



INNOVATIONS AND TOOLS IN CHILD GROWTH MEASUREMENT AND DATA VISUALIZATION

1 WHY ARE INNOVATIONS AND TOOLS NEEDED FOR CHILD GROWTH MEASUREMENT AND DATA VISUALIZATION?

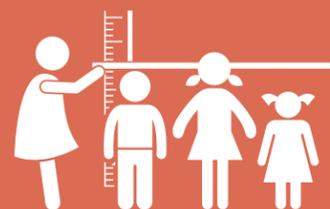
Despite global efforts to address malnutrition, the numbers of children under five who are not growing properly are alarming:

150.8 million (22.2%) are stunted (too short for their age), 50.5 million (7.5%) are wasted (too thin for their height), and 38.3 million (5.6%) are overweight (too heavy for their height). Children living in lower-middle income countries (LMIC) are particularly affected. At these rates, the world is off course to reach the World Health Assembly targets for 2025 and the Sustainable Development Goals for 2030.¹

Ending malnutrition is critical:

Childhood stunting has life-long consequences including negative impacts on health, cognitive development, educational attainment, and income, and makes children less likely to escape poverty as adults.^{2,3} Children suffering from wasting have lower immunity, are more prone to long term developmental delays, and are at increased risk of death, especially those that are “severely” wasted. Children who are overweight - the emerging form of malnutrition - are likely to remain overweight or obese as adults and at risk for developing diet-related noncommunicable diseases later in life.¹

In the context of this double burden of malnutrition, measuring the weight and height of infants and children, especially before a child’s second birthday, is particularly important. Regular assessment of growth and development combined with behavior change counseling, or growth monitoring and promotion (GMP), can help identify early growth



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flourishing or excess and, with adequately trained and supported health workers, help caregivers understand and address the underlying causes of unhealthy growth and nutrition.

There are, however, many challenges to conducting reliable and accurate measurement as part of GMP, using those measurements to counsel caregivers on the results and future actions to be taken, and drawing on the data collected for decision-making at all levels. Section 2 discusses innovative tools that are being developed to address some of these challenges; Table 1 summarizes the advantages and disadvantages of each tool.



CHALLENGE 1 ACCURATE MEASUREMENT AND DATA

High quality, accurate anthropometric data is core to the viability of GMP and is critical for users (parents, caregivers, health workers, communities, and decision-makers) to determine how to respond effectively. However, many health workers - especially at the community level - have problems with measurement, plotting, and interpreting growth monitoring data.^{4,5} These difficulties can be related to lack of appropriate and user-friendly job aids, low educational levels or literacy, poor training, high caseloads, poor remuneration, inadequate supportive supervision, and anthropometric equipment that is not functional.⁴⁻⁶ Errors in measurement are especially common in

young children under age three because they often do not stay still or resist measurement.⁷ Also, cultural or geographic factors can come into play. In some cultures, parents fear height boards and don’t want their children measured, thinking of them as coffins. In some countries such as China, Mongolia, and Afghanistan, during the cold season children are weighed wearing their clothes, making weight difficult to interpret.



CHALLENGE 2 HEALTH COMMUNICATION AND COUNSELING

The quality of health counseling and provider-client communication during GMP is generally weak. Counseling messages during GMP are often too generic: they may not be tied to the growth outcome, may not be age-specific, or do not emphasize follow-up actions that need to be taken.^{8,9} And if counseling is not based on accurate measurements, the resulting information told to caregivers may be wrong.



CHALLENGE 3 CARETAKERS’ UNDERSTANDING OF GROWTH CHARTS AND HEALTHY CHILD GROWTH

The interpretation and use of growth chart data is not always straightforward due to the chart design or the skill, ability, and motivation of the health worker to help caregivers understand the meaning of the growth curves. A well-designed growth chart should ensure that caregivers can see the changes in weight or height, visualize their child’s growth pattern relative to the reference growth pattern, increase their awareness of why growth is important, and help them understand the relationship

between growth, illness, and feeding.¹⁰ Many caregivers have difficulty understanding growth charts and healthy child growth, especially those with lower education and literacy, and as a result are not able to take concrete care-seeking or nutrition actions.^{5,6,11}



CHALLENGE 4 DATA USE

In addition to using growth data for visualizing, communicating and counseling on child growth, child growth data can and should be used for decision-making and accountability at the individual, community, district, and national level. When growth data from all children living in a community are aggregated, potential problems become more visible and can be better understood, thereby stimulating community nutrition and health programming that addresses the underlying determinants influencing child growth and nutrition.¹² For example, in a nutrition program in India, community charts for nutritional status of children registered in Anganwadi Centres have been used as community mobilization tools and are intended to help the communities understand the nutritional status of their children, underlying causes of undernutrition and what should be done to improve them.¹³ This type of work could more easily and accurately be done with reliable growth measurements that can quickly be consolidated within communities and across different government levels and sectors.

