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Anthropometric Kit Development for Stunted Early Detection among Children Under-two Years Old: Providing a Portable Body Length Measurer

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Abstract

BACKGROUND: One of the keys to stunting reduction, a condition of lower height or length compared to their age, is the measurement of children in the community. However, the infantometer as the gold standard is not accessible by all community health workers (CHWs).

AIM: The aim is to develop a stunted early detection tool (SEDT) for Indonesian children under-two years old.

MATERIALS AND METHODS: This qualitative study was conducted as the first phase of the development process and focused on the experts' judgments of the prototype. Experts' judgments were recorded qualitatively. There were five in-depth interviews with anthropometric, health promotion, and media design experts. Rogers' Diffusion of Innovations Theory and thematic content analysis were used to analyze the relative advantages, compatibility, complexity, and observability.

RESULTS: The prototype of the SEDT consists of two tools, including a length mat to measure children's length and a circular disc that helps CHWs classify the nutritional status of the children according to length for age length-for-age Z-score. Most experts agreed that the SEDT is a good instrument for the early detection of stunting among children under 24 months. The tool is designed to be portable, child-friendly, compatible, and easy to use. Although its development has the potential to help CHWs fulfill their responsibilities, major changes were needed specifically to improve the tool's stability and design.

CONCLUSIONS: This analysis gives broad information about the SEDT's potential as a SEDT considering its relative advantages, complexity, compatibility, and observability. Further research is important to validate potential users' responses in a representative population.

Introduction

Stunting is recognized as a serious public health problem in low-to-middle-income countries, including Indonesia [1], [2]. The Global Nutrition Reports in 2016 and 2020 estimated a significant decline in the number of stunting cases among children under-five from 159 to 149 million. However, these efforts should be improved to achieve the 2025 reduction target of stunting prevalence, considering the current and persistent threat of the COVID-19 pandemic [3]. The Indonesian Basic Health Survey showed a promising decline of stunting prevalence from 37.2% to 30.8% from 2013 to 2018 [4]. This number is widely varied in each province, with the highest rate of 42.6% in East Nusa Tenggara.

In Indonesia, collaborative efforts have been made between the government and other stakeholders in conducting nutrition-specific and diet-sensitive programs [5]. These include functional food development and dietary assessments [6], [7]. Among those agents, the roles of the Integrated Health Post (IHP), well-known as *Posyandu* in Indonesia, and community health workers (CHWs) appear to be the most significant in supporting stunting reduction programs. The CHWs play an important role in monitoring the growth of the children, including routine anthropometry measurements and nutrition education [8], [9]. Measurements of children's body length and anthropometric index according to length-for-age Z (LAZ)-score are essential in detecting stunted development, and are seen as some of the first signs of stunting among young children.

An easy-to-use field anthropometry gauge is fundamental to optimizing the role of IHP. In 1990, a study by Zeitlin *et al.* [10] had already demonstrated how developing a simple anthropometry tool could increase the early detection of stunting in the community. Anthropometric tool development is important to both prevent and map the current situation of stunting [11], [12]. More importantly, the availability of a small-scale portable body length measurer should be given more priority since applying stunting management for children under-two years old is the best preventive and most proactive approach [2].

Many IHP struggles in providing appropriate anthropometric measurers, which causes late stunting detection. The CHWs should have the ability to measure young children's body length using a proper tool and standardized procedures. In fact, local CHWs often measure the length of children under-two years using a meter tape, wood measuring instruments, *microtoise*, and a homemade growth mat approximately 2–4 times a year [13], [14]. All mentioned tools have a higher risk of measurement bias because the CHWs could not check its accuracy. On the other hand, not all IHP could provide a modern infantometer due to budget limitations. The authors discerned this situation as a challenge to innovate a field anthropometry gauge, which can help the CHWs in the IHP to better monitor the children's nutritional status. This research aimed to develop a prototype for the stunted early detection tool (SEDT) according to the judgments from experts in anthropometrics, health promotion, and media design. This study provided valuable information about the potential of the SEDT development to support CHWs' work in stunting reduction.

Materials and Methods

Study setting and design

This research was conducted in March-April 2020 in Yogyakarta, Indonesia. This present study, which focused on experts' testimony, was the first of several phases to develop the SEDT. The activities were mainly divided into two parts: (1) Developing the SEDT prototype, and (2) in-depth interviews with the experts. Ethical permission was given by the Medical and Health Research Ethics Committee with ref. no. KE/FK/0004/EC/2019. All respondents understood the course of this research and signed the informed consent form.

