



## Technological innovations for anthropometric measurement instruments in population-based surveys

### Statement of problem

Anthropometric data collection requires devices that will produce accurate height/length and weight measurements and are feasible for use in population-based surveys under difficult conditions and in rough and remote terrain. In particular, height/length measurement devices have remained largely unchanged for the past several hundred years, especially for use in low- and middle-income countries, and are associated with numerous challenges in data collection and quality. While digital height/length readers are often used in the United States and other high-income countries,<sup>1</sup> equivalently sophisticated field-friendly devices for use in population-based surveys in low- and middle-income countries are currently unavailable.

**Improvement of manual measurement techniques or the development and introduction of new technological advances, such as smartphone- and tablet-based systems, can help improve accuracy, speed and cost and minimize the invasiveness of collecting anthropometric data for use in population-based household surveys.**

A Target Product Profile (TPP) released by UNICEF in 2016 (revised in 2017) sought to spur innovation in height/length measurement technologies for children aged 0–23 months and 24+ months to eliminate or mitigate

the two most significant threats to data quality in field-based surveys: measurement error due to the device and human error associated with manually collecting and recording data.<sup>2</sup> The TPP specifically sought products that demonstrated “improvements of current type of designs (measurement boards, stadiometers, etc.) with a digital output” or “innovative devices using technologies such as laser, infrared, ultrasound and optics for height/length measurement.” The TPP also set forth parameters for minimum and ideal accuracy, precision, durability, field-friendliness and cost. While the TPP was specific to height/length measurement devices, the challenges with field data collection and quality summarized in the document are also indicative of the challenges associated with data collection and quality for portable devices to measure weight.

Neale et. al. (2021) identified several laser and photographic-based portable anthropometric devices and innovations that could be suitable for survey use, but noted limitations of currently available products in these categories related to price, durability or suitability for use in field settings that rendered them unresponsive to the specifications set forth in the UNICEF TPP.<sup>3</sup> In addition, the United States Agency for International Development recently undertook a rapid landscape assessment, informed by the UNICEF TPP, to better understand

current innovations in anthropometric measurement for use in low- and middle-income countries.<sup>4</sup> The review identified technologies that were either designed for use in population-based household surveys or were suitable for this purpose and were at relatively advanced stages of development. Based on this review, none of these technologies were ready for widespread use and scale-up as of early 2022.

Looking ahead, the integration of smartphone-based technologies into population-based survey platforms requires consideration of global quality standards and functional features. Additionally, the extent to which smartphone-based technologies will be able to improve data collection and data quality in survey contexts (i.e., in terms of cost, acceptability, ethical concerns, data quality, feasibility, user-friendliness, etc.) remains unclear due to the relatively nascent state of the technologies. Consequently, there is a need to also continue making improvements to manual measurement devices that can be used in household survey settings with difficult

conditions and terrain, particularly those in low- and middle-income countries. Several areas of research around new, emerging and existing technology require further exploration to advance the state of anthropometric measurement. A major barrier to advancements in technologies is their limited profitability. To overcome this, donor prioritization, innovative partnerships and effective financing mechanisms to incentivize product developers will be needed.

This brief describes a research agenda for improving the technology used for the collection of height/length and weight measurements among children under 5 years of age in population-based surveys. The research proposed in this brief is intended to support anthropometry measurement for children under 5 years of age. Height and weight are also frequently measured among older children and adults in surveys; thus, the ability to use the same technology in both populations would be advantageous.



## RESEARCH QUESTIONS AND APPROACH

<b>1</b>	Are there new, emerging or existing height/length or weight technological innovations well suited for settings with difficult conditions and terrain?
<b>2</b>	What height/length or weight technologies can be developed or adapted for use in settings with difficult conditions and terrain?
<b>3</b>	What are the standards for efficacy and effectiveness studies of technological innovations to measure height/length and weight in settings with difficult conditions and terrain?
<b>4</b>	What new or enhanced technologies are efficacious for the measurement of height/length or weight?
<b>5</b>	What new or enhanced technologies are effective for the measurement of height/length or weight?
<b>6</b>	What is the cost-benefit of new or enhanced technologies for the measurement of height/length or weight?

# Proposed research approach for augmenting technological innovations for anthropometric measurement for children under 5 years of age in population-based surveys

## Research topic 1

### Identifying height/ length or weight technological innovations

#### Type of research

**Mixed method review:** Conduct a landscape assessment to identify all possible height/ length or weight innovations. The landscape review should include new or emerging height/length or weight technological innovations and existing height/length or weight technologies that could be adapted or improved. The types of innovations include smartphone/tablet technologies, enhancements to manual measurement devices (e.g., stadiometers, length mats, the ability to transfer data directly from a scale to a tablet) and other types of technology.

