Background: In the past we explored the use of standardized photographic images as a potential method to measure length in newborns, which showed corrigible limitations in accuracy.

Objective: To refine a photographic technique used to assess newborn anthropometry by studying the effect of several technical photographic variables on intrinsic error, using inanimate baby models.

Methods: Vertical (25, 50, 75, 100 and125 cm) and horizontal (left, center and right) camera displacements, reference object size (5, 10, 20 and 25 cm), camera type (digital vs smartphone), and zoom magnification (pre vs post) were varied to optimize length accuracy from the photographic image. Total length from the images was calculated by adding up the head+trunk plus upper- and lower-leg segments of the models, measured in mm on a paper print-out, computer or smartphone screen, and then converted to actual length in cm in reference to the object. These were compared to the gold standard infantometer measurements for accuracy.

Results: Increasing focal length reduces error, with an optimal height at 1 m (0.07% error, p<0.001). Camera must be centered over a focal point equidistant to the baby and reference bar to minimize error (0.01%, p<0.001). Camera optics impact error significantly (p=0.018). Variance in procedures for zoom and in reference bar length do not appear to significantly minimize error.

Conclusion: Thus, technical photographic variables can be optimized to minimize estimated length error in inanimate model figures, promising a new, valid and comfortable camera-based technique for assessing birth-length in newborns.

Optimization of technical photographic variables to assess newborn length using photographic imaging

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Monica N. Orozco[1], Rebecca Gwaltney[2], Noel W. Solomons[1]

[1]Center for the Studies of Sensory Impairment, Aging and Metabolism (CeSSIAM) Guatemala City, Guatemala;

[2]School of Nutrition Science and Policy, Tufts University, Boston, MA.

BACKGROUND

Pediatric growth assessment is a valuable tool to determine whether the physiological needs for growth and development of a child are being met (WHO, 2007). A short length and low weight at birth, in relation to the gestational age of a baby, has been associated with adverse short– and long-term outcomes (Bale et al, 2003).

The current gold-standard technique for measuring newborn recumbent length is inaccurate and potentially dangerous to the fragile newborn, which calls for the development of a safer and more accurate method. In the past, we explored the use of standardized photographic images as a potential method to measure length in newborns, with corrigible limitations in accuracy.

OBJECTIVE

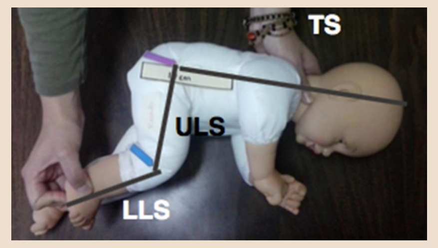
To refine a photographic technique used to assess newborn anthropometry by studying the effect of several technical photographic variables on intrinsic error, using inanimate baby models.

METHODS

1. Photographic variables assessed to optimize length accuracy:

- Vertical (50, 75, and 100 cm) and horizontal (left, center and right) camera displacements.
- Reference object size (5, 10, 20 and 25 cm)
- Camera type (digital vs smartphone)
- Zoom magnification (pre vs post)

2. Total length estimation from photographs: Calculated by adding up the trunk-segment (TS), upper-leg segment (ULS) and lower-leg segment (LLS) of the models, measured in mm on a paper print-out, computer or smartphone screen. Then it was converted to actual length in cm in reference to the object. Estimated measurements were compared to infantometer measurements for accuracy.



3. Statistical analyses: Descriptive statistics were obtained for each group within a variable of interest, as well as a test of comparison between the means of the different groups – such as a paired t-test or one-way ANOVA test. Bonferroni post-hoc testing was used to compare between groups in ANOVA testing.

