A prospective validation of a laser anthropometric device for measuring height and length of children less than 60 Months in Vietnam

Study Protocol

May 26, 2025

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ABBREVIATIONS

AM	Acute Malnutrition
CDC	Centre for Disease Control
CHWs	Community health workers
COVID-19	Corona Virus Disease 2019
FGD	Focus Group Discussions
HAZ	Height-for-Age Z-score
IYCF	Infant and Young Child Feeding
LAZ	Length-for-Age Z-score
LSHTM	London School of Hygiene and Tropical Medicine
MAM	Moderate Acute Malnutrition
MUAC	Mid-Upper Arm Circumference
N/A	Not Applicable
PDH	Positive Deviance/Hearth
RUTF	Ready-to-Use-Therapeutic Foods
SAM	Severe Acute Malnutrition
SD	Standard Deviation
SFF	Specially Formulated Foods
SOC	Standard of Care
UNICEF	United Nations International Children's Emergency Fund
WASH	Water and Sanitation, Hygiene
WAZ	Weight-for-Age z-score
WHO	World Health Organization
WHZ	Weight-for-Height z-score
WLZ	Weight-for-Length z-score

KEYWORDS: Anthropometry, Digital, Laser, Height, Length, Children, Infants, Wasting, Acute Malnutrition, Stunting, Accuracy, Precision, Reliability, Agreement, Validation

STUDY SUMMARY

TITLE	A prospective validation of a laser anthropometric device for measuring height and length of children less than 60 Months in Vietnam
DESIGN	Cross-sectional prospective validation study
AIMS	To improve the screening of wasted children less than 60 months using weight and height/length indices in Vietnam.
OUTCOME MEASURES	Primary outcomes include agreement between methods, precision, and reliability and for secondary outcome I will assess the differences in weight-for-height or weight-for-length z-score and height-for-age or length-for-age z-score categorization when assessed by the two different methods.
POP & ELIGIBILITY	Children less than 60 months of age in Quang Nam, Vietnam
TREATMENT	Testing a laser device to measure children's height/length and comparing it to wooden height board (ShorrBoard)
DURATION	2 weeks of data collection and 9 month total research duration

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TABLE OF CONTENTS

1. **BACKGROUND** 6
2. **AIM AND OBJECTIVES** 7
3. **RESEARCH DESIGN/METHODOLOGY** 7
4. **STATISTICAL ANALYSIS.** 8
5. **DATA MANAGEMENT** 9
6. **ETHICAL CONSIDERATIONS** 10
7. **DISSEMINATION PLAN** 10
8. **TIMELINE** ..... **Error! Bookmark not defined.**
9. **BUDGET** ..... **Error! Bookmark not defined.**

Appendix A – Detailed Data Collection Procedure 11

Appendix B – Local IRB approval (Vietnam) For Study 1 26

Appendix C – Questionnaire tools for collecting height/length data and weight data 28

Appendix D – Consent Forms in English 28

REFERENCES 33

A prospective validation of a laser anthropometric device for measuring height and length of children less than 60 Months in Vietnam

1. BACKGROUND

Accurate anthropometric measurement is critical in child health and nutrition research. WHO recommends using either Mid-Upper Arm Circumference (MUAC) or Weight-for-Height/Weight-for-Length Z-score (WHZ/WLZ) to assess for acute malnutrition or child wasting. MUAC is often preferred due to its simplicity and speed. However, a multi-country study found that WHZ/WLZ and MUAC should be used independently for treatment admissions, as discrepancies between the two varied significantly across countries (1). Thus, accurate measurement of height and length is crucial for monitoring growth and timely referral of wasted children to appropriate health services (2). Measuring height is challenging due to children's movement, untrained measurers (3), and defective locally produced height boards. Additional issues include long hours for assessments, poor data quality, and concerns over data reliability in outreach settings when collected by CHWs.

Traditional wooden height/length boards, such as the ShorrBoard, are the gold standard in low and middle-income countries, but are heavy to transport, expensive (greater than $500 per device), and require extensive training to use it accurately. Emerging laser-based devices offer a potential alternative, promising a low-cost solution that is durable, light in weight, and easy to use.

1.1 Rationale

Interest in digital anthropometry is growing to address the concerns mentioned above. Technologies such as geospatial handheld 3D imaging system (4,5), ultrasound (6), and other laser systems (7), have been tested to improve height and length measurement reliability and accuracy, but none have achieved ≥99% reliability and accuracy at a cost under US$200 at the use of CHWs. A scoping review of portable digital devices identified twelve devices from twenty studies, most with prospective validation - a process used to assess the effectiveness, accuracy, and reliability of a method, tool, or system before it is fully implemented. It confirms that the method consistently produces expected results (8). While some devices show promise, further research and development are needed to ensure their reliability and precision for widespread use (8).

Laser devices tend to be less accurate at high temperatures due to thermal expansion, air density changes, and electronic component sensitivity, but MagpieTech's patented triple laser technology may offer an affordable, portable, and durable solution even in extreme climates. In partnership with World Vision, MagpieTech developed a laser device to measure children's height and length in low- and middle-income country outreach contexts even when used by CHWs. The prototype tested on 60 children under age six showed promising results of reliability and agreement above 99% even with CHWs using it. The device was improved since the prototype testing but has not yet been validated.

The device is similar in design to the ShorrBoard, which makes it easy for CHWs to use. However, the laser device is lighter in weight (by ~3kg), compact for easy transportability (fits into a backpack), affordable (approximately $150 including shipping), and durable for use in the field. With replaceable AA batteries, it can take up to 2000 measurements before needing replacements. If proven accurate, reliable, and precise with CHWs as the main users, it would improve anthropometric measurements, saving time, resources, and improving data quality.

Thus, this prospective validation study in Vietnam will focus on validating the laser device in high temperature and humid low-resource setting such as Vietnam amongst an under-five population.

1.1 Research Questions: Is the laser device in high agreement to the ShorrBoard and is it just as precise or reliable when the frontline health workers use it to measure children less than 60 months of age in Vietnam?

1.2 Hypothesis: The laser height/length measuring device is has high agreement to the ShorrBoard and is just as or more precise and reliable when frontline health workers use it to measure children less than 60 months of age in a rural outreach setting in Vietnam.

2. AIM AND OBJECTIVES:

2.1 Aim: To improve the screening of wasted children less than 60 months using weight and height/length indices in Vietnam.

