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# Posture Assessment of Grade 1B Students of SDN Banyu Urip III with APECS Application

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## ABSTRACT

The early period of primary school is a dynamic musculoskeletal transition phase and is prone to postural deviations due to motor factors and external loads. This descriptive study aims to evaluate the posture status of 22 students in grade 1B of SDN Banyu Urip III Surabaya quantitatively using the Alignment Posture Evaluation and Correction System (APECS) digital photogrammetry application. Frontal and sagittal field data were taken through a smartphone-integrated gyroscope, then analyzed with descriptive statistics on IBM SPSS v26.0 based on clinical asymmetry criteria. The results showed that postural misalignment was more pronounced in the lower extremities, with the highest deviation found in the variables Feet 4.95° (SD=3.873°) and Knees 3.32° (SD=3.957°) which were categorized as significant asymmetry. In contrast, the upper area showed lower deviations in the moderate to normal asymmetry range, including Body Alignment Side (2.77° ± 1.631°), Head Tilt (1.95° ± 2.081°), Pelvic Tilt (1.68° ± 1.217°), Shoulder Alignment (1.68° ± 1.211°), and Front Body Alignment (0.41° ± 0.666°). In conclusion, most students experience postural misalignment in the lower extremity segment and sagittal plane. However, there is a technical note in the form of potential visual occlusion in the leg area if anatomical markers are not accurately identified due to clothing intervention. Despite these limitations, the subject's posture control system is generally still capable of maintaining the stability of the central axis in the frontal plane. The use of the APECS application is still considered effective, safe, and non-invasive as an early detection instrument in schools, so preventive interventions such as ergonomic education are available.

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## INTRODUCTION

Postural balance is a clinical manifestation of the integrity of the neuromuscular and skeletal systems in maintaining the body's center of gravity above the support plane with minimal energy expenditure (Hur et al., 2019). In the early days of primary school, especially children aged six to seven, the musculoskeletal system is in a very dynamic developmental transition phase and is susceptible to external influences (Adhe et al., 2018; Schmid et al., 2020). In this growth period, the child's spine and lower extremities are undergoing active ossification, while the supporting connective tissue still shows a high degree of flexibility (ligamentous laxity) (Widayati et al., 2019). As a result, the motor and postural habits adopted by children at this age will be functionally recorded and are at risk of staying structurally until adulthood if not monitored regularly (Al Ardha et al., 2018; Romeo et al., 2022; Salsali et al., 2023).

The pattern of daily activities at school is often the main trigger for postural deviations in elementary school students. The use of school bags with a weight that exceeds the safe limit of ten percent of the child's body weight, unergonomic sitting positions due to mismatches in the size of tables and classroom chairs, and high sedentary activity duration due to exposure to gadgets (screen time) trigger an imbalance in the strength of the body's supporting muscles (Ashraf et al., 2026; Castellucci et al., 2015). This condition, if neglected, can trigger biomechanical compensation that leads to spinal structural abnormalities such as hyperkyphosis, hyperlordosis, and functional scoliosis, which not only decreases learning comfort but also limits the child's cardiorespiratory and functional capacity for movement later in life (Kempen et al., 2022; Wang et al., 2023).

Therefore, preventive measures through mass postural screening in elementary schools are an indispensable instrument for supporting clinical and academic decisions. Gold standard diagnostic methods such as conventional radiological examinations have significant limitations in screening healthy populations due to high operational costs and the risk of biological hazards due to exposure to ionizing radiation in children (Amzallag-Bellenger et al., 2014; Ng & Bettany-Saltikov, 2018). On the other hand, subjective visual evaluations using plumb lines or manual posture grids are highly susceptible to examiner subjectivity bias and are difficult to produce accurate quantitative data documentation (Fortin et al., 2011; Kartika et al., 2024).

As a solution to these limitations, the use of mobile application-based digital photogrammetry technology is present as a valid, reliable, and efficient alternative to non-invasive postural screening (Arif et al., 2024). One of the applications that has been academically validated is the Alignment Posture Evaluation and Correction System (APECS) (Wijaya et al., 2024). The software was developed with clinicians and utilizes artificial intelligence-based photogrammetry algorithms to identify and measure the angle deviation from the ideal body alignment axis automatically or semi-manually (Trovato et al., 2022). The diagnostic accuracy study proved that the angle measurement using APECS showed a Pearson correlation coefficient of 0.9874 (98.74% conformity) and an inter-rater agreement rate of 94.64% when compared to gold standard radiography (Welling et al., 2023).

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The research was carried out with the main focus being to quantitatively evaluate the postural status of grade 1 students using the APECS application. Through a descriptive case design, this study aims to report a summary of the postural profile of the population based on descriptive statistical parameters which include mean values, medians, standard deviations, minimum values, and maximum values. The data baseline obtained is expected to be a scientific basis for schools, educators, and parents in designing primary preventive programs in the form of physical corrective exercises and a more ergonomic learning environment arrangement to support the optimal growth and development of students.

