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Review Paper

How to use your smartphone smartly? Analyzing body posture with reference to Euclidean geometry

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Abstract

Introduction: Smartphone use has become a common behavior that can lead to physical and mental strain. Body posture while using a smartphone often promotes excessive neck flexion, torso and chest tilt, and unfavorable changes in pelvic position. The authors believe that it is necessary to present clear, practical guidelines for maintaining an ergonomic body posture in various positions throughout the day.

Aim: To present optimal ways of using a smartphone with health-promoting recommendations that result from an analysis of body position geometry.

Material and methods: A scoping review of the literature using ScienceDirect, Taylor & Francis, PubMed, EBSCO, Ovid LWW, and Springer databases was conducted using the keywords 'smartphone,' 'posture,' 'spine alignment,' 'head tilt,' 'smartphone addiction scale,' 'spinal overload,' 'kyphosis,' and 'lordosis;' as well as 'Euclidean geometry.' Articles published after 1995 were included. The analysis was supplemented by the authors' over 40 years of clinical experience.

Results and discussion: Body posture analysis using the principles of Euclidean geometry clearly identified desired behaviors while using a smartphone. It was demonstrated that even small angular changes in the sternum and the sacrum can significantly impact the proportions of individual body segments, including the head, and consequently reduce musculoskeletal overloads.

Conclusions: (1) The assumptions of Euclidean geometry provide a good justification for explaining health-promoting behaviors when using smartphones. (2) Postural education based on understandable geometric patterns should be an integral element of behavioral and preventive health care proposals for the smartphone-using population. (3) Individualized implementation of health-promoting habits is recommended, which increases the effectiveness and sustainability of the effects.

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1. INTRODUCTION

Contemporary scientific reports and clinical observations indicate that smartphone use time is steadily increasing, exceeding several hours per day in many populations. Although available analyses vary in methodologies and cover different age groups, the most commonly reported values fall within the range of approximately 4 h to 6 h per day. According to a 2022 report by the Global System for Mobile Communications Association (GSMA), approximately 65% of the world's population uses a smartphone, confirming the global nature of this phenomenon and justifying the need to analyze its biomechanical consequences.[1]

The results of a meta-analysis covering 24 countries and 33,831 participants also showed that smartphone overuse is becoming increasingly common. The highest rates were recorded in China, Saudi Arabia, and Malaysia; while the lowest rates were recorded in Switzerland, Germany, and France.[2] This variation may be due to both different cultural patterns and differences in access to technology and digital habits.

One of the most characteristic postural features when using a smartphone is the head tilt with a simultaneous lowering of the sternum (Figure 1). This has significant biomechanical significance: with a head tilt of up to 60°, the effective load acting on the cervical spine increases to approximately 27 kg. This highlights a clinically important fact: increasing the neck flexion angle is associated with a significant increase in muscle tone and ligamentous overload, with individual anatomical characteristics such as head mass, neck length, and muscle strength potentially further modifying this effect.[3]

Improper body posture associated with smartphone use causes a number of adverse changes in the musculoskeletal system, including the spine, increasing pressure in the spinal canal and leading to mechanical deformation of nerve tissues and blood vessels.[4] The literature also describes disturbances in the microcirculation of nerve fibers, abnormalities in axonal transport, and impaired nerve conduction resulting from chronically maintaining a flexed posture.[5] It is also important to recognize the significant changes in musculoskeletal loading, particularly within the cervical spine, shoulder girdle, and upper limbs.[6–9]

However, the impact of smartphones on the human body goes beyond the strain on the musculoskeletal system. Epidemiological studies have repeatedly described a range of health consequences, including i.a.:

- impaired cognitive function and attention, especially during multitasking;[10,11]
- increased risk of cardiovascular disease;[12]
- increased frequency of suicidal thoughts and attempts;[13,14]
- sleep disturbances and increased depressive symptoms;[15,16]
- ophthalmological disorders, including dry eye syndrome.[17]

The wide range of potential health consequences associated with smartphone use underscores the need to develop practical recommendations to support the safe and ergonomic use of these devices. This article presents a selected aspect of the problem, which are smartphone use principles that can reduce body axis overload and promote proper posture. The proposed biomechanical solutions are based on an analysis of Euclidean geometry and an attempt to identify simple, implementable ergonomic strategies.

