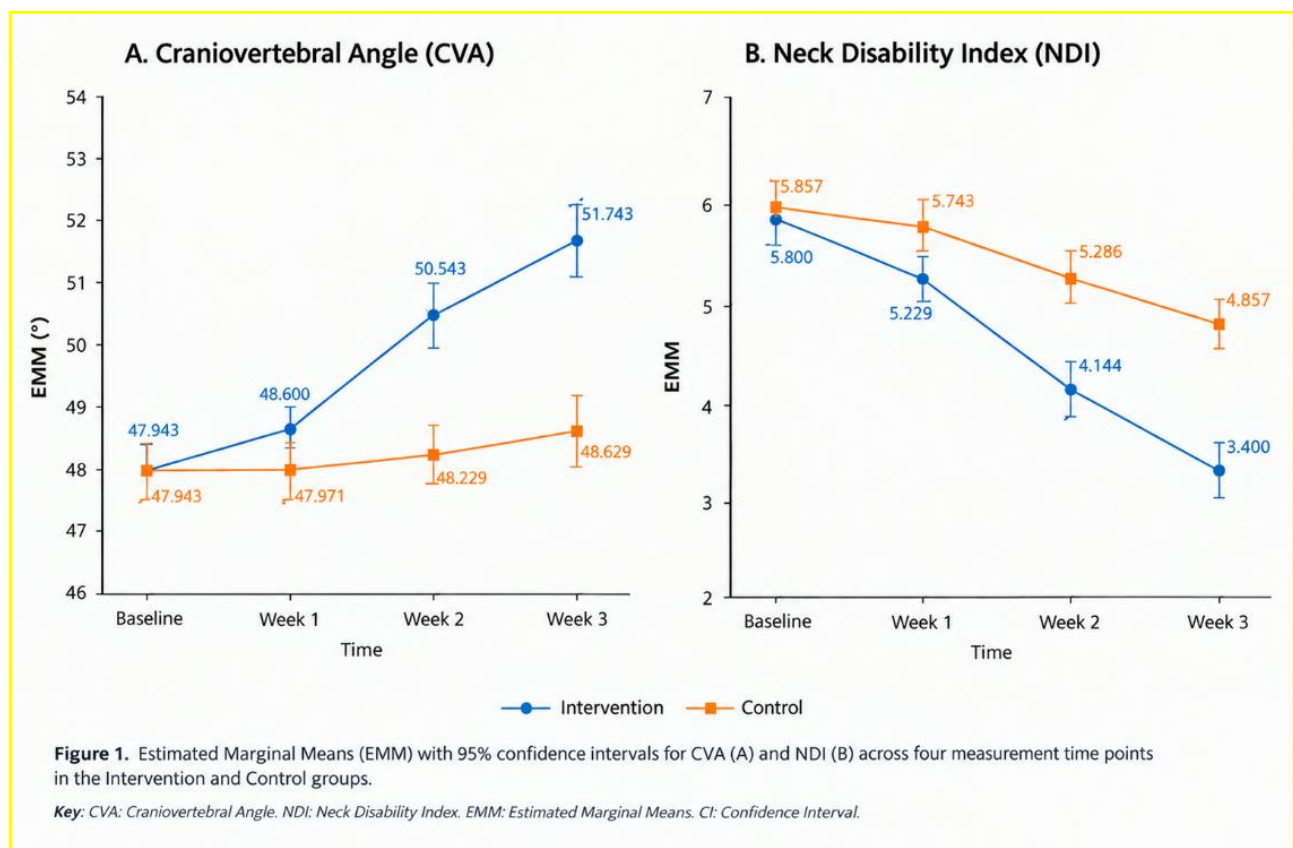


Figure 1. Estimated Marginal Means (EMM) with 95% CI for (a) CVA and (b) NDI across four measurement time points in the Intervention and Control groups.

DISCUSSION

This study demonstrated that School-based Exercise was effective in improving cervical posture and neck functional ability in adolescents with forward head posture (FHP). The School-based Exercise group showed a significant increase in craniovertebral angle (CVA) and a significant reduction in Neck Disability Index (NDI) scores following the intervention. Furthermore, the improvements in both CVA and NDI were greater in the School-based Exercise group than in the ergonomic education group. These findings indicate that combining McKenzie and Neck Calliet exercises may provide a more comprehensive approach to addressing cervical alignment and neck functional limitations in adolescents with FHP (Faenza et al., 2023).

The improvement in cervical posture observed in the School-based Exercise group may be attributed to the complementary effects of McKenzie and Neck Calliet exercises. McKenzie Exercise emphasizes repeated cervical movements, particularly retraction and extension, which may facilitate correction of cervical alignment and improve cervical mobility. Meanwhile, Neck Calliet Exercise emphasizes isometric contraction of the cervical muscles, which may contribute to improved muscle strength and cervical stability. The combination of mobility-oriented and stabilization-oriented exercises may therefore help restore a more favorable head and cervical position, resulting in an increased CVA. This approach is consistent with rehabilitation principles that emphasize individualized exercise interventions to address impairments in mobility,

strength, and functional performance (O'Sullivan et al., 2019). This interpretation is supported by previous studies showing that McKenzie-based and postural corrective exercises can improve the craniovertebral angle in individuals with FHP, including adolescents (Heydari et al., 2022; Laksmi et al., 2024; Romadhoni and Ramadhani, 2024). This finding is consistent with previous research showing that therapeutic exercise targeting cervical mobility and stabilization can improve CVA in individuals with FHP (Cho et al., 2017).