2.2 Objective: To assess a novel laser-based device for measuring the height and length of children aged 0–59 months, comparing its level of agreement, precision, and reliability of the laser device compared to the standard ShorrBoard in an outreach setting of Quang Nam, Vietnam.

3. RESEARCH DESIGN/METHODOLOGY

3.1 Study Setting. In Vietnam, Quang Nam province was selected as the study site for its hot climate (up to 40◦C) (9), for one of the highest rates of wasting in Vietnam (16.7%) (10) despite food security, and because WHZ/WLZ is the main anthropometric index used to identify and refer wasted children. WHZ/WLZ is not measured frequently because of the difficulty in measuring height and length of children in Vietnam, but it is critical for many wasted children to receive timely appropriate treatment before their health deteriorates further. Thus, wasting screening should take place more frequently than it is currently being done. Improving the method of collecting height/length indices can promote increased frequency of screening.

3.2 Study Design and Sampling. A cross-sectional study will evaluate agreement between a laser device and the Shorr Board for measuring height/length of children 0-59.9 months. The study will be embedded in the national routine surveillance system's sampling frame, with data collection in May/June 2025 in villages assigned by the Ministry of Health and Centre for Disease Control (CDC).

In Vietnam, an annual growth monitoring census measures anthropometrics (weight and length/height) for all children 0–59.9 months using expert and hired enumerators. For this study, with government approval, Community Health Workers (CHWs) and expert anthropometrists will collect data, with expert measurements shared with the Ministry of Health for the national survey.

All households with children ≤59.9 months in the selected villages will be mobilized and invited to participate in the evaluation. Each child will be measured twice with both the ShorrBoard and laser device by both expert and volunteer teams, with at least a 30-minute interval between first and second measurements to reduce recall bias. If the two measurements differ by more than 0.7cm, a third will be taken, and the two closest values used for analysis (11,12). Enumerator teams will consist of three members (two measurers and one recorder). Expert and volunteer teams will be trained and standardized by the principal investigator and World Vision. While two expert teams remain the same

across all eight villages, a new volunteer team will be recruited in every two villages. Selection criteria and training procedures will be detailed in the research protocols.

To minimize bias from measurement order and method, the device used first by the community health workers (CHWs) will alternate daily. Within teams, individual roles (measurer or recorder) will remain consistent throughout each day. Additionally, measurement locations will be fixed by device to maintain consistent environmental conditions (e.g., lighting and temperature), with teams rotating between rooms depending on which device they are using. This setup ensures that any variation in conditions does not affect comparisons between devices or team performance.

Detailed data collection procedures can be found in **Appendix A**.

3.3 Sample size. A sample of 560 children – having adjusted for a 10% default rate – will be needed to have 90% power to detect a 0.2cm height difference using a paired t-test at the 5% level of significance. The study will be conducted in Vietnam for 280 children 0-23.9 months of age, 280 children 24-59 months of age. However, since data is being collected within a routine census, all children within the age group will be measured within the catchment area even if it is beyond the required sample size.

4. STATISTICAL ANALYSIS.

Primary outcomes include agreement between methods, precision, and reliability and for secondary outcome I will assess the differences in weight-for-height or weight-for-length z-score and height-for-age or length-for-age z-score categorization when assessed by the two different methods.

To evaluate the agreement between methods, I will use the Bland-Altman plot to compare the laser device measurements taken by the volunteer teams with the ShorrBoard measurements (measures from an established and accepted device) from the expert team (inter-rater inter-method technical error of measurement (inter-TEM)) (13). Small mean difference and narrow limits of agreement translate to high agreement and lower inter-TEM (≤0.7cm difference for height/length measurement) mean acceptable and high agreement.

To assess for reliability, consistency and repeatability of measurements produced by different measurers using the same device or same measurers using the same device or same measurers using different devices under similar conditions and over time, I will calculate the intraclass correlation coefficient (ICC). To determine whether the time gap between when the volunteer teams and the expert teams collected evaluation data (ranging from 30-60 mins apart) affected agreement, we will analyze test-retest consistency (using same device) at different time points (4,14). High ICC (>0.9) translates to high reliability.

For precision, closeness of repeated measurements to each other when measuring using the same device by the same measurer (intra-rater intra-method technical error of measurement), we will calculate coefficient of variation (CV), Standard Deviation (SD), and technical error of measurement (TEM) (11). Lower CV, SD, and TEM mean higher precision.

For assessing the secondary outcome, McNemar's $\chi 2$ test will be used to analyze the categorical classification of wasting and stunting as 'normal' and 'wasted or severely wasted' or 'normal' and 'stunted or severely stunted' (15). Detailed data analysis plan can be found in Statistical Analysis Plan (SAP).

5. DATA MANAGEMENT

A phone application will be developed using KoboCollect to collect the quantitative data including child and caregiver descriptive information, height/length measurement and another application to collect the weight measurement. Paper-based tools will also be used to ensure no data is lost. Questionnaires and hardcopy format can be found in Appendix C.

The quantitative survey will be developed using KoboCollect and collected using Android-based phones/tablets. Resulting data will be imported into Excel and Emergency Nutrition Assessment 2008 (ENA2008) software to analyze the quality of the data every day after data collection. The data quality of the enumerators for height/length-for-age and weight-for-height/length data will be compared to the international WHO reference standards to identify any enumerators that need to be retrained due to digit preferences or flags in children's weight-for-height/length z-scores ±5.0SD, according to WHO growth standards (53). Any data that needs to be re-measured will be re-measured the following day.

All data will be de-identified/anonymized using MS Excel. The data will then be imported to R-Studio and will be further cleaned, processed, and analyzed according to the research protocol. A R-studio script will be generated for all the analysis. KoboCollect tools will include validations and skips to ensure data quality. The data collection workflow to be applied in the study can be seen in Figure 1.

