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PHOTOGRAMMETRY AND POSTURAL EVALUATION, SOFTWARES AND METHODS: A SYSTEMATIC REVIEW

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ABSTRACT

Postural evaluation is commonly used to identify deviations in the physical therapy examination and the programming of therapeutic goals and objectives. The use of photogrammetry in postural evaluation has been used in several areas of physical therapy. It can be defined as the use of technology to obtain reliable information regarding objects or environments, through the measurement and interpretation of images. The aim was to verify the literature to determine which are the most used software, what should be the positioning of the camera and the volunteer and determine which software have more validation studies of inter and intra-examiner comparison. Was performed a systematic review with research in different databases with the following key words: photogrammetry, physiotherapy, respiratory physiotherapy and posture. 47 articles were selected and the results were discussed in relation to the variety of software and study types, regarding the positioning of the photographic camera, the existence of validation articles and methodological use. the standardization of the use of photogrammetry is necessary, however it is not yet observed. The most used software are Alcimage and SAPo. SAPo was the most used software and consequently presented more validation work and intra and inter - examiner comparison with favorable results.

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INTRODUCTION

The term photogrammetry derives from the Greek *photos* and *metron* which mean, respectively, photo and measure (Tommaselli et al., 1999). It can be defined as the use of technology to obtain reliable information about objects or environments by measuring and interpreting images (ASPRS, 2017). The advantages of using this method are the possibility of recording subtle and discreet changes that are difficult to verify by other means such as goniometry and visual postural evaluation (Braz et al., 2008) and also the storage of images for clinical and therapeutic follow-up of each patient with review of the measurements whenever necessary (Miranda, 2014). Postural assessment is commonly used to identify deviations in the physical therapy exam (Fedorak et al., 2003)

and to program therapeutic goals and targets (Dunk et al., 2004). Visual postural evaluation has been shown to be inadequate as the gold standard of evaluation when compared to the use of photogrammetry (Iunes et al., 2009). The use of photogrammetry in postural evaluation has been used in various areas of physical therapy such as occupational physiotherapy, orthopedics and traumatology, and also in respiratory physiotherapy (Riceri et al., 2009) and not only postural evaluation. Several softwares are available for postural evaluation, such as ALCimage, Allbodyscan 3d, Aplob, Appid, Biotonix, Corporispro, Fisimetrix, Posturogram Fisiometer, Physical physio, Physio easy, Posture print and SAPo, however, they are still very distant in methodology. images, utilization and calculated measurements (Camelo et al., 2015). Thus, the aim of this systematic review was to check the literature to determine which software is most used,

which camera and volunteer positioning should be use, and to determine which software has the most inter and intra-examiner validation studies.

MATERIALS AND METHODS

A systematic review, which can be defined as a review of studies with defined methodology and systematic approach (Cook *et al.*, 1995), was performed in databases from November 2019 to December 2019, to identify studies that used some photogrammetric evaluation method. The search strategy included the following databases: LILACS, SciELO, MEDLINE, Cochrane Library and PEDro. The research was conducted with the following keywords combined between themselves, in Portuguese and English respectively: photogrammetry, physiotherapy, respiratory physiotherapy, posture, photogrammetry, physical therapy, respiratory therapy and posture.

After the initial search, the titles and abstracts were analyzed taking into consideration the inclusion criteria: articles that used photogrammetry as a parameter to evaluate physical therapy and articles published in English and Portuguese. Exclusion criteria were: bibliographic review articles and case studies that did not accurately explain the method of image analysis (camera or camcorder distance and tripod height).

RESULTS

In a first moment, search phase (Phase I) were found 551 papers of which 47 were repeated, leaving 504 papers from 1979 to 2019. This second moment of selection of articles (Phase II), 397 papers were excluded by title and two for being in German and Hungarian, which reduced to 105 papers that were then analyzed in full. In the last phase (Phase III), 58 more papers based on the exclusion criteria were excluded. Thus, there were 47 papers that were used in this review.