#### Outcomes

**Primary:** Identification of technologies with potential for use in population-based surveys in settings with difficult conditions and terrain.

#### Data source(s)

A systematic search of peer review and grey literature. An online survey and/ or key informant interviews with stakeholders.

## Research topic 2

### Development or adaption of technologies

#### APPROACH 1

#### Type of research

**Qualitative:** Undertake a Delphi method to define the minimum and ideal parameters for a technology to be suitable for use in population-based in settings with difficult conditions and terrain. Specific to algorithm-based technologies (such as those on phone/tablets) this should include minimum standards necessary for the software to be used at large-scale in the context of a field survey. Minimum standards should include but are not limited to: (1) data transfer and storage; (2) functionality of accompanying software; (3) level of automation for scan processing; (4) cost; (5) ability to produce real time measurements for field referral; and (6) hardware compatibility.

#### Outcomes

**Primary:** Minimum and ideal technology parameters defined. This information should be used to release an updated TPP to inform product development.

#### Data source(s)

Questionnaire administered to a panel of experts in two or more rounds followed by a virtual or in-person meeting.

#### APPROACH 2

#### Type of research

**Product development:** Concept development, product design, build and test prototypes, using a human-centred design or a similar process.

#### Outcomes

**Primary:** Prototypes developed that are ready for efficacy studies.

#### Data source(s)

Anthropometric measurement instruments.

## Research topic 3

### Standards for efficacy and effectiveness studies for technologies

#### Type of research

**Qualitative:** Undertake a Delphi method to refine minimum and ideal parameters for validating a height/length and weight technology from efficacy to effectiveness. For efficacy, this should include but is not limited to: a) the minimum standards required prior to testing technologies; and b) standards for conducting efficacy studies, including defining an acceptable technical error of measurement for precision and accuracy. For effectiveness, this should include but is not limited to: a) operational advantages and disadvantages of technologies (e.g., in terms of relative ease of use; portability, including weight; durability; temperature fluctuations; time use; suitability; and end-user acceptability by measurers and participants); b) key drivers and barriers to technological adoption by users and clients; and c) cost-effectiveness for the implementation of the technology.

#### Outcomes

**Primary:** Minimum and ideal technology parameters defined. This information should be used to develop a standard protocol that can be used to inform efficacy and effectiveness studies. The protocol should include dummy tables and standard data analysis code and tools that can be used to assess measurer and client/caregiver experiences.

#### Data source(s)

Questionnaire administered to a panel of experts in two or more round followed by a virtual discussion.

## Research topic 4

### Efficacy studies for technologies

#### Type of research

**Primary data collection:** Efficacy validation studies comparing technological innovation to standard devices using expert measures.

#### Outcomes

**Primary:** Technical error of measurement for precision and accuracy.

#### Secondary (1):

Operational advantages and disadvantages of technologies.

#### Secondary (2):

Measurer and client/caregiver acceptability.

#### Data source(s)

Small-scale studies (multi-centre or individual) in a controlled environment.

## Research topic 5

### Effectiveness studies for technologies

#### Type of research

**Primary data collection:** Effectiveness validation studies comparing technological innovation to standard devices using expert measures. This requires 'typical' fieldworkers to perform the measurements and these measurements to be compared against a gold standard measurer.

#### Outcomes

**Primary:** Technical error of measurement for precision and accuracy.

#### Secondary (1):

Operational advantages and disadvantages of technologies.

#### Secondary (2):

Measurer and client/caregiver acceptability.

**Secondary (3):** Cost-effectiveness.

#### Data source(s)

Small-scale studies (multi-centre or individual) in a field environment from diverse settings, including in low- and middle-income countries.

Validations independent from the developers are required.

## Research topic 6

### Cost-benefit analysis

#### Type of research

**Primary data collection:** Collecting information on the cost (e.g., capture time) and the benefits (e.g., reduced measurement error) of technological innovations compared to standard devices.

#### Outcomes

**Primary:** Cost-effectiveness.

Secondary: Stratified by the national, subnational and team level.

