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Research Article

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Reliability of Cobb's Angle in a Measurement of Kyphosis – A Meta–Analysis

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Abstract: This study aimed at analyzing the literature systematically on the reliability of Cobb's angle in measurement of kyphosis. Cobb's angle is the most widely used measurement to quantify spinal deformity. Kyphosis is the spinal disorder in which an excessive outwards of the spine results in an abnormal rounding of the upper back. Cobb's angle used as standard measurement to determine and trackthe progression of scoliosis andkyphosis. Hence the purpose of the meta-analysis is to analyze the reliability of Cobb's angle in a measurement of kyphosis Systematic searches in PubMed, Science direct, Google scholar, Cochrane library, Research Gate for systematic review was done. Research article and review article were selected within the published 1999 – 2020. The study design is Meta-analysis study of Analytical type. Study quality was done by PEDro Scale The study duration is about 4 months. A Meta-analysis was conducted by using Medical software to obtain a summary estimate of the standardized mean difference and 95% confidence limit. 100 articles taken for review in which finally 35 articles were summarized. Almost all the study shows that there was a highly significant difference on measurement of kyphosis using COBB'S angle. Outcome of measurement has excellent reliability with the small range of standard error of measurement. Cobb's measurement had excellent reliability when used to measure kyphosis. The findings confirm the significance and the ease of using this method.

Keywords: Cobb's angle, Kyphosis, Medical software, Pedroscale, Meta – analysis

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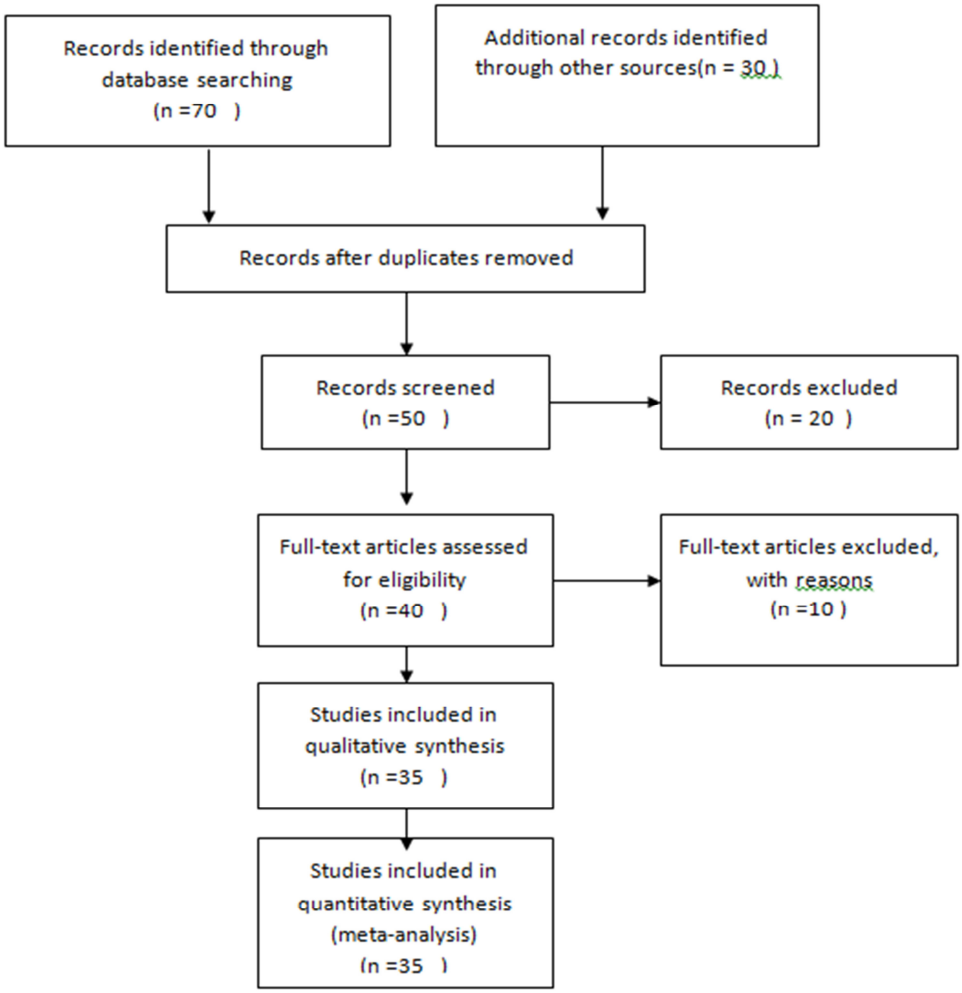
1. INTRODUCTION