Figure 1. A bowed head is a characteristic silhouette of a person using a smartphone.

Euclidean geometry provides a clear and simple framework to quantify spatial relationships between body segments using lines and angles. In the sagittal plane, extending lines along the sternum, sacrum, and spinal curves allows clinicians to evaluate their mutual orientation and coordinated movements. By applying basic geometric principles, such as the sum of angles in a triangle, it is possible to identify consistent postural patterns and a 'common sense' of their interaction. This approach offers a practical, reproducible, and biomechanically justified tool for assessing postural changes related to prolonged smartphone use.[18,19]

2. AIM

The aim of the study was to present optimal ways of using a smartphone and to formulate health-promoting recommendations resulting from the biomechanical analysis of body position in relation to the principles of Euclidean geometry.

3. MATERIAL AND METHODS

A comprehensive scoping review of the literature was conducted using the ScienceDirect, Taylor & Francis, PubMed,

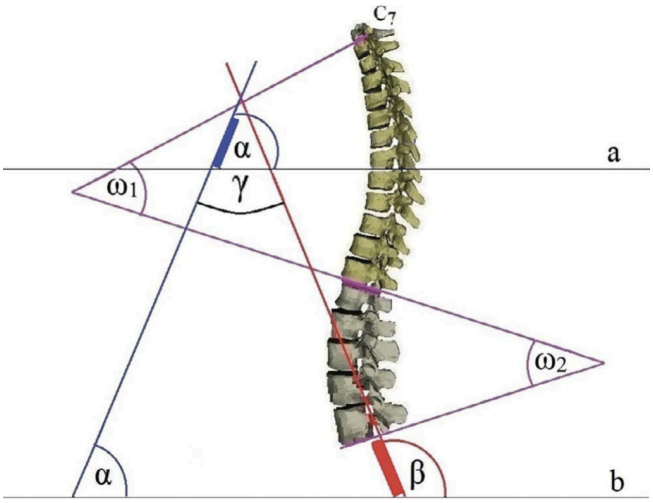

Figure 2. Geometric model of the spine alignment, illustrating the relationship between the position of the sternum and the sacrum. The marked angles α and β form an isosceles triangle describing the proportions of the spine in the sagittal plane.[19]

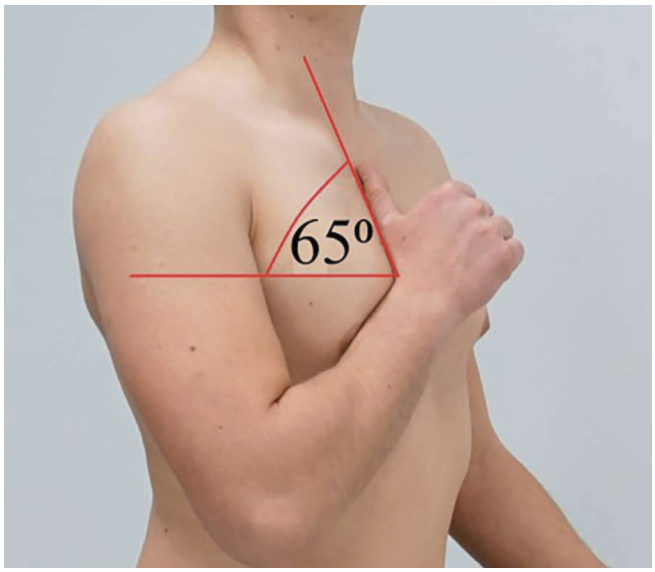

Figure 3. A practical way to determine the approximate value of the angle of approximately 65° by placing the thumb on the body of the sternum.[18]

EBSCO, Ovid LWW, and Springer databases. The search strategy employed the following keywords: smartphone, posture, spine alignment, head tilt, smartphone addiction scale, spinal overload, kyphosis, lordosis, and Euclidean geometry. Articles published after 1995 were included. The literature review was supplemented by the authors' over 40 years of clinical experience in the diagnosis and treatment of musculoskeletal disorders.