PROMISING TECHNOLOGICAL INTERVENTIONS TO HELP ADDRESS CHALLENGES WITH GROWTH MONITORING AND DATA VISUALIZATION



MOBILE PHONES

Mobile phones have been widely implemented in programs to improve maternal and child health. More recently mobile phones are being used in nutrition programs to facilitate tracking and follow up with target populations, improve plotting and interpretation of child growth and counseling, and streamline information systems.^{14,15} While few studies have looked at the impact of these interventions, or do not use rigorous evaluation methodologies, small scale research and pilot studies show promising findings. A cross-sectional study in 14 health posts in Indonesia found that the use of the mobile phone by community health workers (CHWs) significantly improved the accuracy of the classification of children's growth status by 80% on average, especially for children who were mildly underweight and thus were classified as normal. The phones also improved the timeliness of data submission from the village to sub-district levels. Moreover, CHWs with a phone were more likely to provide feedback and arrange follow-up GMP counseling sessions and referrals than those without a phone.¹⁴

A large-scale roll-out of a mobile phone application for low-literate Anganwadi Workers (AWWs) (CHWs) is currently being implemented in India to track clients, provide timely service delivery, improve plotting and interpretation of growth monitoring data, and facilitate counseling on maternal and child health and nutrition. With the mobile app, the data can be entered in real time, offline and online, is spot checked by a supervisor, and then consolidated in a web-based dashboard so that all levels of government can access it and determine how best to improve and target services. For GMP, the application automatically plots the child's data, interprets it and provides multi-media counseling messaging for the AWW and caregiver. The application has been piloted, is currently being used by over 80,000 AWWs across six states and will be rolled out nationally to 1.4 million AWWs in the country through funding from the Government of India and the World Bank. An external evaluation is underway in Madhya Pradesh and Bihar.¹⁵

Mobile phones are also starting to be used to improve, digitize, and streamline supportive supervision practices for the delivery of nutrition services. In Ghana, the Northern Regional Health Directorate of the Ghana Health Service with funding from USAID/ Resiliency in Northern Ghana project is piloting a mobile application to digitize supervision checklists at specific contact points where nutrition services are critical, incorporates real-time feedback to health workers on their strengths and weaknesses, and provides targeted multimedia content/refreshers training to improve health worker performance. The

feedback messages ensure that supervisory visits include high quality mentoring and coaching of the health worker and reinforce static training. The mobile app also makes a subjective process more objective. The plan is to have the data from the mobile checklists feed into a dashboard in the district health information system that provides the Ministry of Health with an overview of health worker performance in each health facility.¹⁶



CHILD LENGTH MAT

The Child Length Mat was developed by The Manoff Group as an inexpensive, easy-to-use tool that helps families and communities focus attention on linear growth and timely action. As a non-clinical tool for community use, it helps to identify if a child under two is at risk of becoming stunted or is stunted. The mat has separate sides for boys and girls. Countries determine the periodicity of measurement, but commonly children are measured every three months, starting from three months of age. The mat clearly shows whether a child's length, while lying on the mat, is $<-2SD$ of the current WHO standard for the child's age. Validation in Cambodia and Guatemala showed high sensitivity and specificity in identifying stunting compared to results when a height board was used.^{17,18} Following implementation in Bolivia in 2008, programs in Cambodia, Guatemala, and Indonesia currently use the mat to be joined soon by Rwanda. In each country, specific adaptations in the mat design, the training package, and the guidelines for family and community actions are tailored to the local context. Health services, communities, and families find positive benefits. For example, in Cambodia, the mat is integrated into community GMP services to trigger referrals and counseling. A review in 41 villages found that the mat helped both village health workers and caregivers visualize linear growth, understand that height and weight gains are important for children's growth,

and that poor growth influences children's health and development. Health workers reported increased use of health services and requests from caregivers for weight and length measures during health center visits.¹⁹



DIGITAL HEIGHT BOARD

This device is currently being developed by UNICEF and is similar to current height boards but with digital output that addresses, among other challenges, reading errors that commonly arise from height measurements. The digital height board can also process and transfer data electronically to a mobile phone or tablet for rapid data capture and analysis. A prototype of the board is being field tested and potential improvements to the board are being communicated to the supplier.



ANTHROIMAGING

The 3-D imaging uses a tablet, phone, or a special camera to measure height, head, and arm circumference. Scans can then be uploaded to provide individual and population-based growth data. Controlled studies have shown that this technique is highly accurate and as reliable as a gold-standard manual measurement.²⁰ It is currently being field tested in Guatemala for accuracy and acceptability (results pending).