Table 1. Description of the authors, software used and main results

Autores	Software	Principais Resultados
AIKAWA, A. C., BRACCIALLI, L. M. P., PADULA, R. S., 2006	ALCimage	High percentage of individuals with dorsal hyperkyphosis and shoulder protrusion, abdominal protrusion and lumbar rectification (the latter two in the 71 to 80-year-old group), posterosuperior iliac spine asymmetries and scoliosis.
ARAÚJO, F. A. et al, 2016	SAPo	Sagittal morphology differed between sexes, emphasizing gender-specific biomechanical loads during the usual upright position even at prepubertal ages, implying different biomechanical loads and perhaps contributing to well-known gender differences in pediatric spinal deformities, such as higher frequency of scoliosis in girls and Scheuermann's disease in boys.
BARBOSA, A. C. et al, 2013	ALCimage	There was a statistically significant difference in the angles analyzed by photogrammetry, decreasing the pelvic anteroversion.
BASSO, D., CORRÊA, E., SILVA A. M. da, 2010	SAPo	There was a significant improvement in the alignment of the shoulder blades, acromials and ASIS, the symmetry and angles of the lower limbs and the head position.
BASTIÃO, M. V. et al. , 2014	SAPo	There was a higher prevalence of thoracic kyphosis, lumbar hyperlordosis, and knee valgus in overweight students.
CANALES, J, Z. et al., 2017	CorelDraw	Patients with recurrent episodes of major depressive disorder had greater postural misalignment than patients with only one episode, and the severity of depressive symptoms was associated with scoliosis.
CARNEIRO, P. R. et al, 2014	CorelDraw	Computerized photogrammetry for the measurement of head position angles presents excellent intra-examiner reliability and poor reliability in inter-examiner evaluation.
CARVALHO, R M F de ; MAZZER, N; BARBIERI, C H. , 2012	ALCimage e CorelDraw	There was excellent inter and intra-examiner reliability. When analyzing and comparing the methods in relation to each angle and each group, it was observed that according to the angle there are different values between the methods. After comparing the groups in relation to each angle and each method, the results revealed that in the flexion angles of the II-finger PIP and flexion of the V-finger MCF for all methods, there were no significant differences between the groups. And in the abduction angle of the thumb, only for the ALCimage® method there was a significant difference between the groups.
COELHO, J. J. et al., 2013	SAPo	High interrater reliability was obtained in all postural angle measurements.
COELHO, J. J. et al., 2014	SAPo	Children with reduced flexibility had knee asymmetry and anteroposterior body inclination.
DAVIDSON, J, et al, 2012	SAPo	Children with shoulder elevation had a statistically smaller acromion / manubrium / acromion angle; a greater manubrium / acromion / trapezius angle and a deeper thoracic retraction. The study was able to describe an objective, accurate and reliable method for detecting chest musculoskeletal changes in premature infants.
DOHNERT, M. B. TOMASI, E, 2008	CorelDraw	Through computerized photogrammetry, the prevalence of some type of scoliosis was 45.5% (143/314). The use of computerized photogrammetry allows quantification of body surface levelings not measured by subjective clinical examination.
DUARTE, R. B. et al, 2014	SAPo	The biophotogrammetry is an appropriate method for the evaluation of the popliteal angle within the established conditions, due to the statistical values that confirm the reproducibility and repeatability of the technique because its inter- and intra-examiner indices were classified with reliability from strong to very strong.
FERREIRA, F. dos S. et al, 2012	SAPo	The respiratory muscle rehabilitation program had positive effects on ventilatory parameters and thoracic mobility. There was a significant reduction in Charpy angle, a significant increase in inspiratory pressure, peak flow and umbilical respiratory coefficient.
IUNES, D. H., et al., 2005	ALCimage	The proposed method for the quantification of postural asymmetries by photogrammetry showed acceptable inter and intra-examiner reliability for most of the proposed angular measurements.
IUNES, D. H. et al., 2008	ALCimage	It can be observed that the frequency of the use of heel and the type of heel used practically do not change the static posture of women, as evaluated by photogrammetry.
IUNES, et al. 2009	ALCimage	There was greater agreement between different examiners who performed postural assessment by photogrammetry than between different examiners who performed postural assessment by visual observation. The data found by photogrammetry do not agree with the results of visual postural assessment. The values of postural analysis found in photogrammetry cannot be used as a reference in visual postural evaluation.
IUNES, D.H. et al, 2010	ALCimage	The Klapp method was found to be a more effective therapeutic technique for treating trunk asymmetries compared to that of the pelvis. Relevant results were obtained to improve flexibility and lumbar lordosis.
LIMA, A. S. et al., 2011	SAPo	There were no postural changes in the angles analyzed between the three gestational trimesters.

