The Journal of Nutrition
Commentary

Reconsidering the "Thin-Fat" Indian Neonate

Jonathan C Wells

Childhood Nutrition Research Centre, Population, Policy and Practice Programme, UCL Great Ormond Street Institute of Child Health, London, UK

Over recent decades, India has emerged as one of the world's "capitals" of type 2 diabetes mellitus (T2DM). In 2016, the national T2DM prevalence in Indian adults aged ≥20 y was estimated at 7.7% (95% CI: 6.9, 8.4%), equivalent to 65 million individuals (1). Among the key risk factors for T2DM are adult overweight and obesity, most commonly indexed by BMI, along with sedentary behavior and energy-dense diets (2). However, it has long been recognized that Indians, in common with other South Asian populations, have an elevated susceptibility to T2DM for a given profile of risk factors. For example, T2DM typically emerges at lower BMI thresholds and at younger ages in South Asian compared with other populations (2).

Several aspects of body composition appear to contribute to this susceptibility. Compared with European adults of similar BMI, South Asians tend to have less lean mass and more body fat, in particular abdominal and visceral fat (3). Moreover, for reasons that remain poorly understood, abdominal fat is more inflammatory in South Asians. For example, the HOMA-IR index, a marker of insulin resistance, rises more steeply in association with body fatness in Indian children compared with those of European or African ancestry (4).

In 2003, Yajnik and colleagues (5) published a landmark article reporting that these phenotypic traits were already evident at birth. Newborn Indian babies from Pune, India, were compared against a sample of European ancestry from Southampton, UK. Both populations had data on weight, length, body girths, and the subscapular skinfold. Whereas weight, length, and girths were substantially smaller in the Indian babies, the subscapular skinfold was less depleted. The authors argued that Indian newborns were thin in terms of lean mass, while maintaining subcutaneous fatness, and coined the term the "thin-fat" Indian baby. The data represented striking early evidence supporting the "thrifty phenotype" hypothesis of Hales and Barker (6), reinforcing the emerging consensus that the etiology of T2DM and other cardiometabolic diseases begins during fetal life.

The "thin-fat" phenotype of Indian babies has become received wisdom, and the article has been cited >600 times. However, in a new article in this issue of the Journal, Kuriyan and colleagues (7) from Bangalore encourage us to re-examine exactly what the thin-fat phenotype is, and what it is not.

One limitation of the anthropometric data of Yajnik and colleagues (5) was that they could not accurately differentiate birth weight into its fat-free and fat components. Using an infant air displacement plethysmograph known as the peapod, along with potassium counting, Kuriyan and colleagues in this issue report new data on total body fat mass (FM) and fat-free mass (FFM) in Indian babies, stratified by whether their birth weight was appropriate for their gestational age (AGA) or small for their gestational age (SGA).

To put their new data into perspective, Kuriyan and colleagues compared them against published values from 18 studies from Australia, Brazil, Ethiopia, Holland, Ireland, Portugal, Singapore, the United Kingdom, and the United States. The authors assessed population differences in terms of percentage fat, but this is a challenging outcome, because higher percentage fat values can relate either to high FM or low FFM (8). Both components of weight merit attention, because both have been linked to T2DM risk. To adjust for size, each of FFM and FM mass can be divided by height squared to give the FFM index (FFMI) and FM index (FMI), expressed in the same kg/m^2 units as BMI. These data allow us to reconsider what we understand by the "thin-fat" phenotype.

First, there is clear agreement between the studies on the "thin" aspect. Yajnik and colleagues identified this on the basis on small thoracic girths, and the new data confirm this by showing that compared with the average of the reference populations, Indian babies have ∼400 g less FFM than the other populations if born AGA, and ∼600 g less if born SGA. When FFM is adjusted for length and presented as FFMI, the lower values of the Indian newborns remain very evident (reference population average = 11.8 kg/m^2, Indian AGA = 10.7 kg/m^2, Indian SGA = 10.4 kg/m^2).

Regarding fatness, Yajnik and colleagues first showed that newborns from Pune were on average 828 g (1.74 *z*-scores) lighter, 2.1 cm (1.01 *z*-scores) shorter, but had 0.4 mm (0.53 *z*-scores) smaller subscapular skinfold than the European newborns. Restricting the comparison to a narrower range of weight, where the newborns from the 2 countries overlapped (2800–3300 g), the Indian neonates were actually longer (49.1 compared with 48.4 cm; $P < 0.001$), and had greater subscapular skinfold thickness (4.6 compared with 4.1 mm; $P < 0.001$). The authors concluded that the Pune newborns had "relatively sparing of subcutaneous fat," but added that "at comparable birth weights Indian babies have higher subscapular fat compared to the [European] babies" (5).

