# artikel

*by* M Nel

TITLE: POSTURE ALIGNMENT: DEVIATION FOR SENSE AND ACTUAL ALIGNMENT

## INTRODUCTION

Health care practitioners treat clients with postural deviations by following among others an educational approach[1,2,3] to correct postural alignment in order to perform safe[4,5], precise and accurate movement during activities of daily life[6]. The body's location in space is important for interacting with the environment[7]. A sense of posture enables safe and mechanically effective movement[8]. The assumption exists that clients are able to accurately perceive and interpret their own postural alignment[9] in relation to ideal alignment, and that posture behaviour adjust accordingly[10,11,12,13] during the performance of activities of daily life.

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The Posture Committee of American Academy of Orthopaedic Surgeons[14], defines posture as "the relative arrangement of the parts of the body". Normal posture is "the state of muscular and skeletal balance which protects the supporting structures of the body against injury or progressive deformity irrespective of the attitude in which these structures are working or resting". Kendall[15] regards postural alignment as ideal when specified anatomical landmarks align with a plumbline, representing 14 a vertical line of gravity through the centre of gravity. This functions as the single point around which the mass of the body is equally distributed[16].

Research findings on the accuracy of posture reporting has mainly focussed on the sense of single joint positions and the influence of external factors on joint positions,[17,18] as well as matching sensed posture of opposite joints. Most studies on the accuracy of sensed posture have been performed at the knee joint[19,20,21,22,23]. Far less research evidence is available on sense of position of the shoulder and elbow joints[17].

In the absence of studies that report on the sense of postural alignment on a multi-joint level,[24,25]
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this study aimed to investigate the difference between sense of postural alignment and the actual postural alignment in sitting and standing, from both anterior and lateral views, for specified anatomical landmarks.

**METHODOLOGY**

This was a quantitative descriptive study. Ethical clearance was obtained from the 2 Health Sciences Research Ethics Committee at the University of the Free State (HSREC 171/2016/1415). Permission to conduct the 4 study was obtained from the District Manager, Mangaung Metro and the Free State Provincial Health Research Committee.

Of the 26 public health care clinics in Botshabelo and ThabaN'chu, 10 clinics were randomly selected and a convenient sample of 10 patients per clinic participated in the study, all of whom met the specified inclusion/exclusion criteria. Participants were included if they were able to assume a standing and sitting position for 2 minutes, willing to participate in the study, and able to speak English, Afrikaans or Sesotho. Participants were excluded if they reported hearing impairments or a spinal cord trapped nerve, or they were diagnosed with acute musculo- skeletal injury and/or musculo-skeletal pathology: i.e. cerebral palsy, scoliosis or radiculopathy.

Data collection: prior to the day of data collection, each clinic was visited by a trained fieldworker (qualified occupational therapist) who informed the clinic personnel about the procedure for data collection, and a suitable venue was located at each respective clinic for data collection. On the day of data collection all patients who attended the clinic 9 were informed about the study, and informed consent was obtained to participate in the study. The field worker provided the participant with information regarding the procedure of postural assessment.

Measurement consisted of three parts namely: a structured interview to collect biographical information which included data on the categories of general health, posture, sporting activities and medical history. In addition actual postural alignment, and sensed postural alignment was assessed using the Photographic Method of Postural Assessment (P-MPA)[26].

*Data collection phase:* To assess postural alignment, a set-up for postural assessment was done according to the P-MPA procedure (Figure 1). Against the wall behind where the participant would assume the standing and sitting position, a number for each individual participant was placed, as well as a 1 meter ruler to indicate actual distance which is used in the P-MPA ratio measurement.

**[Insert Figure 1 here]**

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Method of assessment: marking of anatomical landmarks. The participant was requested to assume a comfortable standing position, for the marking of the following landmarks by making use of a 5mm colour sticker:

- lateral view: anterior aspect of lateral malleolus, mid-knee, greater trochanter, acromion and external auditory meatus (ear lobe);
- anterior view: mid-heels, mid-knees, navel and nose.