.....Continue

LIMA, L. C. De O. et al., 2004	ALCimage	Computerized photogrammetry was considered a safe and reliable method for body angle analysis to determine and compare the posture of children with functional and obstructive mouth breathing compared to nasal breathers.
LOPES, et al. 2012	ALCimage	There was no difference between Charpy's angle of asthmatic and non-asthmatic children.
MARTINELLI, A. R., et al., 2011	SAPo	The evaluation revealed a postural pattern similar to that described in the literature, which includes ankle and knee valgus, as well as hyperextension, medial hip rotation and pelvic anteroversion. It was possible to quantify and signal the main articular deviations and misalignments through a specific tool for this purpose, reliable and with acceptable reproducibility.
MIRANDA, R; SCHOR, E; GIRÃO, M.J.B.C, 2009	CorelDraw	Women with chronic pelvic pain had typical posture with spasms, weakness and trigger points on the abdominal wall and pelvic floor, as well as high costal breathing.
MORAIS, P. A de O. et al., 2012	SAPo	The use of the jump does not alter the posture nor the activity of the spine stabilizing muscles in the standing position in healthy women. In response to upper limb activity, there are adaptations in spinal curvatures and paravertebral muscle activity.
MOTA, D.M. et al, 2013	SAPo	There was improvement in scapular alignment in the analyzed views occurred by the immediate use of the bandage.
MOTA, Y. L. et al., 2014	SAPo	The higher the rotation of the volunteer, the greater the errors of angular measurements.
PACHIONI, C. A. S., et al., 2011	SAPo	Patients with chronic obstructive pulmonary disease present postural changes: anterior pelvic tilt; posterior pelvic unevenness and thoracic kyphosis.
PEZZAN, P. A. De O. et al, 2011	SAPo	Prolonged use of high-heeled shoes, ie chronic use of these shoes since adolescence, has been correlated with increased lumbar lordosis and pelvic anteroversion. Age was correlated with lumbar lordosis when a high heel condition was not present.
REIS, R. M. et al, 2010	SAPo	Minimal musculoskeletal discomfort has been reported after the first month of occupational risk exposure. This self-reported discomfort did not correlate satisfactorily with postural assessment variables.
RIBEIRO, C. L. et al. 2012	SAPo	Photogrammetry using SAPo software showed inter- and intra-rater reliability for measuring popliteal angle range of motion, and is therefore a reliable tool for use in clinical practice.
ROCHA, E. A. B. et al, 2015	AutoCAD R12	Postural assessment using a computerized photogrammetry method with AutoCAD® R12 software, performed by a single evaluator, is reliable and can therefore be used in clinical and scientific practice.
RUIVO, R. M.; et al., 2013	SAPo	When compared to goniometry, SAPo is an accurate and reliable method.
RUIVO, R. M., et al., 2014	SAPo	Photo measurement is a reliable measure for assessing the sagittal posture of the cervical foot. Shoulder protrusion and head anteriorization is a common postural change in adolescents.
RUIVO, R. M.; PEZARAT-CORREIA, P. e CARITA, A. I., 2015	SAPo	Much inter-rater reliability was obtained in all measurements of the postural angles studied.
SAAD, K. R. et al, 2012	CorelDraw	Photogrammetry seems to be a reproducible method for the evaluation of scoliosis.
SAAD, K. R., COLOMBO, A. S., JOÃO, S. M. A, 2009	CorelDraw	Photogrammetry seems to be a reproducible method for the evaluation of scoliosis. The limitations of photogrammetry for the evaluation of scoliosis are the measurements of curves with large rotational components and those of the lumbar region.
SACCO, I. C. N. et al, 2007	SAPo e CorelDraw	Between goniometry and photogrammetry by Corel Draw, moderate and good correlations were found, except for the low hindfoot angle. When relating goniometry with photogrammetry by SAPo, there was a low and non-significant correlation between them. As previously described, the scale of goniometry and Corel Draw software is numeral, while that of SAPo is decimal, giving differences in the results that can be expressed by these low correlations.
SANCHEZ, H. M. et al., 2014	ALCimage	In the supine position there is no Q-angle asymmetry regardless of hip rotation, which is not the case in the orthostatic position.
SANTOS, M. M. et al., 2009	SAPo	Photogrammetric analysis of posture in an infant sample was an adequate and reliable quantitative method.
SIQUEIRA, T.; COSTA, L. L.; FERNANDES, W. V. B., 2010	SAPo	Postural changes in volleyball athletes are frequent due to the very foundations of the sport, bringing them a body disharmony and generating imbalances in the musculoskeletal system.
SOUZA, J. A., et al. , 2011	SAPo	Based on the described results, the proposed angles for the quantification of the postural asymmetries used by the SAPo Software protocol are satisfactorily reliable for most of the angular measurements studied when evaluated by different examiners in the same photographic record.
SOUZA, J. A. et al., 2014	SAPo	In the postural analysis, 3 angles of 18 were different between groups (horizontal pelvic alignment, horizontal distance between the apex of the thoracic curve and the median region of the cervical curve, varus and valgus of the right calcaneus).
UHLIG, S.E. et al, 2015	SAPo	The use of accessory muscle decreases the chance of snoring of MBG students. Shoulder asymmetry decreases the chance of peaceful MBG sleep and increases the chance of coughing and feeling tired when playing or running. Head protrusion decreases the chances of waking up at night and feeling short of breath in the MBG.
VALDUGA, R. et al, 2011	SAPo	We concluded that there was a low correlation between the postural variables and the data regarding the level of physical activity measured in the research participants.
VALENCIANO, P. J. et al. . 2015	SAPo	The study demonstrates the need for more careful attention to the postural aspect in pediatric burn victims after hospital discharge.
WEBER, P. et al, 2012	SAPo	The results of the swiss ball postural treatment associated with manual diaphragmatic stimulation and stretching of the inspiratory accessory muscles provided improvement in craniocervical alignment, with decreased head anteriorization and the restoration of physiological lordosis of the cervical spine in mouth breathing children.

