

## 論文の内容の要旨

論文題目 Improving feeding practices and nutrition status of HIV-positive children in Tanga, Tanzania: the roles of health workers' nutrition training

(タンザニアのタンガにおける HIV 陽性児の摂食行動と栄養状態改善 : ヘルスワーカー・栄養トレーニングの役割)

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**Background:** Child undernutrition is among the off-track targets within the Millennium Development Goals for the majority of low-income countries. Both chronic and acute forms of undernutrition are worryingly high in such countries. Undernutrition is an underlying cause of more than one-third of childhood deaths worldwide, affecting more HIV-positive children compared to their counterparts in the general population. Among HIV-positive children, the stress of undernutrition places a compounded burden on an already weakened immune system and subjects them to a higher risk of opportunistic infections and death.

Undernutrition among HIV-positive children is also associated with poor feeding practices. In this context, undernutrition can be ameliorated if HIV-positive children are given adequate foods with the right frequency and diversity. Food insecurity is known to undermine such efforts, but even in food-rich areas, people suffer from undernutrition. Caregivers of such children may also lack nutritional knowledge and be affected by restrictive feeding beliefs and practices. The detrimental impacts of such shortcomings can be averted if trained health workers provide tailored nutrition counseling to caregivers in general population. However, in most cases, health workers are few and lack the necessary nutritional knowledge, skills to counsel, and competence to manage child undernutrition.

Medical and nursing education lack adequate practical nutrition training to fit the clinical reality that health workers face in their practices. Such a deficit creates health workers with little nutrition knowledge and poor child undernutrition management practices. In-service nutrition training can help to fill this gap. Specifically, trained health workers might contribute to this end through frequent nutrition counseling of caregivers. This may improve child-feeding practices and thus reduce the risk of undernutrition among children of counseled caregivers.

Evidence of effectiveness of nutrition training is available among health workers who care for HIV-negative children. However, no systematic review has examined its collective effectiveness on their nutritional knowledge, skills, and competence to manage child undernutrition. Moreover, no systematic review has been conducted to examine its effectiveness on feeding practices including feeding frequency, dietary diversity, and energy intake of young children. Evidence also varies on effectiveness of such an intervention in different contexts, and is lacking in the context of HIV-positive children and regions with fewer and low cadres of health workers. In the context of HIV-positive children, moreover, evidence is not available on local determinants of undernutrition and association with poor feeding practices in food-rich areas.

This thesis covers four objectives to address the research gaps identified. First, it aims to review evidence on the effectiveness of nutrition training of health workers on their nutrition knowledge, skills, and competence to manage child undernutrition. Second, it aims to review evidence on effectiveness of such intervention on feeding practices such as feeding frequency, energy intake, and

dietary diversity of children. Third, it aims to examine magnitudes and determinants of undernutrition among HIV-positive children in a food-rich region in Tanzania, and to examine associations between undernutrition and poor feeding practices. Fourth and finally, it aims to examine efficacy of nutrition training intervention involving midlevel providers (MLPs) on their nutrition knowledge, feeding practices, anthropometry, and nutrition status of HIV-positive children in Tanga, Tanzania.

## **Methods**

A total of four sub-studies were conducted to address the objectives of this thesis. They utilized four research designs to respond to the research questions posed. This thesis therefore includes two systematic reviews, a mixed-methods formative research study with qualitative and quantitative cross-sectional designs, and a cluster-randomized controlled trial (RCT).

The thesis begins with a summary of available evidence on the effectiveness of nutrition training of health workers. The intervention of interest in the two systematic reviews was nutrition training of health workers. For the first systematic review, the outcome of interest was health workers' nutrition knowledge, skills, and competence to manage children who suffer from undernutrition. The outcome of interest for the second systematic review was feeding practices of children aged six months to two years. Specifically, feeding practices examined were feeding frequency, daily dietary diversity, and energy intake per day among such children.

For the first systematic review, evidence was collected on nutrition interventions from six medical databases: PubMed/MEDLINE, CINAHL, EMBASE, ISI Web of Knowledge, and WHO regional databases. The evidence search was limited to interventional studies conducted using RCT or cluster RCT, pre-post interventional study, quasi-experimental, or prospective cohort study designs. Extracted findings were analyzed descriptively only because of heterogeneity in the methods used for each study and in the types of nutrition training interventions examined.

