International Journal of Movement Education and Social Science
Peer Reviewed and Indexed Journal
IJMESS Vol. 13 Issue 2 (Oct 2024)
ISSN: 2278-0793 (Print) & 2321-2279 (Online)
Impact Factor 5.62
www.ijmess.org

TECHNOLOGY BASED BODY ALIGNMENT ASSESSMENT IN ADOLESCENTS OF GOVERNMENT SCHOOLS

Dr. Gajanana Prabhu B., Associate Professor
Mr. Deekshith B., M.P.Ed. Student
Department of P. G. Studies in Physical Education
Kuvempu University, Shankaraghatta, Karnataka

ABSTRACT

Movement and posture structure are very important for the physical and emotional development of children and young people. Most medical and exercise professionals agree that the major joints should be aligned over one another while in a resting, standing posture. Abnormal posture predisposes several musculoskeletal disorders including pain, impaired proprioceptive feedback, and imbalance in muscle activity, abnormal load-bearing on joints and ligaments, and getting easily fatigued and even increased fall risk. Postural deformity is a commonly encountered problem among Children. One of the causes of postural disturbances is a strong and tight antagonist muscle group and a weak and elongated agonist muscle group. The difference in strength and contractile ability between these agonist and antagonist muscles leads to postural disturbances. Assessment of the postural alignment is one of the most frequently performed assessments by physiotherapists and other rehabilitation professionals in all age populations due to its significant necessity to identify and manage problems rising from postural disorders. Studies related with postural assessment tools by using mobile application (app) have been drawing rising interest due to widespread use of smartphone and its favourable technology integration in image-based apps. The purpose of the present investigation was to assess the body alignment of adolescents in government high schools with and without physical education teachers. Also, the study examined percent wise deviations in alignment at different head, shoulder, pelvic, knee, foot and overall body. For the purpose of the study 120 male students from 8 schools were included in the study. The Government schools located nearby to Kuvempu University Jnanasahyadri campus were selected. The age of selected subjects ranged between 14 to 17 years. Only healthy male subjects were selected with their consent to willingly participate in the present investigation. Photogrammetric evaluation method was used to analyse body alignment. Mobile app was used to collect the data for the present investigation, 8 schools were visited during leisure periods APECS mobile app was used to analyse the postural deviations of 120 students. The subjects were directed to assemble in a class room. Necessary directions were given to all subjects after assembly of subjects. Objectives of the test were made clear and full cooperation was sought. The subjects under investigation were instructed to remove their shirt for accurate assessment. Descriptive statistics like Mean, Standard Deviation and other suitable statics were employed in the present investigation. In order to test the hypotheses formulated for the present investigation, 't' test for independent variables was employed. The level of

ISSN: 2278-0793 (Print) & 2321-2279 (Online)
Impact Factor 5.62
www.ijmess.org

significance was .05 level. Further, percent analysis was carried out in order to examine the proportion of subjects with varied degree of deviations. It is found that there is no significant difference in head, shoulder, pelvic, knee, foot and body alignment between high school students from schools with and without Physical Education Teachers. The proportion of high school students coming under 'High' and 'Very High' normative category of deviation is very negligible.

Keywords: Posture, Alignment, Deviations, Technology, Mobile Application, APECS, and Deformities.

Introduction

Posture is one of the important factors that affect a person's physical and mental state throughout life (Cengiz and Delen, 2024). Posture is the alignment of each part of the body in the most appropriate position relative to the adjacent segments and the whole body (Ferreira, et. al., 2010). Understanding about the effects of posture and mechanics on overall health and injury prevention, body alignment is becoming a popular topic in fitness. Movement and posture structure are very important for the physical and emotional development of children and young people (Solberg, 2008). It is stated that ideal posture occurs when all body segments are vertically aligned, and all joint axes cross the line of gravity (Kendall, 1993). Psychological and social characteristics, ability, mental characteristics, physical and physiological fitness as well as posture and anthropometric structures determine success and performance in sports (Karakuş, 2006).