Developing SEDT

Before receiving the experts' judgments, the researchers developed the SEDT based on a thorough literature review and observations of the currently available tools in Indonesia. There were several steps involved as follows: (1) Specify the problem, (2) literature and experience review, (3) develop the SEDT prototype, and (4) design evaluation by the experts. These steps were done following the design research methods described by Euler [15].

Expert judgment

Experts were people who have more than 20 years of experience in terms of anthropometry and health promotion media. This research included five experts from academician backgrounds (university), public health centers (PHC), and policymakers (provincial public health office). All backgrounds have the capability to judge SEDT based on theoretical and practical experiences as proven by their *curriculum vitae*, research/work interests, and publications. Expert judgment was selected as the first phase to develop SEDT since the experts have prior knowledge and experience in using similar instruments, which is expected to minimize the gap between SEDT characteristics and potential users' needs.

The researchers selected the respondents using purposive and snowballing sampling [16]. Prior relationship with the focus of the study is beneficial so that the respondents can better understand about their role in this research. This focus was intentionally limited to public health and nutrition concerns for the experts to share their perspectives about SEDT characteristics. The researchers did not prompt them for answers beyond the scope of this research. All participants joined in this study voluntarily and gave their consent to be recorded.

Instruments and procedures

A trained research assistant with a background in nutrition and public health conducted the interviews for all respondents. Training was given by the lead researcher, who has a PhD in nutrition and extensive experience in community nutrition research, including the related programs in IHP and PHC. The interviews were also guided by several key-point questions, as written in Table 1. The questions were purposively made to understand experts' opinions on SEDT characteristics by adapting Roger's Diffusion of Innovation theory. The interviews were not limited to closed-ended responses but developed based on their answers. Interviews were

Table 1: Sample questions concerning the innovation characteristics

Themes	Sample questions
Relative advantage	Can you explain in your opinion, do CHWs need SEDT?
Compatibilit	What do you think about the design of SEDT compared to CHWs work at IHP?
	How is the potential for IHP to use SEDT?
Complexity	Do you have any difficulties when using SEDT?
Observability	What do you think about the design of SEDT?

CHW: Community health worker, IHP: Integrated health post, SEDT: Stunted early detection tool.

conducted in private for ~45 minutes each, face-to-face, and all were audio recorded.

Interviews with the experts were done in each of their offices. The researchers brought the SEDT for the demonstration. Before the interview started, the researcher gave them time (approximately 15–30 min) to use and observe SEDT. The interviewers reported the results to the lead researcher after each interview ended to minimize bias. A consensus was reached at least by three researchers to determine when the information saturation had been achieved.

Data analysis

Thematic-content analyses were conducted by researchers trained in qualitative research methodology. Informative details from the interviews were processed following the steps outlined by Thorne [17] that included audio record, verbatim transcription, and classification of several themes. Complete transcripts were written within seven days after each interview, and returned to the informants to ensure the veracity of the data and obtain their approval. Interviews were done in Bahasa Indonesia and translated into English with the help of a professional language editor. The information was synthesized into short narratives to create systematic tables with meaningful details and then further discussed while comparing to the current literature. Trustworthiness was obtained by asking the same question to different participants and collecting data from different sources [18].

This research used thematic content analysis. Several themes were determined before conducting the present study, including relative advantage, compatibility, complexity, and observability following the innovation characteristics described by Roger's Diffusion of Innovation Theory [19]. Trialability was not discussed since it cannot be examined in this phase. The results of the study are presented in a data matrix, with direct quotations, explanations of the results, and details of the researchers' discussions. The identities of the participants remain anonymous and respondents are only referred to by gender and age. Example quotations were written in tables with the references in brackets. For example, [Q2.1a] was used, where "Q" stands for quotation, "2" for the first theme, "1" for the first sub-theme, and "a" for the first quote in the sub-theme.

Results

Stunted early detection tool

The authors developed the SEDT based on a thorough literature review to design a toddlers' field measurer that is convenient for use in Indonesia. Justifications to develop the SEDT according to the strengths and weaknesses of available tools in Indonesia are shown in Table 2.