The new data enable this comparison to be made at the level of whole-body fatness. In absolute terms, fat mass is ∼25 g lower in AGA Indian newborns than the reference population average, and ∼125 g lower in SGA newborns. Expressed as FMI, however, the differences vanish for the AGA Indian babies but remain for the SGA group (reference population mean = 1.3 kg/m^2; Indian AGA = 1.3 kg/m^2; Indian SGA = 0.9 kg/m^2).

The author reported no funding received for this article.
Author disclosures: The author reports no conflicts of interest.
Address correspondence to JW (e-mail: Jonathan.Wells@ucl.ac.uk).
Abbreviations used: AGA, appropriate for gestational age; FFM, fat-free mass; FFMI, fat-free mass index; FM, fat mass; FMI, fat mass index; SGA, small for gestational age; T2DM, type 2 diabetes mellitus.

Manuscript received December 24, 2019. Initial review completed January 13, 2020. Revision accepted January 28, 2020.
First published online 0, 2020; doi: https://doi.org/10.1093/jn/nxaa026.

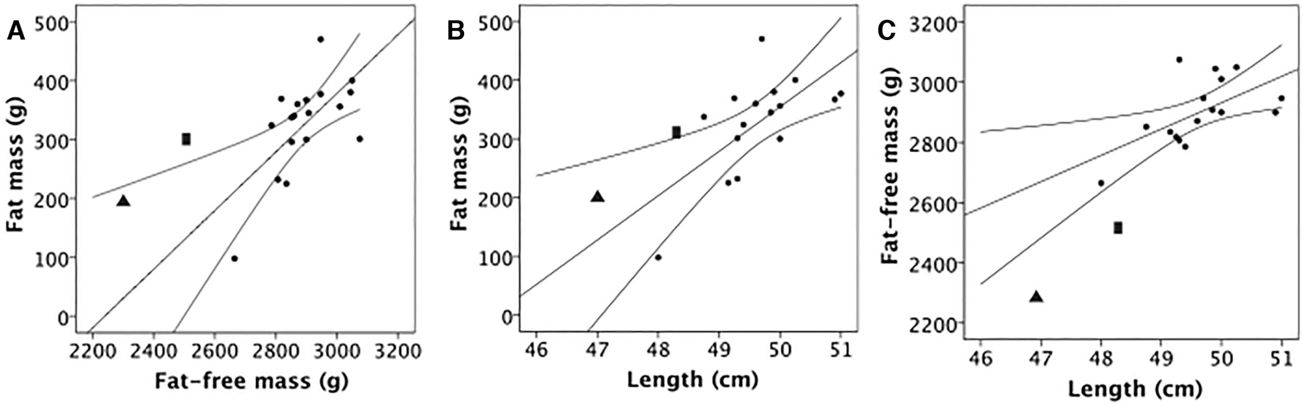

FIGURE 1 Associations of fat mass with (A) fat-free mass and (B) length at birth, and (C) of fat-free mass with length across populations measured using air-displacement plethysmography. Indian neonates with birth weights appropriate for gestational age (squares), or small for gestational age (triangles), compared with other populations (circles).

The AGA Indian infants do therefore tend to preserve their body fat, when compared against their substantial deficit in FFM, whereas the SGA Indian infants maintain a deficit in both FFM and FM.

The data of Kuriyan and colleagues (7) therefore carry an important message, in reminding us that Indian babies do not tend to have higher levels of body fatness compared with other populations. However, the key issue is how the "fat" component of the "thin-fat" baby is actually interpreted. It is better regarded as a "relative preservation" of fat, rather than an excess, and this is consistent with the original assessment of Yajnik and colleague for their whole sample.

To illustrate this in more detail, it helps to plot FM against FFM, and both tissues against length. In any given population, there can be allometric associations between these parameters, and these associations can also be discernible when comparing populations. In each of the 3 panels of **Figure 1**, the reference population data are plotted as a scatter, and a best-fit regression line with error included. The Indian data are then superimposed, to assess whether they lie within or outside the error margin. (One data point, relating to high-birth-weight babies with very high FM, was excluded from the reference data because its inclusion makes the Indian data look much more extreme. Excluding that data point, the pattern is similar but less pronounced.)