The review protocol was registered before commencing the literature search for the second systematic review. The evidence search was limited to published RCTs and cluster RCTs and confined to medical databases including PubMed/MEDLINE, CINAHL, EMBASE, ISI Web of Knowledge, and WHO regional databases. Results of the selected trials were pooled and their quality evaluated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) criteria. Risk of bias was evaluated in four categories: selection bias, performance bias, detection bias, and reporting bias. Meta analyses were conducted to calculate the overall effect size of the intervention on feeding frequency and energy intake outcomes. Analyses were conducted using the *metan* command of STATA version 12.

The formative research was conducted among pairs of HIV-positive children and their caregivers attending 9 out of 32 care and treatment centers (CTCs) in Tanga, Tanzania. It consisted of a quantitative part and a qualitative part. The quantitative data was collected from 748 pairs of children and their caregivers. Face-to-face interviews were conducted with the caregivers and medical data retrieved from the medical records of the HIV-positive children. Anthropometric data was obtained by measuring the children's weight and height.

Seven focus group discussions (FGDs) were conducted in the Swahili language based on results of the quantitative study. Each group consisted of eight caregivers, making a total of 56 caregivers in the FGDs. Audio-recorded data was transcribed, translated, and arranged theme-wise. Both quantitative and qualitative results were triangulated to identify local determinants of undernutrition.

The cluster RCT research protocol was subsequently designed based on the results of the formative research. The protocol was registered in the current controlled trials register, and later published. A cluster RCT was conducted in a total of 16 out of 32 CTCs in Tanga, Tanzania. A CTC was taken as a

unit of randomization. A total of 8 CTCs were randomly assigned to the intervention group and the same number to a control arm by coin flipping.

A total of 16 MLPs were identified from the CTCs of the intervention arm and a similar number for the control arm. A total of 776 pairs of HIV-positive children and their caregivers were recruited, of whom 397 were in the intervention arm. MLPs of the control arm received a one-day refresher course in care and treatment of HIV and went through the protocol and questionnaires used for the trial.

The intervention of interest was the nutrition training of MLPs. This intervention used the standard World Health Organization (WHO) guideline on nutrition training of health workers for HIV-positive children aged 6 months to 14 years. It was modified to emphasize the local determinants of poor feeding practices and undernutrition identified during the formative research. Following the training, the MLPs provided tailor-made nutrition counseling to caregivers of CTCs of the intervention arm. Children were followed up for their nutrition status and feeding practices including feeding frequency, dietary diversity, and quantity and quality of diet monthly for six months. Data were analyzed using instrumental variable random effects regression with panel data to examine the efficacy of the intervention on nutrition status through feeding practices.

## Results

A total of 3910 studies were retrieved in the first systematic review. Of them, only 25 were selected as eligible for the final analysis. Among the selected studies, 18 evaluated health workers' nutrition knowledge and showed improvement after training. A total of 12 studies with nutrition counseling as the outcome variable also showed improvement among the trained health workers. Sixteen studies evaluated health workers' child undernutrition management practices. In all such studies, child undernutrition management practices and competence of health workers improved after the nutrition training intervention.

Ten RCTs and cluster RCTs out of 4757 retrieved articles were eligible for final analyses in the second systematic review. Overall, health workers' nutrition training improved daily energy intake of children between 6 months and 2 years of age. The pooled evidence from the three studies reporting mean energy intake per day revealed a standardized mean difference (SMD) of 0.76, 95% CI (0.63-0.88). For the two studies reporting median energy intake, SMD was 1.06 (95% CI 0.87-1.24). Health workers' nutrition training also improved feeding frequency among children aged 6 months to 2 years. The pooled evidence from the three studies reporting mean feeding frequency showed an SMD of 0.48 (95% CI 0.38-0.58). Regarding dietary diversity, children in intervention groups were more likely to consume more diverse diets compared to their control group counterparts.