Table 2: Characteristics of available tools in Indonesia

Number	Available tools	Strengths	Weaknesses
1	Infantometer	Gold standard	Relatively heavy, not all IHP have the access to this tool [20]
2	Portable length measurer	Portable, the structure made of stainless metal	Relatively difficult to assemble the tool [13]
3	Multifunction tool	Can be used to measure height and length	Made of iron (not child-friendly) [14]
4	Nutritional status disc	Classify children's nutritional status	Difficult to understand did not use current regulations by the Ministry of Health [21]
5	Growth mat	Quickly detect stunting because it is qualitative	Did not know exact length of the children, CHWs had to make their own print so that it is prone to error [22]

CHW: Community health worker, IHP: Integrated health post.

After careful reviews, the SEDT prototype was made with several desired characteristics such as: (1) portable, (2) valid and reliable, and (3) child-friendly. This tool was designed as a package of SEDTs consisting of a body length mat, nutritional status discs to measure LAZ Disc, and a manual book. The length mat has three main sections: (1) a semicircular headboard, (2) a straight-footboard, and (3) a baseboard (Figure 1). The head and footboards are made of safe, biodegradable polylactic acid plastic, while the mat is made of banner fabric. The body length mat has a scale of 0–100 cm and an accuracy of up to 0.1 cm. Meanwhile, the disc consists of two main parts, a large circle and a smaller one. It pinpoints the nutritional status of the children under-two years old using the LAZ index. The disc is made of Ivory paper in pink (for females) and blue (for males). It contains a nutritional status cut-off, for stunting and normal status, for each age of the children aged 0–24 months based on the newest regulations established by the Indonesian Ministry of Health [23]. A user guideline is included with these tools to help the users understand how SEDT works.

Characteristics of the respondents

Five experts joined this study. All informants were only interviewed once and they all confirmed the content and gave consent to share the written transcripts afterward. Subjects' characteristics are shown in Figure 2.

Characteristics of the SEDT

The authors compiled the information from all participants and classified their responses according to four themes: relative advantages, compatibility, complexity, and observability. Table 3 shows the thematic content analysis results.

Discussion

As the largest archipelago country in the world, many IHPs in Indonesia do not have a proper nutrition

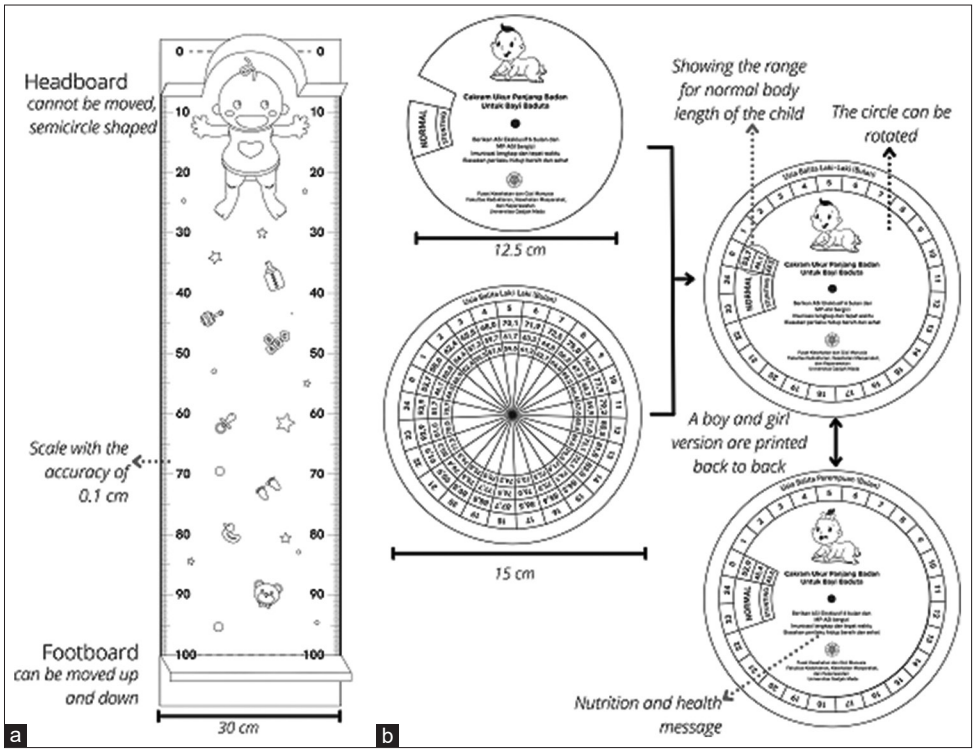

Figure 1: Prototype of Stunted Early Detection Tool consists of (a) body length mat and (b) LAZ disc

