

Review Article

Comparison of International Reference Values for Bone Speed of Sound in Pediatric Populations: Meta-analysis

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Abstract

The aim of this study was to compare international reference values (RV) for tibial and radial speed of sound (SoS) assessed by quantitative ultrasound (QUS) in pediatric populations. These values were compared by age and country of origin in a systematic review with meta-analysis from studies published on QUS (Sunlight Omnisense). A search was carried out in electronic databases. Nine studies with 6963 patients were included in the meta-analysis. For the newborn populations, 3 studies (from Italy, Portugal, and Israel) were used. These studies included subjects with 27–42 wk gestational age. The mean difference (Portugal-Israel) was found to be 23.62 m/s [95% confidence interval [CI] 6.29, 40.95]. Additionally, no difference was found between Italy-Portugal ($p = 0.69$), or Italy-Israel ($p = 0.28$). In pediatric populations, we compared 8 studies from Canada, Mexico, Israel, Greece, Portugal, and Turkey. No significant differences found for SoS RV between Israel-Turkey, Israel-Greece, or Israel-Canada ($p > 0.05$). Significant differences were found in Mexico-Israel -105.29 m/s (95% CI -140.05 , -70.54) ($p < 0.001$); Mexico-Portugal -115.14 m/s (95% CI -164.86 , -65.42) ($p < 0.001$); Mexico-Greece: -239.14 m/s (95% CI -267.67 , -210.62) ($p < 0.001$); Mexico-Turkey: -115.14 m/s (95% CI -164.86 , -65.42) ($p < 0.001$); Mexico-Canada: -113.51 m/s (95% CI -140.25 , -86.77) ($p < 0.001$). This study demonstrates that there are differences in SoS-RV obtained by tibial and radial QUS in pediatric populations between Mexico and other countries (Israel, Portugal, Greece, Turkey, and Canada).

Key Words: Pediatrics; quantitative ultrasound; reference-values and meta-analysis; speed of sound.

Introduction

Osteoporosis (OP) is a major public health problem over the world (1,2). Currently, pediatric population represents a new target in the battle against low bone mass and OP. An

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adequate peak bone mass during childhood and adolescence could help to prevent fragility fractures and OP later in life, and therefore, establishing programs to monitor bone accretion during this period of life is mandatory. Quantitative ultrasound (QUS) is a safe, inexpensive, and non-radiation method for bone density assessment. QUS correlates with dual-energy X-ray absorptiometry (3,4). QUS has raised great expectations due to its safety features (radiation-free), low cost, portability, ease of use, and simple logs, making this technology an attractive method to be used in pediatric populations

where dual-energy X-ray absorptiometry could be impractical (5,6).

Several studies have demonstrated that QUS is able to independently assess the risk for fragility fracture, bone accretion, and follow-up monitoring in pediatric populations (7,8).

Clinical utilization of QUS relies on population-based reference values (RV) to distinguish between normal and abnormal populations. It could be used to recommend changes in life style, especially during the age of bone accretion (9,10).

Nevertheless, some authors argue that there are differences in bone characteristics between countries due to the interaction of genetics, metabolic, and environmental factors and that this phenomenon can be explained based on evidence of differences in bone growth across different populations (11–14).

The RV of the Sunlight QUS equipment is based on a paper in Israeli population (15); nevertheless, other authors have published their own local RV, reporting some differences (16,17). Recently, we reported RV for Mexican population (18), which indeed has different ethnic and genetic background compared with those recently published for European population. Therefore, the goal of the present meta-analysis was to compare the RV reported in the literature with those for the Mexican population looking for differences across studies and trying to demonstrate the importance of using local RV based on similar population backgrounds to obtain reliable measurements.

Methods

A systematic review was performed focusing on healthy pediatric populations (from newborn to 18 yr). We included articles with measurements of bone SoS (tibial SoS and/or radius SoS) using the Sunlight Omnisense QUS equipment.

Literature Survey

The search was conducted electronically and manually from the following databases: PubMed (1965 to November 2013), Embase (1988 to November 2013), LILACS (1990 to May 2012), ARTEMISA (review of the 13th edition up to June 2013). The MeSH terms used were “Reference Standards”(Mesh) or “Reference Values”(Mesh) and “bone and bones” (Mesh) and “speed of sound” (txt). Adaptations required for the different databases were used. References of all identified studies as well as major reviews were inspected for more studies. Additionally, the first or corresponding author of each included study was contacted for complementary information or information regarding unpublished data.

Evidence Quality Evaluation

Standardized methods as described by the Ibero-American Cochrane Collaboration were used to prepare the protocol, applying inclusion criteria, assessing the quality of publications and extracting information. The quality of publications was determined using the GRADE system (19). Two of the authors, in a double-blind, independent manner, extracted relevant information and assessed its quality in formats a priori-designed for this purpose. Any disagreement was resolved by discussion and analysis of the information. Level of agreement between investigators was high (Kappa of 0.91 [$p < 0.001$]).

Inclusion and Exclusion Criteria

Only cross-sectional studies reporting tibial and/or radius SoS measured by QUS (Sunlight Omnisense) in pediatric populations (≤ 18 yr) were selected. Also articles in English, Spanish, French, Italian, or Portuguese were included. If assessment of age, SoS mean, or standard deviation was not possible, the study was discharged.

Table 1
Characteristics of the Population Included in the Meta-analysis

Author, year	Reference	Country	N	Girls	Boys	Age (min-max)
Teitelbaum, 2006	19	Israel	233	NA	NA	25–42 wk
Pereira-da-Silva, 2011	18	Portugal	158	74	84	26–41 wk
Pedrotti 2007 up	29	Italy	212			33–41 wk
Zadik, 2003	22	Israel	1085	595	490	0–18 yr
Anjumanara, 2006	25	Turkey	463	234	229	1–16 yr
Christoforidis, 2009	21	Greece	1549	814	735	4–18 yr
Baptista, 2011	24	Portugal	430	213	217	9–13 yr
Klentrou, 2011	20	Canada	595	NA	595	14–23 yr
Rivas-Ruiz, 2014	23	Mexico	1586	772	814	1–75 yr
Total	9	7	6963	3030	3488	

NA, not available data; up, unpublished data sent by the author.

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