4. RESULTS

This paper presents a proprietary concept for biomechanical posture analysis while using smartphones, encompassing the most frequently observed postural abnormalities and suggesting corrective positions. Simplified relationships for sternal alignment were developed, allowing for an objective description of body segments in three basic positions: sitting, standing, and lying. The illustrative material consists of proprietary photographs with marked vectors.

The results indicate that the position of the torso, particularly the sternum and the sacrum, significantly influences the shape of the spine, which has both clinical and educational implications. A central element is the geometric model of spinal alignment in the sagittal plane, where the positions of the sternal body and sacrum are described using angles α, β, along with thoracic kyphosis ω_1 and lumbar lordosis ω_2. Lines a and b define the sagittal axis of the body, while angles α and β form an isosceles triangle in relation to the thoracic and lumbar spine. Angle γ characterizes the interrelation of these parameters, referred to as the 'common sense' (Figure 2). Any movement in one segment triggers a coordinated response throughout the system.[18,19]

Mathematical analysis indicates that the correct, physiological positioning of the thoracic and lumbar spine and the head in extension of the long axis of the spine corresponds to a sternum elevation angle of approximately 65° (Figure 2).[18,19] This value is the main determinant for practical recommendations regarding maintaining a correct posture during everyday activities, including using a smartphone.

The above-mentioned value of the sternum elevation angle of approximately 65° is a key determinant for practical recommendations regarding maintaining a correct, physiological posture during everyday activities, including using a smartphone (Figure 3).

An isosceles triangle illustrates the course of the extended lines of the sternal body and the sacrum, which, under conditions of proper physiological posture, remain in a balanced geometric relationship. Deviations from this configuration may indicate disturbances in trunk alignment and alterations in the tension of musculoskeletal and ligamentous structures (Figure 4).

The photographs presented below depict a characteristic pattern of postural misalignment, marked by a lowering of the sternal body and a theoretically justified reduction in pelvic tilt.[19] This 'head-toward-smartphone' configuration leads to disruptions in the physiological spinal curvatures and alters the distribution of loads transmitted through the musculoskeletal structures. In sitting, standing, and lying positions both supine and side-lying a repetitive compensation pattern can be observed, which may contribute to overload, reduced trunk stabilization capacity, and pain-related discomfort (Figures 5–7).

The photographs presented below illustrate a proper pattern of trunk alignment, in which the elevation of the sternal body and an increased anterior pelvic tilt allow for

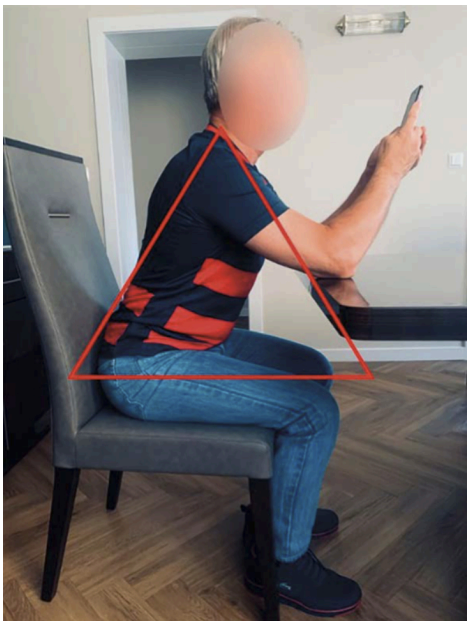

Figure 4. An isosceles triangle showing the extended lines of the sternum and sacrum in the correct physiological position.

Figure 5. Typical incorrect posture in a sitting position: lowered sternum and reduced pelvic tilt.