#### Data source(s)

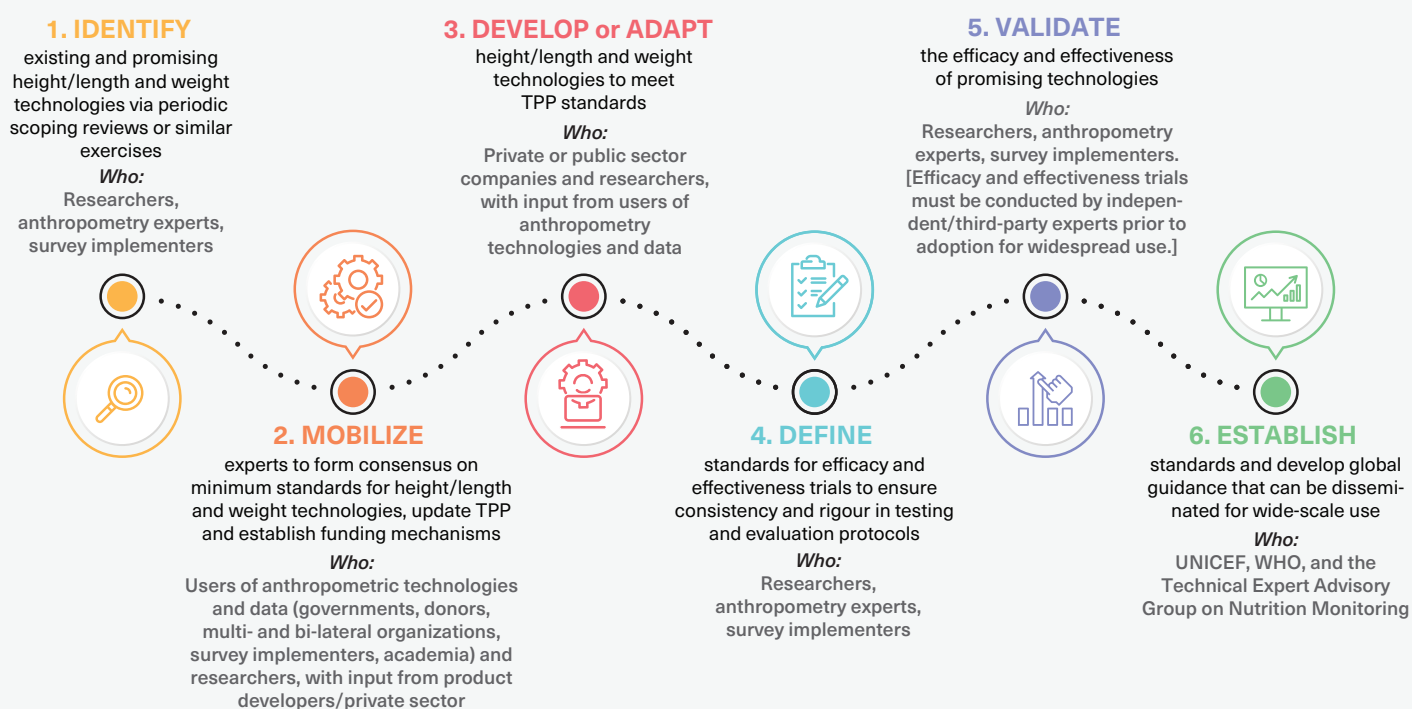
Small-scale studies in a controlled and large-scale studies in field environment from diverse settings including in low- and middle-income countries.

## Research roadmap

Since the 2017 release of the UNICEF TPP to improve height/length measurement devices, no suitable solutions have yet been identified for widespread adoption.

Technological advances in both height/length and weight measurement remain a priority to improve the quality and efficiency of anthropometric data collection in settings

with difficult conditions and terrain, particularly those in low- and middle-income countries. A roadmap towards the establishment of global guidance on this topic is presented below, along with the input needed from key stakeholders to address different aspects of the research agenda.



## Endnotes

<sup>1</sup> National Health and Nutrition Examination Survey (NHANES). Anthropometry Procedures Manual. CDC, 2016. NHANES 2015-2016 Anthropometry Procedures Manual (cdc.gov).

<sup>2</sup> UNICEF Target Product Profile Height/length Measurement Device(s), 2017. <https://www.unicef.org/supply/documents/target->

product-profile-heightlength-measurement-devices

<sup>3</sup> Geoffrey Neale, Santosh Gaihre, Pearse O’Gorman, Ruth K. Price, Ane Galdos Balzategi, Catalina Herrera Barrientos, Shweta Rawal, Margaret Morgan & Helene McNulty (2021) Review of recent innovations in portable child growth measurement

devices for use in low- and middle-income countries, *Journal of Medical Engineering & Technology*, 45:8, 642-655, DOI: 10.1080/03091902.2021.1946181.

<sup>4</sup> This review focused on height/length and weight measurement and excluded technologies that directly diagnose malnutrition.

## If interested in joining this effort

or if you have any questions or comments, please contact the TEAM Working Group on Anthropometric Data Quality at:

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