Evaluation of Quantitative Ultrasonography versus Dual X-ray Absorptiometry for Bone Status Monitoring in South African Children Living with HIV

COLUMBIA | VAGELOS COLLEGE OF PHYSICIANS & SURGEONS
PROGRAM FOR EDUCATION IN GLOBAL AND POPULATION HEALTH

Jackson A. Roberts*, Stephanie Shiau, Yanhan Shen, Stephen M. Arpadi, Michael T. Yin
*Varmus Global Scholar, Columbia University Vagelos College of Physicians and Surgeons

Research Question: Do QUS measurements of bone quality correlate with the gold-standard DXA measurements at cross-section and over time in children living with HIV in South Africa?

BACKGROUND

- Children living with HIV (CLHIV) are at an increased risk of bone loss and frailty compared to uninfected individuals (1)
- Bone status monitoring is therefore essential in this demographic, for which the accepted gold standard is dual x-ray absorptiometry (DXA) (2)
- DXA has a high cost and threshold for technical expertise, which makes its implementation in resource-constrained settings (RCS) challenging (3)
- Quantitative ultrasonography (QUS) offers a lower cost, more widely available alternative; however, its correlational agreement with DXA in CLHIV has yet to be explored (4)

DESCRIPTION OF ORGANIZATION

Data was obtained at outpatient study visits from CHANGES (Childhood HAART Alterations in Normal Growth, Genes, and aGing Evaluation Study), a longitudinal cohort study of perinatally HIV-infected children conducted at the Empilweni Service and Research Unit at Rahima Moosa Mother and Child Hospital in Johannesburg, South Africa

PARTICIPANTS

Participants included in analyses were those with relevant QUS (Achilles or radius) and DXA measurements at both enrollment and 12-month follow-up. Participants with an Achilles speed of sound (SOS) value > 1625 m/s at enrollment or follow-up were excluded, per prior work. This provided a final sample of 170 (80 CLHIV, 90 controls) with Achilles measurements and and 205 (101 CLHIV, 104 controls) with radius measurements.

ACKNOWLEDGEMENTS

Many thanks to Dr. Harold Varmus and the Varmus Global Scholar Fund for providing funding for this research.

Questions or comments: jar2344@cumc.columbia.edu

RESULTS

Visit 1, Insight Achilles Participants

	CLHIV (n=80)	HIV-Control (n=90)	P-value
Age, mean (SD)	7.13 (1.37)	7.29 (1.55)	0.50
Male sex, n (%)	40 (50.0%)	51 (56.7%)	0.47
Weight-for-age Z-score, mean (SD)	-0.579 (1.02)	-0.106 (1.10)	0.0041
Height-for-age Z-score, mean (SD)	-1.21 (0.913)	-0.716 (0.792)	<0.001
BMI-for-age Z-score, mean (SD)	0.230 (1.07)	0.429 (1.19)	0.25
Stunted, n (%)	18 (22.5%)	6 (6.7%)	0.0062

Visit 2, Insight Achilles Participants

	CLHIV (n=80)	HIV-Control (n=90)	P-value
Age, mean (SD)	8.13 (1.38)	8.38 (1.53)	0.26
Male sex, n (%)	40 (50.0%)	51 (56.7%)	0.474
Weight-for-age Z-score, mean (SD)	-0.610 (1.00)	0.0268 (1.13)	<0.001
Height-for-age Z-score, mean (SD)	-1.06 (0.957)	-0.554 (0.822)	<0.001
BMI-for-age Z-score, mean (SD)	0.0489 (0.990)	0.304 (1.30)	0.149
Stunted, n (%)	10 (12.5%)	4 (4.4%)	0.104