and health equipment. The situation is varied but mostly occurs in remote areas. During the COVID-19 pandemic, the availability of an early stunted detection tool is urgently needed. It can help CHWs to maintain essential health services that are promoting stunting reduction programs in the area.

Experts' opinions are important in developing a new tool [15]. Dror [24] stated that experts are people who can give their objective judgment without being influenced by irrelevant information. All experts in this study have practical and theoretical public health experience for more than 20 years.

Durable, safe, and easy-to-use

Based on the experts, three main benefits can be obtained by using SEDT: durability and safety of the materials, ease of function use of SEDT. We can assure

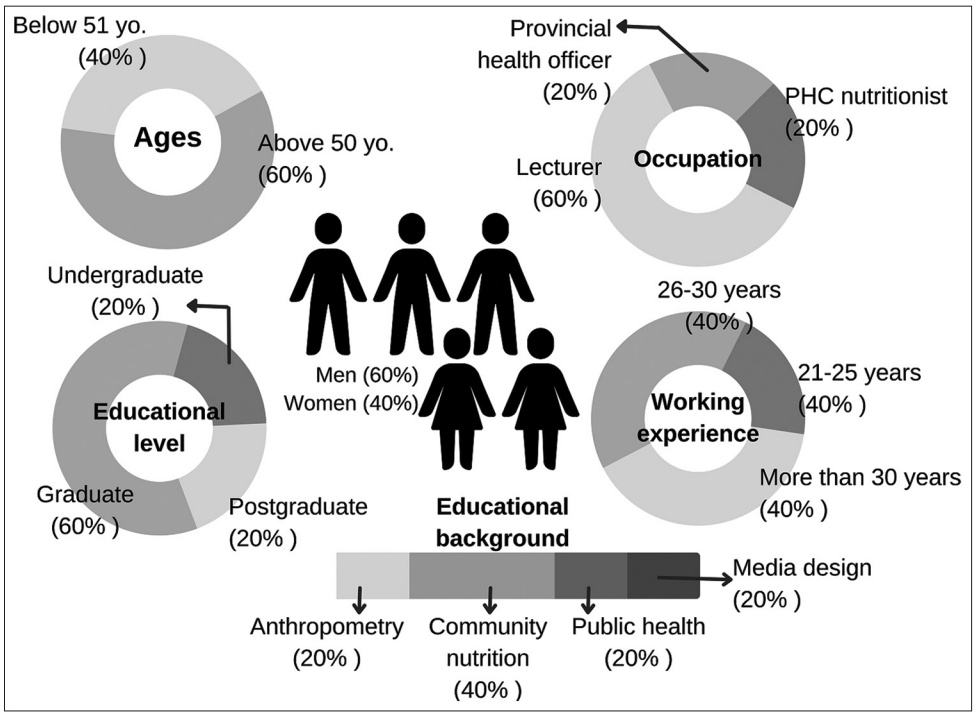

Figure 2: General characteristics of the respondents

Table 3: Expert judgement on the characteristics of stunted early detection tool

Number	Themes	Sub-themes	Example of quotation
1	Relative advantage	Durability and safety	[Q1.1a] ".this is maybe more durable… this plastic will not be ripped easily." *male, 59* years old
			[Q1.1b] "… it's safe. the important thing is that there is no sharp point. There is no (sharp) point, it's not rough . this is not . from materials which if inhaled can be dangerous" *female, 50* years old
		Function	[Q1.2a] "Yes, this is early detection (tool). But for early detection, it shows here (discs), not here (mat) . this (mat) is . just to get the data (data of length measurement) ." *male, 50* years old
			[Q1.2b] ". (stunting can be detected) from growth monitoring in the (KMS – child growth monitoring sheet). so if (SEDT) for stunting detection. it is not appropriate . you know, (from theory) the weight increment will be followed by the height increment as well" *male, 48* years old
		Potential use	[Q1.3a] ".hopefully with this (SEDT) tool, cheaper, better, it can be easier… to obtain. Current situation of body length measurer… (The CHWs) use by turns. From one IHP to another. Because the number is small. Even though the health officers have dropped 1–3 tools per year, the number of IHP is too large." *male, 48* years old
			[Q1.3b] "Ideal design, because it's portable. So, it can be done wherever you can. The current one (infantometer) is massive, it's big. Even though current infantometer is light. but it's big too ." *male, 48* years old
2	Compatibility	Compatibility with current knowledge	[Q2.1a] "if possible, the illustration shall support small child…" *male, 59* years old
			[Q2.1b] "… (The length mat) have to be calibrated, because if we thought its accurate, but is it true when the drawing is calibrated. We measure that (mat) and is it the same with Actual Scale." *female,* N/A
			[Q2.1c] "This tool (the mat) must be . stable, meaning that it doesn't shift. This is how you later ensure that . this tool does not shift, changes position when measuring . (this) is rather bent or folded right . then later after all this is done according to the operational procedures, then this tool must be tested first, the validity (and) reliability" *male, 51* years old
			[Q2.1d] "… This has something to do with the tool (SEDT) actually. if the tool is already. the accuracy is close to that (infantometer). It's (SEDT) already allowed to be used. It (depends on) specificity and sensitivity to be used." *female,* N/A