Most medical and exercise professionals agree that the major joints should be aligned over one another while in a resting, standing posture. From the side (lateral) view, the ear, shoulder joint, hip joint, knee, and front of the ankle should be directly over one another. From the front or back (anterior or posterior) view, the shoulders, hips, and knees should be level and both the feet should point straight ahead or have a slight symmetrical turnout of up to ten degrees. The knees and feet should point in the same direction.

Good posture is considered to be an important health indicator (McEvoy & Grimmer, 2021), and optimal Posture is required for balanced position of musculoskeletal system involving minimum stress and strain on the body (Castro, et. al., 2017). Abnormal posture predisposes several musculoskeletal disorders including pain, impaired proprioceptive feedback, and imbalance in muscle activity, abnormal load-bearing on joints and ligaments, and getting easily fatigued and even increased fall risk (Swann, 2009).

Postural deformity is a commonly encountered problem among Children. There are various reasons for which a child may be subjected to this kind of deformity. Certain corrective measures need to be taken in time to protect the muscles, ligaments and bone tissue from degeneration. Very often, the reason for this problem has been stated as a behavioural outcome. Children subjected to distort position or alignment during their screen timing. Further, children consume fast food more often and lack of regular exercise or physical activity are more prone to problems with body alignment. It must be noted that the working efficiency and ability of humans depend upon good posture. It conveys the level of wellbeing and reflects vigour, vitality and healthfulness of an individual. Postural status aberrations in children and youth represent a global and current problem, and have attracted enormous attention of Experts from exercise science worldwide. Different approaches are being

ISSN: 2278-0793 (Print) & 2321-2279 (Online)
Impact Factor 5.62
www.ijmess.org

identified and varying results of the researches are elicited from studies that are conducted across the globe.

One of the causes of postural disturbances is a strong and tight antagonist muscle group and a weak and elongated agonist muscle group. The difference in strength and contractile ability between these agonist and antagonist muscles leads to postural disturbances. Strengthening exercises are thought to promote adaptive shortening of muscle-tendon length, reposition skeletal segments, and may play a role in reorganizing static posture (Hrysomallis, 2001).

Assessment of the postural alignment is one of the most frequently performed assessments by physiotherapists and other rehabilitation professionals in all age populations due to its significant necessity to identify and manage problems rising from postural disorders (Hopkins, et. al., 2019). One of the most widely used methods for assessing human posture deviations is visual inspection and palpation (Tunnell, 1996). This method is highly subjective and assessor-dependent (Watson & Mac Donncha, 2000) and has low reliability and reproducibility, which makes its application in the scientific environment not recommendable (Singla & Veqar, 2014). To minimize biases produced by this analysis, new methods of postural assessment have been developed (Sedrez, et. al., 2016), which are based on tools to assist in manual assessment, digital tools, radiography methods (Bonanni, 2000) and computer-based solutions.

In recent years, smart phone applications have gained credibility as instruments to support assessment and monitoring of patients (Moreira, et. al., 2020). Remote monitoring and management of health information for people outside the clinical and hospital environment has been favored with the use of mobile healths (Saponara, et. sal., 2016). The widespread use of portable electronic devices worldwide favours their formal application in health services, supporting the conduct and performance of health professionals (Kallander, et. al., 2013).

Image-based technologies lent a hand to researchers and clinicians by providing accurate and accessible postural assessment tools. Various postural assessment software using digitized images where reflective markers are placed on anatomical reference points and limb segments were developed. These marker positions are captured and analysed by the software in anterior, posterior, and lateral views and
calculate body angles and distances on the images (Reina, et. al., 2018).

Studies related with postural assessment tools by using mobile application (app) have been drawing rising interest due to widespread use of smartphone and its favourable technology integration in image-based apps (Timurtaş, et. al., 2021). The use of mobile technology is found to be beneficial for supporting more rapid decisions, planning, and follow up of any treatment, increasing the quality of the data and data accessibility (Fortin, 2018).

Methodology

The purpose of the present investigation was to assess the body alignment of adolescents in government high schools with and without physical education teachers. Also, the study examined percent wise deviations in alignment at different head, shoulder, pelvic, knee, foot and overall body.