Kyphosis is the curvature of the thoracic spine, formed by the shape of the vertebrae and the intervertebral disc and in standing position – Para spinal muscle strength. Hyperkyphosis is present when the kyphosis angle exceeds over 50 degree.[1,2]There are several methods used to measure thoracic kyphosis. The standard method is the Cobb angle, which is measured from a lateral radiograph as the angle subtended by the vertebral endplates above and below the curve.[3]Spine is one of the most important parts of the human body[4].It provides a human with many significant functions, for example, carrying the weight of the body and protecting the spinal cords and nerves within. The spine consists of 33 vertebrae that are subdivided into five regions: cervical (C1-C7); thoracic (T1-T12); lumbar (L1-L5); sacrum (S1-S5); and coccyx (Co1-Co4)[5]. The upper 24 vertebrae are separated and movable providing the spinal column with flexibility. The lower 9 vertebrae are fixed and 5 sacral vertebrae are fused to form the sacrum and 4 coccyxes after adolescence.[6] Kyphosis is an increased thoracic curvature which is commonly observed in older persons affecting up to 40% of older women, depending on the cut-off criterion used to define accentuated curvature. Only 36-38% of those with the most abnormal kyphosis have underlying fractures, while the development of age-related hyper kyphosis is often attributed to underlying spinal osteoporosis.[7] 30% of older population with Kyphosis or accentuated thoracic spinal curvature is a common condition estimated to difficult breath and affect function of heart also. Multifactorial causes occur as a result and are associated with increased health vulnerability[8]. The normal curvature of the thoracic spine is kyphosis, marked by anterior concavity resulting from the shape of vertebral bodies and intervertebral discs. In younger adults, using the Cobb angle measurement of kyphosis, the "normal" falls between 20^0 and 40^0 of curvature.[9] Adverse consequence of hyper kyphosis (excessive thoracic kyphosis) includes physical functional limitations, injurious falls, back pain, respiratory compromise, restricted spinal motion, fractures and mortality.[10,11]The excessive curvature of thoracic spine is the kyphosis which commonly includes fractures, degenerative disc disease, low bone density and bone density loss, and spinal extensor muscle weakness. When severe hyperkyphosis can result in serious health consequences including impaired mobility, risk of injurious falls, on-spine fractures and earlier mortality.[12] The Cobb angle remains one of the most commonly used techniques for radiographic measurements of thoracic kyphosis and it's recognized as the gold standard.[13] Cobb angle include a line drawn along the plane of the superior endplate of T1 and the inferior endplate of T12 and extended to find the angle of their intersection using a protractor[34,35]. A second Cobb angle measured in a similar manner using a line drawn along the superior endplate of T4 and the inferior endplate of T9.[14,15] Reports of prevalence and incidence of hyperkyphosis in older adults vary from approximately 20% to 40% among both men and women[16]. As kyphosis angle increases, physical performance and quality of life often declines making early intervention for hyperkyphosis as apriority.[17] The increase of the thoracic curvature in the sagittal plane is the thoracic hyperkyphosis and indication for treatment is based on kyphosis angular measurement.[18,19]Normal kyphosis ranges from 20^0 to 50^0 when assessed by Cobb's radiographic method. The most commonly used methods for kyphosis measurement is the radiographic methods[20,33].The most important technique for assessment of spinal deformity in both coronal and sagittal planes is based on Cobb method .[21,22] The Cobb angle has been used to standard measurement to determine and track the progression of scoliosis and kyphosis.[23,24] Thoracic kyphosis refers to forward curvature of the thoracic spine in the sagittal plane. Exaggerated thoracic kyphosis or hyper kyphosis is common in the elderly and the age-related increase in thoracic kyphosis has been attributed to the presence of vertebral fracture, intervertebral disc degeneration, loss of spinal muscle strength and degeneration of the intervertebral ligament.[25,26]Thoracic kyphosis is determined by a fixed limit cobb techniques (fixed thoracic kyphosis eg:T4 –T12); conversely the definition of studies kyphosis vary among studies.[27]A study of the thoracic kyphosis angle measured by Cobb angle on lateral thoracic kyphosis spine images suggests increasingly angle with age and an increased angle in the elderly, but few patients were included in the older population.[28] The spine can be measured using several invasive and / or non-invasive postural evaluation methods in the sagittal curvature [29,30]. The gold standard evaluation method for the sagittal plane is in the latero-lateral X-ray(Zaina, Donzelli, Lusini&Negrini, 2012) in which the Cobb angles, represented by the crossing of tangents originating from the cranial and caudal vertebral bodies are calculated.[31,32]