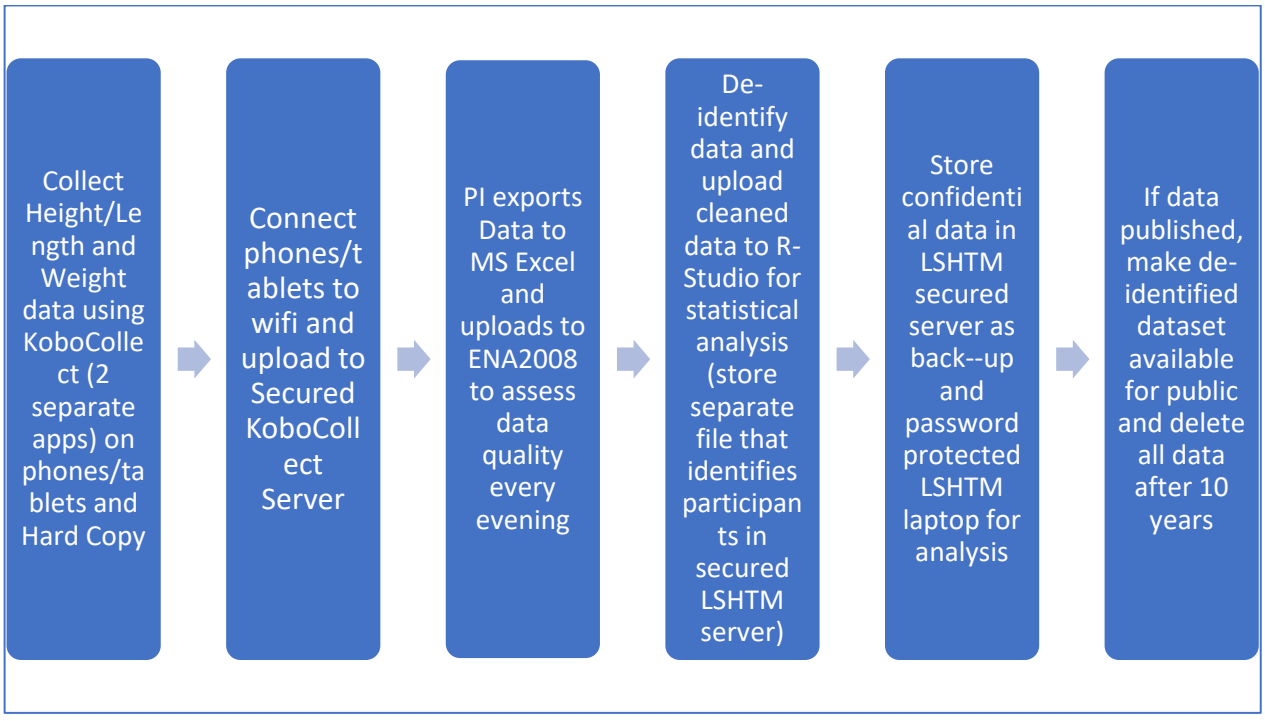


Figure 1.0 Data collection workflow

Survey data will be temporarily held on the android tablets and once internet connection is available, the data will be securely transferred to KoboCollect server operated by World Vision. Following completion of survey work, the complete dataset will be exported and transferred to the LSHTM's secure server for processing. This system uses user authentication to limit access to specific users only. These data will be shared with my supervisor and other advisors. Filenames will be labelled using key characteristics that will

allow relevant files to be located quickly, while protecting participants from identification. For instance, collectionMethod_IDnumber_resourceType_ versionNo.fileformat. E.g. Survey1_01_weight_v1.xml.

5.1 Data Confidentiality, Security, and Storage. I will ensure data is safe and secure by storing data on servers that require username/password, encrypt storage devices, store personal details of participants in a separate secure location and link it via an identifier, encrypt during transfer of data, delete personal confidential details at the earliest opportunity and protect portable devices using security features (password protection). I will also ensure backups are also held securely and already took the "Information Security Awareness Training" at LSHTM. All anonymized data collected will be kept for 10 years and resources will be deleted when no longer needed (e.g. participant identifiable details captured in the survey). All data will be stored on the institutional secure server. Resources will be made available publicly at the same time as findings are published in an academic peer-reviewed journal and/or on completion of my thesis. I will obtain a Digital Object Identifier (DOI) so other researchers are aware of the existence of the resources and save them in open file formats such as csv-format.

6. ETHICAL CONSIDERATIONS

This study will be conducted in accordance with ethical principles outlined in the Declaration of Helsinki and has been designed to minimize any risks to participants. Informed consent will be obtained from all caregivers prior to participation, with special procedures in place to ensure comprehension among illiterate participants, including verbal explanations in the local language and the use of a witness to document consent. The information sheet and consent form can be found in the Appendix D. All anthropometric measurements are non-invasive, pose minimal risk, and will be conducted with care by trained staff to ensure child comfort and safety. Personal identifying information will be collected only as necessary for consent and linkage purposes and will be stored securely and separately from the main dataset on LSHTM's secure OneDrive, which will be accessed through HORIZON. Data will be anonymized prior to analysis, and any child identified as malnourished will be referred to the nearest health facility in accordance with national guidelines. Ethical approval will be obtained from LSHTM's ethics committee and the Hanoi University of Public Health for both studies. Hanoi University of Public Health already approved this study (see Appendix B).

7. DISSEMINATION PLAN

Findings from this study will be disseminated to a range of audiences, including academic, policy, and community stakeholders. Results will be submitted for publication in a peer-reviewed open-access journal and presented at relevant international and national conferences on child health and nutrition. A summary of the findings will also be shared with participating communities, local health authorities, and non-governmental partners in Vietnam in an accessible format. An anonymized dataset and associated tools will be made publicly available through LSHTM's Data Compass data repository upon publication, with a Digital Object Identifier to support data citation and reuse. The dissemination strategy aims to ensure that the knowledge generated contributes to improving child screening and monitoring practices in low-resource settings.

Appendix A – Detailed Data Collection Procedures *(Adapted from Standard Operating Procedure for Anthropometry from the Hub Study)*

Section1: Equipment Checklist

Equipment	Illustrations	For which measurement
1)Child weight scale		Weight (infants and children)
2) Calibration weights		Calibration of weight scale
3) Extra batteries for scales (8 batteries per group)		Weight, Length/Height
4) 70% alcohol wipes to clean before and after participant stands on scale or height/length board		For all measurements

5) ShorrBoard		Height (children 24-59.9m) Length (children 0-23.9m)
6) Laser Device		Height (children 24-59.9m) Length (children 0-23.9m)
7) Meter Stick		Calibration for height/length board and laser device
8) Nappies		

Section 2: Anthropometry process in field

2.1 Set-up and calibrate the equipment (Details in section 3)

For measuring weight:

- Place the weighing scales on a hard, flat surface that is not carpeted

- Calibrate the weighing scales
    - check that the scale reads zero and adjust if necessary
    - weigh the two calibration weights and record these weights on the electronic-tablet.
    - if the scale calibration shows the weight differs by more than 0.2kg from the expected weight then reposition the scale and recalibrate
    - if the scale re-calibration still shows the weight differs by more than 0.2kg from the expected weight then enter this re-calibration weight into the electronic-tablet. Continue with the measurements and the electronic-tablet will subtract the difference between the expected value and the entered value from the measured value.