RESULTS

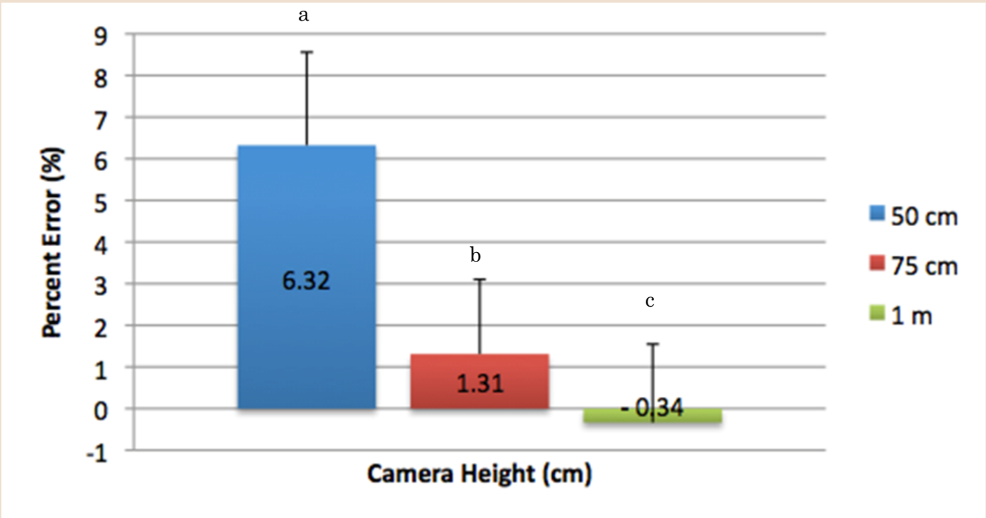


Figure 1: Percent error of length estimated from printed photographic images, at different camera heights.

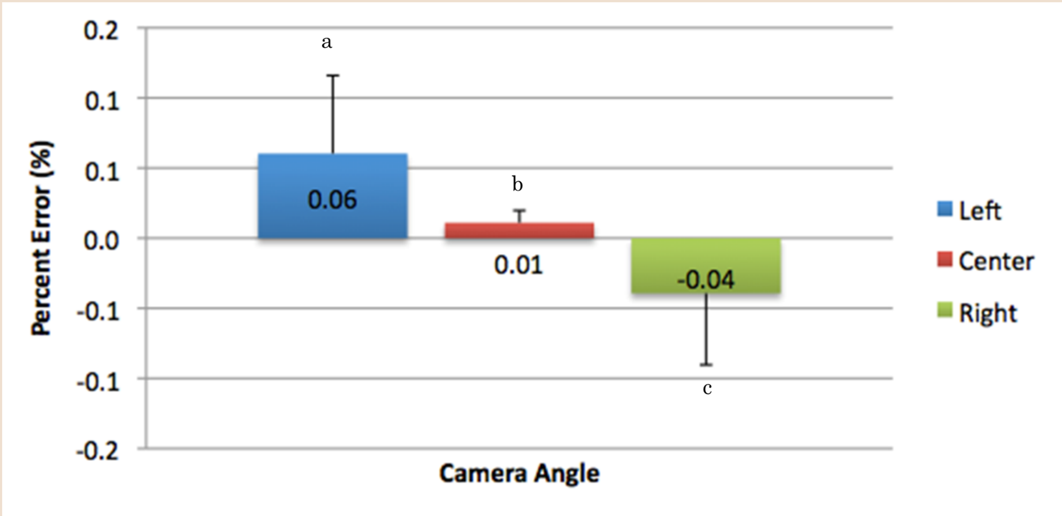


Figure 2: Percent error of length calculated from printed photographs, with different horizontal camera displacements.