2. MATERIALS AND METHODS

A Meta – analysis was conducted following preferred reporting items for systematic review and Meta – analysis group statement.100 Articles from those database mentioned above were collected and duplicates were removed. This systematic review followed the recommendations proposed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The procedures were followed according to the recommendations of Helsinki Declaration of 1964 (as revised in 2008). This study was registered under Faculty of Physiotherapy, Dr.MGR educational and Research institute with C-26/PHYSIO/IRB/2019-2020. 35 articles were selected for the analysis after excluding duplicate article and bias articles.



2.1 Data Extraction

Data were extracted and independently confirmed. Information that is related to the studies and participant characteristics was extracted including the first author, year of publication, study design and outcome measure.

Table: 1 Pedro Scale

S.No	Author Name	Pedro Scale											
		1	2	3	4	5	6	7	8	9	10	11	Total Score
1	G.A.Greendale...,Et Al	1	1	1	0	0	0	1	0	0	1	1	6
2	A.M.Briggs...,Et Al	1	1	0	0	0	0	1	1	1	1	1	7
3	T.H.Tran...,Et Al	1	1	0	0	1	1	1	0	0	1	1	7
4	Donald J.Hunter...,Et Al	1	1	0	1	0	0	1	1	1	1	1	8
5	S.Goh...,Et Al	1	1	0	0	0	0	1	1	1	1	1	7
6	Benjamin Ulmar...,Et Al	1	1	0	0	0	0	1	1	1	1	1	7
7	Said Sadiqi...,Et Al	1	1	1	0	0	0	0	1	1	1	1	7
8	Frederic Jacquot...,Et Al	1	0	1	0	0	0	1	1	1	1	1	7
9	Deborah M.Kado...,Et Al	1	1	1	0	0	0	1	1	0	0	0	5
10	Wendy B.Katzman...,Et Al	1	1	1	0	0	0	1	0	1	0	0	5
11	Alvisa- Negrin...,Et Al	1	1	0	0	0	0	1	0	1	1	1	6
12	TeixeriaFa...,Et Al	1	1	0	0	1	0	0	0	0	1	1	5
13	Mohammed Mustafa Adwani...,Et Al	1	1	1	0	1	1	1	0	1	1	1	9
14	Ming-HuwiHorng...,Et Al	0	0	0	0	1	1	1	0	1	1	1	6
15	Weifei Wu...,Et Al	1	1	0	0	1	1	1	1	1	1	1	9
16	Alexander G.Bruno...,Et Al	0	0	0	0	1	1	1	0	1	1	1	6
17	Walter S.Bartynski...,Et Al	1	1	0	0	1	1	1	0	1	1	1	8
18	Tatiana Scheeren De Oliveria...,Et Al	1	1	1	0	0	0	0	0	1	1	1	6
19	Angelo G.Aulisa...,Et Al	1	1	1	0	1	1	1	0	1	1	1	9
20	Sergio Mendoza-Lattes...,Et Al	1	1	1	0	1	1	1	0	1	1	1	9
21	Diana M.Perriman...,Et Al	1	1	1	0	0	0	1	0	1	1	1	7
22	Deborah M.Kado...,Et Al	1	1	0	0	1	1	1	0	1	1	1	9
23	Sang Won Lee...,Et Al	1	1	1	0	0	0	0	1	1	1	1	7

