Thalir: A Nutrition-Monitoring and Educational Tool for Health Auxiliary Workers

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Abstract

Health auxiliary workers struggle with standardizing malnutrition diagnosis and providing locally accessible treatments for lasting improvement of community nutrition. At the Tribal Health Initiative and proximal villages in Sittilingi valley, it was observed that malnutrition is a common problem, which leads to compromised immune systems, predisposing community members to disease. Health auxiliary workers and THI staff reported a need for innovation in the malnutrition space, citing interest in contextually appropriate diagnostic tools and effective nutrition educational methods for patients. Standardization of the diagnosis process, automated record keeping, integration of qualitative and quantitative diagnostic methods, lasting education of community members and promotion of local treatments were prioritized. To achieve these aims, a novel diagnostic tool with educational modalities was developed. To promote the continuity of the project, team members intend to invest time in strengthening existing partnerships at THI, applying for an IDIN microgrant and other start-up funding, as well as leveraging resources available to team members in their respective networks.

Context

Background

Malnutrition is a common problem in India, with childhood malnutrition levels being the second highest of any country (Parimalavalli, 2012), exceeding 30% (UNICEF, n.d.). Malnutrition in children not only leads to disease spreading, but also physical abnormalities and cognitive impairment (de Onis, Brown, Blossner, & Borghi, 2012). Additionally, malnutrition is known to decrease immune response, leading to higher incidence rates of communicable diseases including Tuberculosis (TB), for which over half of cases can be linked (Bhargava et al., 2014).

Rural villages have especially high incidence rates of malnutrition. In the Salem district children have even higher rates malnutrition rates than the national average, with over 93% of children 5-6 years old being underweight (Parimalavalli, 2012). In the Sittilingi Valley, malnutrition has historically begun upon a child's transition to supplementary feeding from breastfeeding at 6 months of age.

Community Description

Tribal Health Initiative (THI) is a public charitable trust located in Sittilingi Valley of Tamil Nadu, India. THI endeavors to provide medical care to 22 villages located in the valley, and 11 villages in the Kalrayan Hills. 75% of patients are tribal (Initiative, 2015). THI strives to improve community health using contextually appropriate methods and local solutions. Through medical

care, patient education, and local industry creation, THI achieves its mission of improving holistic community health.

THI has started a number of community empowering initiatives. This includes staffing of local community members as health auxiliary workers (HAW), for which it provides medical training. Through HAWs, it monitors the health of the local villagers, identifies those needing care, and educates community members about maternal and child health, nutrition, disease treatment, and prevention.

THI staff includes literate and illiterate HAWs, and THI provides them with transportation to the villages as well as educational, diagnostic, monitoring, and treatment materials. Cell phones are not included among their tools, although half of HAWs do have basic phones.

The villages themselves function based on a primarily agricultural economy, with 88% of community members being farmers (Parimalavalli, 2012). Community members typically farm for their own personal consumption, with only a few members producing excess crops for market with intentionality. Although the community is agricultural, due to the introduction of white rice rations provided by a government subsidy program 8 years ago, white rice is consumed preferentially over more nutritionally beneficial crops such as millet. Village diets are primarily vegetarian, with few vegetables, little fruit, and oftentimes no milk available.

Through nutrition as well as maternal and child health improvement education and monitoring initiatives, THI was able to significantly decrease morbidity and mortality in the region. Due to the government pledging to take over malnutrition monitoring, beliefs that education provided by the community would pass on through generations, and funding cuts, the malnutrition monitoring and education program conducted by THI was ceased in 2008. Due to a lack of efficacy of the government program and a lack of community memory of good nutrition practices, community members are undernourished. In response, THI is looking to reinstate a malnutrition prevention program in conjunction with a new maternal and child health program. For this program, THI is seeking innovative tools and methods.

