Reference Values for Human Posture Measurements Based on Computerized Photogrammetry: A Systematic Review

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Abstract

Objective: The main objective of this study was to review the literature to identify reference values for angles and distances of body segments related to upright posture in healthy adult women with the Postural Assessment Software (PAS/SAPO).
Methods: Electronic databases (BVS, PubMed, SciELO and Scopus) were assessed using the following descriptors: evaluation, posture, photogrammetry, physical therapy, postural alignment, postural assessment, and physiotherapy. Studies that performed postural evaluation in healthy adult women with PAS/SAPO and were published in English, Portuguese and Spanish, between the years 2005 and 2014 were included.
Results: Four studies met the inclusion criteria. Data from the included studies were grouped to establish the statistical descriptors (mean, variance, and standard deviation) of the body angles and distances. A total of 29 variables were assessed (10 in the anterior views, 16 in the lateral right and left views, and 3 in the posterior views), and its respective mean and standard deviation were calculated. Reference values for the anterior and posterior views showed no symmetry between the right and left sides of the body in the frontal plane. There were also small differences in the calculated reference values for the lateral view.
Conclusion: The proposed reference values for quantitative evaluation of the upright posture in healthy adult women estimated in the present study using PAS/SAPO could guide future studies and help clinical practice. (J Manipulative Physiol Ther 2016;xx:1-13)
Key Indexing Terms: *Posture; Photogrammetry, Female*

Introduction

Posture may be defined as the biomechanical alignment of the body and its orientation in relation to the environment.[1] The correct or ideal postural alignment involves maximum physiologic and biomechanical efficiency with little overload on the supporting structures.[2]

In the ideal body posture, adopted as the standard international reference,[3] the right and left halves of the body are symmetrical as viewed from the frontal plane, and, from a side view, a plumb line should be anterior to the lateral malleolus and the knee joint, posterior to the hip joint, and extend through the bodies of the lumbar vertebrae, shoulder, and external auditory meatus. However, the ideal posture is still a controversial issue. Studies that analyzed either individual body segments[4-15] or the whole-body posture[16-18] of healthy individuals revealed different alignment patterns. The same occurred with studies that evaluated postural alignment in individuals with a wide range of pathologies.[6,18-20] Several factors affect body alignment, such as muscular dysfunctions, faulty postures in daily life, pain, respiratory disorders, obesity, differences in lower limb length, and joint and connective tissue disorders.[21,22]

Postural assessment is widely used in health care systems to complement the diagnosis of joint and bone disorders,

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muscle dysfunctions, and neurologic diseases. It also helps define the best treatment intervention and exercise prescription for these problems, in addition to being a good indicator of treatment progression. Qualitative postural assessment based on visual inspection is the most common method used to evaluate posture.[23] Nevertheless, this method is subjective, increases the chance of errors between evaluators, and makes the identification of subtle postural changes difficult.[24,25] It also has low interrater reliability and less validity when compared with quantitative approaches.[23,26]

Currently, many quantitative methods are available to assess posture. Among them is the biophotogrammetry approach. It relies on the application of the principles of photography to images from body segments and motion.[27] The main advantages of this approach are that it allows evaluation of the whole body easily using the same picture, and that it does not involve exposure to radiation.[28,29] On the basis of previously obtained images, software such as the Postural Assessment Software (PAS/SAPO) is used to assess angles and distances of body segments. PAS/SAPO was developed at the University of São Paulo, Brazil.[8] It was built by a multidisciplinary team and provides a comprehensive overall analysis of posture or independent analysis of angles and distances. This software was chosen from the available biophotogrammetry tools because of characteristics that enable many potential clinical and research applications: (1) it provides a tutorial for marker placement at specific anatomic landmarks, therefore contributing to reduction of error analysis (https://code.google.com/p/sapo-desktop/); (2) it was designed for health professionals and has a friendly interface[30]; (3) it has been employed in many observational and clinical trials for postural assessment[31]; (4) it is in the public domain[32]; (5) it can be installed on multiple operating systems[31]; (6) it allows calibration and data image storage for offline analysis[8]; (7) it enables the implementation of different protocols to provide a global analysis of posture, as well as the analysis of independent angles and distances[31]; and (8) it has good accuracy,[32] as well as good intrarater[17,19,32,33] and interrater[19,32-34] reliability.

Despite the advantages of a postural assessment with PAS/SAPO, the reference values provided by the software[16] are not supported by the literature,[4,6,16,20] and, to date, no consensus has been reached on the standard values for angles and distances of different body segments during upright posture. Moreover, there are some anatomic differences between males and females. For instance, compared with males, females are likely to have more pronounced pelvic anteversion, femoral anteversion, and genu recurvatum.[35,36] For these reasons, knowledge of the reference values for postural alignment in young females is necessary and can benefit both research and clinical practice. The reference values can be used, among other applications, to assess the impact of many neurologic and musculoskeletal diseases on postural alignment, evaluate the efficacy of therapies, guide the prescription of individualized exercise or therapeutic interventions, and describe the influence of aging on postural alignment.

The objectives of this systematic review were to identify studies that evaluated postural assessment of healthy adult females with PAS/SAPO, to analyze the methodology of these studies, and to propose reference values for the angles and distances for postural assessment during upright posture.

Methods

A systematic review was conducted on studies extracted from the BVS, PubMed, SciELO, and Scopus databases. The search methodology included the following descriptors: evaluation, posture, photogrammetry, physical therapy, postural alignment, postural assessment, and physiotherapy. Each search was conducted using at least 2 descriptors that always included the term *posture* or *postural*. Thus, the following combinations were used: photogrammetry posture; evaluation posture physical therapy; evaluation posture photogrammetry; postural alignment evaluation; posture photogrammetry; review postural therapy; and postural assessment photogrammetry.

On the BVS and SciELO databases, the searches were conducted using key words in English and in Portuguese; in the PubMed and Scopus databases, the searches were made only in English. In all searches, a filter was used to select studies published from January 2005 to December 2014. The database searches were carried out in January and February 2015. Studies published in English, Portuguese, and Spanish were included.

The goal of our work was to propose reference values for angles and distances related to upright posture in healthy adult women. To make it possible to merge data from different studies, the following inclusion and exclusion criteria were employed: the PAS/SAPO protocol must be employed; the sample must be composed of healthy adults or only healthy adult women. Review studies, opinion articles, final course papers, guidelines, case reports, basic research, studies missing abstracts, studies that assessed posture using a nonstandard standing position, and studies missing means and standard deviations or standard errors of the mean of the measured angles, as well as studies with a mixed sample that did not report the results of the angles measured solely in women were excluded.

Studies that met the inclusion criteria were analyzed based on the year of publication, the place where the study was conducted, the sample studied, the average age of the participants, the study design, the sample size, and the angles and distances measured during the postural assessment. Methodology of the clinical trials was assessed using the Physiotherapy Evidence Database (PEDro) scale,[37] and observational studies were evaluated using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) initiative.[38] The PEDro scale is a valid tool widely used as a criterion-based checklist for quality assessment of randomized clinical trials. It evaluates internal