24	Deed E.Harrison...,Et Al	I	I	I	0	0	0	0	I	I	I	I	7
25	Jean- Marc Mac-Thiong...,Et Al	I	I	I	0	I	I	I	0	I	I	I	9
26	DmKado...,Et Al	I	I	I	0	0	0	I	0	I	I	I	7
27	TAYEBEH ROGHANI…,Et Al	I	I	I	0	0	0	I	0	I	I	I	7
28	SOREN OHRT-NISSEN…,Et Al	I	I	I	0	0	0	0	I	I	I	I	7
29	PANAGIOTIS KOROVESSIS…,Et Al	I	I	I	0	0	0	0	0	I	I	I	6
30	CARLOS ALBERTO GIGLIO…,Et Al	I	I	I	0	0	0	0	0	I	I	I	6
31	S.Goh...,Et Al	I	I	I	0	0	0	0	I	I	I	I	7
32	PATCHARAWAN SUWANNARAT…,Et Al	I	I	I	0	0	I	0	0	I	I	I	7
33	RAFAEL PAIVA RIBERIO…,Et Al	I	I	0	0	0	0	0	0	I	I	I	5
34	JEREMYS LEWIS…,Et Al	I	I	0	0	0	0	0	I	I	I	I	6
35	FANNY-MAUD PINEL-GIROUX…,Et Al	I	I	0	0	0	0	0	I	I	I	I	6

3. STATISTICAL ANALYSIS

All the data were analyzed qualitatively and presented briefly in the result section. Meta – analysis were performed using the Medical software. For outcome measure to assess the data extracted. The results from data analysis are present in the forest plot and funnel plot including the statistical analysis.

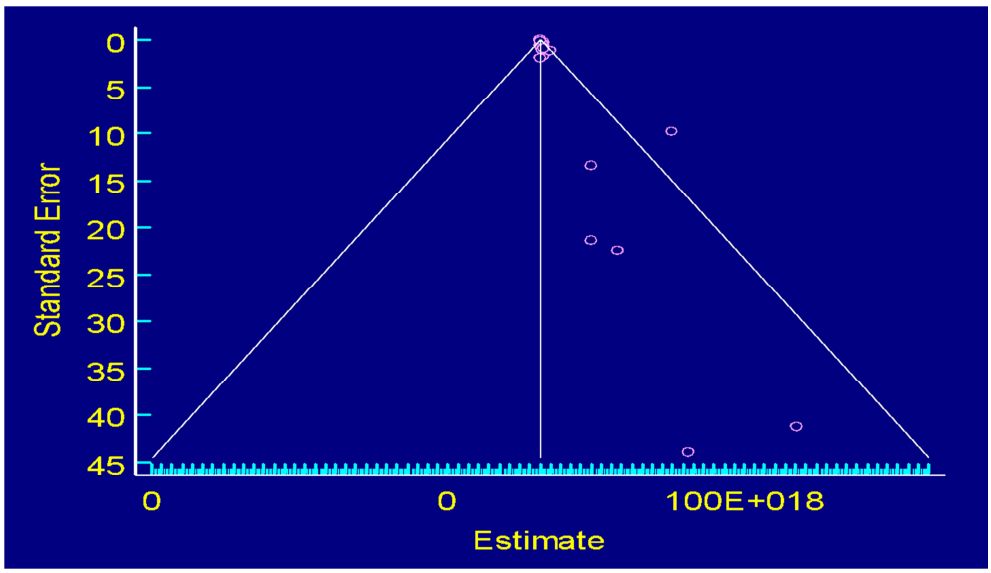
After complete analysis with 35 articles the brief summary of the article regarding author name, study design, article, subject, criteria, outcome measures, results are tabulated. Majority of the studies reported that highly significant differences were found in the reliability of Cobb's angle in the measurement of Kyphosis. The data analysis using Medical software shows high significance with $p < 0.0001$ reliability of Cobb's angle in measurement of kyphosis.