Partitioning weight into FFM and FM (Figure 1A), there is a positive correlation in the reference data, whereby FM broadly increases in association with FFM. Relative to that association, the Indian AGA babies lie outside the error line for FM, given their lower FFM, whereas the SGA group lie within the error margin. A similar pattern emerges if FM is plotted against length (Figure 1B). Finally, if FFM is plotted against length, both AGA and SGA Indian babies have FFM below the lower error line (Figure 1C).

Similar findings have emerged from a study of slightly older infants in the United Kingdom, using the same plethysmograph methodology. At 3 mo of age, compared with infants of European ancestry, those of South Asian ancestry had lower FFM but similar FM, and these differences remained after adjustment for length (9).

So the issue comes down to how the term "thin-fat" is interpreted. In absolute terms, Indian babies either do not have excess fat mass (AGA) or they have lower values (SGA), but in relative terms Indian AGA babies have a similar FMI, and when considered alongside their lower FFMI this indicates a relative preservation of FM at the expense of FFM. If the term "thin-fat" is used, it therefore needs to be used with caution, so that "excess" adiposity is not assumed.

So, what of the comparison of babies of similar birth weights by Yajnik and colleagues, where the Indian babies were found to have greater length and subscapular skinfolds than their European counterparts? In Southampton, the neonates weighing 2800–3300 g were all below the local average birth weight (3494 g), and therefore represented a less well-nourished group. Conversely, infants in the same range of weight in Pune were all above the local average birth weight (2666 g), and could therefore have been not only well nourished, but possibly even exposed to excessive levels of maternal nutritional supply. For example, other studies in India have linked maternal glucose concentrations with neonatal size in nondiabetic pregnancies (10). In other words, although the birth weights might be comparable across these 2 populations, the mothers were probably of different nutritional status.

Acknowledgments

The sole author was responsible for all aspects of this manuscript.

References

1. India State-Level Disease Burden Initiative Diabetes C. The increasing burden of diabetes and variations among the states of India: the Global Burden of Disease Study 1990–2016. Lancet Glob Health 2018;6(12):e1352–e62.
2. Hills AP, Arena R, Khunti K, Yajnik CS, Jayawardena R, Henry CJ, Street SJ, Soares MJ, Misra A. Epidemiology and determinants of type 2 diabetes in south Asia. Lancet Diabetes Endocrinol 2018;6(12):966–78.
3. Misra A, Anoop S. Non-obese south Asians with diabetes: a pathophysiological conundrum. Diabetes Obes Int J 2016;1(4):000124.
4. Nightingale CM, Rudnicka AR, Owen CG, Wells JC, Sattar N, Cook DG, Whincup PH. Influence of adiposity on insulin resistance and glycemia markers among United Kingdom children of South Asian, Black African-Caribbean, and White European origin: child heart and health study in England. Diabetes Care 2013;36(6):1712–9.
5. Yajnik CS, Fall CH, Coyaji KJ, Hirve SS, Rao S, Barker DJ, Joglekar C, Kellingray S. Neonatal anthropometry: the thin-fat Indian baby. The Pune Maternal Nutrition Study. Int J Obes 2003;27(2):173–80.

6. Hales CN, Barker DJ. Type 2 (non-insulin-dependent) diabetes mellitus: the thrifty phenotype hypothesis. Diabetologia 1992;35(7):595–601.
7. Kuriyan R, Naqvi S, Bhat KG, Ghosh S, Rao S, Preston T, Sachdev HS, Kurpad AV. The thin but fat phenotype is uncommon at birth in Indian babies. J Nutr 2020; in press.
8. Wells JC, Cole TJ. Adjustment of fat-free mass and fat mass for height in children aged 8 y. Int J Obes Relat Metab Disord 2002;26(7):947–52.
9. Stanfield KM, Wells JC, Fewtrell MS, Frost C, Leon DA. Differences in body composition between infants of South Asian and European ancestry: the London Mother and Baby Study. Int J Epidemiol 2012;41(5):1409–18.
10. Hill JC, Krishnaveni GV, Annamma I, Leary SD, Fall CH. Glucose tolerance in pregnancy in South India: relationships to neonatal anthropometry. Acta Obstet Gynecol Scand 2005;84(2):159–65.