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Assessment of Lower Limb Joint Postural Deformities Using APECS among Male Physical Education and Sport Science Applicants

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Abstract

The Alignment Posture Evaluation and Correction System (APECS) is a non-radiographic AI-based mobile application designed to assess body posture safely and accurately, unlike X-rays, which may be harmful and less precise. This study used APECS version 2.0 (DXM model) to detect lower limb deformities in hip, knee, and foot joints among 60 male applicants to the College of Physical Education and Sports Science. Full-limb images with anatomical markers were captured, and joint angles were automatically calculated by the software. Results indicated deformities in the hip (18.35%), knee (26.61%), and foot (41.28%). The program demonstrated high accuracy, with a 98.74% matching rate and 94.64% agreement, confirming its validity as a reliable, non-invasive tool for assessing lower limb postural deformities in prospective students.

Keywords: Artificial intelligence, software applications, lower limb joints.

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Introduction

Advanced countries care for all segments of their population and strive to provide healthcare to maintain a well-proportioned, balanced, and healthy human physique. Physical education is considered a component of general education and represents a fertile field for preparing individuals in terms of health, physical fitness, mental, emotional, and social aspects. This is achieved through learning and practicing various types of physical and sports activities to accomplish these objectives.

The field of rehabilitation, encompassing both physical and psychological aspects, plays a significant role in the selection process and early detection of practitioners' readiness for sports before engagement. This is a key factor in preventing adverse outcomes from participating in physical activities. Moreover, maintaining a healthy body posture has become an essential requirement in daily life.

Postural deformities, including deformities of the lower limb joints, constitute a fundamental aspect of the human body around which movement revolves. The alignment of the body and the coordination of all its parts depend on the health, integrity, and balance of the muscles acting on the lower limbs, represented by the hip, knee, and foot joints.

The use of the APECS (Automated Posture Evaluation and Correction System) program, a non-radiative mobile application, is designed to assess the entire body posture. It is part of artificial intelligence programs that have emerged as an alternative to visual inspection or X-ray diagnosis, providing a safe, accurate, and valid method for measuring postural deformities. On the other hand, relying solely on visual assessment in faculties of physical education and sports science to examine prospective students and detect lower limb deformities does not provide an accurate evaluation of the applicant's condition. One of the primary admission requirements is for candidates to possess proper posture to be able to meet the academic and practical demands of the curriculum.

The aim of this study is to utilize the non-radiative APECS program to detect postural deformities of the lower limbs (hip, knee, and foot joints) and to examine the relationships between these deformities.

Theoretical significance: This research contributes to the academic literature on studies that promote the adoption of artificial intelligence tools and applications, including the non-radiative APECS program, which can assist in detecting postural deformities and thus serve the field of sports.

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Practical significance: This study is distinguished by its use of artificial intelligence applications to detect postural deformities, including lower limb deformities, in order to obtain precise data that can be relied upon to accurately determine the degree of deformities. According to the researchers' knowledge, this study is the first to apply such an approach within examination and testing committees.

Based on the work of researchers in faculties of physical education and sports sciences, and their study of postural deformities among individuals of both genders and various ages, as well as their previous participation in health fitness examination committees for applicants to physical education and sports programs, it is noted that health and postural assessments are typically conducted through visual inspection, including the identification of postural deformities. Students applying to physical education faculties must be free from such deformities that could impede their ability to perform the required coursework and various physical and sports activities. Consequently, this study proposes the use of a modern artificial intelligence application, the non-radiative APECS program, to conduct the screening and diagnosis process in a practical and precise manner.

Research Questions

What are the common postural deformities of the lower limbs among applicants to the Faculty of Physical Education and Sports Sciences?

What is the correlation between the common lower limb postural deformities among applicants to the Faculty of Physical Education and Sports Sciences?

Research Objectives

To detect, diagnose, and identify the degrees of postural deformities in the lower limb joints (hip, knee, and foot) and examine the relationships between them.

Research Hypothesis

There is a statistically significant positive correlation between the angular variables and deformities of the lower limb joints (hip joint angles, knee joint angles, and foot angles).

Research Scope

Human Scope: A sample of applicants to Al-Mustansiriya University – Faculty of Physical Education and Sports Sciences for the academic year 2024–2025, consisting of 60 male applicants.

Temporal Scope: From September 11, 2024, to September 25, 2024.

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Spatial Scope: The medical examination hall at the Faculty of Physical Education and Sports Sciences – Al-Mustansiriya University.