4. RESULT

Table: 2 Test For Heterogeneity

Test For Heterogeneity	
Q	171.614
Df	34
Significance Level	P < 0.0001
I^2 (Inconsistency)	80.19%
95% Ci For I^2	73.07 To 85.42

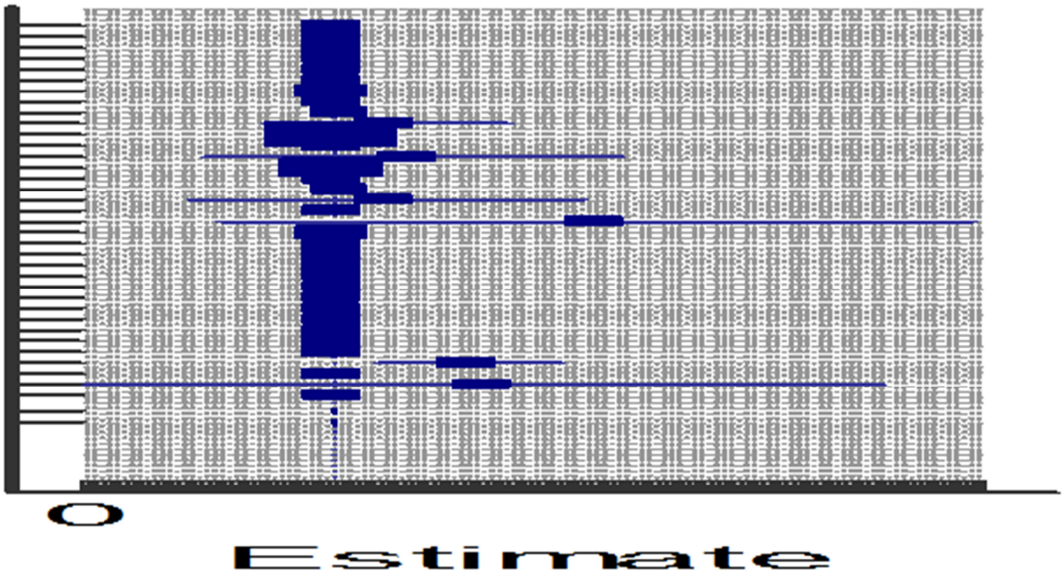
The test of heterogeneity shown that there is a significance level at p <0.0001level and inconsistency is 80.19%.



Funnel plot used in analysis to measure study precision. It is used to detect systematic heterogeneity

Graph 1: Funnel Plot

The forest revealed the information from each and every study examined in meta-analysis(graph 2) .It shows visually the amount of heterogeneity among results



Graph used to compare several clinical or scientific studies studyying the same thing.
Funnel plot shows 6 plot in the right side bias occurred from the imbalance between the distances between studies

Graph 2: (Forest plot)

5. DISCUSSION

Kyphosis can be due to a combination of muscle weakness and muscle imbalance.2 Patients with vertebral fracture have a further biomechanical alteration with a reduction in anterior vertebral height in comparison to the posterior height, increasing with multiple fractures (Genant et al 1993, Myers & Wilson 1997).Cobb's method has been regarded as a valid and reliable method for measuring kyphosis. The Cobb's angle of kyphosis is calculated from perpendicular lines drawn on a standard thoracic spine radiograph: a line extends through the superior endplate of the vertebral body, marking the beginning of the thoracic curve (usually at T4), and the inferior endplate of the vertebral body, marking the end of the thoracic curve (usually at T12)35.The presentation of the intervals of normality grouped according to the age of the examined persons in relation to each region of the spine is a noteworthy contribution of the current study, aside from the systematization of the data published in the literature. The most common curvature studied was the lumbar curvature, which was followed by the thoracic curvature Limitations associated with the reliability and validity of the traditional Cobb method have raised doubts regarding its clinical utility as an accurate indicator of kyphotic .The results of the systematic study and a meta-analysis were in the form of a forest plot and a funnel plot. The forest plot showed an overview of information from each of the studies examined in the meta-analysis and the estimation of the overall results. The forest plot showed visually the amount of variation (heterogeneity) among study results .The spine can be measured using several invasive and / or non-invasive postural evaluation methods in the sagittal curvature. The gold standard evaluation method for the sagittal plane is in the latero-lateral X-ray(Zaina, Donzelli, Lusini&Negrini, 2012) in which the Cobb angles, represented by the crossing of tangents originating from the cranial and caudal vertebral bodies are calculated. This systemic review and meta-analysis study discussed the effect of Cobb's angle measurement for measuring kyphosis. The estimation was processed using Medical software. The result of the study were in the form of forest and funnel plot. The forest revealed the information from each and every study examined in meta-analysis (graph 2) .It shows visually the amount of heterogeneity among results. Funnel plot shows 6 plot in the right side bias occurred from the imbalance between the distances between studies(graph.1). The test of heterogeneity shown that there is a significance level at p <0.0001level and inconsistency is 80.19%. Thus providing that meta-analysis with several studies, Cobb's angle measurement is reliable in measuring kyphosis. A useful definition was given by Huque "A statistical analysis that combines or integrates the results of several independent clinical trials considered by the analyst to be combinable". Based on the result of this study, Cobb's angle measurement for measuring kyphosis shows highly significant.