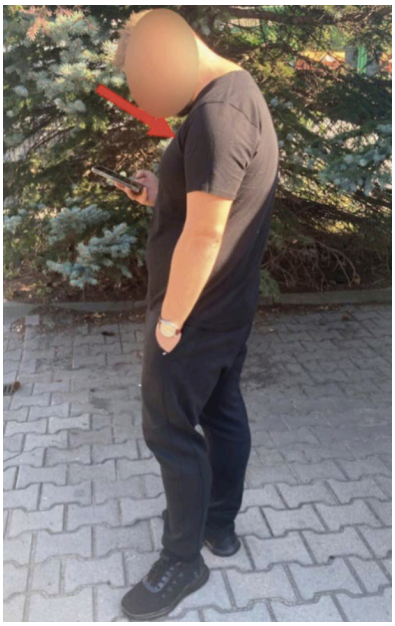

Figure 6. Typical incorrect posture in the standing position: lowered sternum and reduced pelvic tilt.

Figure 7. Typical incorrect posture in the supine position: (A) on the back, (B) on the side; lowered sternum and reduced pelvic tilt.

an optimal sagittal-plane orientation of the spine. Stabilizing the pelvis in a slight anterior tilt supports lumbar control and promotes balanced activation of the deep musculature, including the diaphragm, the transversus abdominis, and the pelvic floor muscles. Elevating the sternum, in turn, facilitates the maintenance of thoracic and cervical extension, thereby reducing excessive loading of the shoulder girdle. In sitting, standing, supine, and side-lying positions, this anatomical configuration promotes appropriate force distribution, efficient breathing, and reduces postural compensations.[18] The key principle is to ergonomically raise the smartphone to eye level 'smartphone to the head' (Figures 8–10).

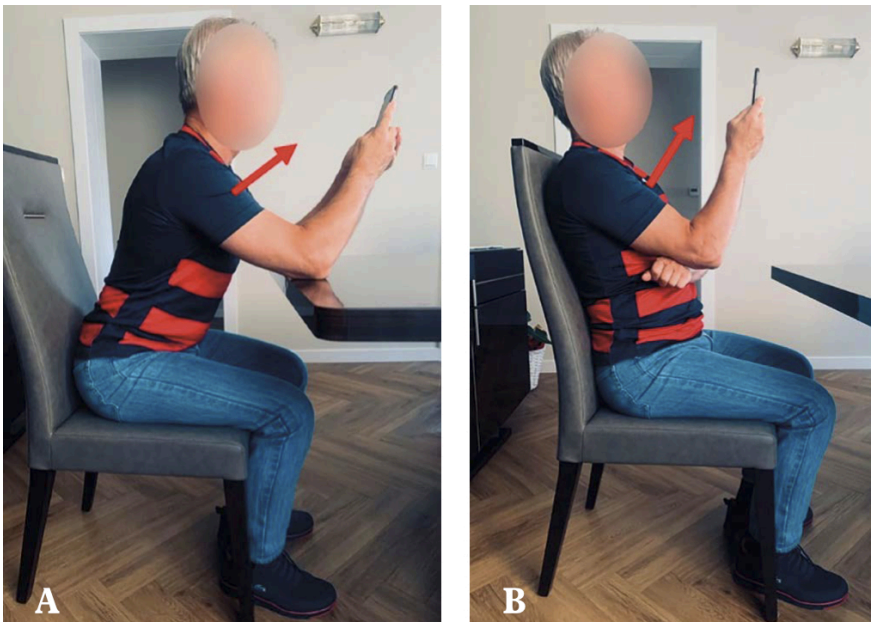

Figure 8. Correct posture in a sitting position: raised sternum and increased pelvic tilt (A) at a table with elbow rests, (B) in a position with back support.

Figure 9. Correct posture in a standing position: raised sternum and increased pelvic tilt.