Assessment of posture. The *participant* assumed a position 1 meter behind the plumbline, with the plumbline aligned with the anterior aspect of the lateral malleoli for the standing position, and with the plumbline aligned with mid heels for the anterior position. The participant was asked to assume his/her most natural standing and sitting position. For the taking of measurement, the *field worker* assumed a position of 2 meter distance from the plumbline. A photo was taken by the field worker using a smartphone that was fixed on a tripod at a height of 950mm. After the photo had been taken the participants sense of posture was assessed by asking the participant to indicate their *sensed deviation* from the plumbline for each anatomical landmark. Each landmark was assessed in comparison to the plumbline, and documented onto the data form. This was done for sitting and standing in both lateral and anterior views. Each photograph was printed in A4 size, after which each participant's *actual deviations* from the plumbline were measured with a ruler with increments in mm, and transferred to data forms by the researchers.

The actual (real) distance on photos was established by calculating the ratio of *measured/real distance x distance from plumbline for each photo*[26]. A clinical significant difference from the reference point as measured on the photo was set at 10mm[27]. The coding was done by the researchers, followed by data analysis. Descriptive statistics, namely frequencies and percentages for categorical data, and medians and percentiles for numerical data, were calculated. The sense and actual deviation at each landmark, for sitting and standing were compared by means of 95% confidence intervals (CI) for median differences for paired data.

**Pilot study**

A pilot study was done to clarify any questions participants had regarding the questionnaire or study, and to identify practical obstacles during data collection and the coding of questionnaires. No corrections were made, and results of the pilot study formed part of data analysis.

**Results**

Data was collected for 95 participants, from 2 to 13 October 2017 at the sampled clinics. Most participants (80.0%) were female with a median age of 42.5 years (range 18.2 to 84.7 years) and a median level of grade 10 education (range 0 (none) to 13 (diploma). Most participants had a normal weight (85.3%) and were of medium length (67.4%). Most (68.4%) participants had a good general health.

More than half (54.7%) of participants did not think about their own postural alignment, and more than half (52.6%) indicated not being concerned about their own postural alignment. Most (64.2%) considered themselves as ‘in touch with their sense of movement’, and most (63.2%) considered themselves to be ‘in touch with the sense of postural alignment’. Almost all participants (96.8%) have never had their posture assessed. Most (73.7%) participants participated in sport including running (26.3%), netball (54.3%) and soccer (37.1%).

Table I reports on all 95 participants data for sensed and actual (real) postural deviation from the plumbline.

**[Insert Table I here]**

For sense: Participants mostly indicated no deviation from the plumbline for the anterior view, though less indicated no deviation for the lateral view. As can be seen in the range for sense (Table I) there were participants who did indicate deviations.

For actual: The pattern of deviation differed from sense as can be seen in Table I.

Statistical significant differences were found at all the anatomical landmarks for the lateral view for both sitting and standing between the actual and sensed posture regarding the plumbline. The nose was the only landmark from anterior view that had statistical significant differences between actual and sense per participant, though no clinical significant differences were found at landmark nose. Clinical significance was seen as 10mm for this study, therefore all the lateral view landmarks, showed clinical significant differences for both standing and sitting.

Table II reports on results for participants who sensed a deviation of posture: their sensed and actual deviations are stated.

**[Insert Table II here]**

In order to determine by how much participants sensed and actual deviations differed 95% confidence intervals for the median difference were calculated.

When sensed deviation occurred for mid-knee standing the sensed deviation was statistical significantly more than the actual. For lateral view when deviation was sensed the actual deviation was statistical significantly more than the sensed variation.

Table III reports on when actual posture deviation occurred, the actual and sensed are stated and compared by means of 95% confidence intervals.

**[Insert Table III here]**

95% confidence intervals for the median difference were calculated in order to determine by how much participants sensed and actual measurements differed. If actual deviation occurred it always deviated statistical significantly more than sensed deviation for all landmarks, and with the exception of the navel landmark (anterior view, sitting) and mid-knee (anterior view standing). Sense and actual deviations differed clinical significantly for all the landmarks.