6. CONCLUSION

In summary this meta –analysis found a large , the test of heterogeneity shown that there is a significance level statistically significant reliability on cobb's angle measurement for kyphosis. Based on the present systematic review with meta-analysis, it is proved to a conclusion that Cobb's angle measurement for measuring kyphosis shows highly significant difference. In general, the studies show highly variable results, with wide confidence reliability compromising the classification process. More studies can be used for analysis also comparison of two or more measurements can be used in future studies for analysis..

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8. AUTHORS CONTRIBUTION STATEMENT

G.Vaishnavi, S. Preethi, R.Rajashri collected the data; data extraction done by K.Kirupa, S.M.Divya Mary, A.Sangeetha and G.vaishnavi, V.rajalaxmi, G.Tharani has contributed in completing the analysis. G.Vaishnavi and RNV.Deepthi has done final writing.

9. CONFLICT OF INTEREST

Conflict of interest declared none.

10. REFERENCE

1. NingZhang, HaoLi Zheng KuanXu,Wei, Shan ChenQi, Xin Chen Fang. Caili, computer simulation of two-level pedicle subtraction osteotomy for severe thoracolumbar kyphosis in ankylosing spondylitis. Indian J Orthop.2020;51(6):666-71.
2. KoeléMC, Lems WF, Willems HC. The clinical relevance of hyperkyphosis: A narrative review. Front Endocrinol.2020;11(5):5. doi: 10.3389/fendo.2020.00005, PMID 32038498.
3. Ming-HuwiHorngChan, PangKuok, Min-JunFu, ChiiJenLin Yung, AngleNienSun Cobb. Measurement of spine from X-ray images using convolutional neural network. Comp Math Methods Med.2019,6357171,1-18.
4. AdawiMM, Aboulfetouh I, Saleh A, Younis W. Posterior short-segment fixation with implanting pedicle screw in the fractured level as a feasible method for treatment of thoracolumbar fracture, Adawi et al. Egypt J Neurosurg.2019;34(1):1-9. doi: 10.1186/s41984-018-0026-3.
5. Noelia Gonzalez Galvez, Gea GemmaM, Garcia PabloJ. Marcos – Pardo. Effects of exercise programs on kyphosis and lordosis angle: A systemic review and meta-analysis. PLOS ONE.2019;14(4):1-18.
6. FurlanettoTS, Sedrez JA, Candotti CT, Loss JF. Reference values for Cobb angles when evaluating the spine in the sagittal plane: a systematic review with meta-analysis. Motricidade.2018;14(2-3):115-28. doi: 10.6063/motricidade.10890.
7. HunterDonald J, RivettDarren A, McKiernan Sharmain, Weerase karaIshanka, Snodgrass Suzanne J. Is the inclinometer a valid measure of thoracic kyphosis? A cross-sectional study.Braz J PhysTher.2018;22(4):310-7. doi: 10.1016/j.bjpt.2018.02.005, PMID 29576490.
8. BezalelTomerEt Al.,CarmeliEli.LeviDror, KalichmanLeonid, the effect of Schroththerapy on thoracickyphotic curve and quality of life in Scheuermann's patients: Arandomized controlled trial. Asian Spine J.2018;13(3):490-9.
9. SørenOhrt-Nissen, Yin CheungJasonPui, Dennis Winge Hallager, Kwan Martin Gehrchen Kenny, BennyDahl, Cheung KennethMC, Dino Samartzis…,Reproducibility of thoracic kyphosis measurements in patients with adolescent idiopathic scoliosis, Ohrt-Nissen et al. Scoliosis Spinal Disord.2017;12(4):1-8.