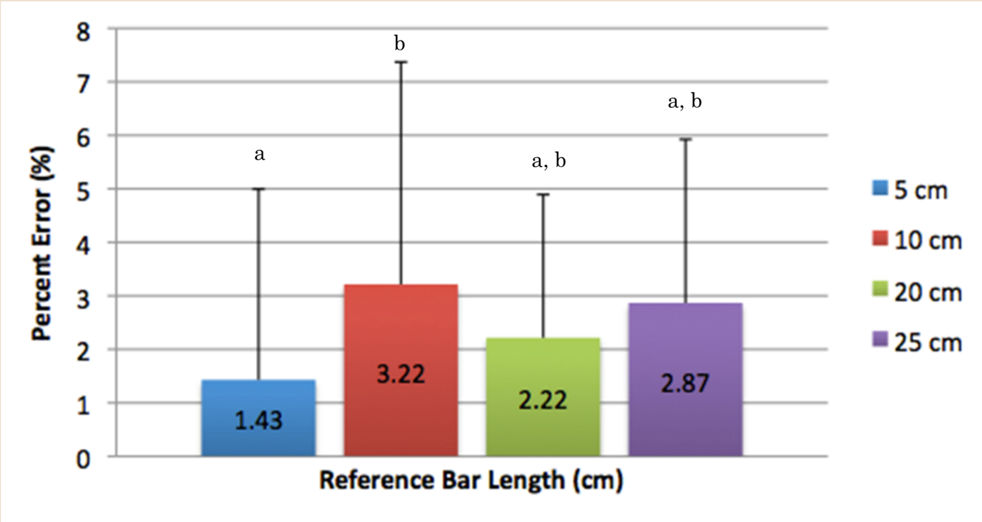


Figure 3: Percent error of length calculated from printed photographic images, using different reference bar lengths.

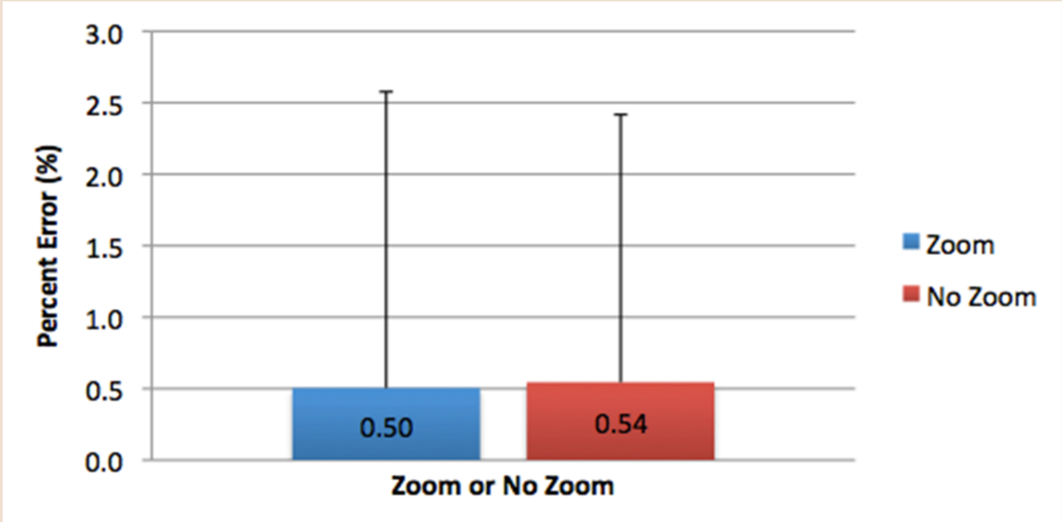


Figure 4: Percent error of model length estimated from printed photographs, using camera zoom and no zoom.