**Discussion**

Good postural alignment provides a basis for effective and safe movement during participation in activities of daily life. The implementation of correct postural alignment in activities of daily life relies largely on accurate sensing of postural alignment and the subsequent repositioning”[10,11,12,13] of postural alignment. Literature reports on numerous disciplines’ interest in the field of accuracy studies[28], and results influencing practices and development of professions such as human factors in aviation[29], sport performance ergonomics and management[30].

Results from the present study show five important findings regarding the accuracy of sensing postural alignment. Firstly, a difference occurs in sensing postural deviation from the plumbline between anterior and lateral views for both the positions of sitting and standing, where participants sensed *less deviation from the* plumbline in the *anterior view than the lateral view*. In this regard, the role of vision in the readjustment of posture is well described in literature[8,31].

In the current study the plumbline fell within the central field of vision of the participant (anterior view). This supports the role of central vision in postural alignment, consistent with the findings of other investigators. Thomas[32] found increased postural sway during smooth visual pursuits in more challenging stance positions, demonstrating the importance of visual inputs on postural sway of adults during quiet stance. Similarly Agostini[33] found that central vision seems to affect mostly the medio-lateral direction of postural sway. In further support of the role of vision in perceiving body position, Gibson[34] found that vision is more dominant than touch and proprioception. Gibson explains if an object was made to merely look large using a lens, while it was being palpated, it also felt large. Findings in literature that also aligns with results of the present study further report on The Ponzo- and The Mueller-Lyre Illusion[35] stating that illusions occur when the perceptual processes or perceptual constancy are “altered” by a particular situation so that something is *seen* that does not exist or that is incorrect. The theory of perceptual constancy suggests that “we always perceive the same object in the same way, despite the fact that sensations that it creates on our receptors changes dramatically". This ability to perceive a stimulus as constant despite changes in visual sensation may further relate to participants' in the present study's more accurate interpretation of the plumbline as central.

Secondly, significant differences were found at all the anatomical landmarks for the lateral view between the actual and sensed posture regarding the plumbline. Regarding the anterior view for the landmark nose (sitting and standing) statistical significant differences were seen between actual and sense per participant, though no clinical significant differences were found.

A third finding from the current study is that, when responses from the *participants who sensed deviation from the plumbline* (anterior view, standing), were compared to their actual deviation, a statistical significant difference was found at the anatomical landmark of the knee (a weight bearing joint). However, from a lateral view, both statistical and clinical differences were found for *all* the anatomical landmarks in standing.

Literature on postural adjustment and maintenance indicates the importance of frequency and stretch intensity in sensory fibres, force intensity of and joint position of[36] as it is perceived by receptors throughout the body. The receptors include muscle spindles, Golgi tendon organs and mechanoreceptors[37]. In the current study stability was provided by weight bearing joints i.e. knee and hip joints; whereas the shoulder (acromion landmark) and head (ear lobe) were less exposed to mechanoreceptor proprioceptive input, and more subjected to open kinematic chain movements. Congruent with single joint research findings of Tiago[17] on accuracy of the knee joint's sensed posture, and Drouin's [16] conclusion that sensed posture is superior in closed kinematic chains[38], our findings show that statistical as well as clinical significant differences were found for landmarks proximally to the greater trochanter, namely the shoulder (landmark acromion) and ear lobe. These joints are situated more proximally in the kinematic chain and typically perform more open kinematic chain movements. An important finding from the present study, and in contrast with “Feedforward and internal feedback mechanism”[6,7,8], the weight bearing joints (mid-knee and greater trochanter) *also* show both statistical and clinical significant differences, indicating that the role of proprioceptive structures’ feedback is a clinically noteworthy concern for educational approach to the repositioning of posture. In addition, support for the findings in the current study is further evidenced by Dae-Hyouk Bang[39] who found that knee proprioception of chronic stroke patients differs significantly between the weight-bearing and non-weight-bearing positions.

The fourth finding from the current study indicates that, if actual deviation occurred and the actual deviation from the plumbline was compared with the sensed responses, statistical significant differences were found for all landmarks, and likewise clinical significant differences were found for all landmarks, with the exception of the navel landmark (anterior view, sitting) and mid-knee (anterior view standing). Again, results for the knee joint are in line with proprioception theories relating to weight bearing joints[39], and similarly to sensed deviation, shows no clinically statistical difference between actual and sensed deviations. Although the time aspect was not the focus of the present study, literature indicates that the retention of postural alignment decreases with the passing of time. Di Xie and Yukio Urabe found a significant increase of absolute error regarding sensed posture over the time span of 5 to 30 minutes[40].