For measuring height or length:

- Set-up height/length-board for measuring infant's length (<24m) or child's height (24-59.9m):
    - calibrate the height/length-board, for child height or infant length, using the calibration meter ruler and enter the value into electronic-tablet.
    - if the length-board calibration shows the length differs by more than 0.3cm from the expected length then continue with the measurements and the electronic-tablet will subtract the difference between the expected value and the entered value from the measured value.

2.2 When meeting participant

- Introduce yourselves and explain the nature of the study to the participant
- Explain all the measurements that you will be doing that visit
- Go through the consent form with the participant and obtain permission
- Take the measurements
- Clean all equipment before using in front of participant

2.3 Once measurements are complete

- Thank the participant for their time

After all measurements are taken then and you do not have another participant:

- Take one battery out of the weighing scales and laser device
- Pack up the equipment as appropriate – weighing scales, length-board, the scale batteries, calibration weights, calibration rods, extra battery, and electronic-tablet

Table 1: Summary of measure, measurements, quality check and items to record

Measure	Measurements			Record if the following:
	1st	2nd	3rd	
Infant weight	x	x	If 1 and 2 differ by ≥ 0.2kg and/or weight for age (WAZ) > +5 SD or <-6 SD	Child has oedema Unable to do nude-weight Has disability that affects weight measurement (e.g. missing an arm)
Child weight	x	x	If 1 and 2 differ by ≥ 0.2kg and/or weight for age (WAZ) > +5 SD or <-6 SD	Child has oedema Unable to do nude-weight Has disability that affects weight measurement (e.g. missing an arm)
Infant length	x	x	If 1 and 2 differ by > 0.7cm and/or length-for-age (LAZ) > +6 SD or <-6 SD	Only one leg recorded Spinal curvature Refer children with WLZ<-3.0SD to health centre for wasting services
Child height	x	x	If 1 and 2 differ by > 0.7cm and/or height-for-age (HAZ) > +6 SD or <-6 SD	Only one leg recorded Spinal curvature Refer children with WHZ<-3.0SD to health centre for wasting services

Section 3: Detailed description of the measurement process

3.1 Measurements

3.1.1 Weight –Children able to stand on their own

- Ask the participant children to remove their shoes, nappies, hats, and clothing
- Turn on the scale and wait until it shows zero (i.e., 00.0 appears)
- Ask the participant to stand still over the centre of the scales with feet together and the weight distributed equally on the scales. Arms should be hanging loosely by their sides and their head facing forward
- Allow the scales to stabilise and record the reading to the nearest 0.1 kg.

3.1.2 Weight – Infant

- Ask the mother to remove the infant's shoes, hats, nappies and any clothing (tell the mother that you will give her a new nappy after recording the second weight)
- Check of oedema on child's feet and record if the infant has oedema in the electronic-tablet

- After you have recorded the mother's weight, tare the scale so it is zeroed again (i.e., 00.0 appears)
- Hand the infant to the mother and wait until s/he is settled
- Record weight (kg) to nearest 100g (0.1kg)

3.1.3 Standing height – Child aged 24-59.9m

- Ask the participant child to remove shoes, hats and hair ornaments. If their hair is done up on top of the head, ask if the child's caregiver if they are willing to undo it.
- Ensure that the calibrated height-board or laser device is set-up preferably next to a wall or a table. Use floor stabilisers if necessary
- Ensure the participant is in the correct standing position on the height-board: They should stand with their feet flat on the base plate, heels together, toes pointed slightly outward (60^{o}) and weight evenly distributed over both feet. Ensure head, shoulder blades, buttocks and heels touch the height-board. If they cannot all touch the board, when standing straight, then the head can be positioned away from the board
- The assistant helps to position the participant's head: ensure the horizontal **Frankfort Plane position** (lower ear canal to the lower border of the eye socket is perpendicular to the back board). If head is not aligned properly, ask participant to lower or raise their chin so that it is in the Frankfort Plane position
- Ask the participant to take a **deep breath in** and stretch to their fullest height when the measurement is taken without raising her/his feet off the ground.
- The assistant checks that their knees are not bent or that they are not standing on their tip-toes
- The enumerator slowly lowers the head piece down onto the top of the head (vertex) with sufficient pressure to compress the hair
- Ensure that the measurement is taken at **eye level** with the head piece when taking the measurement
- Record the height (cm) to the nearest 0.1 cm while the participant holds a deep breath

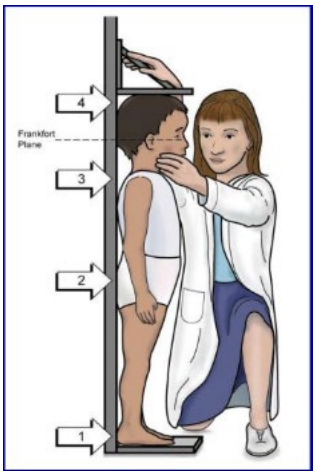


Figure 2: Measuring child height. Head in Frankfort horizontal plane ***Image Reference: Iowa Department of Public Health, 2010.***

3.1.4 Length – Infants aged <24m

- Ask the mother to remove infant's shoes, hat and hair ornaments
- Ask the mother to stand over the infant keeping eye contact and using comforting words
- The assistant positions and hold the infant's head in this position, cupping their hands around the infant's ears to ensure the head is held in vertical Frankfort Plane position (lower canal to the lower border of the eye socket is perpendicular to the horizontal board) and against the length board
- The enumerator, straightens the trunk and legs, holding the knees straight with their left hand
- With their right hand they position the feet, moving the footboard up against the feet
- Take the measurement, ensuring the infant's feet are flat against the board, their head is in the right position, their trunk is straight, and knees are held flat
- Record length (cm) to last completed 1mm