Legend: ASIS (anterior superior iliac spine),PIP (proximal interphalangeal), MCF (metacarpophalangeal), MBG (mouth breathing group).

The description of the study phases can be viewed in the flowchart. The papers generally used four types of software, namely: SAPo, ALCimage, CorelDraw and Autocad. Since in two works there was a combination of two software, so that CorelDraw was combined with ALCimage (Carvalho *et al.*, 2012) or as SAPo (Sacco *et al.*, 2007). The list of articles with author, software and main results can be seen in Table 1.

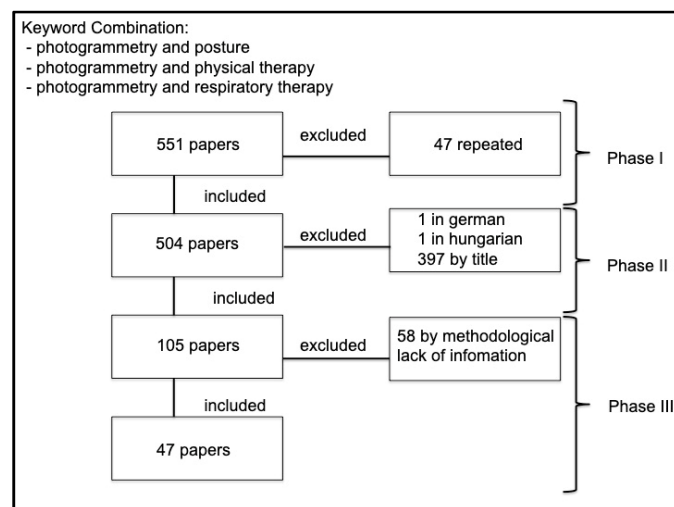
Only four articles were controlled studies (Webber *et al.*, 2012; Ferreira *et al.*, 2012; Basso e tal., 2010, Barbosa *et al.*, 2013), and the other cross-sectional studies that had the characteristic to identify postural and / or angular alterations in specific populations, such as: the elderly (Mota *et al.*, 2013; Valduga *et al.*, 2011; Aikawa *et al.*, 2006), patients with spinal changes (Iunes *et al.*, 2010; Miranda *et al.*, 2009, Saad *et al.*, 2012; Dohnert *et al.*, 2008), children (Uhling *et al.*, 2015,