HIV-positive children had high magnitudes of undernutrition according to the formative research in Tanga, Tanzania. Stunting, underweight, wasting, and thinness were prevalent among 61.9%, 38.7%, 26.0%, and 21.1% of HIV-positive children, respectively. They also had poor feeding practices: 88.1% were fed at a frequency below the recommendations, and 62.3% had a low level of dietary diversity. Lower feeding frequency was associated with stunting ( $\beta=0.11$ ,  $p=0.016$ ), underweight ( $\beta=0.12$ ,  $p=0.029$ ), and thinness ( $\beta=0.11$ ,  $p=0.026$ ). Lower feeding frequency was also associated with low wealth index ( $\beta=0.06$ ,  $p<0.001$ ), food insecurity ( $\beta=-0.05$ ,  $p<0.001$ ), and caregiver's education. In the FGDs, participants discussed the causal relationships among the key associations; undernutrition was mainly due to low feeding frequency and dietary diversity. Such poor feeding practices resulted from poor nutrition knowledge, food insecurity, low income, and poverty.

In the cluster RCT, the mean nutrition knowledge scores were higher post-training compared to pre-training among MLPs (37.1 vs. 23.5,  $p<0.001$ ) in Tanga, Tanzania. Feeding practices of HIV-positive children improved in the intervention arm following nutrition training of MLPs who cared for them. Such feeding practices included feeding frequency and dietary diversity scores. For example, feeding

frequency improved significantly in the intervention arm and at follow-up ( $\beta=1.17$ ,  $p<0.001$ ). Meanwhile, an increase in each unit of feeding frequency was associated with a 1.27 kg increase in the child weight ( $p < 0.001$ ) and a 1.19kg/m<sup>2</sup> increase in the BMI ( $p < 0.001$ ), but not height ( $\beta = -0.10$ ,  $p = 0.830$ ). An increase in each unit of feeding frequency was associated with a 0.15-unit decrease in the child underweight ( $p < 0.001$ ), but not stunting. The intervention improved dietary diversity ( $\beta = 1.12$ ,  $p < 0.001$ ). An increase in each unit of dietary diversity was associated with a 1.39kg increase in the child weight ( $p < 0.001$ ) and a 0.01kg/m<sup>2</sup> increase in the child's BMI ( $p < 0.001$ ). However, the association with the height did not reach statistical significance ( $\beta = -0.01$ ,  $p = 0.984$ ). An increase in each unit of dietary diversity was associated with a 0.16-unit decrease in the child underweight ( $p < 0.001$ ). However, the association with the dietary diversity and child stunting did not reach statistical significance ( $\beta = -0.10$ ,  $p = 0.632$ ). Also, such association was not significant for thinness ( $p=0.078$ ).

## **Conclusions**

In-service nutrition training improves quality of health workers by rendering them more knowledgeable and competent to manage child undernutrition. Trained health workers can bring about changes in feeding practices of children aged between 6 months and 2 years. Such feeding practices include feeding frequency, energy intake, and dietary diversity.

Feeding practices and nutrition status were poor among HIV-positive children even in the food-rich region in Tanga, Tanzania. In this region, undernutrition was associated with poor feeding practices, especially low feeding frequency, poor dietary quality, and restrictive feeding practices; poverty and unemployment; low level of education among caregivers; and household food insecurity.

Nutrition training improved nutrition knowledge among MLPs caring for HIV-positive children attending CTCs in Tanga, Tanzania. Caregivers' feeding practices also improved as demonstrated in the feeding frequency and dietary diversity scores. These positive changes led to a modest weight gain among HIV-positive children in the intervention group. Such intervention did not, however, bring about linear growth after 6 months of follow-up.

## **Recommendations**

Scaling up is important for in-service nutrition training to fill the gap of inadequate nutrition training in the existing medical and nursing education system. In this way, steps can be taken towards improving the overall feeding practices of the children. Scaling up of nutrition training for health workers thus presents a potential entry point to improve nutrition status among children.

Tailor-made interventions are needed to address the unprecedented magnitudes of undernutrition among HIV-positive children in Tanga, Tanzania. By improving feeding practices, especially feeding frequency, undernutrition can be ameliorated among HIV-positive children. Interventions in this region should also target children of poor households, the food insecure, and caregivers who have received only a low level of education to bring about positive and sustainable nutritional changes.

Nutrition training of MLPs can improve their knowledge to manage undernutrition among HIV-positive children, if it emphasizes addressing local determinants. Scaling up of such intervention can improve feeding practices and growth among children. To achieve linear growth and sustain weight gain, efforts should be made to improve households' food security and caregivers' education in addition to in-service nutrition training for caregivers of children in Tanga Tanzania, and in other areas with similar characteristics.