Methodology. For the purpose of this study 120 male students from 8 schools were

ISSN: 2278-0793 (Print) & 2321-2279 (Online)
Impact Factor 5.62
www.ijmess.org

included in the study. The Government schools located nearby to Kuvempu University Jnanasahyadri campus were selected. The age of selected subjects ranged between 14 to 17 years. Only healthy male subjects were selected with their consent to willingly participate in the present investigation. Photogrammetric evaluation method was used to analyse body alignment. Photogrammetry is the most widely used method for non-invasive measurement of postural measures, and it does not require printing of photographs. Photogrammetry quantifies postural assessment by measuring linear distances and angles (formed between lines produced through body markers and horizontal or vertical lines) on digital photographs by using software specifically designed for this purpose. Mobile app was used to collect the data for the present investigation, 8 schools were visited during leisure periods. APECS mobile app was used to analyse the postural deviations of 120 students.

APECS uses standardized landmarks and anatomical angles for postural assessment. A full list of anthropometric landmarks (with Latin names and descriptions) and angles involved can be found in the application. These anthropometric landmarks have been the subject of extensive research by scientists and doctors over the past 50 years. A lot of useful information about their validity can be obtained by checking literature review articles or specific studies like Garrett et al. (1993), Shaghayeghfardet al. (2015) etc. Researchers, physiotherapists, Doctoral candidates and students have used APECS in their research projects.

The spare time of the subjects were made known prior to going to school for data collection. The subjects were directed to assemble in a class room. Necessary directions were given to all subjects after assembly of subjects. Objectives of the test were made clear and full cooperation was sought. The subjects under investigation were instructed to remove their shirt for accurate assessment.

Descriptive statistics like Mean, Standard Deviation and other suitable statics were employed in the present investigation. In order to test the hypotheses formulated for the present investigation, 't' test for independent variables was employed. The level of significance was .05 level. Further, percent analysis was carried out in order to examine the proportion of subjects with varied degree of deviations.

Findings

The raw data on head, shoulder, pelvic, knee, foot and body alignment were subjected to descriptive statistics. The results on Mean and Standard Deviation are presented in table 1 as below.

TABLE NO. 1
DESCRIPTIVE RESULTS OF ALIGNMENT AT VARIOUS BODY SITES OF HIGH SCHOOL STUDENTS WITH AND WITHOUT PHYSICAL EDUCATION TEACHER (PET).

Variables	Status of School	Mean	Std. Deviation	Std. Error Mean
Head Alignment	With PET	3.45	2.89	0.37291
	Without PET	3.13	2.46	0.31755
Shoulder Alignment	With PET	1.54	1.44	0.18553
	Without PET	1.67	1.30	0.16777
Pelvic Alignment	With PET	0.51	0.56	0.07281
	Without PET	0.65	0.75	0.09747
Knee Alignment	With PET	0.88	0.89	0.11462
	Without PET	0.73	0.78	0.10119
Foot Alignment	With PET	1.83	2.21	0.28581
	Without PET	1.72	1.75	0.22644
Body Alignment	With PET	1.02	0.79	0.10135
	Without PET	1.05	0.67	0.08703

From table 1 it becomes apparent that the results are normally distributed with acceptable homogeneity displayed in terms of standard deviation. The deviation in Head tilt in schools with Physical Education Teacher was 3.45±2.89 and in schools without Physical Education Teacher was 3.13±2.46; The

ISSN: 2278-0793 (Print) & 2321-2279 (Online)
Impact Factor 5.62
www.ijmess.org

deviation in shoulder in schools with Physical Education Teacher was 1.54±1.44 and in schools without Physical Education Teacher was 1.67±1.30; The deviation in pelvic alignment in schools with Physical Education Teacher was 0.51±0.56 and in schools without Physical Education Teacher was 0.65±0.75; The deviation in knee alignment in schools with Physical Education Teacher was 0.88±0.89 and in schools without Physical Education Teacher was 0.73±0.78; The deviation in foot alignment in schools with Physical Education Teacher was 1.83±2.21 and in schools without Physical Education Teacher was 1.72±1.75; and The deviation in whole body alignment in schools with Physical Education Teacher was 1.02±0.79 and in schools without Physical Education Teacher was 1.05±0.67. The raw scores on head, shoulder, pelvic, knee, foot and body alignment were further subjected to independent sample 't' test in order to find differences in mean scores between High school students from schools with Physical Education teacher and Without Physical Education Teacher. The results are provided in table 2 as under.