TABLE 1: ADVANTAGES AND DISADVANTAGES OF TOOLS TO MEASURE CHILD GROWTH

TOOLS	ADVANTAGES	DISADVANTAGES
<p>MOBILE APPLICATIONS: Digitize, standardize, and streamline the work of community health workers, including child growth monitoring and promotion</p> <p>Improve supportive supervision of health care workers</p>	<ul style="list-style-type: none"> • Can potentially improve calculation and interpretation of growth charts, patient registration, provider counseling, data entry, consolidation of data across sectors and levels of government^{14,15} • Can reduce the workload of CHWs by accelerating the plotting of child data and providing timely feedback to mothers¹⁴ • Some caretakers find that they can trust the results from a mobile phone app more, and find them less judgmental, than those of CHWs¹⁴ • Can improve supportive supervision and health worker performance for nutrition services 	<ul style="list-style-type: none"> • Costs: Procurement of devices, training, help desk, development of software, training vs. cost savings from implementation in terms of time and impact • Limited battery life of mobile phones, lack of electricity to recharge the phone, low confidence by CHWs to use apps²¹ • Health workers may use mobile phones for their personal use, which can affect data security and confidentiality
<p>ANTHROIMAGING: The 3-D imaging uses a tablet, phone or a special camera to measure height, head, and arm circumference</p>	<ul style="list-style-type: none"> • Low-cost, portable system • Scans can be uploaded to not only provide individual but also population-based growth data • Highly accurate measurements as shown by controlled studies 	<ul style="list-style-type: none"> • Technique is still being field tested for accuracy and acceptability • Scanning and processing software need further development before routine use of 3-D anthroimaging²⁰ • Same as “mobile applications” (above)
<p>CHILD LENGTH MAT: Poly-vinyl mat that employs visual cues to assess if a child (3-24 months) is at risk for becoming stunted or is stunted</p>	<ul style="list-style-type: none"> • Inexpensive, durable, easy to use, and intuitive for communities • Easy to adapt to country context, by tailoring the age groups, colors, graphics, and format to reflect the national stunting profile and local preferences • Helps providers, community leaders and families visualize stunting and appreciate linear growth • Integrates well with on-going community GMP: offers straight-forward training and use and involves the caregiver in measurement • Can help drive demand for clinical measures at health centers • Heightens accountability for action on stunting by giving parents the information on their child; allowing leaders and health providers to know if stunting is increasing or decreasing in their jurisdiction 	<ul style="list-style-type: none"> • Currently, does not sufficiently capture growth faltering, but adaptations are being made in several countries to add one or two more markers so that trends between measures are easier to assess to determine faltering • Not a clinical measure; for community awareness raising and promotion of action
<p>DIGITAL HEIGHT BOARD: Similar to current height boards but with digital output</p>	<ul style="list-style-type: none"> • Easier to read the measurement value than when using a board with measuring tape for readings, thereby increasing the likelihood of accurate reading • Digital output can potentially reduce reading errors and measure, process and transfer data electronically to a mobile phone or tablet • Much lighter than current height board 	<ul style="list-style-type: none"> • Still under development • Needs to be field tested on a wider scale • Currently twice the price of a regular height board



CONCLUSIONS AND NEXT STEPS

3 New tools to measure child growth have great potential to improve anthropometric diagnostic accuracy and data quality, improve the classification and value of routine nutritional assessments, and increase needed referrals. Some of the new tools under development can help caregivers visualize their children's growth, provide tailored communication messages, enhance their trust of health workers, and facilitate changing nutrition behaviors and taking necessary follow-up actions. Mobile phones that standardize nutrition supportive supervision can improve health worker performance. Reliable, easily aggregated data can be used by the community or different government levels to detect problems and develop potential responses. The development of these tools is a turning point for GMP, which in the past has been criticized for measurement errors, poor health worker performance, and inadequate provider-caregiver counseling.

Of course, implementation and use of these tools should not be undertaken without implementation research in a health facility and community settings that analyzes the tools' impact, cost-effectiveness, ability to improve quality data, and barriers to use. It is also important to evaluate the impact of programs and tools for consolidating data, tracking data, and using child growth data for accountability and decision-making as a means of improving child growth.