Araújo *et al.*, 2017; Davidson *et al.*, 2012; Martinelli *et al.*, 2011; Lima *et al.*, 2004; Santos *et al.*, 2009), adolescents (Ruivo *et al.*, 2014; Coelho *et al.*, 2014; Coelho *et al.*, 2013; Ruivo *et al.*, 2015; Bastião *et al.*, 2014), high heel users (Pezzan *et al.*, 2011; Iunes *et al.*, 2008; Morais *et al.*, 2012), scleroderma (Lima *et al.*, 2015), pregnant women (Lima *et al.*, 2011), athletes (Siqueira *et al.*, 2010), patients with chronic obstructive pulmonary disease (Pachioni *et al.*, 2011), patients with temporary mandibular dysfunction (Souza *et al.*, 2014), patients with depression (Canales *et al.*, 2017) and burned (Valenciano *et al.*, 2015). Unlike the others, an paper evaluated the interference of subject positioning for angular measurement using SAPo (Mota *et al.*, 2014). Table 2 shows the average camera distance and tripod height. Regarding the distance from the camera, the papers that use half of the subject's height as a parameter were not taken into consideration in the calculation (Valduga *et al.*, 2011; Saad *et al.*, 2012; Martinelli *et al.*, 2011; Pachionie *et al.*, 2011; Mata *et al.*, 2014; Saad *et al.*, 2009; Souza *et al.*, 2011). In the study by Davidson *et al.* (2012), thorax asymmetry of premature babies was analyzed, so that camera positioning was atypical, so the data from this study did not enter the statistical analysis presented in Table 2.

Table 2. Mean and standard deviation of camera distance and height using the papers searched

Camera to subject distance	Tripod height
2,70 ± 0,54 m	1,01 ± 0,21 m

Legend: m (meters).



Flowchart

DISCUSSION

Regarding the variety of software and type of studies: In the study by Mota *et al.* (2014) different positions of the subject in the SAPo calibrations were evaluated and it was observed that the higher the rotation of the volunteer the greater the errors of angular measurements, so there is need to be careful in the angular analysis when the volunteers present body follow-up rotations. Among the controlled studies that used SAPo as an assessment tool, Weber *et al.* (2012) evaluated the craniocervical posture of mouth breathing children before and after Swiss ball treatment and concluded through photogrammetric evaluation that there was a decrease in anteriorization of the reestablishing the physiological lordosis of the cervical spine. In a similar study, Ferreira *et al.*

(2012) also evaluated mouth breathing children in relation to the Charpy angle, and SAPo was able to measure the decrease in this angle after intervention of 20 physical therapy sessions. In the study by Basso *et al.* (2010), a controlled study using the same software as the two previously mentioned, aimed to verify the effect of RPG on body alignment of patients with temporomandibular dysfunction, and found that the software was an adequate tool for postural evaluation of these patients. Using different software from the previous ones, Barbosa *et al.* (2013) used ALCimage to verify pelvic anteroversion of a patient with low back pain after a joint manipulation protocol with specific exercises for pelvic stability and obtained a significant difference in the reduction of pelvic anteroversion. It had only seven participants, which makes its conclusions little recommended.