10. Minoo Khalkhali Tayebeh Roghani, ZaviehFarideh Dehghan. Mashadi,NicoleKing, Wendy Katzman, Age-related hyperkyphosis: update of its potential causes and clinical impacts—narrative review, Aging ClinExpRes. Author manuscript; available in PMC. 2017;29(4):567-77.
11. Rafael Paiva Ribeiro. Barbara Vendramini Marchetti, Eduardo BojungaDeOliveria, Kyphosis index obtained in X-ray and with flexi curve assessment in children and young people. Rev Bras Saúde Matern Infant, Recife. 2017;17(1):79-87.
12. Pattra Wattanapan Patcharawan Suwannarat, Pawipa Chokphukiao Arpassanan Wiyanad, Sugalya AmatachayaSininat Wilachit, Reliability of novice physiotherapists for measuring Cobb angle using a digital method,Hong Kong Physiotherapy Journal2017,37,34-8.
13. SaidSadiq, Jorrit, VerlaanJan MechteldLehrA, Jens ChapmanR, DvorakMarcelF, Frank KandzioraS, Rajasekaran Klaus, SchnakeJ, AlexanderR, VaccaroF. CumhurOner, Measurement of kyphosis and vertebral body height loss in traumatic spine fractures:an international study,Eur spine. 2016;26:1483-91.
14. TranTH, Wing D, Davis A, BergstromJ, SchousboeJT, NicholsJF, Kado DM. Correlations among four measures of thoracic kyphosis in older adults.OsteoporosInt.2016;27(3):1255-9. doi: 10.1007/s00198-015-3368-7, PMID 26475287.
15. AngelioG Aulisa, Francesco Falciglia, Marco Giordano,Giuseppe Mastantuoni, AndreaPoscia, Vincenzo Guzzanti. Conservative treatment in Scheurmann's kyphosis: comparison between lateral curve and variation of the vertebral geometry, The author(s). Scoliosis Spinal Disord.2015;11(2); 33:19-23.
16. JieLiang WeifeiWu, XiaoyiTanYuanliDu, XuanpingXiang, Wanhong Wang, Le NengRuJinbo. Reliability and reproducibility analysis of the Cobb angle and assessing sagittal plane by computer-assisted and manual measurement tools.BMC MusculoskeletDisord.2014;15(33):1-8.
17. Deborah KadoM, Miller-Martinez Dana, Li-YungLuiPeggy Cawthon, Katzman Wendy TeresaA Hillier. Howard, A. Fink, Kristine, E. Ensrud, hyperkyphosis. Kyphosis progression, and risk of non-spine fractures in older community dwelling women: the study of osteoporotic fractures (SOF),J bone miner Res. Author manuscript; available in PMC. 2014;29(10):2210-6.
18. KadoDeborah M, HuangMei-Hua, KarlamanglaArun S, CawthonPeggy, KatzmanWendy, HillierTeresa A, Ensrud Kristine, Cummings Steven R. Factors associated with kyphosis progression in older women: 15 years' experience in the study of osteoporotic fractures. J Bone Miner Res.2013;28(1):179-87. doi: 10.1002/jbmr.1728, PMID 22865329.
19. Barrett EvaKaren, McCreeshJeremy Lewis…,Intrarater and interrater Reliability of the flexi curve index,flexi angle and manual Inclinometer for the measurement of the thoracic kyphosis. Rehabil Res Pract.2013:1-7:article475870.
20. WendyB, KatzMan, Mei-Hua. Huang, NancyE. lane, KristineE. Ensrud, DeborahM.Kado…, kyphosis and decline in physical function over 15 years in older community-dwelling women: the study of osteoporotic Fractures 2013;68(8):976-83.