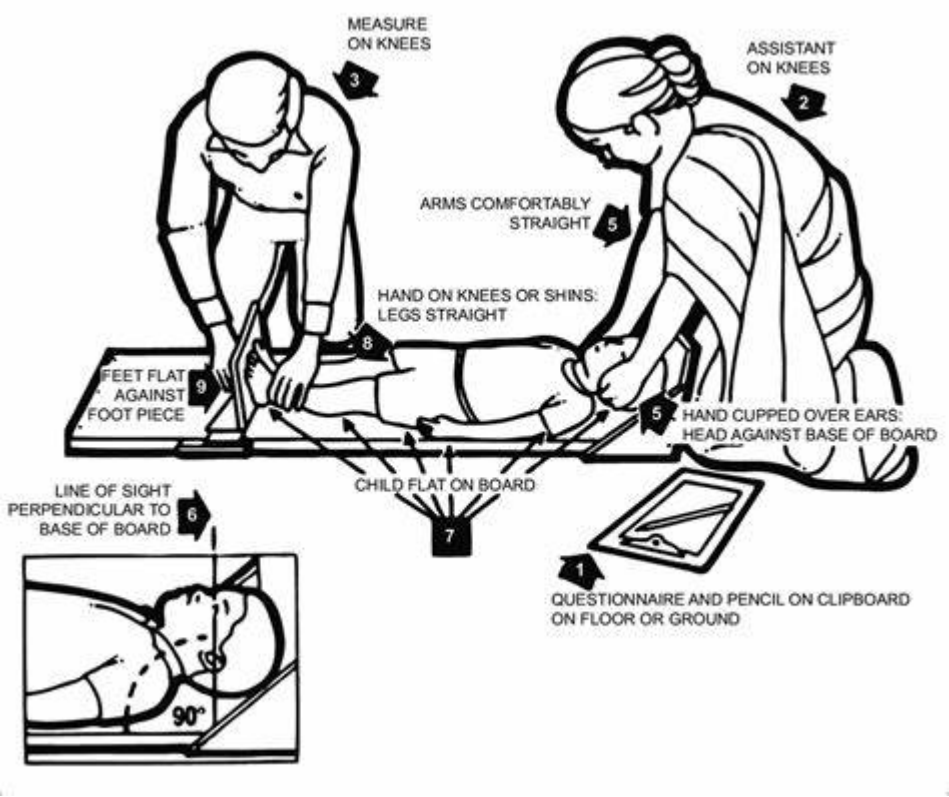


Figure 3: Measuring child length. Head in Frankfort horizontal plane ***Image Reference: Indian National Health Service Guidelines for Height and Weight Measurement for Infants.***

Section 4: Problem Solving

4.1 Participant does not show up for the measurements at the clinic

- Call and find out what has happened and if the participant is still coming to the clinic
    - If they are coming to the clinic then wait for them
    - If the participant cannot come to the clinic, ask if she would come if the study team sends a car to pick her up and do it if she agrees
    - If the participant cannot come that day, find out if the measurements at the clinic can be re-scheduled for another day
    - If the participant does not want to come to the clinic but agrees for the team to come to their home then go to her home and do the measurements
- If you are unable to reach the participant by telephone then go to their home to see if she can be located
- If you are unable to find the participant then report to the field co-coordinator/assistant coordinator who will address the issue

4.2 Participant does not agree to be measured

- Thank them for their co-operation and **do not** make the measurements they do not want done
- Record this in the electronic-tablet

4.3 Maternal or Infant Weight

4.3.1 The mother's weight exceeds 250 kg

- In electronic-tablet enter that they could not be weighed with the reason that the mother's weight is over 250 kg

4.3.2 The child cannot be separated from the mother so the mother cannot be weighed alone

- Ask if someone else could hold the infant while the mother is weighed
- If unsuccessful then thank them for their co-operation and **do not** make the measurements. Record this in the electronic-tablet.

4.3.3 The mother does not agree to be weighed, either herself or her child

- Thank them for their co-operation and **do not** make the measurements. Record this in the electronic-tablet.
- If she is happy for the child to be weighed then ask if someone else could hold the infant to measure the infant's weight measurement

4.4 Infant Length

4.4.1 Cannot straighten the infant's knees to lie flat on the board

- Straighten **one** leg and make the measurement with only one foot in contact with the footboard
- Record that the measurement was made with only one foot in the electronic-tablet
- Ensure the child remains positioned flat on the board while taking the measurement

4.4.2 Cannot position the infant's feet flat against the foot board

- Tickle the bottom of the feet

4.4.3 The infant is very upset and will not lie still

- Ask the mother to distract the infant with comforting words
- Give the mother a toy to distract the infant, sing to the child to calm the child down
- Record the child cried and measurement was very difficult to do because the infant was upset if you are concerned about the quality of the measurement
- If the infant is too upset to be measured after a good attempt then do not measure them a second time and record the reason a measurement was not done

4.5 Infant Length

4.5.1 Cannot straighten the infant's knees to lie flat on the board

- Straighten **one** leg and make the measurement with only one foot in contact with the footboard
- Record that the measurement was made with only one foot in the electronic-tablet
- Ensure the child remains positioned flat on the board while taking the measurement

4.5.2 Cannot position the infant's feet flat against the foot board

- Tickle the bottom of the feet

4.5.3 The infant is very upset and will not lie still

- Ask the mother to distract the infant with comforting words
- Give the mother a toy to distract the infant
- Record the measurement was very difficult to do because the infant was upset if you are concerned about the quality of the measurement
- If the infant is too upset to be measured after a good attempt then do not measure them a second time and record the reason a measurement was not done

4.6 Child height

- If child's caregiver does not want to take out the child's braids, enter this into CommCare so that it can apply the conversion factor. Ensure that caregiver takes her hair down so that her head can be placed flat on length-board
- If child has very high hair(that cannot be taken out), try to press the headboard of the length-board down as much as possible and record this in the electronic-tablet.
- If child is not able to stand up straight, record this in the electronic-tablet.

