Educating Chiropractic Students About Intraobserver and Interobserver Variability Through the Use of Skinfold Measurement

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Purpose: Skinfold measurements taken by novice observers are fraught with high rates of intraobserver variability and even higher rates of interobserver variability, and therefore having students collect and analyze skinfold measurements is an ideal way to present the concepts of both measurement and physiological variability. **Methods:** Students in a 1st trimester clinical biochemistry laboratory were assembled into groups of four, and within each group the students were asked to volunteer to be either a subject, a data recorder, or one of two observers. To demonstrate intraobserver versus interobserver variability the subject was assessed by four separate observers who each took four separate skinfold measurements. The skinfold measurement obtained from each separate observation was based on the sum of four skinfold sites. The average sums of the skinfold measurement (in mm) and standard deviations were calculated and posted for postlaboratory discussion. **Results:** Skinfold measurements were taken on 76 1st-trimester chiropractic students (46 males and 30 females). The average intraobserver and interobserver variability across all 76 participants was 4.8 ± 2.3 mm and 10.0 ± 6.3 mm, respectively, representing a twofold increase in variability, which was statistically significant ($p < .0001$). The noticeable differences between intraobserver and interobserver variability provided a great back drop for postlab discussion, which was the intended purpose of performing this demonstration project. **Conclusion:** Measuring skinfold thickness can prove to be a useful and inexpensive method for easily and safely demonstrating the concepts of variability to students. (J Chiropr Educ 2009;23(2):147–150)

Key Indexing Terms: chiropractic; education; interobserver variability; intraobserver variability; skinfold thickness

INTRODUCTION

Objective data are often obtained by chiropractic physicians for evaluating pretreatment and posttreatment outcomes. These data are usually acquired in some numerical form and may consist of glucose or cholesterol concentrations, blood pressures, goniometry, dolorimetry, calorimetry, height, weight, waist or hip circumferences, or skinfold measures. Objective measurements taken on any patient will always be subject to both measurement and inherent physiological variability. As with any objective clinical measurement, variability should always be recognized before making important clinical decisions. This point is well supported by Choi et al., who found that educating physicians about the concept of variability improved their consistency and accuracy in clinical decision making.[1]

The purpose of this project is to illustrate to the chiropractic educational community a working model for introducing chiropractic students to the concept of both intraobserver and interobserver variability (also known as within-observer and between-observer variability, respectively). The model exhibited utilizes skinfold measurements taken by 1st-trimester chiropractic students. Skinfold measurements taken by novice observers are fraught with high rates of intraobserver variability and even higher rates of interobserver variability.[2,3] Therefore having students collect and analyze skinfold measurements is an ideal way to present the concept of measurement variability.

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METHODS

During the prelaboratory meeting time for a 1st-trimester clinical biochemistry laboratory, students were asked to arrange themselves into groups of four. Within each group students volunteered to be either a subject, a data recorder, or one of two observers. During the prelaboratory meeting, a brief discussion about variability was presented and a two-page instruction guide on taking skinfold measurements with Lange calipers was provided to all students. This study was approved by the college's institutional review board.

To demonstrate intraobserver versus interobserver variability the subject was assessed by four separate observers (to determine interobserver variability), who each took four separate skinfold measurements (to determine intraobserver variability) using the Lange skinfold calipers. The skinfold measurement obtained from each separate observation was based on the sum of four skinfold sites (biceps, triceps, subscapular, and suprailiac). Although each observer read off each caliper measurement to the data recorder, the data recorder and the subject were advised not to provide any feedback to the observers, therefore keeping the data collection process somewhat "blinded" from the observers.

For every subject the average sum of the skinfold measurements (in mm) for each of the four observers was calculated. The standard deviations indicating intraobserver variation were also calculated and the subject's percentage body fat was obtained using the sum of skinfolds from the tables provided in the lab. The interobserver sum of the skinfold measurement was calculated using the averages obtained from the four separate observers, and the corresponding standard deviation and percentage body fat were obtained in the same manner as stated above.

Each group was responsible for posting only the intraobserver and interobserver standard deviations on the black board (neither the sum of the skinfold measures nor the calculated percent body fat was posted to protect the privacy of the subjects). These results were then used for postlaboratory discussion, which focused on the clinical implications of human measurement and its inherent variability.

To illustrate the benefit of using skinfold measurement as an educational tool for differentiating between intraobserver and interobserver variability, the average intraobserver and interobserver variability across all subjects was calculated and statistically compared using a Student's pairwise *t*-test in Microsoft Excel (Microsoft Inc, Redmond, WA), where each individual subject's intraobserver variability value was compared with his or her interobserver variability value. This statistical analysis is not designed to be part of the laboratory exercise, but was performed here for the purpose of showing that the interobserver and intraobserver variability could be "statistically" different, and therefore supporting that this exercise is suitable to perform with the knowledge that there will be a difference between the intraobserver and interobserver variability at the end of the laboratory exercise.