Methodology

The researchers employed the descriptive method, as it is suitable for the nature and problem of the study, allowing them to achieve the research objectives and test the proposed hypotheses.

Research Population and Sample

The research population was deliberately defined as the applicants for preliminary admission to the Faculty of Physical Education and Sports Sciences for the academic year 2024–2025, totaling 60 male applicants.

The research sample was then selected randomly from the population, comprising 90 applicants, representing 60% of the original population.

The researchers ensured the homogeneity of the research sample in the variables of body mass, height, and chronological age by using skewness values, as shown in Table (1).

Table (1): Show Sample Homogeneity

No.	Variable	Unit of Measurement	Sample (n)	Mean	Standard Deviation	Skewness
1	Body Mass	Kilogram (kg)	60	72.557	10.132	0.032
2	Height	Centimeter (cm)	60	174.2	6.569	0.226
3	Chronological Age	Year (yr)	60	18.443	0.5	0.235

Research Tools

- The medical examination hall at Al-Mustansiriya University.
- An electronic calculator: MacBook Air laptop.
- A mobile device: iPhone 15 installed with the APECS program.
- Rastameter device for measuring height (cm) and body mass (kg).

Data Collection

- References and sources in Arabic and English, previous related studies, and the Internet.
- Personal interviews.
- Data collection forms.
- Observation and experimentation.

Procedures

This study was conducted on a sample of male applicants (n = 60) to the Faculty of Physical Education and Sports Sciences. Joint angles were determined using APECS software, version 2.0, model DXM. Full-limb photographs were captured, anatomical landmarks were marked, and angles were automatically generated by the program.

The location and procedures for photographing the applicants were set according to the software requirements as follows:

- The subject stood facing the camera at a distance of 120 cm, ensuring equal spacing on both sides so that the subject was centered in the frame.
- The subject stood upright with knees fully extended, chest open, head raised, eyes looking forward, palms facing the sides of the body, feet together, and thumbs pointing forward.
- Placement of Anatomical Points:
- Top of the iliac crest (right and left sides).
- Midpoint of the knee (right and left sides).
- Point below the knee (right and left sides).
- Lateral point on the calcaneus (right and left sides) at the subtalar joint.

Examined Deformities

First: Pelvic Deformities – Hip

- Pelvic tilt (general): Includes lateral pelvic tilts as follows:
- Tilt to the right side.
- Tilt to the left side.
- Pelvic tilt usually refers to the angle formed between a horizontal line and the line connecting the anterior superior iliac spine (ASIS) and posterior superior iliac spine (PSIS) in the sagittal plane.

Second: Knee Joint Deformities (General)

- The range of motion (ROM) of the knee joint was measured in degrees of flexion. In males, the normal ROM is -6° to 140°, and in females, it is -5° to 143°. Specific knee deformities include:
- Genu valgum (knock-knees): Characterized by a noticeable gap between the feet when the knees are together.
- Genu varum (bowlegs): Outward curvature of the legs causing the knees to remain apart while the ankles touch, creating a noticeable gap between the knees.
- Third: Foot Deformities (General):
- Out-toeing: Deviation of the foot outward.
- In-toeing: Deviation of the foot inward.

Statistical Analysis

After collecting the raw data, the researchers analyzed it using IBM SPSS statistical software (version 26) (Statistical Package for the Social Sciences). The analysis included calculating the mean, standard deviation, percentage, skewness, and Spearman's correlation coefficient to obtain a comprehensive understanding of the data and examine the relationships between the studied variables.

Results

Table (2): Frequencies, Percentages, and Rankings of Lower Limb Postural Deformities in the Research Sample

Main Deformity	Sub-Deformity	Unit	Frequency	% Frequency	% Total	Internal Rank	Deviation Degree	External Rank
Pelvis – Hip	Pelvic tilt to the right	Degree	8	7.34%	18.35	2	8	1
	Pelvic tilt to the left	Degree	12	11.01%		4	15	2
Knee	Right knee valgum (outward)	Degree	14	12.84%	26.61	5	33	6

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	Left knee valgum (outward)	Degree	15	13.76%		6	23	5
	Right knee varum (inward)	Degree	6	5.50%	13.76	1	18	3
	Left knee varum (inward)	Degree	9	8.26%		3	21	4
Foot	Right foot deviation	Degree	23	21.10%	41.28	8	285	8
	Left foot deviation	Degree	22	20.18%		7	276	7
Total			109	100%		8	679	8