		Compatibility with subjective value	[Q2.2a] "Too much color (in SEDT), too crowded is annoying. Disturb the focus of writing. What important is these letters, numbers, right…" *male, 59* years old
			[Q2.2b] "…maybe the material (of the mat) should be replaced… because if like this… it (the floor) should be flat… (if not, the mat) will be curled up… the accuracy will change" *female, 50* years old
3	Complexity	Potential use	[Q3.1a]". (The LAZ disc) will be used by CHWs, (they already) have high level of education, maybe (they) can. Can understand. O… normal length will be 81–93 for 24 months old" *male, 59* years old
			[Q3.1b] "Not hard (to use SEDT), even easier, just like infanto (*read*: Infantometer), just slide here and there… measurement has (the potential for) a lot of errors… the measurer, position, it needs patience (to measure)…" *female,* N/A
		Functional design	[Q3.2a] "here (Scale in the mat) don't you need (number) 1 2 3 4 5? . (for example) this is 50 (if I want the accuracy of 1 mm, I must count) 1 2 3 4 . The Scale here should be made easier" *male, 48* years old
			[Q3.2b] ". the numbers (LAZ index on the disc) are in accordance with the WHO table (read: WHO growth standard)… this (the disc) is already a good design…" *male, 51* years old
4	Observability	Design	[Q4.1a] "The text on the disc is too much. can't it be more compacted, shorten it like that. This is an institution name, right, the identity of the institution. maybe (the name can be) abbreviated if it can. or. vice versa. it must (look good when) be seen upfront. yes, here, but maybe (the writing should be) smaller." *male, 59* years old
			[Q4.1b] ".because clearly, concretely it (the Scale) is not visible. Does this (the Scale on the SEDT mat) show zero? Try to pay attention. (It is) not. Where. It's suddenly jumped to 10 (because Scale no 1–9.9 cm is covered with the headboard). Where is the zero." *female, 51* years old
		Information written	[Q4.2a] "The writing is not consistent . so this is the writing, capital or not" *male, 59* years old
			[Q4.2b] "Now, this (the disc) was adjusted, from the normal to severe stunting, it's not yet (easy), it's still difficult. ordinary people difficult to understand. There are still other interpretations if you don't know, for example in lower limit (meaning what), this between (number) this (meaning what)…" *male, 50* years old
		Appearance	[Q4.3a] ".Yes, the important thing is that colors are good. Bright colors are better because they create, sorry, the child's memory is obtained from hearing and sight. The more they see. good picture, they will feel comfortable. So, when they were measured they don't (easily) cry, it's okay." *female, 51* years old
			[Q4.3b] ".The meter (mat illustration inside the guideline) is white, the background should not be white. It's less captivating. less contrast …" *male, 59* years old

KMS: *Kartu Menuju Sehat*, CHW: Community health worker, IHP: Integrated health post, SEDT: Stunted early detection tool, N/A: Not available, LAZ: Length-for-age Z-score.

that the material of the length mat will not be ripped easily and there are no sharp points or edges.