Design Process

Summary of Design Process

The design process utilized was grounded on co-creation, with special emphasis on appropriately identifying and framing the problem for which a solution would be designed. During the design process, the following activities occurred:

- Initial Community Visit
- High-Level Problem Framing
- Co-Creation Community Visit
- Narrowing of Problem Frame
- Solution Ideation
- Solution Identification
- Value Proposition Generation

The initial community visit focused on identifying prevention strategies for transmission of communicable disease, such as TB. Recurring community feedback indicated that proper nutrition was the primary means by which community members were familiar with for disease prevention. Recurring sentiments expressed that nutritional status was waning because of increased reliance on free rationed white rice. Combined with confirmatory secondary research that nutritional status and immunity are highly correlated, the team pivoted the focus to improving nutritional status specifically. A second community visit and co-creation feedback session informed the choice of a more specific problem frame in this space. Ideation using brainstorming, brainwriting, and bisociation strategies lead to identification of several solutions. These ideas were filtered based on relevance, impact, innovation, and feasibility to a narrowed problem frame.

Community Engagement

Semi-structured interviews and focus group discussions were carried out with THI staff and community members. Two community visits were conducted. The first community visit focused on assessing disease prevention strategies, efficacy and education in the region. Repeated feedback from the community that adequate nutrition was the strongest defence against communicable disease, and that nutritional status was waning, caused a shift from the team to focus during the second community visit on the topic of nutrition.

Initial Community Visit

Tribal Health Initiative

The THI founders, a selection of health workers, and HAWs were interviewed. Subsequently community members and HAWs in Akthand and Sthathampatty were also interviewed.

The THI staff expressed that TB, leprosy, heart disease, and hypertention were the most prevalent ailments. It was noted TB occurrences had dropped significantly since THI began, although upon observing the diagnostic records, approximately 6-8 confirmed cases of TB were being documented monthly. Local belief was that TB was contracted by migrant workers, specifically local farmers resorting to jobs in the city during droughts. When the farmers return to their villages, they were bringing in the TB from those jobs. TB diagnosis is based on a sputum test at THI, and most of those tested positive are treated at THI under the DOTS regime provided by the government. Other diagnostic test capacity includes ability to detect iron deficiency, sodium, and potassium deficiency, as well as cholesterol levels.

Disease prevention within THI is conducted using several methods. All ill patients are placed in one ward, separate from a healthy ward. Gloves are reused, but autoclaved in between, to be used a maximum of 3 times. Masks, washed between uses, are meant to be warn, but compliancy suffers due to discomfort in the heat, and because it blocks facial expressions, compromising HAW to patient interactions.

THI has numerous HAWs who do house visits for diagnosing, treating, monitoring, and educating patients. Flashcards were used to educate the community about disease prevention although families do no always comply with the methods. HAWs noted that community members sometimes use herbal

medicine before seeking THI interventions, although the composition of treatments isn't given with the prescriptions.

THI relies upon contextually relevant methods. To promote holistic health, millet processing facilities and a millet cookie manufacturing industry has been implemented through the Sittilingi Organic Farmers Association. The Sittilingi Organic Farmers Association, or SOFA, is the official organization for farmers applying organic techniques. THI currently trains 200 farmers from the Sittilingi Valley in these techniques. This industry is also meant to promote eating of nutritionally beneficial millet in replacement of white rice.

Community Members

Interviews indicated that other than through proper nutrition through food consumption, community members were not well aware of how healthy people could prevent disease transmission. For example, an interview with a community member indicated that despite the educational tools utilised by THI to teach Tuberculosis prevention, he didn't remember because so many years had passed.

Community members repeatedly commented on the importance of nutrition. They had complaints that, due to the eating of free government-rationed rice, nutrition was suffering from a lack of nutrients historically provided by locally-grown alternatives.

Co-Creation Community Visit

The second community visit was geared toward a focus on nutrition, as this was identified as the most promising means of preventing disease transmission.