Regarding camera positioning: Care must be taken to ensure the quality and accuracy of the photogrammetric exam (Miranda, 2014). Camera positioning is an important item in relation to the possibility of image distortion, as previously mentioned (Table 2) (Mota *et al.*, 2014), but there was no agreement regarding this positioning among the papers, not even among those using the same software. The papers that used ALCimage had a camera distance of 0.94m, when only the head position was evaluated (Iunes *et al.*, 2009), up to 3.58m (Aikawa *et al.*, 2006), and most studies that evaluated the full body posture at a distance of 2.4m (Iunes *et al.*, 2009; Iunes *et al.*, 2010; Iunes *et al.*, 2008; Iunes *et al.*, 2005), also having studies with 3m of distance (Barbosa *et al.*, 2013; Lima *et al.*, 2004) and with 2.90m (Sanchez *et al.*, 2014). Regarding the height of the tripod, there was greater agreement, since five articles used 1m (Iunes *et al.*, 2009; Iunes *et al.*, 2010; Iunes *et al.*, 2008; Iunes *et al.*, 2005); Lopes *et al.*, 2012), and the others used heights ranging from 0.75m (Lima *et al.*, 2004) to 0.94 (Aikawa *et al.*, 2006), and one of them analyzed the posture beyond orthostatic positioning of the head, so the tripod was 1.53 m from the floor (Iunes *et al.*, 2009).

In studies using only Corel Draw, there was also no agreement regarding camera positioning, and the tripod height ranged from 0.85m (Dohnert *et al.*, 2008) to 1.12m (Carvalho *et al.*, 2012), with three studies using 1m (Miranda *et al.*, 2009; Canales *et al.*, 2017; Carneiro *et al.*, 2014) and two studies used the variable height and it was calculated according to the height of the subject, being then at a height that corresponded to half the height of the subject (Saad *et al.*, 2012; Saad *et al.*, 2009). Regarding the distance from the camera there was also variation between studies, from 1m (Carvalho *et al.*, 2012) to 3m (Sacco *et al.*, 2007) being that the first was a hand mold analysis, thus not requiring much distance for framing. The only study using Autocad that was Rocha *et al.* (2015), the camera was at 3m distance and 1m height. SAPo was the most widely used software and yet there was no agreement between the articles regarding camera positioning, however, the vast majority, 18 articles, kept the camera at a distance of 3m from the subject (Basso *et al.*, 2010; Valduga *et al.*, 2011; Martinelli *et al.*, 2011; Santos *et al.*, 2009; Ruivo *et al.*, 2014; Coelho *et al.*, 2013; Ruivo *et al.*, 2015; Bastião *et al.*, 2014; Morais *et al.*, 2012; Lima *et al.*, 2015; Pachioni *et al.*, 2011; Souza *et al.*, 2014; Valenciano *et al.*, 2015; Mota *et al.*, 2014; Ribeiro *et al.*, 2012; Ruivo *et al.*, 2013; Souza *et al.*, 2011). The other articles ranged from 2m (Webber *et al.*, 2012; Ferreira *et al.*, 2012; Araújo *et al.*, 2017) to 3.5m (Siqueira *et al.*, 2010). However, there was no agreement on tripod height, and 8 articles used 1m height (Weber *et al.*, 2012; Ferreira *et al.*, 2012; Basso *et*

al., 2010; Mota *et al.*, 2013; Pezzan *et al.*, 2011; Morais *et al.*, 2012; Lima *et al.*, 2015; Souza *et al.*, 2014), 5 articles used half the subject's height (Valduga *et al.*, 2011; Martinelli *et al.*, 2011; Pachioni *et al.*, 2011; Mota *et al.*, 2014; Souza *et al.*, 2011), and the others ranged from 0.6 (Araújo *et al.*, 2017) to 1.63m (Lima *et al.*, 2015). In the study by Davidson *et al.* (2012), the positioning was differentiated since the thorax of premature newborn infants were evaluated, so there was a need to adapt the camera positioning to analyze the supine position. The study by Araújo *et al.* (2016) evaluated the posture of 2413 children in order to describe the postural pattern of this phase of childhood (7 years). For this, the camera positioning was 2 meters away and 0.60m high. Regarding the reference points marked in the subjects, the articles that used SAPo used the points recommended by the software, which are mostly bone references, such as spinal processes of vertebrae, tuberosity and trochanters, which does not differ from other software.