A last noteworthy finding from the present study is that all the lateral view landmarks show both statistical and clinical significant differences between sense and actual deviation for standing position.

Congruent with proprioception theories, which argue that perceiving proprioceptive information form part of the individual’s ‘internal feedback mechanism’[8,11] when trying to adjust and correct postural alignment during activity participation, results from the present study show that the distance(degree) to which a client sense deviation from the plumbline should also be considered and accommodated during assessment and planning of intervention programmes.

**Recommendations**

In the absence of existing evidence regarding the accuracy of multi-joint postural alignment in sitting and standing, findings from the present study should alert assessment and intervention practices to the discrepancies between sensed and actual postural alignment.

The authors firstly recommend that the distance of deviation from the plumbline be considered an additional aspect in the procedure of assessment and intervention planning to ensure and optimise accuracy in assessment and postural intervention practices.

Secondly, health care professionals and educators are advised to accommodate the discrepancy between sensed and actual postural alignment in the design of educational and intervention programmes.

Health care professionals practising in the field of postural retraining programmes, should take note that weight bearing joints, functioning in a closed kinematic chain, show a clinically significant difference between sensed and actual repositioning of postural alignment.

The authors recommend that follow up studies investigate postural repositioning during motion and in addition to speed and direction, also test the degree to which discrepancy between sense and actual values occurs.

## Conclusion

To our knowledge, this is the first study to report on multi-joint postural alignment and the difference between actual and sense deviation from the plumbline. Results from this study showed statistical and clinical significant differences for sense and actual deviations from the plumbline, for certain anatomical landmarks in standing and sitting positions in the anterior and lateral views. The authors therefore wish to raise awareness among health care workers to accommodate for inaccuracy of postural readjustment in the planning of intervention programmes.

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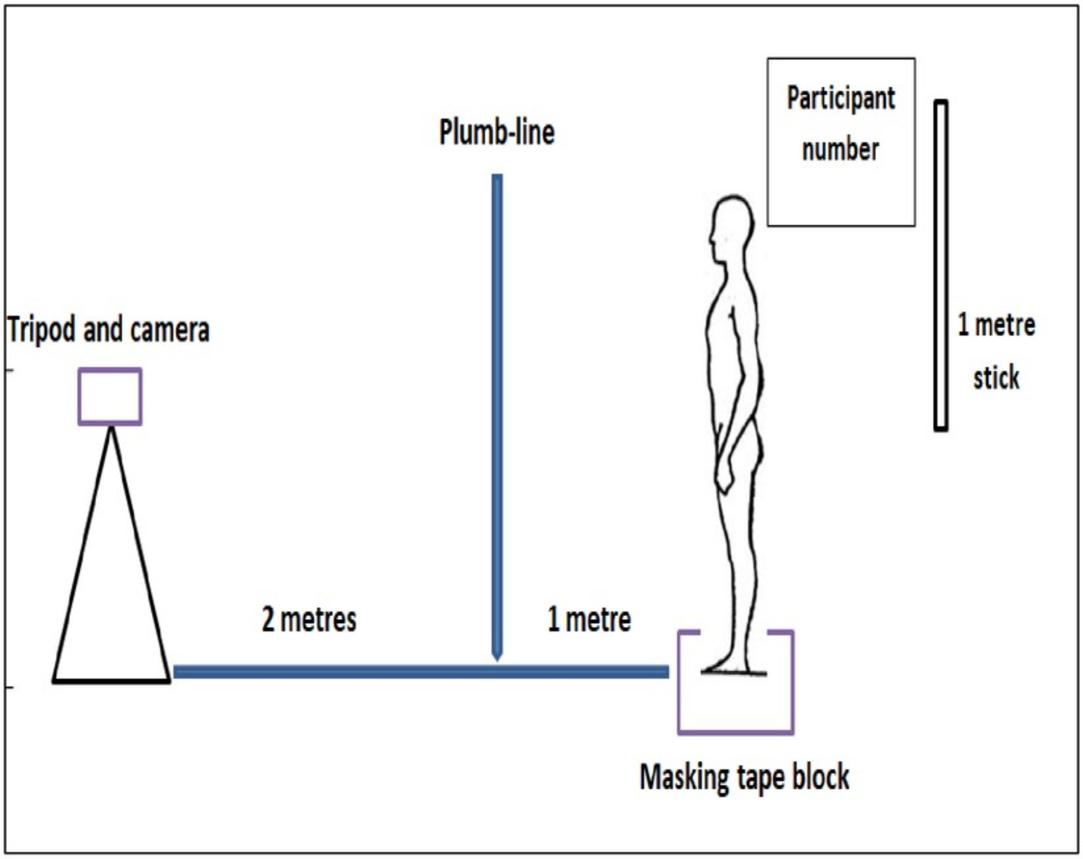