21. Bruno AlexanderG, Anderson DennisE,D' AgostinoJohn, MaryL. Bouxsein…, The effect of thoracic kyphosis and sagittal plane alignment on vertebral compressive loading,J Bone miner Res. Author manuscript. 2013;27(10):2144-51.
22. Jacquot Frederic, Charpentier Axelle, Khelifi Sofiane, Gastambide Daniel, Rigal Regis, SautetAlain. Measuring the Cobb angle with the iPhone in kyphoses: a reliability study.IntOrthop.2012;36(8):1655-60. doi: 10.1007/s00264-012-1579-5, PMID 22653103.
23. Scheeren De OliveiraTatiana, ClaudiaTarrago Candotti Marcelo.La Torre Patricia Paula Tonin Pelinson. TassiaSilveiraFurlanetto,FernandaMachadoKutchak,JeffersonFagundesloss…, validity and reproducibility of the measurements obtained using the flexicurve instrument to evaluate the angles of thoracic and lumbarcurvatures of the spine in the sagittal plane. Rehabil Res Pract.2012;2012:Article ID186156, 9 pages.
24. Alvisa-Negrín. Jc,Gonzalez – Reimers EHernandez – Beta cor I, Martin – GonzalezC. Fernandez – Rodriguez C, Rodringuez – RodriguezE Santolaria Fernandez F…, Cobb angle, vertebral deformity and fractures in alcoholic patients,Rev Osteoporos Metab Miner 2012;4(1):15-21.
25. GreendaleGA, Nili NS, Huang MH, Seeger L, Karlamangla AS. Karlamangla, The reliability and validity of three non-radiological measures of thoracic kyphosis and their relations to the standing radiological Cobb angle, OsteoporosInt. OsteoporosInt.2011;22(6):1897-905. doi: 10.1007/s00198-010-1422-z, PMID 20938766.
26. Ulmar Benjamin, Gühring Markus, SchmälzleTraude, WeiseKuno, Badke Andreas, Brunner Alexander. Inter- and intra-observer reliability of the Cobb angle in the measurement of vertebral, local and segmental kyphosis of traumatic lumbar spine fractures in the lateral X-ray. Arch Orthop Trauma Surg.2010;130(12):1533-8. doi: 10.1007/s00402-010-1104-5, PMID 20424848.
27. Perriman Diana M, Scarvell Jennifer M, Hughes Andrew R, Ashman Bryan, Lueck Christian J, SmithPaul N. Validation of the flexible electro goniometer for measuring thoracic kyphosis. Spine.2010;35(14):E633-40. doi: 10.1097/BRS.0b013e3181d13039, PMID 20505565.
28. Lewis JeremyS, Valentine Rachel E…, Clinical measurement of the thoracic kyphosis. A study of the intra-rater reliability in subjects with and without shoulder pain. BMC Musculoskeletal Disord.2010;2474/11(39):1-7:1471.
29. KatzmanWendy B, WanekLinda, ShepherdJohn A, SellmeyerDeborah E. Age-related hyperkyphosis: its causes, consequences, and management. J Orthop Sports PhysTher.2010;40(6):352-60. doi: 10.2519/jospt.2010.3099, PMID 20511692.
30. BriggsAM, Wrigley TV, Tully EA, Adams PE, Greig AM, Bennell KL. Radiographic measures of thoracic kyphosis in osteoporosis: Cobb and vertebral centroid angles. SkeletRadiol.2007;36(8):761-7. doi: 10.1007/s00256-007-0284-8, PMID 17437103.
31. GiglioCarlos Alberto, VolponJose Batista. Development and evaluation of thoracic kyphosis and lumbar lordosis during growth. J Child Orthop.2007;1(3):187-93. doi: 10.1007/s11832-007-0033-5, PMID 19308494.
32. LeeSang Won, HongJaeTaek, SonByungChul, SungJaeHoon, KimIl Sub, ParkChun Kun. Analysis of accuracy of kyphotic angle measurement for vertebral osteoporotic compression fractures. J ClinNeurosci.2007;14(10):961-5. doi: 10.1016/j.jocn.2006.08.005, PMID 17646103.
33. TeixeiraFa, CarvalhoGA. Reliability and Validity of thoracic kyphosis measurement using the flexicurvemethod.Rev Bras Fisioter São Carlos. 2007;11(3):173-7.
34. MarcMac-ThiongJean, Pinel-GirouxFanny-Maud, De Guise JacquesA, HubertLabelle,Comparison between constrained and non-constrained cobb techniques for the assessment of thoracic kyphosis and lumbar lordosis,Eur spine J2007,16;1325-31.
35. Kado DeborahM, ChristiansonLisa, PalermoLisa, Smith-BindmanRebecca, StevenR.Cummings,GailA.Greendale. Comparing a supine radiologic versus standing clinical measurement of kyphosis in older women: the fracture intervention trial, Spine (PhiliaPa1976). 2006;15(31 (4)):463-7.