The Severity of Attention Deficit Hyperactivity Disorder Symptoms and Neck Posture in Children

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Abstract. Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterised by attention deficits, impulsivity, and hyperactivity, often accompanied by sensorimotor disorders that affect body posture. This study aims to analyse the relationship between the severity of ADHD symptoms and neck posture, particularly forward head posture, in children aged 6–12 years. The study employed a cross-sectional design involving 200 primary school children as participants. ADHD severity was measured using the Copeland Symptom Checklist, while neck posture was assessed via Craniovertebral Angle (CVA) using the Quick Angle Physio application. Statistical analysis utilized Spearman's correlation test and linear regression with a significance level of $p < 0.05$. Results showed a significant negative correlation between ADHD scores and CVA ($r = -0.537$; $p = 0.000$), indicating that higher ADHD scores are associated with a greater tendency for children to exhibit forward head posture. Attention deficits, hyperactivity, unintegrated primitive reflexes, and gadget usage duration are suspected to contribute to this postural disorder. These findings underscore the importance of physiotherapy interventions, including postural exercises, reflex integration, ergonomic education, and monitoring of gadget use, as early preventive measures to improve postural control and quality of life in children with ADHD.

1 Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterised by attention deficits, impulsivity, and hyperactivity that are inappropriate for the child's developmental level [1]. ADHD is one of the most common neurodevelopmental disorders in children, with a global prevalence of approximately 5–7% in the school-age population [2]. Boys are more frequently diagnosed than girls, with a ratio of approximately 3:1, as symptoms in girls tend to be less noticeable [3]. This disorder not only impacts a child's academic and social abilities but is also associated with sensorimotor disorders that can affect posture and body balance [4].

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Previous studies, including one by Wang et al., (2023), have shown that children with ADHD often experience delays in the integration of primitive reflexes, such as the Asymmetrical Tonic Neck Reflex (ATNR) and Symmetrical Tonic Neck Reflex (STNR). These reflexes should disappear by early childhood, but in some children with ADHD, they persist and can affect postural control and movement coordination. An active ATNR can cause difficulties in maintaining head and body balance during movement, while a delayed STNR can contribute to poor posture, such as forward head posture, due to the child's tendency to maintain the head in an suboptimal position [6]. This imbalance in reflexes can also disrupt muscle tone control and lead to excessive muscle tension or, conversely, weakness in certain muscle groups.

Research by Goulardins et al., (2024) shows that children with ADHD often experience motor coordination and balance disorders. These disorders can contribute to postural problems such as forward head posture, which often goes unnoticed by parents and medical professionals until more serious problems arise, such as chronic back pain, muscle fatigue, and decreased physical activity performance. The primary factors contributing to poor posture in children with ADHD include proprioceptive disorders, deficits in postural control, and reduced body awareness due to hyperactivity and an inability to maintain static positions for extended periods [8]. Additionally, poor posture can be exacerbated by daily habits such as prolonged sitting in non-ergonomic positions and insufficient physical activity that supports balance and postural muscle strengthening [9].

Some studies also indicate that children with ADHD often experience muscle imbalance, which can lead to poor muscle tone, core muscle weakness, and a tendency toward muscle spasms due to excessive hyperactivity [8]. The inability to maintain attention for extended periods often results in uncontrolled movement patterns, which can exacerbate postural disorders. Children with ADHD tend to exhibit poor muscle coordination, making it difficult for them to maintain optimal body posture during daily activities. Additionally, prolonged hyperactivity can cause unconscious muscle tension, which ultimately contributes to postural changes such as forward head posture due to slouching and excessive neck muscle tension.

This study aims to further investigate the relationship between ADHD and postural disorders, particularly the tendency toward forward head posture that can occur due to muscle weakness, muscle tone imbalance, and attention disorders that lead to unstable movement patterns. It is hoped that the results of this study will provide broader insights into the mechanisms underlying postural disorders in children with ADHD and serve as a basis for the development of more effective physiotherapy interventions. Additionally, this research may also serve as a foundation for early prevention strategies to minimise the negative impact of postural disorders on the quality of life of children with ADHD.