TABLE 2
SUMMARY OF 'T' TEST ON ALIGNMENT AT VARIOUS BODY SITES OF HIGH SCHOOL STUDENTS WITH AND WITHOUT PHYSICAL EDUCATION TEACHER.

Variables	t-ratio	df	Significance Two-Sided p	Mean Difference	Std. Error Difference
Head Alignment	0.643	118	0.521	.31500	.48980
Shoulder Alignment	-0.520	118	0.604	-.13000	.25014
Pelvic Alignment	-1.164	118	0.247	-.14167	.12166
Knee Alignment	0.981	118	0.329	.15000	.15290
Foot Alignment	0.288	118	0.774	.10500	.36464
Body Alignment	-0.237	118	0.813	-.03167	.13359

Table 2 provides results on 't' test for deviation in alignments at Head (.643), Shoulder(-.520), Pelvic (-1.164), Knee (.981), Foot (.288) and whole body (-.237). It is found that there is no significant difference in head, shoulder, pelvic, knee, foot and body alignment between high school students from schools with and without Physical Education Teachers. Details on normative categories, deviation values and percentage wise presentation of data on head tilt is presented in table 3 as under.

TABLE 3
DETAIL ON NORMATIVE CATEGORIES, DEVIATION VALUES AND PERCENTAGE WISE PRESENTATION OF DATA ON HEAD TILT.

Normative Categories	Deviation Values	Frequencies	Percentage
Normal	0 – 0.99	30	25.01
Low	1 – 2.99	40	33.33
Medium	3 – 5.99	35	29.16
High	6 – 8.99	9	7.5
Very High	9 and above	6	5

From the table 3 it is obvious that 33.33% of high school students were having Low postural deviation; 29.16% % were having medium postural deviation; 7.5% % of high school students were having high postural deviation; and 5% % of high school students were having very high postural deviation as per alignment measures. It is observed that 25.01% of high school male students in the present investigation were normal in head tilt deviation measures. Details on normative categories, deviation values and percentage wise presentation of data on shoulder alignment is presented in table 4 as under.

TABLE 4
DETAIL ON NORMATIVE CATEGORIES, DEVIATION VALUES AND PERCENTAGE WISE PRESENTATION OF DATA ON

ISSN: 2278-0793 (Print) & 2321-2279 (Online)
Impact Factor 5.62
www.ijmess.org

SHOULDER ALIGNMENT.

Normative Categories	Deviation Values	Frequencies	Percentage
Normal	0 – 0.99	59	49.18
Low	1 – 2.99	40	33.33
Medium	3 – 5.99	19	15.83
High	6 – 8.99	2	1.66
Very High	9 and above	0	0

From the table 4 it is clear that 33.33% of high school students were having Low postural deviation; 15.83% of high school students were having medium postural deviation; 1.66% of high school students were having high postural deviation; and none of high school male students were having very high postural deviation as per alignment measures. It is observed that 49.18% of high school male students in the present investigation were normal in the shoulder alignment deviation measures. Details on normative categories, deviation values and percentage wise presentation of data on pelvic tilt is presented in table 5 as under.

TABLE 5
DETAIL ON NORMATIVE CATEGORIES, DEVIATION VALUES AND PERCENTAGE WISEPRESENTATION OF DATA ON PELVIC TILT

Normative Categories	Deviation Values	Frequencies	Percentage
Normal	0 – 0.99	91	75.83
Low	1 – 2.99	28	23.33
Medium	3 – 5.99	1	0.83
High	6 – 8.99	0	0
Very High	9 and above	0	0

From the table 5 it is clear that 23.33% of high school students were having Low postural deviation; 0.83 % of high school students were having medium postural deviation; none of high school students were having either high or very high postural deviation as per alignment measures. It is observed that 75.83% of high school students in the present investigation were normal in Pelvic tilt deviation measures. Details on normative categories, deviation values and percentage wise presentation of data on knee alignment is presented in table 6 as under.