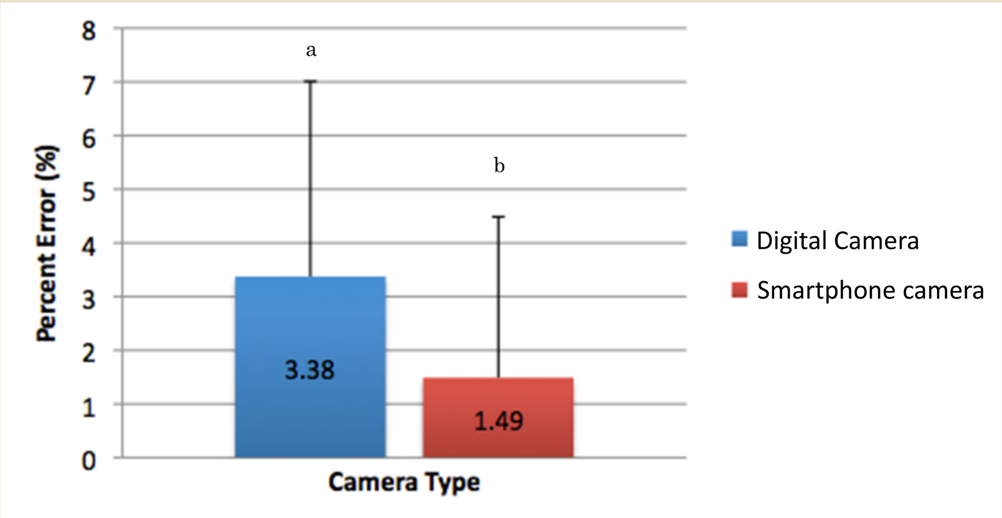


Figure 5: Percent error of length calculated from photographic images derived from a digital camera and a smartphone camera.

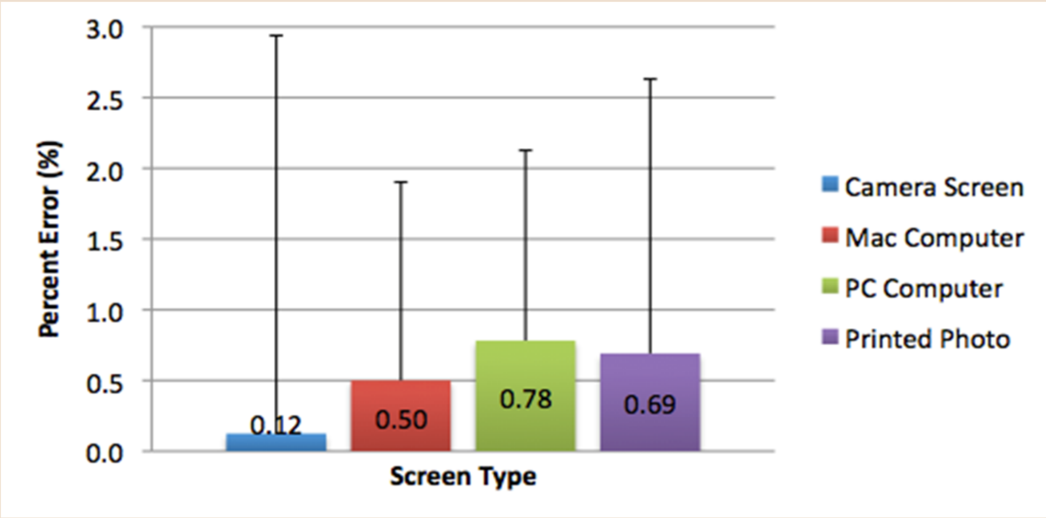


Figure 6: Percent error of length calculated from printed photographic images, computer, and camera screens. There were no differences between the screens or printed photograph.

DISCUSSION/CONCLUSION

- The greatest camera heights began to *underestimate* the length measurement, with an "ideal" camera height between 75cm and 1m.
- The greater the vertical displacement between the model and the reference bar, the greater the error. Therefore, when applying this technique to length assessment in babies, the baby and the reference bar should be in the same vertical plane.
- The camera angle affects the error, even when the objective and reference are in the same vertical plane. The camera must be centered over a focal point, equidistant between the baby and reference bar, in order to get precise images.
- The reference bar length does affect percent error, but not as expected. On average, the 5 cm reference had 1.79% points less error than the 10 cm reference. No other significant relationships were found. Reference bar length does not appear to play an important role in minimizing error.
- Zooming the camera before taking the photo versus zooming the image after taking the photo does not affect the percent error.
- Individual camera optics may play a role in refining this technique in the future. Thy type of screen or print by which the length is measured does not affect percent error. Therefore, the length can be measured on whichever screen or print is most convenient for the investigator.
- These technical photographic variables can be optimized to minimize estimated length error, promising a new valid and comfortable technique for assessing birth-length in newborns.

REFERENCES

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Contact Information:
Dr. Mónica Orozco
Center for Studies of Sensory Impairment Aging and Metabolism —CeSSIAM— Guatemala City, Guatemala
mnorozco@uvg.edu.gt