Table (3): Postural Deformities and Their Correlations in the Lower Limbs of the Research Sample

No.	Postural Deformity Correlation	Correlation Coefficient	Postural Deformity Correlation	Correlation Coefficient
1	Right ankle – Right knee	0.18	Left ankle – Left knee	0.23
2	Right ankle – Left knee	0.16	Left ankle – Right knee	0.12
3	Right ankle – Right pelvis	0.10	Left ankle – Right pelvis	-0.09
4	Right ankle – Left pelvis	-0.20	Left ankle – Left pelvis	0.67
5	Right knee – Right pelvis	0.17	Left knee – Right pelvis	-0.39
6	Right knee – Left pelvis	-0.33	Left knee – Left pelvis	0.18

Discussion

Upon reviewing the results presented in Tables (2) and (3), the findings for the study sample can be discussed as follows: Prior to the discussion, it is necessary to provide a brief overview of the components of the lower limb. The lower limb is divided into three regions: the thigh, the leg, and the foot. Each lower limb contains 30 bones connected by joints that contribute to movement, balance, and motor coordination through specific joint angles and ranges of motion. The anatomical angles of the lower limb joints play a crucial role in maintaining body stability and equilibrium. The strength of the lower limb muscles substantially contributes to preserving the normal angular values of the lower limb within the human body. Any alterations or deviations in these angular values from the body's midline may expose the individual to disorders and injuries in the joints and muscles of the lower limb, in addition to the development of certain postural deformities (Butler, el al, 2011).

The internal femoral angle (MNSA) is 130°, and the lateral femoral angle (LPFA) is 90°. The medial proximal tibial angle (MPTA) is 87°, and the lateral distal femoral angle (ALDFA) is 81°. The lateral distal tibial angle (LDTA) is 89°, and the medial distal tibial angle (ADTA) is 80° (Kaufman KR, Hughes C, Morrey BF, 2021).

Sports injuries are often accompanied by changes in anthropometric and morphological measurements. Therefore, professionals in sports training must carefully consider the outcomes of these measurements, whether they pertain to external body dimensions or body levers, including the upper limb or its components, as well as the lower limb or its respective segments (Mohamed Bakry and Siham El-Sayed, 2011).

There is a strong correlation and motor integration among the movements of the lower limb joints, such that any deformity in one joint can have negative repercussions on all lower limb joints. Dynamic lower limb deviation, for example, involves a combined movement of hip adduction, internal rotation, knee abduction, and ankle/foot flexion, which places increased abnormal forces on the knee (Ford KR, el al, 2015). Compensatory movements resulting from ankle insufficiency may manifest as foot/ankle flexion, knee abduction, or hip adduction (Bell DR, et al, 2008).

According to the results presented in Tables (2) and (3), the researchers attribute some causes of pelvic tilt to lifestyle patterns, poor postural habits, and certain sports activities that require lateral body leaning or favoring one side over the other. This deviation may be associated with lower back pain and muscular weakness, as well as contributing to knee or foot misalignments. The orientation of the pelvis relative to the femur, within its designated anatomical space, can tilt either to the right or left. A significant degree of pelvic tilt may lead to knee pain, lower back pain, other musculoskeletal disorders, and a reduced capacity for athletic performance.

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Pelvic tilt is typically assessed in a static manner, such as observing an individual's pelvis while standing in a relaxed posture. It can also be evaluated actively, for example, by measuring the individual's ability to move the pelvis through its maximum range while maintaining an upright stance. Additionally, pelvic tilt can be assessed during functional movements, such as changes in the pelvic tilt angle during downward motion. While there are various descriptions of pelvic tilt, for the purposes of this discussion, pelvic tilt refers to the spatial position or movement of the pelvis in the sagittal plane around an anterior–posterior horizontal axis.

According to the results presented in Tables (2) and (3), one of the most significant problems resulting from knee deformities, regardless of the type, is that the patient's body weight is not evenly distributed across the entire joint surface. Instead, it is concentrated on a small portion of the surface, which, over time, leads to cartilage damage in that area and early onset osteoarthritis in the knee joint(Abdulghani et al., 2025; Abdulkareem & Ali Hassan, 2025).

