A pediatric echocardiographic *Z*-score nomogram for a developing country: Indian pediatric echocardiography study – The *Z*-score

Sir,

We thank the author for his keen interest in our study[1] and his valuable response for the same.[2] We read with utmost interest the four issues put forth by the author and wish to provide relevant clarifications. As far as the point about body surface area (BSA) is concerned, we agree that there is no universal consensus on which formula is appropriate.[3] However, concluding that this lack of consensus renders any one formula, in this instance Haycock's,[4] inappropriate in the Indian population is not justified. There is, in fact, no consensus on any other formula being more appropriate in the Indian population. We had decided to use the Haycock's formula[4] to calculate the BSA in our study population for the following reasons:

1. Among the various available formulae, it is the one recommended by the writing group of the American Society of Echocardiography, Pediatric and Congenital Heart Disease Council,[5] and other experts,[6,7] as it yields the best correlation between

BSA and the size of cardiovascular structures even at lower values of height and weight.

2. Some routinely used formulae for the calculation of BSA in children have been calculated from data that did not include children in the study population.[8]
3. A study done previously for estimation of echocardiographic *Z*-score in children compared the variously available formulae for estimation of BSA including DuBois and DuBois,[8] Haycock *et al.*,[4] Dreyer and Ray,[9] Boyd,[10] Mosteller,[11] Gehan and George,[12] and Meban.[13] Among these, the authors identified the Haycock's formula as the one with the best fit for BSA estimation in their study cohort. While Boyd and Meban formulae overestimated the BSA, the other formulae were found to underestimate the BSA in comparison to the Haycock's formula.[14]

Regarding the role of gender as a probable confounding factor, an attempt was not made in our study to make gender-specific *Z*-scores because it is known that the size of cardiac structures is a function of cardiac output and the closest available tool for correlation with cardiac output is the BSA.[15] Since gender differences in valve sizes and other structures are also explained by differences in the cardiac output between the two genders, and since cardiac output correlates directly with BSA, we concluded that the differences due to gender can be addressed by differences in BSA. Furthermore, previous studies have found little differences while attempting to exclude gender as a possible source of bias.[14]

Three-dimensional echocardiography (3DE) for measurements might be better than two-dimensional echocardiography (2DE) for certain parameters such as left ventricular volumes and ejection fraction, but its superiority over 2DE in acquisition of valvular and arterial dimensions is questionable.[16] Since we were interested in providing valvular, M mode, and arterial dimension parameters in our study, we did not find 3DE as a mandatory tool for these measurements.

We agree that children of different ethnic backgrounds might have differences in the sizes of cardiac structures. Although we initiated an effort towards including children of various ethnic groups, we could only include children from the Rajasthan and Punjab states and children from Punjab comprised of only a smaller subset of the entire study cohort. A larger attempt with representation from Indian children of various ethnic origins would provide more comprehensive information on the role played by ethnic differences in the sizes of cardiac structures.

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Conflicts of interest

There are no conflicts of interest.

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