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REFERENCES

1. UNICEF/WHO/World Bank Group. Levels and trends in child malnutrition 2018 [Internet]. 2018. Available from: <http://www.who.int/nutgrowthdb/estimates2017/en/>
2. Galasso E, Wagstaff A, Naudeau S, Shekar M. The Economic Costs of Stunting and How to Reduce Them. World Bank Policy Res Notes [Internet] 2016; Available from: <http://pubdocs.worldbank.org/en/536661487971403516/PRN05-March2017-Economic-Costs-of-Stunting.pdf>
3. Shekar M, Kakietek J, Dayton EJ, Walters D. An Investment Framework for Nutrition: Executive Summary [Internet]. 2016. Available from: <http://elibrary.worldbank.org/doi/book/10.1596/25292>
4. Ashworth A, Shrimpton R, Jamil K. Review Article Growth monitoring and promotion : review of evidence of impact. *Growth Monit Promot Rev Evid impact* 2008;86-117.
5. Mangasaryan N, Arabi M, Schultink W. Revisiting the concept of growth monitoring and its possible role in community-based nutrition programs. *Food Nutr Bull* 2011;32(1):42-53.
6. Bilal SM, Moser A, Blanco R, Spigt M, Dinant GJ. Practices and challenges of growth monitoring and promotion in Ethiopia: A qualitative study. *J Heal Popul Nutr* 2014;32(3):441-51.
7. Conkle J, Martorell R. Perspective: Are We Ready to Measure Child Nutritional Status with Lasers? *Adv Nutr* 2019;10(1):S10-6.
8. Gyampoh S, Otoo GE, Aryeetey RNO. Child feeding knowledge and practices among women participating in growth monitoring and promotion in Accra, Ghana. *BMC Pregnancy Childbirth* 2014;14(1):1-7.
9. Schaetzel T, Griffiths M, Miller Del Rosso J, Plowman B. Evaluation of the AIN-C Program in Honduras. 2008;69-79. Available from: <https://www.manoffgroup.com/AIN-CEvaluation.pdf/>
10. Griffiths M, Dickin K, Favin M. Promoting the Growth of Children: What Works Rationale and Guidance for Programs. Washington DC: 1996.
11. Roberfroid D, Pelto GH, Kolsteren P. Plot and see! Maternal comprehension of growth charts worldwide. *Trop Med Int Heal* 2007;12(9):1074-86.
12. Report of the Technical Consultation on Growth Monitoring and Promotion. Revisiting Growth Monitoring and its Evolution to Promoting Growth as a Strategic Program Approach: Building Consensus for Future Program Guidance. 2007;1-19. Available from: https://www.unicef.org/nutrition/files/Report_of_Technical_Consultation_on_GMP-2007.pdf
13. Programme Evaluation Organization. Evaluation Report on Integrated Child Development Scheme (ICDS) Jammu & Kashmir. Gov India [Internet] 2009;1-73. Available from: http://planningcommission.nic.in/reports/peoreport/peo/peo_icds.pdf
14. Barnett I, Yosellina, Sulistyo S, et al. Mixed-method impact evaluation of a mobile phone application for nutrition monitoring in Indonesia. 2016;(July):46 p. Available from: http://opendocs.ids.ac.uk/opendocs/bitstream/123456789/12077/1/ER200_MixedMethodImpactEvaluationofaMobilePhoneApplicationforNutritionMonitoringinIndonesia.pdf
15. Global Financing Facility. Summary Report of the Convening on "Rethinking Growth Promotion: New Approaches for Results in the SDG Era." Washington DC: unpublished; 2019.
16. John Snow Inc. Digital Supportive Supervision. Boston, MA:
17. Nutri-Salud Project. Nota Tecnica: La Manta de Crecimiento: Una herramienta comunitaria para la deteccion oportuna de la desnutricion cronica, Resultados de la Validacion en Guatemala. 2017.
18. NOURISH PROJECT. Validation of the Child Length Mat. 2016.
19. Save the Children. Child Length Mat Pilot in Pursat. 2017.
20. Flores-Ayala R, Suchdev PS, Martorell R, Ramakrishnan U, Alexander E, Conkle J. Accuracy and reliability of a low-cost, handheld 3D imaging system for child anthropometry. *PLoS One* 2018;13(10):e0205320.
21. Louw J, Richter L, Sen D, Desmond C, van Heerden A. App-Supported Promotion of Child Growth and Development by Community Health Workers in Kenya: Feasibility and Acceptability Study. *JMIR mHealth uHealth* 2017;5(12):e182.



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“ NEW TOOLS TO MEASURE CHILD GROWTH HAVE GREAT POTENTIAL TO IMPROVE ANTHROPOMETRIC DIAGNOSTIC ACCURACY AND DATA QUALITY, IMPROVE THE CLASSIFICATION AND VALUE OF ROUTINE NUTRITIONAL ASSESSMENTS, AND INCREASE NEEDED REFERRALS. ”

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