TABLE 6
DETAIL ON NORMATIVE CATEGORIES, DEVIATION VALUES AND PERCENTAGE WISE PRESENTATION OF DATA ON KNEE ALIGNMENT

Normative Categories	Deviation Values	Frequencies	Percentage
Normal	0 – 0.99	76	63.34
Low	1 – 2.99	42	35
Medium	3 – 5.99	2	1.66
High	6 – 8.99	0	0
Very High	9 and above	0	0

From the table 6 it is clear that 35% of high school students were having Low postural deviation; 1.66% of high school students were having medium postural deviation; none of high school students were having either high or very high postural deviation as per alignment measures. It is observed that 63.34% of high school students in the present investigation were normal in Knee Alignment deviation measures. Details on normative categories, deviation values and percentage wise presentation of data on foot angle is presented in table 7 as under.

TABLE 7
DETAIL ON NORMATIVE CATEGORIES, DEVIATION VALUES AND PERCENTAGE WISE PRESENTATION OF DATA ON FOOT ANGLE

Normative Categories	Deviation Values	Frequencies	Percentage
Normal	0 – 0.99	59	49.19
Low	1 – 2.99	38	31.66
Medium	3 – 5.99	17	14.16
High	6 – 8.99	4	3.33
Very High	9 and above	2	1.66

From the table 7 it is clear that 31.66% of high school students were having Low postural deviation; 14.16% of high school students

ISSN: 2278-0793 (Print) & 2321-2279 (Online)
Impact Factor 5.62
www.ijmess.org

were having medium postural deviation; 3.33% of high school students were having high postural deviation; 1.66% of high school students were having very high postural deviation as per alignment measures. It is observed that 49.19% of high school students in the present investigation were normal in foot angle measures. Details on normative categories, deviation values and percentage wise presentation of data on whole body alignment is presented in table 8 as under.

TABLE 6
DETAIL ON NORMATIVE CATEGORIES, DEVIATION VALUES AND PERCENTAGEWISE PRESENTATION OF DATA ON BODY ALIGNMENT

Normative Categories	Deviation Values	Frequencies	Percentage
Normal	0 – 0.99	68	56.67
Low	1 – 2.99	50	41.66
Medium	3 – 5.99	2	1.66
High	6 – 8.99	0	0
Very High	9 and above	0	0

From the table 6 it is clear that 41.66% of high school students were having Low postural deviation; 1.66% of high school students were having medium postural deviation; none of high school students were having either high or very high postural deviation in body alignment as per alignment measures. It is observed that 56.67% of high school students in the present investigation were normal in body alignment deviation measures.

Discussion

It is found that there is no significant difference in head, shoulder, pelvic, knee, foot and body alignment between high school students from schools with and without Physical Education Teachers. The Physical Education Teachers need to conduct more systematic analysis of deviations in body alignment. Also, there need to be a comprehensive approach to detect and remediate deviations in body alignment in schools with and without Physical Education Teachers.

Conclusion

It is found that there is no significant difference in head, shoulder, pelvic, knee, foot and body alignment between high school students from schools with and without Physical Education Teachers. The proportion of high school students coming under 'High' and 'Very High' normative category of deviation is very negligible.

References:

Bahiraei, Saeid & Daneshmandi, Hassan & Karimi, Noureddin. (2014). The relationship between alignment of upper limb and postural control in adolescents with Down Syndrome. MedicinaSportiva. 2. 2322-2329.

BibekRai and Liu Shenglan International Journal of Scientific & Engineering Research, Volume 7, Issue 9, September-2016 562 ISSN 2229-5518 Zhong, Jiugen & Wang, Wenhao& Yu, Ligen & Hou, Xiaohui. (2021). Analysis of The Global Posture of College Students With Chronic Neck Pain. 10.21203/rs.3.rs-1089151/v1.