The safety and durability indicators of the tools may vary depending on the intended function of the tools. As an example, Keller *et al*. [25] mentioned that regarding exoskeleton robotics for children with movement disorders, tool safety and durability depend on the child's anatomical condition, no mechanical parts close to the head or body, easy to operate, easy to control, etc. Aflatoony and Parsons [26] stated that children's measuring tools just as clothes, will last longer if they adjust to the needs and size of the child. This fact emphasizes that safety and durability are essential characteristics on a newly developed tool, as stated by the respondents.

> *".this is maybe more durable… this plastic will not be ripped easily."*
> *(male, 59 yo.)*
> *"… it's safe. the important thing is that there is no sharp point. There is no (sharp) point, it's not rough. this is not. from materials which if inhaled can be dangerous"*
> *(female, 50 yo.)*

The United Nations Children's Fund mentioned safety as one aspect that must be met in child anthropometric measuring devices [27]. The child-friendly nature is fundamental because the target subjects to be measured by the SEDT are children aged 0–24 months. Aflatoony and Parsons [26] stated that a tool will be more durable and easily accepted when adjusting to the size of the child. This has been fulfilled in the development of SEDT, which can accommodate a maximum body length scale of Indonesian children aged 0-24 months which is 97 cm [23]. The World Health Organization [28] also supported the feature of a good body length or height measurer that should accommodate the accuracy of 0.1 cm, which was in accordance with the specifications of the SEDT. The SEDT mat also has three main parts: A headboard that cannot be moved, a baseboard for placing children, and a footboard that is adjustable and can be easily moved.

Another relative benefit is the portability of SEDT. Portable devices are one of the advantages that make it easy for prospective users to accept and utilize products [29]. Portable products are easy to use, can be

easily moved and used in various situations, and tend to be easily accepted by potential users [30], [31], [32]. The experts in this study agreed about the benefits of portable tools such as easy to use, can be moved and used in various situations, and have a higher potential to be accepted by prospective adopters [31].

> *"ideal design, because it's portable. So, it can be done wherever you can. The current one (infantometer) is massive, it's big. Even though current infantometer is light... but it's big too." (Male, 48 yo.)*

The experts compared our newly developed tool with the infantometer as the gold standard. In some situations that required CHWs to measure in many places, SEDT was more helpful because it is light and has a smaller size.

On the complexity aspect, experts thought that CHWs are accustomed to measuring body length and monitoring growth so that it will not be difficult to use SEDT.

> *"Not hard (to use SEDT), even easier, just like infanto (read: infantometer), just slide here and there… measurement has (the potential for) a lot of errors… the measurer, position, it needs patience (to measure)…" (female, N/A)*

This response is in line with the program promotions of the Indonesian Ministry of Health [8], which published training modules for CHWs so that they can perform nutritional monitoring and education during the implementation of IHP. Training is important to improve the knowledge, attitude, and skills of the CHWs in understanding the signs of stunting among young child [33]. Tse *et al*. [34], on the contrary, stated that in carrying out their tasks, sometimes the CHWs are not given adequate training. In addition, if limited in time or tools, the CHWs' work experience will also affect their performance in measuring body length and determining nutritional status.

Rogers' diffusion of Innovation theory usually includes trialability aspects of an innovation. However, this term is not discussed in this article since it was the first phase of prototype development and does not have any trialability features. Trialability refers to the degree of experimentation, or how potential users can try to use innovations on a limited basis. The trialability is closely related to the intention to adopt an innovation because it provides a direct experience for potential users to try to use the innovation [19]. The aspect of trialability will be written in another article after follow-up research has been conducted and potential adopters have enough time to use SEDT daily.

Improvements are needed for SEDT

On the observability aspect, the experts gave their opinions about the perceived functional aspects and artistic design of the SEDT. A good innovation must follow the needs of potential users [35]. In this study, the potential users are CHWs, while the subjects measured are children 0–24-month-old. All experts agreed that the design of the SEDT needed to be improved. This included almost all aspects of SEDT, from language clarity to functional design, such as the length of the footboard, shapes, and materials.