## METHODS

This study uses a quantitative approach with a descriptive design. This design was chosen to identify, and systematically describe the profiles and characteristics of postural deviations in the student population objectively based on statistical parameters, without providing specific treatment or intervention to the study subjects.

### *Participants and Sampling*

This research was carried out in class 1B of SDN Banyu Urip III Surabaya, with a total of 22 students. The inclusion criteria in this study included active students in class 1B who were between six and 7 years old, were physically healthy, and were willing to follow all shooting procedures with the approval of the homeroom teacher and the principal. The exclusion criteria consist of students who have a history of major injuries to the lower extremities or spine in the last six months.

### *Instruments and Apparatus*

The main instrument used for postural screening is a smartphone camera device integrated with APECS (AI Posture Evaluation and Correction System) software version 6.1.6, developed by New Body Technology/Saneftec in Grenoble, France. The APECS application uses digital image processing and photogrammetry algorithms to calculate body angle deviations in units.

In the APECS application to minimize camera tilt inconsistency bias during image acquisition, the application interface provides a gyroscope feature in the form of a digital circular target that will automatically turn green when the camera is in a position perfectly perpendicular to the floor (leveled). In addition, the room is equipped with a static floor reference line to determine the student's standing position as well as constant lighting of the room so that the anatomical markers of the body are clearly visible in the photographs.

### *Procedures / Data Collection*

The data collection procedure is designed to be safe, non-invasive, and efficient with a duration of about five minutes per student to maintain the subject's concentration. Prior to photography-based anthropometric data collection, students were instructed to remove their footwear and wear school sports clothes that fit their bodies to ensure that body curves and anatomical markers could be clearly identified. The measurement is carried out in a relaxed

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standing posture above a predetermined reference point on the floor. Shooting was taken from two directions of projection using a smartphone camera positioned parallel to the height of the student's pelvis at a constant distance of 2.5 meters. The two documented body projections include the frontal plane (anterior coronal plane) and the sagittal plane (right lateral plane).

After the digital image is stored, the researcher places a virtual anatomical marker (virtual landmark) at the skeletal reference point through the Automatic Posture Evaluation and Correction System (APECS) application based on a standard clinical protocol. In frontal view, digital markers are placed in the ear lobe to measure head tilt, the bilateral acromion tip for shoulder alignment, the bilateral anterior superior iliac spine (ASIS) for pelvic tilt, tibia tuberosity for knee straightness, and the talus corpus and metatarsal for foot angles. The overall deviation of the center axis of the body to the vertical line of gravity is measured through the body front alignment variable. Meanwhile, in the side view projection, markers are placed vertically starting from the ear lobe, acromion (shoulder joint), trochanter major femur, lateral knee joint, to lateral maleolus to measure the deviation of body alignment side (body alignment) to the perpendicular line of gravity. The APECS application automatically processes the pixel coordinates of the marker points to generate a mathematical calculation of the magnitude of the angular deviation in units of degrees (°). In order to comply with research ethics and ensure the confidentiality of the subject's personal data, all photo files and reports of the results of the analysis are stored locally on the researcher's digital storage device.

***Data Analysis***

The quantitative data obtained from the APECS application angle calculation is systematically transferred into a Microsoft Excel worksheet before being exported to the IBM SPSS Statistics statistical analysis program version 26.0. Descriptive statistical analysis was applied to process 22 functional data from class 1B. The reported statistical values include mean, median, standard deviation, minimum value, and maximum value for each postural parameter. The interpretation of postural status refers to clinical categories adapted from the pediatric anthropometric literature and moire assessments, which establish criteria based on the degree of angular asymmetry (Adair et al., n.d.; Piccolo et al., 2025). Here is a table of classifications:

***Table 1.*** *Classification Table*

| Classification | Description | Value |
|---|---|---|
| Normal | No significant asymmetry was observed | < 1,5° |
| Moderate Asymmetry | Minor deviation | 1,5° – 3,0° |
| Significant Asymmetry | Mayor deviation | > 3,0° |

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## RESULTS

Based on the results of statistical tests on 22 data of grade 1B students of SDN Banyu Urip III, the postural parameters tested included seven measurements, namely, *Body Alignment Front*, *Head Tilt*, *Shoulder Alignment*, *Pelvic Tilt*, *Knees*, *Foot*, and *Body Alignment Side*.