Section 5: Villages and total children assigned for data collection on each day

Table 2.0 – Itinerary for data collection

Date of Data Collection	Expert Team Number	Volunteer Team Number	Name of Village	Name of Commune	Estimated Travel time to village (mins)	Children Aged <24 Months	Time of Data Collection	Children 24-59.9 Months	Time of Data Collection	Total Children
5/28/2025	A	1 & 2	Diên Sơn	Long Sơn	20	33	1st Morning (Laser first)	37	2nd Morning (WHB first)	70
5/28/2025	A	1 & 2	Gò Chè	Long Sơn	20	22	2nd Afternoon (WHB first)	28*	1st Afternoon (Laser first)	22
5/28/2025	B	3 & 4	Biều Qua	Long Sơn	35	26	1st Morning (Laser first)	29*	2nd Morning (WHB first)	26
5/28/2025	B	3 & 4	Yên Ngựa	Long Sơn	35	13	2nd Afternoon (WHB first)	27	1st Afternoon (Laser first)	40
5/29/2025	A	1 & 2	Đồng Tròn	Long Sơn	25	43	Afternoon (WHB first)	37	Morning (Laser first)	80
5/29/2025	B	3 & 4	Sơn Châu	Long Sơn	30	40	Afternoon (WHB first)	30	Morning (Laser first)	70
5/30/2025	A	5 & 6	Long Thượng	Long Mai	10	13	1st Morning (WHB first)	20	2nd Morning (Laser first)	33
5/30/2025	A	5 & 6	Trung Thượng	Long Mai	10	20	2nd Afternoon (Laser first)	27	1st Afternoon (WHB first)	47
5/30/2025	B	7 & 8	Dư Hữu	Long Mai	15	16	1st Morning (WHB first)	30	2nd Morning (Laser first)	46
5/30/2025	B	7 & 8	Mai Lãnh Hữu	Long Mai	10	12	2nd Afternoon (Laser first)	23	1st Afternoon (WHB first)	35
5/31/2025	**Rest Day – Data Cleaning**									
6/1/2025	A	5 & 6	Hà Bôi	Long Hiệp	10	26	Morning (Laser First)	28	Afternoon (WHB first)	54
6/1/2025	B	7 & 8	Hà Xuyên	Long Hiệp	10	18	Morning (Laser first)	33	Afternoon (WHB first)	51
6/1/2025	**Go to additional back-up villages if more participants needed**									
					Total	282		292		574

Section 6: Team Composition and Roles (see Table 3.0)

- **10 Teams (20 Enumerators Total)**
    - **2 Expert Anthropometrist Teams**
        - 2 Measurers
        - 1 Recorder
    - **8 Volunteer Enumerator Teams (2 teams per village)**
        - 2 Measurers
        - 1 Recorder
- **Selection Criteria** (based on the WHO growth standard study (26))
    - **Expert Anthropometrists**
        - Prior anthropometric measurement training
        - Experience measuring anthropometry data in surveys
        - Precision & agreement verified through manual standardization
    - **CHW Anthropometrists**
        - Prior anthropometric training
        - Participation in Vietnam's national growth monitoring census
        - Precision & agreement verified through manual standardization
- **Additional Support Staff**
    - **Play Area:** 3 Volunteers + 1 WV Staff for every 1 Expert group and 1 CHW enumerator group (support Mobilization of children and caregivers & Child Play Area Supervision to provide snacks, play games, and sing songs with children; total of 8 additional support staff)

Table 3.0 – FIELD WORK TEAMS

Team	Measurement	Supporter	Data entry (mHealth)	Hard copy	Team Names
Team A					
1	Expert Anthropometrist (Nguyen Thi Trang)	Expert Anthropometrist (Nguyen Huu Ky)	WV Staff 3 (Nguyen Minh Thuat - PEO)	Partner 1 (District staff)	Expert Group A
2	CHW 1	CHW 2	WV Staff 4 (Duong Duc Hanh – PES)	Partner 2 (CHW 5)	Volunteer group 1&2
3	CHW 3	CHW 4	Commune Health Officer (Chi Hien, Y te xa Thanh An)	Partner 3 (CHW 6)	Weight measurement group
Floaters	CHW7, CHW8 WV Staff 1 (Thanh Nguyen, Hai C. Ta)				
Play Area	CHW15, CHW 16				
Team B					
1	PI (Diane Baik)	Expert Anthropometrist (Nguyen Anh Vu)	WV Staff 5 (Nguyen Quoc Tuan – PES)	Partner 1 (Provincial staff)	Expert Group B
2	CHW9	CHW 10	WV Staff 6 (Vo Tuan Hai – PEO)	Partner 2 (CHW 17)	Volunteer group 3&4
3	CHW11	CHW 12	Health Centre Nurse (Chi Le, Y te xa Thanh An)	Partner 3 (CHW 18)	Weight measurement group
Floaters	CHW13, CHW14 WV Staff 2 (Nguyen Minh Chi)				
Play Area	CHW19, CHW 20				

Section 7: Quantitative Data Collection Procedure

- **Training**
  - CHWs, CHW Supervisors, and Recorders will be trained in height/length measurement with laser device & ShorrBoard
- **Community Mobilization**
  - Orientation on ShorrBoard and laser device will be provided to caregivers prior to obtaining written consent
  - Written consent from caregivers will be collected before measurements are taken
  - There will be a child play area setup with toys & snacks while children and caregivers are waiting to be measured and again measured a second or third time
- **Daily Measurement Process**
  - **Measurement Site**: Regular growth monitoring site
  - **Children Measured in 2-4 villages per Day (each village will have 2 volunteer teams and 1 expert team measuring the children)**
    - **On average about 40 Children will be measured per village per day (approximately 2 villages per day for a total of about 80 children)**
      - Approximately 20 children aged <24.0 months AND 20 children aged 24-59.9 months per village
      - Each village and child measured by both Expert & CHW teams
    - **15-20 children per time slot** (2 slots in morning for children aged <24 months and 2 slots in afternoon for children aged 24-59.9 months per day – Caregiver and child pair will be grouped into 8-9 pairs and given a number. Numbers will be called and the child's length or height will be measured once. Enumerators will measure a second time using the same device after all children were measured once in the group. A third measurement will be taken at the end if the difference between first and second measurement is >0.7cm (16). The caregiver-child pair will be re-directed to the play area once the child was measured. Once all 17-18 children were measured, the devices will be switched between the expert and CHW enumerator teams and the children will be measured again for a total minimum of 8 measurements per child
    - CHW enumerator teams who will be measuring children will be changed every 2 days to account for heterogeneity of the measurers (total of 8 different CHW teams will be used)
    - Enumerator Groups will switch which device is used first at the start of each time slot to minimize bias
    - All children will be measured with both laser device and ShorrBoard
    - A minimum of 280 children (aged 24-59.9 months) and 280 children (aged 0-23.9 months) measured

Data quality of the quantitative data will be assessed in the evenings throughout the data collection period using the ENA2008 software to compare the data quality of the enumerators for height-for-age, and weight-for-height data to the international WHO reference standards to identify any enumerators that need to be retrained due to digit preferences or flags in children's height-for-age z-scores or weight-for-height/length z-scores ±5.0SD, according to WHO growth standards (11).