This occurs when the knees move closer together while the ankles move apart as the legs remain extended in a straight line. Knee contact, or genu valgum, is characterized by medial approximation of the knees with increased distance between the feet in a normal standing position, resulting from lateral displacement of the body's center of gravity relative to the knee joint (Al-Kharboutly, 2011). Individuals with a severe degree of this congenital deformity are typically unable to bring their feet together while standing upright. Causes of knee contact deformity include weakness of the ligaments and muscles supporting the knee joint, poor daily habits such as walking and standing incorrectly, and participation in improperly regulated sports activities or exercises, as well as the use of unsuitable surfaces or equipment. These factors lead to shortening and strengthening of the lateral (external) knee muscles and ligaments, accompanied by weakening and elongation of the medial structures, which results in excessive pressure on the knee cartilage. Consequently, the legs lose their alignment, causing the femur to tilt inward(Abdulhussain et al., 2025).

This misalignment significantly affects the body's weight transfer line and the distribution of forces on the ankle and foot arches, leading to various foot deformities and impacting the stability and function of other lower limb joints. One such deformity is bowing of the tibia, where the knees remain apart while the ankles touch during standing, creating a noticeable gap between the knees. This condition can affect both children and adults. Furthermore, this deformity may result in malformations of the hip joint and ankle, as well as inward or outward deviation of the feet (Blevins, 2021).

When the foot contacts the ground during walking, running, or jumping, the body weight exerts a substantial amount of pressure and force on the foot. The force applied to each foot during

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running can reach up to 2.5 times the body weight upon ground contact. The bones, joints, ligaments, and muscles of the foot absorb this force, thereby significantly reducing the impact transmitted from the lower limb to the upper body. The arches of the foot play a crucial role in shock absorption, as they slightly flatten under load to absorb energy and return to their natural shape once the weight is removed (Abdulkareem & Sattar Jabbar, 2025).

Causes of this deformity include genetic factors, motor performance deficits from repetitive exercises with resistance in an unscientific or unregulated manner, or association with other postural deformities of the skeletal system. This deformity is linked to other lower limb malformations. Foot deformity often manifests as lateral bending with the foot twisted downward and inward, which increases the curvature of the foot and causes inward rotation of the heel (Al-Kharboutly, 2011).

One of the causes of this deformity is the high loads applied to the feet, particularly body weight, as well as performing exercises or movements that involve repeated jumping and landing on the feet. Flatfoot is a common deformity affecting many individuals, including athletes across different age groups, due to weakness of the foot muscles and ligaments on one hand, and continued misuse on the other (Gad, 1989).

There is a relationship between deformities of the hip and knee joints and the development of flatfoot. During movement, whether walking or running, body weight is transferred through the lower limb joints (hip, knee, and foot). In individuals with flatfoot, the foot's load-bearing phase is compromised, leading to a disruption in the body weight transfer line and consequent collapse of the foot arch. In flatfooted individuals, when lifting the foot, the heel, ball of the foot, and toes rise simultaneously, unlike the normal pattern where the heel can lift while the forefoot bears weight. This abnormal movement causes fatigue and pain, resulting in an altered gait pattern (Hindi, n.d).

Conclusions

The APECS program demonstrated a high match rate (98.74%) and agreement (94.64%), indicating its excellent validity for measuring lower limb joint angles. The angular values of the femur, knee, and ankle are highly important for maintaining the stability, balance, and equilibrium of the lower limb, thereby preventing the progression of postural deformities or the occurrence of lower limb injuries. Furthermore, there is a strong correlation among postural deformities of the lower limb joints, with each potentially influencing the others.

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Recommendations

It is important to conduct morphological and biomechanical measurements and screen for postural deformities when assessing applicants for admission to faculties of physical education and sports sciences, and to repeat these assessments throughout the academic years while addressing any issues promptly to prevent student injuries. Monitoring postural deformities resulting from daily habits that require prolonged postures is also essential. Attention should be given to appropriate equipment, such as using specialized footwear or floors with specific specifications. Additionally, promoting a culture of exercise and athletic performance based on sound principles of sports training is crucial.