5. DISCUSSION

Modern medicine encompasses not only diagnosis and treatment, but also the analysis of everyday behaviors that influence the functioning of the musculoskeletal system at various stages of life.[20,21]

One such behavior, particularly important in the 21st century, is smartphone use. Available literature describes selected postural characteristics when using mobile devices; these publications refer to individual body positions and are generally suggestive.[23–25] In this paper, the authors propose the use of Euclidean geometry[19] as a tool enabling a clear, measurable, and objective presentation of postural patterns conducive to ergonomic smartphone use.

From a clinical perspective, even small movements of the sternum and secondary changes in pelvic position at the sacral level can trigger significant angular reactions affecting whole-body proportions. These reactions modify, among other things, the type and distribution of muscle tone, as confirmed by electromyographic studies of trapezius muscle activity during smartphone use.[26] These disturbances can also affect the human body in ways that go far beyond the strain on the musculoskeletal system.[6–17] In this paper, the original photographs and geometric diagrams provide a clear educational tool that facilitates the identification of health-promoting behaviors.

The obtained results and long-term clinical observations confirm the validity of early postural prevention. It has been shown that a small, easily induced postural correction through gentle sternum elevation can significantly reduce the risk of the previously described health consequences in people of all ages who use smartphones. A key element of these interventions is the gentle, conscious modification of unhealthy behaviors into health-promoting ones, without excessive, forced 'straightening' of the body. Our own clinical observations indicate that maintaining a sternum angle of approximately 65° relative to the body's sagittal axis is a parameter supporting proper trunk alignment. The validity of this approach is supported by previous studies on the relationship between the sternum and sacrum, the influence

Figure 10. Correct body positioning in the lying position: (A) on the back, (B) on the side; raised sternum and increased pelvic tilt.

of sternum position on the shape of the spine, and the importance of motor control in various clinical groups.[27–30]

The authors' key message is the need to adapt the pace of implementing health-promoting behaviors to the individual's capabilities. Even short-term, but regularly repeated, adjustments to body posture can be an effective start to shaping stable, health-promoting postural habits. Rational smartphone use is particularly important given reports indicating that excessive or compulsive use of mobile devices negatively impacts the learning process and academic achievements of students.[31,32] At the same time, it should be emphasized that introducing posture correction into daily activities can foster positive thoughts and improve the quality of life, as confirmed by research on the impact of posture on cognitive and emotional processes.[33]

The authors of this study emphasize the necessity of recognizing the issue presented and highlight that even brief adjustments to trunk alignment may generate meaningful biomechanical and functional beneffts. The effectiveness of such corrective actions is likely to be most evident when applied within appropriately selected time intervals and with consideration of age-specific characteristics, including differences in load tolerance and the rate at which compensatory patterns develop. Future research should aim to establish precise, age-differentiated recommendations for safe exposure times to mobile devices, incorporating the principles of controlled postural self-correction and ergonomic smartphone use outlined in this manuscript. In this context, the overarching principle can be summarized succinctly: 'using your smartphone smartly.'

6. CONCLUSIONS

(1) The assumptions of Euclidean geometry provide a good justification for explaining health-promoting behaviors when using smartphones.
(2) Postural education, based on understandable geometric patterns, should be an integral element of behavioral and preventive health care proposals for the smartphone-using population.
(3) An individual pace of implementing health-promoting habits is recommended, which increases the effectiveness and sustainability of the effects.

Conflict of interest

Authors declare that there is no conflict of interest.

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Ethics

Patient's permission was obtained to publish this report.