Pre-testing mHealth application. An mHealth data collection application will be developed and translated from English to Vietnamese. A child and caregiver profile are already in World Vision Vietnam and Ministry of Health's database system where each child and caregiver have a barcode that can be scanned during the data collection to speed up the data collection process since names, gender, and date of birth don't need to be re-entered. The overall mHealth application will also be field tested prior to data collection.

Trainings and Tools. World Vision (WV) anthropometric experts will carry out training of Community health workers (CHWs) in traditional manual height and length measurement techniques using the ShorrBoard and additional techniques in using the laser device. The training will include theoretical classroom training on how to accurately measure children's height or length using World Vision's *Measuring Child Growth Training Manual* (17). The training includes practical hands-on training using the ShorrBoard and laser device; and standardization exercises with a total of 10 children, 5 children <24.0 months and 5 children 24-59.9 months of age in the classroom. The standardization data will be collected by the CHWs and the CHW supervisors who are nurses at health centres will record the data. The CHW supervisors will be known as 'recorders' and will record the standardization exercise data using pen and paper to practice. Four WV staff will be trained in the mobile data collection application (from now on referred to as "mHealth app") and they will record the standardization exercise measurements and time on the mHealth app to give them time to practice and become comfortable. All the anthropometric experts and CHWs will have to pass the training manual's standardization exercise, which aligns with **WHO's Recommendations for Anthropometric Data Collection where the acceptable TEM cut-offs for length/height are TEM <0.6cm and <0.8cm for precision and agreement, respectively for CHWs and CHW supervisors.** The difference between the first and second measurement of the expert anthropometrist should be <0.4cm for his or her measurements to be used as the reference values to compare the measurements of the CHW enumerators during the standardization exercise (12).

The technology partner who developed the laser device will conduct the training on the laser device and will train the experts and CHWs in how to use the laser device and how to calibrate it. Each child will be measured using the ShorrBoard and laser device by each team. Classroom training on calibration of ShorrBoards, laser device, obtaining consent, collecting data using the mobile phone app and hardcopy registers will be conducted with all enumerators. Child's name, caregiver's name, gender, and date of birth is already in WV's excel database so each child will be given a barcode that will be used to identify the child, so the child's information does not need to be re-entered during the data collection.

Table 4.0 – Itinerary for Data Collection

Day #	Date	Activities
Day 1	**Mon May 26**	Train supervisors, WV staff, recorders (phone and hardcopy), floater, timer, Floaters and Play Area entertainers
Day 2	**Tues May 27**	Training of 16 CHWs, 1 Commune Health and 1 DHO (afternoon) - include 10 children (standardization exercise 5 length and 5 height) Lunch Setup community and do orientation simulation/practice (Simulation in community)
Day 3 to Day 5	**Wed May 28 to Fri May 30**	**7:00-8:00 – Depart hotel (Travel) to village** **8:00-8:30** - Orientation for community **8:00-10:00** - Measure First Age Group in Village **10:00-11:30** – Measure Second Age Group in Village **11:30-2:00** - **Lunch (Quick feedback meeting) and travel to next village** **2:00-2:30** - Orientation for next village **2:30-4:00** - Measure Second Age Group in Next Village 4:00-5:30 – Measure First Age Group in Next Village **Evening Feedback meeting and data quality check**
Day 6	**Sat May 31**	**Rest Day – Data cleaning/analysis, debrief meeting**
Day 7	**Sun Jun 1 & 2**	**7:00-8:00 – Depart hotel (Travel) to village** **8:00-8:30** - Orientation for community **8:00-10:00** - Measure First Age Group in Village **10:00-11:30** – Measure Second Age Group in Village **11:30-2:00** - **Lunch (Quick feedback meeting) and travel to next village** **2:00-2:30** - Orientation for next village **2:30-4:00** - Measure Second Age Group in Next Village 4:00-5:30 – Measure First Age Group in Next Village **Evening Feedback meeting and data quality check**

Appendix B – Local IRB approval (Vietnam) For Study 1

MINISTRY OF HEALTH
HANOI UNIVERSITY OF PUBLIC HEALTH

SOCIALIST REPUBLIC OF VIETNAM
Independence – Freedom - Happiness

No.: 66/2024/YTCC-HD3
Subject: Ethical Approval

Hanoi, April 11th, 2024

DECISION
On Ethical approval for research involving human subject participation

THE CHAIR OF THE ETHICAL REVIEW BOARD FOR BIOMEDICAL RESEARCH
HANOI UNIVERSITY OF PUBLIC HEALTH

- Based on decision No. 70/QĐ-ĐHYTCC by the Dean of Hanoi University of Public Health on the Issuing Regulation of the Institutional Ethical Review Board of Hanoi University of Public Health; February 01st, 2023;
- Based on Decision No. 310/QĐ-ĐHYTCC by the Dean of Hanoi University of Public Health on Establishment of The Institutional Ethical Review Board of Hanoi University of Public Health; June 01st, 2021;
- Based on Decision No. 123/QĐ-ĐHYTCC by the Dean of Hanoi University of Public Health about the member replacement of The Institutional Ethical Review Board of Hanoi University of Public Health; March 01st, 2023;
- Based on the minutes of meeting to review ethics application No. **024-066/DD-YTCC** dated April 11th, 2024,

DECIDED:

Article 1. Grant ethical approval for ethnographic study project:

- Study Title: **Accuracy of laser height and length measuring device in children under 5 years of age in annual growth monitoring census: An effectiveness validation study in Vietnam**
- Principal Investigator: **Diane Baik,** World Vision International (WVI)
  Nguyen Anh Vu, World Vision International (WVI)
- Research site: Minh Long district, Quang Ngai province
- Project time: from 01/01/2024 to 30/3/2025
- Data collection time: from 29/11/2024 to 10/12/2024
- Review type: Expecdited review

Article 2. This decision is effective from **11/4/2024** to **10/12/2025**

Article 3. Principal Investigator must report to IRB (The Institutional Ethical Review Board) about any change and risk associated with closing the research implementation. Active research projects are subject to random inspection by the IRB of HUPH.