Tribal Health Initiative

It was revealed that malnutrition programming had ceased in 2008. This is because government monitoring had started at this time, funding had decreased, and a belief that the nutritional education provided through THI's program was institutionalized within the community. Regular weight monitoring stopped at this point. Therefore, it is unknown the precise incidence rates of malnutrition currently. It is becoming evident that the government program has not sufficiently monitored and diagnosed malnutrition within the community. Additionally, community members are in need of further education, as previous lessons did not pass between generations as expected. Thus THI is seeking to reinstate a version of the program and seeking innovation in this space.

THI uses clinical symptoms to diagnose deficiencies. Unless a community member is inactive, not eating, or not sick, nutrition is not considered inadequate by staff irrespective of patient weight. Malnutrition diagnosis is based on clinical symptoms observed by HAWs or health workers, followed by a more thorough assessment by a doctor at THI and a laboratory test when needed (such as in the case of suspected anaemia).

The previous nutrition-monitoring program included monitoring of infant weight monthly after birth up to 6 months, followed by biannual weighing up to five years. Malnutrition was prevalent, affecting 40% of infants at the initiation of the program, with deficiencies beginning upon the initiation of supplementary feeding to breast feeding. Infant weights were tracked using a spring scale

attached to a chart to which weights were automatically indicated for the HAW to mark. This allowed for illiterate nurses to use WHO weight versus age charts.

During the co-creation feedback session, nutrition diagnosis, monitoring, and education was discussed. Current tools utilised by HAWs, including supplements and treatments, were identified. Sketch models of potential additional tools were presented. HAWs emphasised that they desire their diagnostic tools to double as educational tools for their patients. They liked a proposed symptom card with which they could diagnose and educate malnutrition. They felt a tool that assisted in calculation of BMI would be useful to them if they were to begin tracking this metric. They also expressed an interest in educational videos to use in the communities.

Community Farmers

Interviews with a focus group of community farmers resulted in a list of products they farm, with sugar cane, turmeric, kamu, and rice cited as the most profitable respectively. During the co-creation session, farmers identified the most challenging aspects of their jobs, from farming to production, through the use of a model agricultural process. Farmers specifically cited difficulty ploughing their fields due to a lack of animal power, and difficulty processing their millet due to a lack of appropriate tools for threshing, sieving and grinding the product.

Processing Facilities

SOFA processing facilities were visited, where oil extraction and millet sorting, grinding, sieving, and separating was observed. Electricity was noted as spotty due to unannounced, but intentional electricity blackouts utilized by the government. Most products manufactured are sold to other cities. Products include millet, groundnut oil, and coconut oil.

SOFA representatives noted that 60% of farmers were moving to cities for jobs and income for their family during the droughts.

Local School

An interview with the Head Mistress of the school provided information about food, supplements, and weight tracking present at the school. Supplements, including ferrous sulphate and folic acid for 6^{th} to 8^{th} graders, are given once a week. Deworming is provided to all children every 6 months. Meals are provided based on government recipes with 3 meals a day given to boarding tribal children, and separate lunch given to the other children. It was noted that THI measures weights of children monthly.

The cook at a local palvad was also interviewed, who revealed that the government tracks weights at the school, providing supplemental cereal in accordance with BMI.

Local Store

A local SOFA store was visited. This store distributed millet cookies and herbal medicines. The intention of the visit was to assess what types of traditional treatments and local products were sold by and to community members.

Problem Framing

The initial project problem framing identified disease prevention as a need in the community surrounding THI. However, this pivoted to nutrition as described. This was achieved through a problem framing tree tool, which was used to explore various approaches to disease prevention. The first layer of themes were education, nutrition, hospital practices, hospital infrastructure and community lifestyle choices. From these, nutrition and education were identified as the most impactful, and based on community feedback, of the most of interest contextually. The problem frame was then pivoted towards improvement of local nutritional status through tools and education. Following the second community visit, the problem frame was further narrowed to address the aforementioned challenges HAWs face in monitoring and educating the community in the nutrition space.