RESULTS

Skinfold measurements were taken on 76 1st-trimester chiropractic students (46 males and 30 females). The average intraobserver and interobserver variability across all 76 participants was 4.8 ± 2.3 mm and 10.0 ± 6.3 mm, respectively. This was a twofold increase in variability and the difference was statistically significant ($p < .0001$). When comparing male versus female participants, the average intraobserver variability was similar (5.0 mm vs. 4.4 mm), as was the interobserver variability (10.2 mm vs. 9.8 mm). The average percent body fat calculated from the skinfold measurements for the male and female participants was 21.6% and 28.2%, respectively (Table 1). The noticeable differences between intraobserver and interobserver variability provided a great backdrop for postlab discussion, which was the intended purpose of performing this project.

DISCUSSION

In this project it was demonstrated that taking skinfold measurements can be an ideal method for showing students that any measurement on a human subject can be fraught with both intraobserver and interobserver variability. More importantly, this project also demonstrates that skinfold measurements can prove to be a useful and inexpensive method for easily and safely demonstrating the concepts of variability to students.

It is well documented that both intraobserver and interobserver variability are exaggerated with novice users of skinfold calipers and therefore this makes skinfold measures a very useful tool for demonstrating variability in clinical measurements.[4,5] Thus

Table 1. Comparison of Intraobserver Versus Interobserver Variability

	Number of subjects	Intraobserver variability (mm)	Interobserver variability (mm)	Estimated percentage body fat (%)	Weight (lbs)
All subjects	76	4.8 ± 2.3	10.0 ± 6.3[a]	24.2 ± 6.0	169.8 ± 37.4
Male subjects	46	5.0 ± 2.5	10.2 ± 6.5[a]	21.6 ± 4.5	193.0 ± 29.3
Female subjects	30	4.4 ± 2.0	9.8 ± 6.0[a]	28.2 ± 5.6	134.3 ± 18.3

[a] $p < .000$ for comparison between intraobserver and interobserver variability.

students who are selected to be observers should not include individuals who have extensive current or previous experience with using skinfold calipers. Therefore, during the prelaboratory discussion, students who had previous experience using skinfold calipers were asked to volunteer as either a subject or data recorder.

Variability observed in a measurement is due to measurement variation (imprecision) and physiological variation (undependability). Variability may therefore reflect both biological and technical factors, and under the direction of the instructor the students can in the postlaboratory discussion use the obtained data to hypothesize the specific sources of errors that attributed to the observed intraobserver and interobserver variability. Various examples of the sources of error brought up in discussion included variations in selection of skinfold sites, size of the skinfold grasp and the varying amounts of subcutaneous tissue drawn, time delay in reading the skinfold measurement, holding the caliper at various angles (which may be due to the different heights of the observer relative to the subject), taking measures on the left instead of the right side of the body, variation in the compressibility of fat, variations in the posture of the subject when measurements were taken, and rounding errors made when reading the caliper or data transcription errors when recording the obtained values.

Measurement error can be random or systematic, but in either case the clinical significance can be important. For example, the average intraobserver variability could account for a percentage body fat calculation of $\pm 2\%$. More significantly, the average interobserver variability could account for a percentage body fat calculation of $\pm 4\%$. Such differences, especially in the case of interobserver variability, could have a significant impact on clinical decisions that are made based on such observations.

It has been previously demonstrated, through using senior versus junior medical residents, that clinical training can improve interobserver variability with respect to clinical decision making.[6] It has also been demonstrated, through using senior hospital staff members versus final-year medical students, that clinical experience itself can improve intraobserver variability.[7]

CONCLUSION

This project was designed to illustrate to the chiropractic educational community a working model for introducing chiropractic students to both the concepts of intraobserver and interobserver variability. This project hopefully demonstrates that having students collect and analyze skinfold measurements is an ideal way to present the concepts of measurement variability. More importantly, through postlaboratory discussion, the instructor can guide these future physicians to be more cautious about making clinical decisions based on the objective data obtained in their assessments.

CONFLICT OF INTEREST

The author has no conflicts of interest to declare.

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Erratum

In the Spring 2009 Abstracts of ACC Conference Proceedings: Platform Presentations, the abstract by Koo et al. titled Continuous Measurement of Muscle Morphology Using Sonomyography: A New Technique to Quantify Chiropractic Treatment Efficacy, one of the authors was accidentally omitted.

The correct list of authors is: Terry Koo, New York Chiropractic College; Yongping Zheng, The Hong Kong Polytechnic University; Xin Chen, The Hong Kong Polytechnic University; Antonio Wong, New York Chiropractic College; Lillian Ford, New York Chiropractic College; and Michael Zumpano, New York Chiropractic College.

We apologize for this error and regret any misunderstanding this may have caused.