CHAIR OF HUPH IRB
(Signature and full name)

Nguyen Thuy Quynh

SECRETARY
(Signature and full name)

Vu Thi Hau

BỘ Y TẾ
TRƯỜNG ĐẠI HỌC Y TẾ CÔNG CỘNG

HỘI ĐỒNG ĐẠO ĐỨC TRONG NCYSH
Số: 66/2024/YTCC-HD3
V/v chấp thuận các vấn đề đạo đức NCYSH

CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM
Độc lập – Tự do – Hạnh phúc

Hà Nội, ngày 11 tháng 4 năm 2024

CHẤP THUẬN (CHO PHÉP) CỦA HỘI ĐỒNG ĐẠO ĐỨC TRONG NGHIÊN CỨU Y SINH HỌC TRƯỜNG ĐẠI HỌC Y TẾ CÔNG CỘNG

- Căn cứ Quyết định số 70/QĐ-ĐHYTCC ngày 01 tháng 02 năm 2024 của Hiệu trưởng Trường Đại học Y tế công cộng về việc ban hành Quy chế tổ chức và hoạt động của Hội đồng đạo đức trong nghiên cứu y sinh học của Trường đại học Y tế công cộng;
- Căn cứ Quyết định số 310/QĐ-ĐHYTCC ngày 01 tháng 06 năm 2021 của Hiệu trưởng Trường Đại học Y tế công cộng về việc thành lập Hội đồng đạo đức trong nghiên cứu y sinh học nhiệm kỳ 2021-2026 (Gọi tắt là Hội đồng đạo đức - HĐĐĐ) xét duyệt các vấn đề đạo đức trong nghiên cứu y sinh học của các đề tài/ dự án;
- Căn cứ Quyết định số 123/QĐ-ĐHYTCC ngày 01 tháng 03 năm 2023 của Hiệu trưởng Trường Đại học Y tế công cộng về việc kiện toàn thành viên Hội đồng đạo đức trong nghiên cứu y sinh học Trường Đại học Y tế công cộng nhiệm kỳ 2021-2026;
- Căn cứ xem xét của Hội đồng đạo đức ngày 11/4/2024.

Nay Hội đồng đạo đức **chấp thuận (cho phép)** về các khía cạnh đạo đức đối với nghiên cứu:

- Tên nghiên cứu: **Đánh giá độ chính xác của thiết bị đo chiều cao, chiều dài bằng laser ở trẻ dưới 5 tuổi trong tổng điều tra theo dõi tăng trưởng hàng năm: Nghiên cứu kiểm chứng hiệu quả tại Việt Nam**
- Mã số: **024-066/DD -YTCC**
- Nghiên cứu viên chính: **Diane Baik** – Tổ chức World Vision International (WVI)
  Nguyễn Anh Vũ – Tổ chức World Vision International (WVI)
- Địa điểm tiến hành nghiên cứu: Huyện Minh Long, tỉnh Quảng Ngãi
- Thời gian thực hiện nghiên cứu: Từ 01/01/2024 đến 10/12/2024
- Thời gian thu thập số liệu: Từ 29/11/2024 đến 10/12/2025
- Quy trình xét duyệt: nghiên cứu được xem xét theo quy trình rút gọn
- Nghiên cứu viên chính phải báo cáo khi có bất kỳ thay đổi nào hoặc sự cố phát sinh với nghiên cứu
- ***Thời gian được chấp thuận (cho phép):*** Từ **11/4/2024** đến **10/12/2025**

Lưu ý: **HĐĐĐ có thể kiểm tra ngẫu nhiên trong thời gian tiến hành nghiên cứu.**

CHỦ TỊCH HỘI ĐỒNG	**THƯ KÝ HỘI ĐỒNG**
(Ký và ghi rõ họ tên)	*(Ký và ghi rõ họ tên)*
Nguyễn Thúy Quỳnh	**Vũ Thị Hậu**

Appendix C – Questionnaire tools for collecting height/length data and weight data

Laser Device Research

Data entry Child Height/Length measurement

Scan ID Number

-

Enter ID Number

-

Date of survey

2025-04-16

2025-04-16

Child details

2. Child's name

Please update if information has changed.

3. Child's sex

Please update if information has changed.

- 1= Male
- 2 = Female

4. Child birthdate

Please update if information has changed.

yyyy-mm-dd

The child is NaN months NaN days

8. Child's caregiver name

Please update if information has changed.

Laser measurement

The location of the measurement board has

- ◯ 1 = Fully shade
- ◯ 2 = Semi shade
- ◯ 3 = No Shade

Height 1st time

by cm. Type "." if the height is decimal

_____

Minute

-

_____

Second

-

_____

Is the child crying during measurement?

- ◯ 0 = No
- ◯ 1 = Yes

Height 2nd time

by cm. Type "." if the height is decimal

_____

Is the child crying during measurement?

- ◯ 0 = No
- ◯ 1 = Yes

Length/Height difference between 2 measurements is NaN cm

_____

3rd MEASUREMENT REQUIRED!!!!!

_____

Height 3rd time

by cm. Type "." if the height is decimal

_____

Is the child crying during measurement?

- 0 = No
- 1 = Yes

Wooden Height Board

Height 1st time

by cm. Type "." if the height is decimal

_____

Minute

-

_____

Giây

-

_____

Is the child crying during measurement?

- 0 = No
- 1 = Yes

Height 2nd time

by cm. Type "." if the height is decimal

_____

Is the child crying during measurement?

- 0 = No
- 1 = Yes

Length/Height difference between 2 measurements is NaN cm

_____

3rd MEASUREMENT REQUIRED!!!!!

_____

Height 3rd time

by cm. Type "." if the height is decimal

_____

Is the child crying during measurement?

- 0 = No
- 1 = Yes

1. Hardcopy format for collecting height/length data:



Paper data entry tool for height and length.:

2. Questionnaire for measuring child weight:



Weighing Questionnaire tool.pd

3. Standardization Exercise Template:



Standardization Exercise Template.xlsx

Appendix D – Consent Forms



Consent Forms in English.pdf

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