The experts demanded to change the illustration drawn on the mat. Children aged 0–5 years have high curiosity to understand their surroundings. They learn by playing through the images and sounds they see and hear [36]. This is supported by Ganea *et al*. [37], who mentioned that pictures or illustrations that resemble the real world can help children in learning about their surroundings. In addition, the use of bright colors is also associated with children's emotions which are expected to help with the measurement process [37], [38], [39].

Besides its mat illustration, the LAZ Disc also needed to be improved. The SEDT consists of two tools that complement each other. A length mat is used to measure the body length of the children with 1 mm accuracy. Measurement results are then classified into several categories of nutritional status according to LAZ z-score using the SEDT discs. Moreover, the discs also play an important role as health education media that are simple tools suitable to be used not only by CHWs but also other health workers. Several essential messages written by respondents include exclusive breastfeeding, weight monitoring, and infant feeding, which are considered common yet important messages to be given [40]. This feedback suggested that there are many improvements that can be made.

> *"the text on the disc is too much... can't it be more compacted, shorten it like that. This is an institution name, right, the identity of the institution... maybe (the name can be) abbreviated if it can... or... vice versa. it must (look good when) be seen upfront. yes, here, but maybe (the writing should be) smaller..." (male, 59 yo.)*

The opinions about observability also correspond to that of the compatibility aspect. Even though, according to the complexity assessment, the experts said that CHWs could easily understand how to use SEDT, some parts of the length mat might hamper the measurements accuracy. For instance, the material could be folded during measurement and it was hard to get the right position of the footboard. The illustrations added at first to the length mat, and the LAZ disc was also considered not appropriate for the children and the way CHWs worked.

> *"This tool (the mat) must be... stable, meaning that it doesn't shift... This is how you later ensure that... this tool does not shift, changes position when measuring... (this) is rather bent or folded right... then later after all this is done according to the operational procedures, then this tool must be tested first, the validity (and) reliability" (male, 51 yo)*
>
> *"too much color (in SEDT), too crowded is annoying. Disturb the focus of writing. What*

important is these letters, numbers, right…" (male, 59 yo)

The Diffusion of Innovation Theory is essential for managers or policymakers in an organization to make decisions. This theory is chosen as the paradigm throughout our development process, not only during the consideration of the experts' judgments but also for the responses and assessments of potential users in a larger population in the future. This analysis provides good forecasting of whether the tool will be accepted or needs further improvement. For example, the higher the observability of an innovation, the more confident the CHWs leaders will be in the advantages that can be obtained when adopting the innovation.

The development of the SEDT aimed to provide a portable and child-friendly measuring tool. Compared to several tools available in Indonesia, SEDT seems to overcome the others' limitations. For example, SEDT can easily be used everywhere because it is light and has a small packed size compared to an infantometer, which is sometimes also hard to obtain. The prototype was also made of 1 mm plastic without sharp edges and was given playful illustrations to reassure the children when they see the tool. This trait is also improving the characteristics of the multifunctional [14] and portable measurer [13]. The utilization of SEDK needs collaboration between the innovator, experts, and also community as the final users. As mentioned by Chen *et al*. [41], examples from the scientific community are needed to create lifelong learners who are not afraid of innovation and change.

This study has some limitations by only using the qualitative approach. This method implies that the results must be carefully analyzed and are not easily generalized in a larger population. On the other hand, qualitative research can manage information without destroying its complexity and context [42], which was the main aim of the researchers. Conducting qualitative approach to identify, manage, and analyze the opinions from the experts can give more in-depth understanding about how to improve the SEDT rather than using only quantitative questionnaires.

This study emphasizes the potential of the SEDT as an alternative SEDT that is easy to use by the Indonesian CHWs and also possibly for other developing countries who are facing a similar problem of stunting. Bearing in mind that this study is part of the first steps of SEDT development, the researchers aim to continue with other follow-up analyses. One of those follow-up steps was the validity test that has been previously published in Nurlita *et al*. [43]. The kit is also in the process for patent registration with the number: P00202004432.

Conclusions

The development of the SEDT has the potential to be used as a body length measurer and stunted early detector among children under-two years old. Some of the relative advantages identified in the SEDT were portability, safety, and its function as an early detection tool for stunting. Many improvements, according to the experts, were needed, particularly to improve its observability and compatibility and lower its complexity. Further developing processes and research involving potential users in a larger population are important to make the optimal improvements to the SEDT.

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