**Figure 1 Setup for Photographical Method of Postural Assessment (P-MPA)**

**Table I Posture deviation (n=95)**

| View | Anatomical landmarks | Sitting | | Standing | | Sitting | | Standing | | Sitting | Standing |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Median Deviation from plumbline in mm (range) | Percentage indicated no deviation | Median Deviation from plumbline in mm (range) | Percentage indicated no deviation | Median Deviation from plumbline in mm (range) | Percentage measured no deviation | Median Deviation from plumbline in mm (range) | Percentage measured no deviation | 95% Confidence Interval for the median difference (in mm) | |
| | | Sensed posture deviation | | | | Actual posture deviation | | | | Sense - Actual | |
| Anterior | | | | | | | | | | | |
| | Mid-knee | - | - | 0(-30–+20) | 73.7 | - | - | 0(-35.7-+5.7) | 88.4 | | [ 0 ; 0 ] |
| | Navel | 0(-30–+20) | 83.2 | 0(-20–+20) | 81.1 | 0 (-49.4 –+37.0) | 58.9 | 0(-65.2-+61.7) | 43.2 | [ 0 ; 0 ] | [ 0 ; 7.0 ] |
| | Nose | 0(-30–+30) | 73.7 | 0( -30–+40) | 75.8 | 0 (-72.7-+92.1) | 28.4 | 0(-72.7-+54.9) | 28.4 | [ 5 ; 14.6 ]* | [ 5.9 ; 13.5 ]* |
| Lateral | | | | | | | | | | | |
| | Mid-knee | - | - | 0(-30–+30) | 55.8 | - | - | -26.8 (-135.8-+18.5) | 14.7 | | [ 17.4 ; 32.9 ]* # |
| | Greater trochanter | - | - | 0(-30–+30) | 55.8 | - | - | -50.6(-162.2-+35.7) | 9.5 | | [ 35.7 ; 53.2 ]* # |
| | Acromion | 0 (-30 – +30) (n=94) | 67.0 (n=94) | 0 (-30 – +30) | 62.1 | 1.6 (-98.8-+163.6) | 26.3 | 0 (-107.1-+109.8) | 17.9 | [ 5.2 ; 27.8 ]* | [ 13.2 ; 26.8 ]* # |
| | Ear lobe | 0 (-30 – +30) (n=94) | 55.3 | 0 (-30 – +30) (n=94) | 51.6 | 0 (-149.3-+132.5) | 23.2 | -43.0 (-147.1-+91.8) | 10.5 | [ 7.7 ; 24.7 ]* | [ 25.8 ; 50.2 ]* # |

* Statistical significant difference # Clinical significant difference

Please note that the deviation of posture from the plumbline was indicated as negative when it was left of the plumbline for the anterior view and posterior for the lateral view of the participant. All values are indicated in millimetre