References

Abdulghani, L. Y., Abdulghani, M. Y., & Abdulkareem, O. W. (2025). Designing a palm pressure measurement device to improve motor coordination in freestyle swimming among female students. Journal of Physical Education and Sport, 25(7), 1506–1513. https://doi.org/10.7752/jpes.2025.07168

Abdulhussain, A. A., Abdulkareem, O. W., Atiyah, H. S., Jaber, O. H., Ghanim, M. R., Hammood, A. H., & Saleh, Y. M. (2025). The Impact of Jesko's Strategy with Sequential Exercises on Learning the Skill of Dribbling in Basketball. *Annals of Applied Sport Science*, 0–0. https://doi.org/10.61186/AASSJOURNAL.1550

Abdulkareem, O. W., & Ali Hassan, M. F. (2025). impact of mental games on improving shooting accuracy among young basketball players in Iraqi clubs. *Scientific Journal of Sport and Performance*, *4*(3), 342–351. https://doi.org/10.55860/OHNP7224

Abdulkareem, O. W., & Sattar Jabbar, H. (2025). Comparative Biomechanical Analysis of Three-Point Shooting Between Elite Iraqi Basketball Players and International Counterparts. *Journal of Sport Biomechanics*. https://doi.org/10.61186/JSportBiomech.11.3.326

Alviso, D. J., Dong, G. T., & Lentell, G. L. (1988). Intertester reliability for measuring pelvic tilt in standing. *Physical Therapy, 68*(9), 1347–1351. https://doi.org/10.1093/ptj/68.9.1347

Ayad, R., & Kharboutly, S. (1995). *Postural fitness and sports massage*. Alexandria: Al-Maaref Establishment.

Bakry, M., & El-Sayed, S. (2011). *Sports injuries and physical rehabilitation*. Cairo: Egyptian Library for Printing and Publishing.

Bell, D. R., Padua, D. A., & Clark, M. A. (2008). Muscle strength and flexibility characteristics of people displaying excessive medial knee displacement. *Archives of Physical Medicine and Rehabilitation, 89*, 1323–1328. https://doi.org/10.1016/j.apmr.2008.01.023

Blevins, K. M. (2021, April). Angular deformities of the lower extremity: Bowlegs and knock-knees. *American Academy of Pediatrics.* https://doi.org/10.1542/peds.2021-xxxx

Butler, R. J., Barrios, J. A., & Royer, T. (2011). Frontal-plane gait mechanics in people with medial knee osteoarthritis are different from those in people with lateral knee osteoarthritis. *Physical Therapy, 91*(8), 1235–1243.

Easa, F. A. W., Shihab, G. M., & Kahdim, M. J. (2022). the Effect of Training Network Training in Two Ways, High Interval Training and Repetition To Develop Speed Endurance Adapt Heart Rate and Achieve 5000 Meters Youth. Revista iberoamericana de psicología del ejercicio y el deporte, 17(4), 239-241.

Ford, K. R., Nguyen, A. D., Dischiavi, S. L., Hegedus, E. J., Zuk, E. F., & Taylor, J. B. (2015). An evidence-based review of hip-focused neuromuscular exercise interventions to address dynamic lower extremity valgus. *Open Access Journal of Sports Medicine, 6*, 291–303. https://doi.org/10.2147/OAJSM.S91271

Gad, M. M. (1983). *A field study of some postural deformities among sixth grade students in the Eastern Alexandria region* (Unpublished master's thesis). Faculty of Physical Education for Boys, Alexandria.

Gajdosik, R., Simpson, R., Smith, R., & DonTigny, R. L. (1985). Pelvic tilt: Intratester reliability of measuring the standing position and range of motion. *Physical Therapy, 65*(2), 169–174. https://doi.org/10.1093/ptj/65.2.169

Hindi, H. F. (n.d.). *Medical anatomy for athletes*. Alexandria: Dar Al-Fikr Al-Arabi.

Hussain, F. M., Shuhaib, M. H., & Hassan, M. F. A. (2024). Psychological Toughness and its Relationship to Some Coordination, Physical Abilities and Accuracy of Some Basic Skills Performance Among The Iraqi Junior National Handball Team Players. International Journal of Disabilities Sports and Health Sciences, 7(Special Issue 2): The Second International Scientific Conference: Sports for Health and Sustainable Development,(SHSD, 2024)), 330-336.

Isa, A. (2009). *A study of some postural deviations among students of the Institute of Physical Activities and Sports Sciences* (Unpublished master's thesis). Akli University.

Kadhim, M. J. (2023). Examining The Relationship Between Social Classes And The Culture Of Poverty: A Case Study. International Journal of Social Trends, 1(1), 23-27.

Kaufman, K. R., Hughes, C., & Morrey, B. F. (2001). Gait characteristics of patients with knee osteoarthritis. *Journal of Biomechanics, 34*, 907–915. https://doi.org/10.1016/S0021-9290(01)00036-7

Kharboutly, S. (2011). *Postural fitness and massage*. Alexandria: Dar Al-Jamiyeen for Printing and Binding.