2 Methods

This study has been approved by the Ethics Committee of Muhammadiyah University Surakarta, Faculty of Health Sciences, with reference number No.733/KEPK-

FIK/XII/2024. This study is expected to provide further insights into the relationship between ADHD and postural disorders in children, as well as implications for the development of more effective physiotherapy intervention strategies.

2.1 Participants

This study used a cross-sectional design to evaluate the relationship between ADHD levels and head posture (forward head posture) in children aged 6–12 years. The study included 198 children recruited from primary schools in a specific region with the consent of their parents or guardians. Inclusion criteria included children without a history of neurological or musculoskeletal disorders that could affect posture, while children who had undergone special physiotherapy interventions for postural disorders were excluded from the study.

2.2 Clinical Assessment

Head posture measurements were taken using the Quick Angle Physio app, which is used to measure the Craniovertebral Angle (CVA). This app enables accurate measurements through digital image analysis taken from the side using a standard camera. Quick Angle Physio has been validated in previous studies and has proven to have high reliability (ICC: 0.75) in objectively measuring postural angles, making it suitable for use in this study. The smaller the CVA value, the greater the tendency toward forward head posture, indicating more significant postural dysfunction.

Meanwhile, ADHD levels are assessed using the Scoring for the Copeland Symptom Checklist (ADHD/ADD), which is a standard tool for identifying ADHD symptoms in children. This instrument has good validity in assessing ADHD symptoms (with a negative predictive value exceeding 96%), with high sensitivity and specificity in detecting attention and hyperactivity disorders. The checklist consists of various categories covering aspects of attention, hyperactivity, impulsivity, and other behavioural factors, where higher scores indicate more significant levels of ADHD.

2.3 Data Analysis

In the research procedure, each child was photographed in an upright standing position from the side for CVA measurement using the Quick Angle Physio application. Parents or teachers were asked to complete the Copeland Symptom Checklist to assess the child's ADHD level. The collected data were then analysed to examine the relationship between ADHD severity and head posture (forward head posture). Statistical analysis was performed using Pearson or Spearman correlation tests to assess the relationship between ADHD scores and CVA values. Linear regression tests were also used to explore the extent to which ADHD contributed to postural changes, with statistical significance set at $p < 0.05$.

3 Results and Discussion

3.1 Results

3.1.1 Respondent Characteristics

This study involved 200 children aged 6–12 years (mean age 9.17 ± 2.00 years). The respondents consisted of 101 males and 99 females, resulting in a fairly balanced gender distribution. The characteristics of the respondents are presented in Table 1. In terms of nutritional status, the average Body Mass Index (BMI) of the respondents was 19.93 ± 2.84, with a range between 15.00 and 25.00. This indicates variation in nutritional status, from underweight to overweight. In terms of ADHD severity, the ADHD scores of the respondents ranged from 10 to 89, with an average of 46.10 ± 24.40. These scores reflect a range of ADHD severity, from mild to severe.

Table 1. Characteristics of respondents based on age, BMI, ADHD level, duration of gadget use, and craniovertebral angle (CVA).

Variable	Mean ± SD (Standard Deviation)	Min - Max
Age (year)	9,17 ± 2,00	6 - 12
Body Mass Index (BMI)	19,93 ± 2,84	15,00 - 25,00
Under wight (<18,5)	52 (26,0%)	
Normal (18,5-24,9)	126 (63%)	
Obesitas (>25)	22 (11%)	
ADHD Level (scor)	46,10 ± 24,40	10 - 89
High	40 (30%)	
Moderate	100 (50%)	
Low	60 (20%)	
Duration of gadget use (hours/day)	3,29 ± 1,38	1,1 - 5,9
Craniovertebral Angle (CVA)	47,06 ± 4,23	35,0 - 54,8
Normal Posture (>48)	85 (42,5%)	
Forward Head Posture (<48)	115 (57,5%)	

The duration of gadget use was also analysed, with an average of 3.29 ± 1.38 hours per day and a range of 1.1 to 5.9 hours per day. This duration indicates that most children use gadgets for a considerable amount of time, which could potentially affect their posture. For head posture, the Craniovertebral Angle (CVA) had an average of 47.06 ± 4.23 degrees, with a range of 35.0 to 54.8 degrees. A lower CVA value indicates a tendency toward forward head posture, which may be associated with higher levels of ADHD.

