gigs: A package for standardising fetal, neonatal, and child growth assessment

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Summary

There is a gap for clear guidance and open access tools for assessing nutrition and growth indicators as part of individual clinical care and population-based epidemiology. To enable better identification of at-risk infants, a unifying framework and clear guidance for how, when and for whom to use the existing international newborn and child growth standards developed by the WHO and INTERGROWTH-21st is needed. Such guidance is essential to enable tracking of progress towards Sustainable Development Goals and the WHO Global Nutrition targets. This need is the motivation for gigs - a package for researchers and policymakers that facilitates the appropriate use of growth standards for the determination and assessment of growth outcomes at the population level (e.g. stunting, wasting, underweight and trajectories over time) among vulnerable infants. For clinicians, gigs also provides support in choosing which standards to use when assessing growth of individual infants.

Statement of need

Without accurate global data on newborn and child growth patterns using appropriate tools, true gaps and achievements in newborn and child health and survival will not be revealed. Those most vulnerable to poor growth outcomes will not be properly identified, tracking progress towards global targets (e.g. the Sustainable Development Goals) will be more difficult, and evaluating what changes are 'true progress' will be even more challenging. The gigs package allows researchers, policy-makers, and other key stakeholders to apply and correctly identify at-risk, vulnerable infants at a population level. This can then inform appropriate interventions to make progress towards global, national and local goals. Similarly, use of appropriate standards by clinicians will enable proper identification of at-risk infants and inform the clinical care management and decision-making.

Applying appropriate growth standards can be difficult - not all research groups have the ability to implement growth standards in software, and may make errors whilst doing so. Furthermore, researchers must pick and choose the right growth standards for their work - which is not always achieved in practice (Perumal et al., 2015). The gigs package makes these issues less common. Firstly, extensive unit testing ensures that each growth standard in gigs is accurate to published charts, for every growth standard we've implemented:

  - The INTERGROWTH-21st Fetal Standards (Drukker et al., 2020; A. T. Papageorghiou et al., 2014; Aris T. Papageorghiou et al., 2014, 2016; Rodriguez-Sibaja et al., 2021; Stirnemann et al., 2017, 2020)
  - INTERGROWTH-21st Newborn Size and Very Preterm Newborn Size Standards (Villar et al., 2014, 2016, 2017)

- INTERGROWTH-21st Postnatal Growth of Preterm Infants Standards (Villar et al., 2015)
- WHO Child Growth Standards (WHO Multicentre Growth Reference Study Group & de Onis, 2006; World Health Organisation, 2006, 2007)

This is more growth standards than made available in other R packages designed to perform the same sorts of analyses. For example, the WHO Child Growth Standards are implemented in many other packages: the zanthro package for Stata (Vidmar et al., 2013), and the R packages anthro (Schumacher, 2023), AGD (van Buuren, 2024), childsds (Vogel, 2022), growthstandards (Hafen, 2024), sitar (Cole, 2023), and zscorer (Myatt & Guevarra, 2019). However, only gigs implements the full set of INTERGROWTH-21st Fetal standards and INTERGROWTH-21st Postnatal Growth of Preterm Infants standards.

Next, gigs offers specific functions (classify_growth(), gigs_waz(), and friends) which select an appropriate growth standard to apply to each observation in a flat, tabular dataset. Growth standards are selected based on the chronological and gestational age for each observation, and the specific criteria can be found in the package documentation. These functions can be used to investigate growth indicators including size-for-gestational age, small vulnerable newborns (Ashorn et al., 2023; Lawn et al., 2023), stunting, wasting, weight-for-age (underweight), and micro/macrocephaly.

When benchmarked against each other, gigs for R outperforms almost all the packages mentioned above, or is at most a few milliseconds slower. It does this whilst checking inputs to ensure they are formatted correctly, to make life easier for gigs users. For example, gigs will detect missing (NA) or infinite (-Inf/Inf) numeric inputs, and flag these to the user in the console. Full benchmarking results are available on the package documentation website.

In addition to the R package, a Stata package and SAS package are available for users of those statistical applications. All versions of gigs are already in use by researchers at LSHTM, Harvard, the Small Vulnerable Newborn Collaboration and an international collaboration investigating stillbirths. Thanks to its speed, input checking, and unit test-backed accuracy, we believe gigs will be used widely by those looking to assess newborn, infant, or child growth in R.

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