References

1 Candussi CJ, Kabir R, Sivasubramanian M. Problematic smartphone usage, prevalence and patterns among university students: A systematic review. *J Affect Disord Rep.* 2023;14:100643. https://doi.org/10.1016/j.jadr.2023.100643.
2 Olson JA, Sandra DA, Colucci ES, et al. Smartphone addiction is increasing across the world: A meta-analysis of 24 countries. *CHB.* 2022;129:107138. https://doi.org/10.1016/j.chb.2021.107138.
3 Hansraj KK. Assessment of stresses in the cervical spine caused by posture and position of the head. *Surg Technol Int.* 2014;25:277–279.
4 Harrison DE, Cailliet R, Harrison DD, Troyanovich SJ, Harrison SO. A review of biomechanics of the central nervous systempart III: Spinal cord stresses from postural loads and their neurologic effects. *J Manipulative Physiol Ther.* 1999;22(6):399–410. https://doi.org/10.1016/s0161-4754(99)70086-2.
5 Shacklock M. Neurodynamics. *Physiotherapy* 1995;81(1):9–16. https://doi.org/10.1016/S0031-9406(05)67024-1.
6 Chen YJ, Hu CY, Kuang-Ting Ye KT, et al. Association of smartphone overuse and neck pain: a systematic review and meta-analysis. *Postgrad Med J.* 2025;101(1197):620–626. https://doi.org/10.1093/postmj/qgae200.
7 Jacquier-Bret J, Gorce P. Effect of day time on smartphone use posture and related musculoskeletal disorders risk: a survey among university students. *BMC Musculoskeletal Disord.* 2023;24:725. https://doi.org/10.1186/s12891-023-06837-5.
8 Nawasreh ZH, Gaowgzeh RM, et al. Neck pain associated with smartphone usage among university students – *Maayah MF, PLoS ONE.* 2023;18(6):e0285451. https://doi.org/10.1371/journal.pone.0285451.
9 Banadaki FD, Rahimian B, Moraveji F, et al. The impact of smartphone use duration and posture on the prevalence of hand pain among college students. *BMC Musculoskelet Disord.* 2024;25:574. https://doi.org/10.1186/s12891-024-07685-7.
10 Hartanto A, Lee KY, Chua YJ, Quek FY, Majeed NM. Smartphone use and daily cognitive failures: A critical examination using a daily diary approach with objective smartphone measures. *Br J Psychol.* 2023;114(1):70–85. https://doi.org/10.1111/bjop.12597.
11 Liu W, Kawashima T, Shinohara K. Effects of cell phone presence on the control of visual attention during the Navon task. *BMC Psychol.* 2023;11:334. https://doi.org/10.1186/s40359-023-01381-2.
12 Zhang Y, Ye Z, Zhang Y, Qin X, et al. Regular Mobile Phone Use and Incident Cardiovascular Diseases: Mediating Effects of Sleep Patterns, Psychological Distress, and Neuroticism. *Can J Cardiol.* 2024;40(11):2156–2165. https://doi.org/10.1016/j.cjca.2024.06.006.
13 Yu Z, Chen Z, Wang M, et al. Mobile Phone Addiction- and Suicidal Behaviors in Adolescents School-Based

Cross-Sectional Study in Zhejiang Province, China. *J Med Internet Res.* 2025;24:27:e80410. https://doi.org/10.2196/80410.

14 Karas M, et al. Smartphone Screen Time Characteristics in People With Suicidal Thoughts: Retrospective Observational Data Analysis Study. *JMIR Mhealth Uhealth.* 2024;11:12:e57439. https://doi.org/10.2196/57439.

15 Khan A, McLeod G, Hidajat T, Edwards EJ. Excessive Smartphone Use is Associated with Depression, Anxiety, Stress, and Sleep Quality of Australian Adults. *J Med Syst.* 2023;47(1):109. https://doi.org/10.1007/s10916-023-02005-3.

16 Dewi RK, Efendi F et al. Adolescents' smartphone use at night, sleep disturbance and depressive symptoms. *Int J Adolesc Med Health.* 2018;33(2). https://doi.org/10.1515/ijamh-2018-0095.

17 Wang C, Yuan K, Jin X, et al. HighIntensity Use of Smartphone Can Significantly Increase the Diagnostic Rate and Severity of Dry Eye. *Front Med.* 2022;9: e829271. https://doi.org/10.3389/fmed.2022.829271.

18 Kiebzak W. *The positioning of the sternum and sacrum in relation to the curvature of the spine as a means of evaluating the body posture while sitting* [in Polish]. Kielce: UJK. 2018.