3.1.2 Correlation Analysis

Correlation analysis was performed to assess the relationship between ADHD levels and head posture (Forward Head Posture) in children aged 6-12 years. The Shapiro-Wilk normality test showed that the ADHD level (score) data ($p = 0.000$) and Forward Head Posture (CVA) data ($p = 0.000$) were not normally distributed ($p < 0.05$) (Table 2). Therefore, the correlation analysis used the Spearman test.

Table 2. Results of normality tests between ADHD levels and forward head posture (CVA).

Variable	Shapiro-Wilk statistics	Sig. (p-value)
ADHD Level	0.930	0,000
Forward Head Posture (CVA)	0.959	0,000

The results of Spearman's correlation test in Table 3 show a significant negative correlation between ADHD level (score) and forward head posture (CVA) with a correlation coefficient of r = -0.537 and a p-value of 0.000. This correlation indicates that the higher the ADHD level, the smaller the CVA angle, meaning there is a greater tendency for children to exhibit forward head posture.

Table 3. Results of Spearman's correlation test between ADHD level and forward head posture (CVA).

Variable	Correlation Coefficient (r)	Sig. (p-value)	Interpretation
ADHD Level vs. CVA	-0.537	0,000	Significant negative correlation

These findings support the hypothesis that attention and hyperactivity disorders in children with ADHD can affect body posture, particularly head posture. Hyperactivity and lack of postural control may cause children to maintain unergonomic head positions more often, thereby exacerbating the tendency toward forward head posture. In addition, retained primitive reflexes and proprioceptive disorders in children with ADHD may contribute to unstable postural patterns.

3.2 Discussion

3.2.1 Respondent Characteristics and Data Variability

This study involved 200 children with a fairly representative age range between 6 and 12 years, reflecting important stages of physical and cognitive development in children. With an average age of 9.17 ± 2.00 years, this study covered various age groups that were in a period of rapid growth. This age range is highly relevant because at this age, children are undergoing significant motor development and the formation of postural habits that can have long-term effects on their physical health [10]. Additionally, the relatively young age of most respondents allows researchers to evaluate risk factors for postural disorders that may develop early on, particularly in children with ADHD.

The gender distribution among respondents was fairly balanced, with 101 boys and 99 girls. Although there were slight differences, this distribution still provided a representative picture of the prevalence of ADHD disorders in both genders. ADHD is known to be more common in boys, but the significant number of female respondents in this study helps expand our understanding of how ADHD affects children of different

genders, as well as potential differences in its impact on posture and motor disorders (Silva et al., 2020).

In terms of nutritional status, the average Body Mass Index (BMI) of the respondents was 19.93 ± 2.84, with a range from 15.00 to 25.00, indicating variations in nutritional status from underweight to overweight categories. This varied nutritional status provides insight into the potential influence of nutritional factors on children's physical and postural development, although no direct relationship was found in this study between nutritional status and head posture.

However, the duration of gadget use was one of the most interesting findings in this study. The average time spent using gadgets was 3.29 ± 1.38 hours per day, with a range of 1.1 to 5.9 hours per day. The amount of time children spend in front of electronic devices can have a significant impact on their posture. Prolonged gadget use can lead children to frequently adopt a hunched or bent-over position, which may contribute to postural disorders such as forward head posture (FHP) (Shimaa & H Abdelazeim, 2022). Children with ADHD, who often have difficulty focusing or managing their time, may be more prone to spending excessive time in front of gadgets without realising the impact on their posture [13].

In this study, high gadget usage can be an additional factor exacerbating children's postural conditions, particularly in cases of FHP, which often develops due to poor body habits when using electronic devices. Hunching or slouching for hours, which often occurs when playing games or watching videos, can potentially add strain to children's neck and back muscles, which are already affected by attention disorders and poor postural control.

3.2.2 The Relationship Between ADHD and Neck Posture

The ADHD scores of the respondents in this study ranged from 10 to 89, with an average of 46.10 ± 24.40, reflecting the variation in the severity of ADHD among children, from mild to severe. This variability in scores allowed researchers to evaluate the effect of ADHD severity on children's posture, especially head position. The results of the correlation analysis showed a significant negative relationship between ADHD severity (score) and head posture, measured using the Craniovertebral Angle (CVA). The correlation coefficient $r = -0.537$ and p-value = 0.000 indicate that the higher the ADHD severity, the smaller the CVA value, meaning that children with higher ADHD severity are more likely to have a forward-tilted head posture, or forward head posture (FHP).