The existence of validation articles: Among the studies found, eleven analyzed inter and intra-examiner reliability and also the comparison of angle measurement by goniometry and photogrammetry. Studies using ALCimage (Iunes *et al.*, 2009; Iunes *et al.*, 2005) resulted in good agreement among examiners, however Iunes *et al.* (2005) do not recommend the use of software to monitor the natural history of the disease or the evolution of clinical intervention, but rather as a method of screening. Another article by the same author published later (Iunes *et al.*, 2009) also does not recommend the use of photogrammetry for comparison with visual posture analysis, as it did not present satisfactory agreement. In the study by Rocha *et al.* (2015), Autocad was used to analyze inter and intra-examiner reliability of linear and angular measurements, and it was found that intra-examiner evaluation was more reliable and recommended. Among the papers that used Coreal Draw, Carneiro *et al.* (2014) did not obtain good inter-examiner reliability, however this can in part be attributed to the non-marking of two points because the external acoustic meatus and the limit were considered easy to view bottom of the orbit. In contrast, Carvalho *et al.* (2012) found excellent inter and intra-examiner reliability in the analysis of angular measurements of the opening of the first thumb space. Two studies (Duarte *et al.*, 2014; Ribeiro *et al.*, 2012) aimed to analyze the popliteal angle through SAPo and in both the software was considered of good reproducibility and reliability. A similar result was also found in a study by Ruivo *et al.* (2015), in which much inter-rater reliability was obtained in all measurements of the postural angles studied. Partially divergent from these studies, Souza *et al.* (2011) found no reliability in the inter-examiner evaluation at two sagittal angles (vertical trunk alignment and hip angle) and in relation to intra-examiner reliability two angles were also different (horizontal alignment). Head and cervical head alignment). In the study by Ruivo *et al.* (2013) SAPo was considered an accurate and reliable method that can then be useful in clinical practice because it offers the opportunity to assess posture quantitatively facilitating diagnosis, planning and follow-up of physical therapy treatment. In the study by Sacco *et al.* (2007), a comparison of Coreldraw with SAPo was made and it can be concluded that the latter may be more reliable in the angular analysis because it is decimal.

Methodological care: As previously mentioned, the study by Mota *et al.* (2014), the positioning of the subject may interfere with the measurement of angles due to image distortion. In

order to also avoid image distortion Iunes *et al.* (2009) adopted a wooden bench for the smaller volunteers so that the camera was centered on the subject's body. Some studies have adopted EVA rectangle measuring 7.5cm positioned between the participants' feet in order to maintain neutral postural position and thus the images are more reliable and reproducible ((Iunes *et al.*, 2010; Lima *et al.*, 2004; Pezzan *et al.*, 2011; Iunes *et al.*, 2008; Lima *et al.*, 2015; Iunes *et al.*, 2005; Rocha *et al.*, 2015). Also with In order to maintain the position of the volunteer as the position of the photo changes, frontal, right sagittal and left and posterior, some studies asked the participants to position themselves for the photo in frontal view and after this position they were marked on cardboard or EVA mat contoured the feet, so as the view changed, the marking was rotated so that the volunteer always adopted the same positioning of the feet (Miranda *et al.*, 2009; Martinelli *et al.*, 2011; Coelho *et al.*, 2013 Pachioni *et al.*, 2011). Still aiming to maintain the reliability of the photos Reis *et al.* (2010) used a platform with previous demarcation of the feet and waited two minutes for accommodation of the subject before taking the photos. And finally, another methodological care adopted was the previous marking on the floor of the feet positioning in order to keep the volunteer as perpendicular to the camera as possible (Ruivo *et al.*, 2014; Ruivo *et al.*, 2015).

Conclusion

In this systematic review it is clear that the standardization of photogrammetry is necessary to maintain the methodological reliability since the distortion of the images may occur depending on the positioning of the subject, but is not yet observed. The most used software are Alcimage and SAPo. SAPo proved to be the most used software and consequently presented more validation and inter and intra-examiner comparison works with favorable results. The choice of software must take into account not only its validation but also a researcher's analysis of what wants to measure and the advantages and disadvantages of each. Thus, further studies are recommended to determine the most appropriate methodology for imaging and also greater inter and intra-examiner reliability.

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