Commentary

Spirometry in undernourished children in sub-Saharan African

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Malnutrition remains a major public health concern in the world today. Estimates from 2015 show that 156 million children under 5 years of age were stunted, and 50 million were wasted (1). Both acute and chronic undernutrition are known to have lasting effects on health (2,3), however the impact of malnutrition on one vital organ: the lungs, is still unclear. This, in part, has to do with the lack of suitable reference for spirometry outcomes for children in areas most affected by undernutrition, such as sub-Saharan Africa.

We read with interest the recent publication by Arigliani *et al.*, "*Evaluation of the Global Lung Initiative 2012 Reference Values for Spirometry in African Children*" [2017] (4) which found that the GLI 2012 Black reference equations are appropriate for use in sub-Saharan Africa. The authors report that undernutrition results in small lungs due to smaller chest size, but has no obvious effects on lung function.

Arigliani *et al.* used low body mass index (BMI) values (<–2 z-scores) as an indication of current undernutrition, finding that while FEV_1Z (forced expiratory volume in 1 second z-score) and FVCZ (forced vital capacity z-score) were diminished, FEV_1/FVCZ remained preserved in such children. Their conclusions might, however, have been limited by the small proportion of undernourished children who were studied (168/1,082) and the fact that children not attending school, who are likely to come from more vulnerable households, were not included in their study.

We recently conducted a study on survivors of severe acute malnutrition (SAM), the most extreme form of undernutrition, seven years after treatment in hospital (2). Our study was conducted in low socioeconomic communities where 8% of children in the sample were not attending school. The impact of a previous episode of SAM was evaluated after adjusting for age, sex, height, and HIV status using the GLI-Black reference equations. Whether compared with sibling controls or those recruited from the community, very few deficiencies in either lung size or function were observed (2,5). The mean FEV_1, FVC and FEV_1/FVC z-scores for the SAM survivors using the GLI-Black 2012 reference equations were –0.47, –0.32, –0.21 respectively (n=201, median age =9.3 years); these values are within 0.5 of those for African-American children despite a large proportion of the Malawian SAM survivors continuing to be stunted [height-for-age (HAZ) <–2 z-scores using WHO growth standards; 42%] and underweight (weight-for-age <–2 z-scores; 22%).

When considering current anthropometric status for the sample as a whole, we found that both stunted children (HAZ <–2) and children with low BMI (BMIZ <–2) had reduced FEV_1 and FVC z-scores but relatively preserved FEV_1/FVCZ ratio (*Table 1*). As seen in Arigliani *et al.*'s study, this suggests deficiencies in lung size (FEV_1Z and FVCZ), though not lung function (FEV_1/FVCZ). It is important to note that we also found very few children had BMI <–2 z-scores (10%), resulting in a limited sample size for this analysis.

Although stunting or low BMI appear to result in smaller lung size, our results provide further evidence for the apparent preservation of lung function in sub-Saharan African children exposed to adverse nutritional conditions. As a vital organ, it is possible that lung development is "spared" at the expense of less vital organs, as has been seen with malnutrition and brain development (5,6). Follow-

Table 1 spirometry z-scores for Malawian children disaggregated by BMI and height-for-age

Spirometry outcomes	BMIZ <–2 (n=41) mean (SD)	BMIZ >–2 (n=418) mean (SD)	HAZ <–2 (n=160) mean (SD)	HAZ >–2 (n=297) mean (SD)
FEV_1 z-score	–1.10 (0.9)	–0.37 (1.1)	–0.64 (1.1)	–0.33 (1.0)
FVC z-score	–1.04 (0.9)	–0.22 (1.0)	–0.47 (1.0)	–0.19 (1.0)
FEV_1/FVC z-score	–0.09 (1.0)	–0.24 (0.9)	–0.28 (0.9)	–0.22 (0.9)

SAM, severe acute malnutrition; BMIZ, body mass index for age z-score based on WHO growth standards; HAZ, height-for-age z-score based on WHO growth standards; spirometry z-scores use GLI 2012 African American reference values. FEV_1, forced expiratory volume in 1 second; FVC, forced vital capacity.

up into adulthood is required to ascertain any longer-term implications. Our results also concur with the conclusion that the GLI-2012 African-American reference values are appropriate for use in sub-Saharan African children. We add evidence from Malawian community children to that of school-attending children in Angola, Democratic Republic of Congo and Madagascar, used in the Arigliani study (4). We hope that this validation of an appropriate reference will lead to further exploration of spirometry in children in the region in order to find ways to minimise insults and maximise lung health.

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Footnote

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