Figure 1: Visit 1, Cross-sectional Spearman Correlations

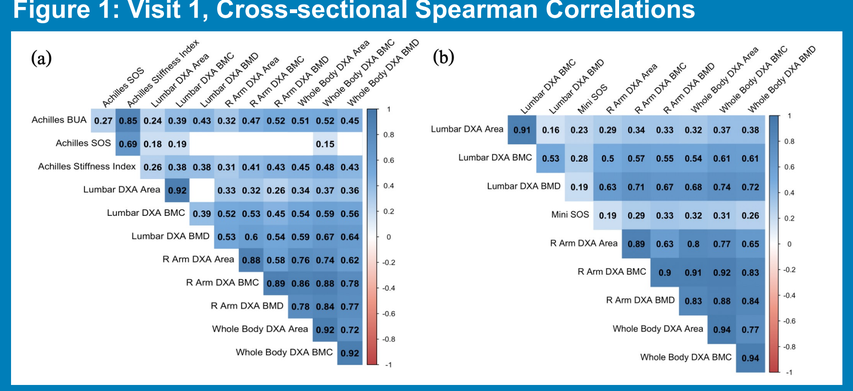


Figure 2: Visit 2, Cross-sectional Spearman Correlations

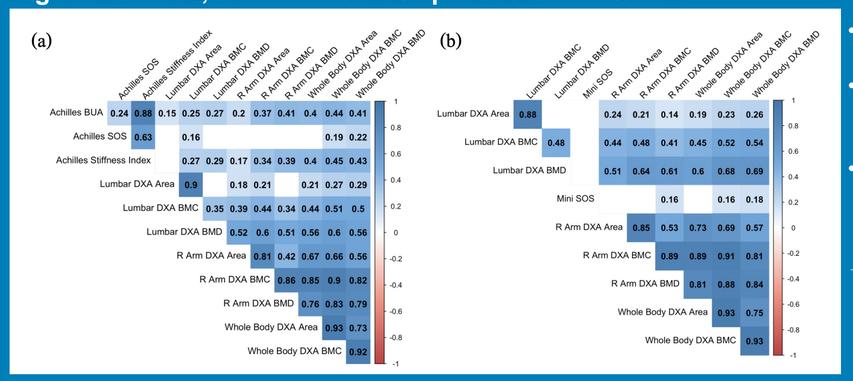
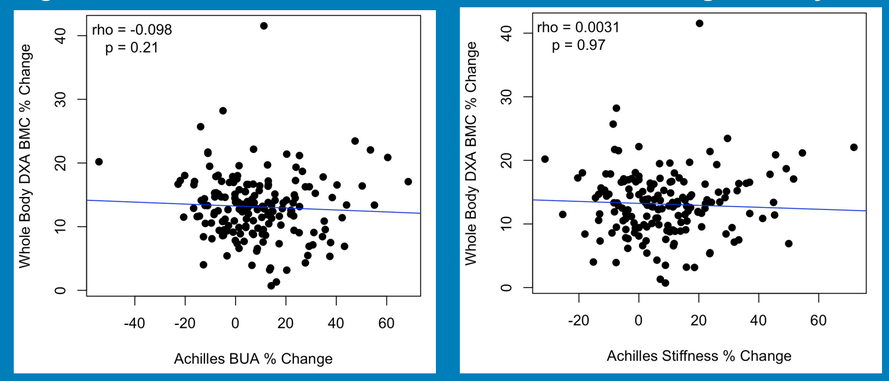


Figure 3: Achilles QUS Does Not Correlate with DXA Longitudinally



METHODS

- DXA measurements of bone mineral content (BMC: g), bone area (cm^2), and bone mineral density (BMD: g/cm^2) were collected at the same visit as Insight Achilles QUS measurements of speed of sound (SOS: m/s), broadband attenuated ultrasound (dB/MHz), and calculated stiffness index (SI). MiniOmnisense radial QUS generated SOS measurements.
- Spearman correlations were used to correlate QUS measures with DXA measures cross-sectionally at enrollment and follow-up, pooled across HIV status. Percent change between enrollment and follow-up was calculated for measurements with strong cross-sectional concordance with DXA, and Spearman correlations were performed between percent changes.

Achilles ultrasound measures of BUA and SI correlated strongly with DXA at both enrollment and follow-up cross-sectionally but failed to correlate well longitudinally (percent change). QUS may offer a potential alternative to DXA at cross-section.

DISCUSSION

- QUS may offer a more widely available alternative for bone status monitoring in CLHIV, though longitudinal discrepancies remain
- While correlated, QUS and DXA record different properties of bone architecture that may have different trajectories in children, which may explain why changes in one parameter do not correspond to changes in another
- Further exploration of QUS in relation to clinical endpoints in CLHIV may provide greater insight into the clinical utility of the technique in RCS

REFERENCES

1. S. M. Arpadi, S. Shiau, C. Marx-Arpadi, M. T. Yin, Bone health in HIV-infected children, adolescents and young adults: a systematic review. *J AIDS Clin Res* **5**, (2014).
2. F. K. Matovu, L. Wattanachanya, M. Beksinska, J. M. Pettifor, K. Ruxrungtham, Bone health and HIV in resource-limited settings: a scoping review. *Curr Opin HIV AIDS* **11**, 306-325 (2016).
3. C. Powers, B. Fan, L. G. Borrud, A. C. Looker, J. A. Shepherd, Long-term precision of dual-energy X-ray absorptiometry body composition measurements and association with their covariates. *J Clin Densitom* **18**, 76-85 (2015).
4. K. Y. Chin, S. Ima-Nirwana, Calcaneal quantitative ultrasound as a determinant of bone health status: what properties of bone does it reflect? *Int J Med Sci* **10**, 1778-1783 (2013).