19 Kiebzak WP. Application of Euclidean geometry in the assessment of body posture in a sitting position. *Pol Ann Med.* 2022;29(2):167–171 https://doi.org/10.29089/2021.21.00194.

20 Kiebzak W, Żurawski A, Dariusz Czaprowski D, Kowalski IM. Types of improper child carrying. *Pol Ann Med.* 2020;27(2):250–255. https://doi.org/10.29089/2020.20.00138.

21 Kiebzak W. Basics of physiological carrying babies. *Pol Ann Med.* 2021;28(1): 89–93. https://doi.org/10.29089/2021.21.00194.

22 Tao D, Zhang T, Qu X. Typing with mobile devices: A comparison of upper limb and shoulder muscle activities, typing performance and perceived workload under varied body postures, typing styles and device types. *Appl Ergon.* 2022;102:103760. https://doi.org/10.1016/j.apergo.2022.103760.

23 Kim S-H, Jung J-H, Cho H-Y, et al. The impact of smartphone use on gait in young adults: Cognitive load vs posture of texting. *PLoS One* 2020;15(10):e0240118. https://doi.org/10.1371/journal.pone.0240118.

24 Tapanya W, Neubert MS, Puntumetakul R, Boucaut R. The effects of shoulder posture on neck and shoulder musculoskeletal loading and discomfort during smartphone usage. *Int J Ind Ergon.* 2021;85:103175. https://doi.org/10.1016/J.ERGON.2021.103175.

25 Madardam U, Veerasakul S, Tamrin SBM, Mongkonkansai J. The effect of laying down posture while using smartphone among school children in Nakhon Si Thammarat. Thailand. *Rocz Panstw Zakl Hig.* 2022;72(2):221–229. https://doi.org/10.32394/rpzh.2022.0210.

26 Tang Z, Jin X, Yang C et al. Ergonomic evaluation of the effects of forearm conditions and body postures on trapezius muscle activity during smartphone texting. *Int. J. Ind. Ergon.* 2021;82:103085. https://doi.org/10.1016/j.ergon.2021.103085.

27 Kiebzak WP, Żurawski AŁ, Kosztołowicz M. Alignment of the Sternum and Sacrum as a Marker of Sitting Body Posture in Children. *Int J Environ Res Public Health* 2022; 19(23):16287. https://doi.org/10.3390/ijerph192316287.

28 Kiebzak WP, Ha SY, Kosztołowicz M, Żurawski A. Forced Straightening of the Back Does Not Improve Body Shape. *Diagnostics.* 2024;14(3):250. https://doi.org/10.3390/diagnostics14030250.

29 Żurawski, AŁ Ha SY, Kiebzak WP et al. Targeted Motor Control Considering Sternal Position Improves Spinal Alignment in Pregnant Women at Risk for Preterm Birth with Low Back Pain. *J Clin Med.* 2024;13:7661. https://doi.org/10.3390/jcm13247661.

30 Ha S-Y, Żurawski A, Kiebzak W. The Use of Sternum and Sacrum Angles in the Assessment of Sitting Posture in Adolescents: A Cross-Sectional Comparison of Cohorts Assessed Before and After the COVID-19 Pandemic. *Children.* 2025;12:1547. https://doi.org/10.3390/children12111547.

31 Sunday OJ, Adesope OO, Maarhuis PL. The effects of smartphone addiction on learning: A metaanalysis. *CHB Rep.* 2021;4:100114. https://doi.org/10.1016/j.chbr.2021.100114.

32 Ramjan LM, Salamonson Y, Batt S, et al. The negative impact of smartphone usage on nursing students: An integrative literature review. Nurse Educ. *Today.* 2021;102: 104909. https://doi.org/10.1016/j.nedt.2021.104909.

33 Wilson VE, Peper E. The effects of upright and slumped postures on the recall of positive and negative thoughts. *Appl Psychophysiol Biofeedback.* 2004;29(3):189–195. https://doi.org/10.1023/b:apbi.0000039057.32963.34.