This relationship can be explained by several physiological and psychological factors related to ADHD. Children with ADHD often struggle with attention regulation and impulse control, which affects their ability to maintain good body posture [14]. Hyperactivity, which is a characteristic of ADHD, can cause children to move more often and have difficulty maintaining a stable body position [13]. In addition, a lack of attention to body position during daily activities, such as using gadgets, increases the risk of children with ADHD experiencing postural disorders [15].

3.2.3 The Phenomenon of Forward Head Posture

Forward head posture, or a head posture that leans forward, is a condition in which a child's head tends to be positioned further forward than the body's natural line. In this study, lower CVA values (average 47.06 ± 4.23 degrees) indicated a tendency toward FHP, which may be related to limited postural control in children with ADHD. Children with ADHD who experience hyperactivity or lack of attention to their body position are more likely to maintain non-ergonomic head positions, such as tilting or bending forward.

Several factors, such as delayed primitive reflexes and proprioceptive disorders, which are commonly found in children with ADHD, may exacerbate this tendency. Proprioception, which is the ability to sense the position of the body in space, is often impaired in children with ADHD, leading to difficulties in maintaining stable and healthy body posture. The lack of postural awareness in these children often causes them to develop poor body positioning habits, including forward head posture.

3.2.4 The Impact of Reflex Disorders on Postural Control and Motor Coordination

Postural disorders caused by an inability to integrate primitive reflexes also have a significant impact on children's motor skills, both fine and gross motor skills. Children with ADHD often have difficulty performing more complex motor activities, such as writing, drawing, or even moving efficiently in daily activities. Postural instability caused by the ATNR and STNR reflexes, which are not yet fully integrated or remain active, can disrupt a child's ability to maintain good body coordination.

Disrupted coordination between the upper and lower body due to the STNR reflex makes children with ADHD struggle to stabilise their body posture when performing certain motor tasks [6]. For example, when writing, children with primitive reflex integration disorders may have difficulty stabilising their body position, which can lead to poor posture, such as slouching or hunching over. This not only affects fine motor skills but also gross motor skills, such as walking or running, where they demonstrate poorer coordination.

The inability to control good body posture and integrate ATNR reflexes also disrupts children's ability to perform daily tasks efficiently, such as standing or walking long distances, which ultimately affects their overall quality of life. Persistent postural instability, particularly in the head and neck region, can lead to chronic muscle tension, physical fatigue, and more serious musculoskeletal issues, resulting in pain and discomfort that disrupt normal activities. This condition directly impacts the craniocervical angle (CVA), which is the angle between the horizontal line and the line connecting the first cervical vertebra to the suboccipital point. Children with unintegrated reflexes tend to exhibit forward head posture, which increases muscle tension in the neck and upper back and disrupts balance.

3.2.5 Clinical Implications and Interventions

Based on these findings, it is important for healthcare practitioners, especially physiotherapists, to pay more attention to children with ADHD in terms of monitoring and improving their posture. One approach that can be applied is postural training aimed at improving the postural awareness of children with ADHD. Physiotherapists can design exercise programmes that not only focus on improving posture but also on proprioceptive

and motor reflex aspects, which can help children with ADHD develop better postural control.

Additionally, interventions involving reducing the duration of gadget use or changing gadget usage habits to healthier ones can have a positive impact on children's posture. Parents and caregivers can also be empowered to monitor children's postural habits and provide guidance in maintaining good posture.

4 Conclusion

There is a significant negative correlation between ADHD severity and craniocervical angle (CVA) ($r = -0.537$, $p = 0.000$), meaning that the higher the ADHD severity, the greater the tendency toward forward head posture. Attention disorders, hyperactivity, unintegrated primitive reflexes, and proprioceptive disorders contribute to unstable postural patterns and neck muscle weakness in children with ADHD.

These findings underscore the importance of interventions such as reflex integration therapy, postural exercises, and physiotherapy approaches to improve postural control. Additionally, proper posture education and reducing gadget usage duration can help prevent postural disorders in children with ADHD and improve their quality of life.

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