Figure 1: THI Health Workers

Final Problem Framing Statement

HAW struggle with standardizing malnutrition diagnosis and providing locally accessible treatment for lasting improvement of community nutrition because of contextually inappropriate tools, which we address by developing a qualitative and quantitative nutrition assessment tool.

Solution Ideation

Several rounds of ideation took place during the design process. The initial phase occurred prior to the second community visit to gain more information about how HAWs or farmers, through their work, could improve community nutritional status. Co-creation, as described in the Community Engagement session, was used. From the feedback, ideas for solutions to benefit HAWs and farmers were generated. The team then committed to focusing on HAWs for its end-user. At this point, a more narrow project frame was drafted, and another round of ideation occurred. Solutions were pooled by theme, then screened based on feasibility, cultural acceptability and impact.

Solution Identification

A relationship map was generated. From this map, all relations between the health auxiliary worker and other immediate stakeholders were identified. Possible methods of improving the HAWs' ability to diagnose, monitor, or educate in the malnutrition space were mapped. Methods that seemed to have the most potential for achieving the most objectives was identified. Specifically, a nutrition monitoring and recording tool with educational functionality was identified as a potentially useful tool for HAWs.

Technology/Final Prototype

Based on community engagement feedback regarding local needs, as well as secondary research in the field of malnutrition assessment, several goals for a potential diagnostic and educational tool were established.

Goals

- Standardize the diagnosis process
- Introduce additional diagnosis methods
- Automate record keeping of qualitative and quantitative metrics
- Educate patients about malnutrition
- Encourage locally available treatment options

These goals were set with the intention of providing HAWs, regardless of literacy, standardized, repeatable methods for educating, diagnosing and monitoring malnutrition in the field. The approach prioritized enabling locally available metrics and treatment options, while integrating additional methods to increase the accuracy and robustness of the malnutrition diagnosis process.

Design Requirements:

To achieve the aforementioned goals, regardless of the literacy level of the HAW, the following design requirements were identified:

- Capacity to measure and record patient
    - height
    - weight
    - clinical qualitative malnutrition symptoms
- Insurance of reproducible diagnosis
- Ability to educate community members during diagnosis
- Capacity to prescribe locally available, agriculture-promoting treatments

Tool Functions

The tool provides HAWs, regardless of literacy, with the capacity to robustly, accurately, and reproducibly diagnose, monitor, and record community nutritional status (Fig. 2). Through a holistic, mixed-method qualitative and quantitative approach, the tool standardizes the diagnostic process. It simultaneously facilitates education of community members during the monitoring process. The treatments the device recommends promote local agriculture and healthy nutritional choices.

Figure 2: Thalir Tool for Malnutrition Monitoring and Education (digital rendering on left, and physical 'dummy' prototype on right)

The tool allows for weight and height measurements to be conducted in conjunction with automatic data recording onto WHO height/weight growth charts, simplifying the identification of underweight individuals for illiterate HAWs. To cater towards the Indian population, the WHO growth chart may also be switched out in preference for the Indian Academy of Pediatrics Growth Chart. Qualitative observable nutrient deficiencies can be identified, monitored, and recorded using a standardized symptom spectrum provided by the tool. The interactive nature of the tool, allows the HAW to explain the diagnostic process as they assess symptoms, and show the patient their condition with an attached mirror. The tool then recommends locally available agricultural products, which can be consumed as supplements for any diagnosed deficiencies.

The tool is designed to be used from birth through 12 years. To enable this, patients may be measured in the standing or lying position depending on capacity to stand. For infants, who cannot stand, an extendable mat, is unfolded from the device to extend the surface area of the weight scale.

Value Propositions

The tool benefits largely two groups, HAWs and community members, as stated in the following value propositions:

- The tool helps health auxiliary workers, who want to improve community nutritional status, by providing a standardized method of nutritional status monitoring coupled with community educational modalities.