The reduction in NDI scores in the School-based Exercise group indicates an improvement in neck functional ability following the intervention. This improvement may be related to the combined effects of improving cervical mobility, muscle strength, and cervical stability. McKenzie Exercise may contribute to improved cervical movement and alignment, while Neck Calliet Exercise may enhance cervical muscle strength and stability, thereby supporting more efficient control of the head and neck during daily activities. Improvements in cervical posture and neuromuscular control may subsequently reduce functional limitations associated with neck problems, which is reflected by lower NDI scores. This finding is consistent with previous research showing that cervical exercise interventions can improve functional status measured by the NDI in individuals with forward head posture (Cho et al., 2017; Sikka et al., 2020).

The findings of the present study are consistent with previous studies examining McKenzie exercise and neck calliet exercise separately. McKenzie Exercise has been shown to improve the craniovertebral angle (CVA) in adolescents and individuals with forward head posture, supporting its role in improving cervical alignment. Neck Calliet Exercise has also been reported to improve

neck pain and disability, suggesting its potential contribution to cervical muscle function and neck functional ability. These findings support the rationale for combining the two approaches in the present study, in which School-based Exercise produced improvements in both cervical posture and neck functional ability (Kim et al., 2019; Heydari et al., 2022; Wulan et al., 2023; Laksmi et al., 2024).

The greater improvement observed in the School-based Exercise group compared with the ergonomic education group may be explained by the different nature of the interventions. Exercise-based rehabilitation directly addresses physical impairments through targeted movement and strengthening, whereas ergonomic education primarily focuses on modifying behavioral and environmental factors. This distinction may explain the greater improvement observed in the School-based Exercise group, as targeted exercise can improve movement, muscle performance, and functional capacity (Brukner et al., 2017; Gianggara and Manske, 2018). Ergonomic education provides information regarding appropriate posture and movement habits and may improve awareness of ergonomic practices. Previous research has also indicated that ergonomic education and appropriate sitting posture are relevant to reducing ergonomic risk factors and neck-related problems (Pristianto et al., 2023; Putra and Pristianto, 2023).

Beyond the observed changes in cervical posture and neck functional ability, these findings have implications for adolescent musculoskeletal health and school-based health promotion. The presence of forward head posture and neck-related functional limitations among adolescents highlights the importance of addressing musculoskeletal problems during the school years, particularly as adolescents are

increasingly exposed to prolonged sitting and electronic-device use. From a public health perspective, the findings suggest that school-based exercise may provide an opportunity to integrate early management of postural and functional problems into adolescent health promotion programs. Delivering exercise within the school environment may facilitate early identification and intervention among adolescents who experience postural problems, while also providing a practical setting for promoting healthy movement and postural behaviors. Although the present study was conducted over a short intervention period and does not establish long-term preventive effects, the findings may support the potential role of school-based exercise as part of preventive strategies aimed at promoting musculoskeletal health during adolescence.

This study has several limitations. First, the intervention was conducted for only three weeks, so the long-term effects and sustainability of the improvements in cervical posture and neck functional ability could not be determined. Second, the participants were recruited from a single school, which may limit the generalizability of the findings to adolescents from other schools or populations. Third, blinding of the participants and intervention providers was not feasible because of the nature of the exercise and educational interventions. Finally, although participants were monitored during the intervention, factors outside the intervention, such as participants' daily posture and use of electronic devices, could not be fully controlled.

In conclusion, School-based Exercise was effective in improving cervical posture and neck functional ability in adolescents with forward head posture, as indicated by the greater increase in craniovertebral angle (CVA) and greater reduction in Neck

Disability Index (NDI) scores compared with ergonomic education. These findings suggest that combining cervical mobility exercises with cervical muscle strengthening and stabilization may provide a useful physiotherapy intervention for adolescents with forward head posture. In practice, School-based Exercise may be considered as part of preventive and rehabilitative physiotherapy programs in school settings, particularly for adolescents at risk of postural problems associated with prolonged use of electronic devices.

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AUTHOR CONTRIBUTIONS

Rika Safitri conducted the study, including the study design, data collection, data analysis, and manuscript preparation. Arif Pristianto provided guidance throughout the study process and contributed to the methodological review and critical revision of the manuscript. Wulan Adis Arianti contributed to the review of the research and provided suggestions and assistance during the revision of the manuscript.

CONFLICT OF INTEREST

The authors declare that there are no commercial or financial relationships that could be perceived as a potential conflict of interest in relation to this study.

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