**Table II Sensed and actual deviation for those whom had indicated deviations when sensing posture**

| View | | Sensed | Actual | | Sensed | Actual | Sense-Actual | |
|---|---|---|---|---|---|---|---|---|
| Anterior | Frequency | Median Deviation from plumbline in mm (range) | Median Deviation from plumbline in mm (range) | Frequency | Median Deviation from plumbline in mm (range) | Median Deviation from plumbline in mm (range) | 95% Confidence Interval for the median difference (in mm) | |
| | | Sitting | | | Standing | | Sitting | Standing |
| Mid-knee | | - | - | 25 | 5.0(-30-+20) | 0(-27.0-0) | - | [ 6.1 ; 20 ]* |
| Navel | 16 | -7.5(-30–+20) | 0(-36.4-+35.7) | 18 | 7.5(-20-+20) | 0(-14.5-+44.8) | [ -8.9 ; 10.0 ] | [ -2.7 ; 10 ] |
| Nose | 25 | -5.0(-20–+30) | 6.0(-72.7-+92.1) | 23 | 5.0(-30-+40) | 5.7(-72.7-+50.5) | [ -12.2 ; 5.0 ] | [ -14.6 ; 0 ] |
| Lateral | | Sitting | | | Standing | | | |
| Mid-knee | | - | - | 42 | 10.0(-30–+30) | -31.6(-108.7-+18.5) | - | [ -40.6 ; -11.5 ]* # |
| Greater trochanter | | - | - | 42 | 10.0(-30–+30) | -56.3(-162.2-0) | - | [ -55.2 ; -33.5 ]* # |
| Acromion | 32 | 5.0(-30–+30) | 8.4(-98.8-+163.6) | 36 | 5.0(-30–+30) | -4.4(-95.7-+109.8) | [ -21.1 ; 1.8 ] | [ -34.3 ; -14.1 ]* # |
| Ear lobe | 43 | 10.0(-30–+30) | -11.4(-86.9-+132.5) | 46 | 10.0(-30– +30) | -54.7(-138.3-+91.8) | [ -16.5 ; -0.6 ]* | [ -60.9 ; -28.1 ]* # |

*Statistical significant difference

# Clinical significant difference

**Table III Actual posture deviation measured (only for those who had actual deviations)**

| View | | Actual | Sensed | | Actual | Sensed | Sense-Actual | |
|---|---|---|---|---|---|---|---|---|
| Anterior | Frequency | Median Deviation from plumbline in mm (range) | Median Deviation from plumbline in mm (range) | Frequency | Median Deviation from plumbline in mm (range) | Median Deviation from plumbline in mm (range) | 95% Confidence Interval for the median difference (in mm) | |
| | | Sitting | | | Standing | | Sitting | Standing |
| Mid-knee | | - | - | 11 | - | 0 (-20-+20) | - | [ 5.7 ; 30.3 ]* |
| Navel | 39 | -5.4 (-49.4 – +37.0) | 0 (-20-+20) | 54 | [ 8.5 ; 13.9 ]* | 0(-10-+20) | [ 8.5 ; 13.9 ]* | [ 10.1 ; 14.6 ]* # |
| Nose | 68 | 13.3 (-72.7-+247.3) | 0 (-30-+30) | 68 | [ 12.2 ; 21.7 ]* # | 0(-30-+40) | [ 12.2 ; 21.7 ]* # | [ 10.9 ; 18.5 ]* # |
| Lateral | | Sitting | | | Standing | | Sitting | Standing |
| Mid-knee | | - | - | 81 | -34.2 (-135.8-+18.5) | 0(-30-+30) | - | [ 22.7 ; 40.5 ]* # |
| Greater trochanter | | - | - | 86 | -56.3 (-162.2-35.7) | 0(-30-+30) | - | [ 37.1 ; 61.2 ]* # |
| Acromion | 78 | -6.7 (-107.1-+109.8) | 0(-30-+30) | 36 | -4.4 (-95.7-+109.8) | 5(-30-+30) | [ 15.2 ; 34.1 ]* # | [ 20.3 ; 32.6 ]* # |
| Ear lobe | 85 | -45.5 (-147.1-+91.8) | 0(-30-+30) | 46 | -54.7 (-138.3-+91.8) | 10(-30-30) | [ 13.5 ; 30.0 ]* # | [ 33.5 ; 58.2 ]* # |

*Statistical significant difference

# Clinical significant difference

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