- The tool helps the local community, which wants to improve its nutritional status, by enabling lasting healthy eating behavior change, through a contextually appropriate educational and nutrition monitoring system.

Lessons Learned

Community Engagement

In summary, the villages surrounding THI are aware of the faced nutritional status challenges. It is well-known that over-consumption of free ration white rice in place of healthier alternatives is contributing to nutritional status decline. It is also understood among community members that proper nutrition is the best defence against communicable diseases.

THI, after ending its malnutrition-monitoring program, largely because of instigation of a government program to provide this service, is interested in restarting it due to efficacy concerns. THI is therefore actively seeking innovations to aid this program as they strategize its form.

Health auxiliary workers, the individuals who would be implementing the program, are willing to learn new methods and use new tools to assist them in diagnostic and educational practices. Patient education is a fundamentally important aspect of their roles. Tools, which double as medically functional and educationally beneficial, are therefore desirable. Malnutrition monitoring is to begin shortly at THI, for which new innovation is sought.

Health auxiliary workers have varying skill sets, tools, and resources. Literacy levels vary, as well as access to cell phones (of which none are smart phones). Furthermore, electricity availability is unreliable.

Generally, the local economies are hugely important to the region, with subsistence farming being the primary economic activity. Importantly, the community values promotion of local agricultural practices, specifically organic ones. Promotion of healthy nutrition through locally available foodstuffs rather than imported supplements is preferred. The use of contextually relevant diagnosis of nutritional status, based on clinically observable symptoms rather than weight and height measurements alone, is important to THI.

Next Steps/Project Future

Project Viability

The IDDS team is very interested in taking the idea forward. Feedback at the final presentation reinforced the gap in which the Thalir tool is meant to fill. It also indicated an interest in creating partially electronic and mechanical means for recording the weight of a patient, not just solely mechanical ones.

Other Design Opportunities

The team also sees value in other potential solutions, which were not focused on during the summit. The ideas, summarized and grouped by theme below, are recommended for interested students, partners or organizations:

Alternative Design Opportunities

- Human powered (or solar-powered) millet threshing and sieving machine(s)
- Locally manufactured supplement pills using local crops
- Iron-releasing water pots
- Nut-butter processing equipment

The millet processing equipment is of special interest because millet eating is heavily encouraged by THI. Additionally, there is a local processing equipment engineer very interested in this project, who could serve as a collaborator for prototyping, testing, and implementing.

Continuity/Dissemination Model

The team intends to continue involvement in the project, with all team members interested in either a project lead or advisory role.

The following activities are prioritized:

- Fundraising (grant, donations)
- Identification of engineering facilities and personnel for further prototyping (universities, design firms, maker-spaces etc.)
- Planning of further community engagement through acceptability studies (THI and/or other similar contexts)
- Public engagement through media channels
- Establishment of advisors in the nutritional space (national labs, universities)

6-Month Plan and Team Engagement

The team intends to pursue the aforementioned activities through delegation of responsibilities based on accessibility to relevant networks for completing relevant tasks. The team will use Skype regularly for progress meetings, to report on new findings and to plan for future milestones.

Specifically, the team will spend the next three months identifying start-up funding schemes in their local cities, affiliated universities, and in the malnutrition space at large. Student project teams at various universities interested in development innovation will be identified and approached to take on prototyping and engineering design activities. The team will also reach out to numerous existing contacts in the medical device development space in the US, UK and India for advisory support and project direction advice. Business advice will be pursued early on to ensure project sustainability is built into the final product from the early design phase. IDIN resources in the form of mentorship (formally and informally), and microgrants will be sought.

In the three months following, the team will identify and begin setting up for an acceptability study with potential end-users to further inform the prototype design. Fundraising efforts will continue, likely aided by the creation

of a cohesive social media strategy, inclusive of a website, and various press releases and blog posts on numerous platforms.

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