Bonanni, P. G. (2017). Contour and angle-function based scoliosis monitoring: relaxing the requirement on image quality in the measurement of spinal curvature. International Journal of Spine Surgery, 11(3).

Castro, A. P. G., Pacheco, J. D., Lourenço, C., Queirós, S., Moreira, A. H. J., Rodrigues, N. F., & Vilaça, J. L. (2017). Evaluation of spinal posture using Microsoft Kinect™: A preliminary case-study with 98 volunteers. Porto biomedical journal, 2(1), 18-22.

Cengiz, Ş. Ş., & Delen, B. (2024). Postural analysis of adolescent young athletes in different sports branches. Journal of Human Sciences, 21(3), 292-300.

Dorota Groffik, Josef Mitáš, Lukáš Jakubec, Zbyněk Svozil & Karel Frömel (2020) Adolescents' Physical Activity in Education Systems Varying in the Number of Weekly Physical Education Lessons, Research Quarterly for Exercise and Sport, 91:4, 551-561, DOI: 10.1080/02701367.2019.1688754

Ferreira, E. A. G., Duarte, M., Maldonado, E. P., Burke, T. N., & Marques, A. P. (2010). Postural assessment software (PAS/SAPO): validation and reliabiliy. Clinics, 65(7), 675-681.

Fortin, C., Van Schaik, P., Aubin-Fournier, J. F., Bettany-Saltikov, J., Bernard, J. C., & Ehrmann Feldman, D. (2018). The acceptance of the clinical photographic

posture assessment tool (CPPAT). BMC musculoskeletal disorders, 19, 1-9.

Han, Hyunsook & Shin, Su-Jeong. (2015). Body scan alignment reducing body posture variations for fit evaluation. International Journal of Fashion Design, Technology and Education. 8. 1-13. 10.1080/17543266.2015.1093178.

HARUTA, Midori & MIZUTA, Yohei & ITO, Takayasu & Ota, Susumu & UCHIYAMA, Yasushi. (2016). Analysis of Body Alignments of Patients with Medial Knee Osteoarthritis. Rigakuryohokagaku. 31. 661-666. 10.1589/rika.31.661.

Hasegawa K, Okamoto M, Hatsushikano S, Shimoda H, Ono M, Homma T, Watanabe K. Standing sagittal alignment of the whole axial skeleton with reference to the gravity line in humans. J Anat. 2017 May;230 (5):619-630. doi: 10.1111/joa.12586. Epub 2017 Jan 27. PMID: 28127750; PMCID: PMC5382592.

Hopkins, B. B., Vehrs, P. R., Fellingham, G. W., George, J. D., Hager, R., & Ridge, S. T. (2019). Validity and reliability of standing posture measurements using a mobile application. Journal of manipulative and physiological therapeutics, 42(2), 132-140.

Hrysomallis, C., & Goodman, C. (2001). A review of resistance exercise and posture realignment. Journal of strength and conditioning research, 15(3), 385–390.

Jalai, Cyrus & Cruz, Dana &Diebo, Bassel & Poorman, Gregory & Lafage, Renaud & Bess, Shay & Ramachandran, Subaraman & Day, Louis & Vira, Shaleen & Liabaud, Barthélemy & Henry, Jensen & Schwab, Frank & Lafage, Virginie & Passias, Peter. (2016). Full-Body Analysis of Age-Adjusted Alignment in Adult Spinal Deformity Patients and Lower-Limb Compensation. Spine. 42. 10.1097/BRS.0000000000001863.

Kallander, K., Tibenderana, J. K., Akpogheneta, O. J., Strachan, D. L., Hill, Z., ten Asbroek, A. H., Conteh, L., Kirkwood, B.R. & Meek, S. R. (2013). Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low-and middle-income countries: a review. Journal of medical Internet research, 15(1), e2130.

Karakuş, S., & Kılınç, F. (2006). Posture and sportive performance. *Kastamonu Journal of Education*, 14(1), 309-322.