***Table 2.*** *Statistical Test Results*

| Variable | Mean (M) | SD | Min | Max |
|---|---|---|---|---|
| Body Alignment Front | .41 | .666 | 0 | 2 |
| Head Tilt | 1.95 | 2.081 | 0 | 6 |
| Shoulder Alignment | 1.68 | 1.211 | 0 | 4 |
| Pelvic Tilt | 1.68 | 1.217 | 0 | 4 |
| Knees | 3.32 | 3.957 | 0 | 18 |
| Feet | 4.95 | 3.873 | 0 | 13 |
| Body Alignment Side | 2.77 | 1.631 | 0 | 5 |

Based on the results of the analysis of 22 student subjects (N=22) without any missing data (*Missing Data*), a comprehensive picture was obtained of the degree of posture deviation measured in units of degrees. The statistical results show that the highest average deviation is found in the lower body area, namely the *Feet* variable of 4.95° with SD of 3.873° indicating that the feet are asymmetrical high, followed by the *Knees* variable of 3.32° with SD is 3.957° indicating that the knees are still considered to be in a high asymmetrical range, after that at *Pelvic Tilt* the mean of 1.36° with SD of 1.217 indicates that the pelvis is in the range of moderate asymmetry. Meanwhile, the deviation value in the upper body area shows a relatively lower and homogeneous figure, including the average *Head Tilt* is only 1.95° with SD is 2.081° indicating the tilt of the head in the moderate asymmetric range, then on the average deviation the *Body Alignment Side* is in the range of 2.77° with SD is 1.631° indicating that the back is in the moderate asymmetric range, *Body Alignment Front* averages 0.41° with an SD of 0.666°, and an average *Shoulder Alignment* of 1.68° with an SD of 1.211°, indicating that the average shoulder is normal.

## DISCUSSION

Posture in elementary school age children (6 - 7 years old) is a crucial instrument because this phase is the golden age of bone development. Postural deviations that are not detected early have the potential to become structural fixations that persist into adulthood. The APECS application measures the degree of deviation (slope) of body segments from the ideal plumb line. Based on the principles of body mechanics, the smaller the angle deviation

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score obtained (closer to 0°), the better and ideal the student's posture. Conversely, the greater the angle deviation score, the higher the severity of postural asymmetry experienced.

Based on the results of statistical tests on 22 students, this study shows that there are varied postures, with a tendency for *misalignment* that is much more prominent in the lower extremity segment than in the upper body axis. The high average deviation in the *Feet* (4.95°) and *Knees* (3.32°) variables, as well as the extreme maximum value in the knee reaching 18°, indicate the presence of biomechanical instability in the basis of the child's weight base. At school age, the musculoskeletal system is still in a very dynamic phase of growth and ossification, so the structure of joints and ligaments tends to be more flexible and susceptible to postural changes (Lestari et al., 2019; Romeo et al., 2022). This variation in height in the angle of the knees and feet is most likely a form of structural compensation for everyday habits, such as incorrect sitting patterns, the use of unergonomic footwear, or adaptation to the decline in the arch of the feet (flat feet) commonly found in growing age (Mosca, 2010; Shih et al., 2012; Sujarwo et al., 2021).

In contrast, a very minimal deviation in *the Body Alignment Front* (0.41°) indicates a phenomenon of good postural control. Despite considerable local variations and deviations in the leg and knee area, the student's body as a whole is still able to maintain its central axis close to the ideal vertical line of gravity in the frontal plane. This proves the effectiveness of the central nervous system in regulating postural control strategies to maintain stability and minimize energy expenditure when standing upright (Hall et al., 2023; Shanbhag et al., 2023). However, in the sagittal projection, the Body Alignment Side deviation value of 2.77° indicates a tendency to shift the posture towards the anterior or posterior direction (for example, forward head posture or swayback). This phenomenon is often triggered by prolonged external stresses, such as the use of school bags that are too heavy or the high duration of sedentary patterns in today's children (Ashraf et al., 2026; Rinakit Adhe et al., 2020; Salsali et al., 2023).

Methodologically, the sensitivity of the APECS application in detecting variations in decimal angles confirms that digital photogrammetry-based screening is very effective in being used as an early screening tool in the school environment. Given that deviations in the leg and knee area have the potential to develop into structural abnormalities that persist into adulthood (such as genu valgum/varum or gait disorders), early intervention in the form of body attitude education and core muscle strengthening exercises is highly recommended to be implemented early.

## CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that most of the student subjects experience postural misalignment that is much more prominent in the lower extremity segment as well as the body projection of the sagittal field, compared to the middle axis of the front body. Although there are significant variations in local deviation in the feet and knees, the student's overall postural control system is still proven to be able to maintain optimal stability of the middle axis of the body in the frontal plane (Body Alignment Front). In addition, a methodological approach based on digital photogrammetry using the APECS

application has been proven to be effective, safe, and non-invasive as an instrument for early detection of postural disorders in the school environment.

As a practical implication, these findings emphasize the importance of early preventive interventions to prevent these functional postural deviations from progressing into persistent structural deformities. Schools are advised to implement ergonomic education programs, including setting the weight of school bags and getting used to the correct sitting posture, as well as integrating structured physical exercises that focus on strengthening core muscles and posture correction in students' daily activities.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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