Kendall, F. P., & McCreary, E. K. Posture and pain (3 ed.). Baltimore: Williams & Wilkins, 1993.

McEvoy, M. P., & Grimmer, K. (2005). Reliability of upright posture measurements in primary school children. BMC musculoskeletal disorders, 6, 1-10.

Moreira, R., Teles, A., Fialho, R., Baluz, R., Santos, T. C., Goulart-Filho, R., Rocha, L., Silva, F.J., Gupta, N., Bastos, V.H. & Teixeira, S. (2020). Mobile applications for assessing human posture: a systematic literature review. Electronics, 9(8), 1196.

Ozyurek, Seher & Genc, Arzu & KARAALİ, Hayriye & Algun, Candan. (2017). Three-dimensional evaluation of pelvic posture in adolescents with and without a history of low back pain*. TURKISH JOURNAL OF MEDICAL SCIENCES. 47. 1885-1893. 10.3906/sag-1607

Reina, N., Cognault, J., Ollivier, M., Dagneaux, L., Gauci, M. O., & Pailhé, R. (2018). The CJOrtho app: A mobile clinical and educational tool for orthopedics. Orthopaedics & Traumatology: Surgery & Research, 104(4), 523-527.

Saponara, S., Donati, M., Fanucci, L., & Celli, A. (2016). An Embedded sensing and communication platform, and a healthcare model for remote monitoring of chronic diseases. Electronics, 5(3), 47.

Sedrez, J. A., Candotti, C. T., Furlanetto, T. S., & Loss, J. F. (2016). Non-invasive postural assessment of the spine in the sagittal plane: a systematic review. Motricidade, 12(2), 140-154.

Shohat, Noam & Machluf, Yossy & Farkash, Rivka & Finestone, Aharon & Chaiter, Yoram. (2018). Clinical Knee Alignment among Adolescents and Association with Body Mass Index: A Large Prevalence Study. The Israel Medical Association journal : IMAJ. 20. 75-79.

Singla, D., & Veqar, Z. (2014). Methods of postural assessment used for sports persons. Journal of clinical and diagnostic research: JCDR, 8(4), LE01.

Singla, Deepika & Veqar, Zubia & Hussain, Dr.mohammed. (2017). Photogrammetric Assessment of Upper Body Posture Using Postural Angles: A Literature Review. Journal of Chiropractic Medicine. 16. 10.1016/j.jcm.2017.01.005.

Solberg G. (2008): Postural disorders and muscoloskeletal dysfunction. 2008, *Elsevier Limited. Second edition*. ISBN: 978-0-443-10382-7.

Swann, J. (2009). Good positioning: the importance of posture. Nursing And Residential Care, 11(9), 467-469.

Timurtaş, E., Avcı, E. E., Mate, K., Karabacak, N., Polat, M. G., & Demirbüken, İ. (2021). A mobile application tool for standing posture analysis: development, validity, and reliability. Irish Journal of Medical Science (1971-), 1-9.

Tunnell, P. W. (1996). Protocol for visual assessment: Postural evaluation of the muscular system through visual inspection. Journal of Bodywork and Movement Therapies, 1(1), 21-27.

Watson, A. W. S., & Mac Donncha, C. (2000). A reliable technique for the assessment of posture: assessment

ISSN: 2278-0793 (Print) & 2321-2279 (Online)
Impact Factor 5.62
www.ijmess.org

criteria for aspects of posture. Journal of sports medicine and physical fitness, 40(3), 260.

Woodhull AM, Maltrud K, Mello BL. Alignment of the human body in standing. Eur J Appl Physiol Occup Physiol. 1985;54(1):109-15. doi: 10.1007/BF00426309. PMID: 4018044.

Zhao J, Xiao Y, Zhai X, Chen Z, Li M. Difference of Sagittal Alignment between Adolescents with Symptomatic Lumbar Isthmic Spondylolisthesis and the General Population. Sci Rep. 2018 Jul 19;8(1):10956. doi: 10.1038/s41598-018-29260-6. PMID: 30026509; PMCID: PMC6053459.