GENDER AND NUTRITION META-ANALYSIS: A FINAL REPORT OF THE FINDINGS

AN ACTION AGAINST HUNGER CANADA AND UNIVERSITY OF TORONTO PROJECT EXPLORING GENDER AND NUTRITION IN EMERGENCIES

2021 - 2023

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ACKNOWLEDGEMENTS

This work was carried out by the University of Toronto meta-analysis team, in partnership with Action Against Hunger and the Government of Canada's Department of Foreign Affairs, Trade and Development. Together a multi-year meta-analysis project was conducted to explore gender in nutrition within emergencies. This work could not have been done without the expertise of the University of Toronto's dedicated team and the multiple key Action Against Hunger Canada staff who supported this effort. Action Against Hunger Canada retains the right to amend this acknowledgement in a manner compliant with the Government of Canada's Federal Identity Program. All results and intellectual property herein are owned by Action Against Hunger Canada.

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ACCRONYMS AND ABBREVIATIONS

AAH	Action contre la faim Canada/ Action Against Hunger canada
cGAM	Combined Global Acute Malnutrition
CrI	Credible Intervals
cSAM	Combined Severe Acute Malnutrition
DHIS2	District Health Information Software
DIC	Deviance information criterion
DRC	Democratic Republic of the Congo
FEMA	Fixed effects meta-analysis
FEMR	Fixed effects meta-regression
FSIN	Food Security Information Network
GAM	Global Acute Malnutrition
GTFN	Gender Transformative Framework for Nutrition
HALE	Healthy Life Expectancy
HAZ	Height-for-Age Z-Score
HNO	Humanitarian Needs Overviews
HRP	Humanitarian Response Plan
KAP	Knowledge, Attitude, Practice
KII	Key Informant Interviews
MEAL	Monitoring, Evaluation, Accountability, and Learning
MICS	Multiple Indicator Cluster Surveys
MUAC	Mid-upper Arm Circumference
OR	Odds Ratio
PAHO	Pan American Health Organization
REMA	Random Effects Meta-Analysis
REMR	Random Effects Meta-Regression
SADD	Sex-and-Age-Disaggregated Data
SAM	Severe Acute Malnutrition
SES	Socioeconomic Status
SMART	Standardized Monitoring and Assessment of Relief and Transitions
SRAB	Sex Ratio at Birth
TSFP	Transition from Supplementary Feeding Program
WAZ	Weight-for-Age Z-Score
WHO	World Health Organization
WHZ	Weight-for-Height Z-Scores
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund

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EXECUTIVE SUMMARY

There is growing evidence that gender inequality is positively associated with malnutrition. In response to this evidence, Action Against Hunger has been making efforts to increase the gender sensitivity of its operations and is striving to facilitate shifts in gender norms and structures towards gender equality. The collaboration for this meta-analysis project between Action Against Hunger Canada and the University of Toronto leveraged complementary expertise and capacity to empower communities to address gender inequality and provide useful knowledge in fighting malnutrition through a gender-transformative approach.

METHODS

The Gender Transformative Framework for Nutrition (GTFN) was used as the main analytical framework for this project. Mixed methods analyses were conducted to understand the differences in undernutrition among sexes within seven countries of interest (Afghanistan, Bangladesh, Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen) and to detect whether the status of undernutrition differs between sexes. Secondary questions were concurrently identified to explore the relationship of other plausible factors that may cause differences in nutrition outcomes (in addition to gender), such as geography and access to undernutrition services.

In addition to a secondary data review, data from sub-national SMART (Standardized Monitoring and Assessment of Relief and Transitions) surveys were analyzed using Bayesian statistical methods. Qualitative data were collected via key informant interviews, where respondents were selected using purposive and snowball sampling. Reponses from seventeen participants were explored through deductive thematic analysis using NVivo software.

RESULTS

This meta-analysis was iterative in nature, with various learnings and outputs to support Action Against Hunger's aim to move towards gender transformative action. The quantitative component of this project assessed acute and chronic malnutrition indicators by sex across seven countries. Findings showed that boys under five had significantly higher odds of being malnourished than girls

when assessed using WHZ for GAM and SAM (GAM WHZ: OR 1.30, 95% CrI: 1.23-1.38; SAM WHZ: OR 1.47, 95% CrI: 1.33-1.63). Measures for chronic undernutrition indicated that boys under five had significantly higher odds of stunting than girls under five (OR 1.45, 95% CrI: 1.37-1.53). MUAC measurements, however, indicated that boys under five had lower odds of being malnourished (GAM MUAC: 0.82, 95% CrI: 0.77-0.87; SAM MUAC: OR 0.87, CrI: 0.78-0.97). An analysis was then run using combined indices for GAM and SAM, this assessment indicated that there were *slightly* higher odds of malnutrition among male children based on cGAM and cSAM (cGAM: OR 1.06, CrI: 1.01-1.12; cSAM: OR 1.10, CrI: 1.01-1.20). Although results by cGAM and cSAM exhibit statistical significance, these results should be interpreted clinically with caution.

A landscaping review was conducted alongside the qualitative analyses to identify the availability of SADD and gender metrics across Humanitarian Needs Overviews, Humanitarian Response Plans, and country dashboards for comparison against SMART survey data. Results from this landscaping review revealed a paucity of SADD and a lack of consistency collected and available standardized gender metrics. The qualitative component of the project helped to further interpret the quantitative findings that boys have slightly higher odds of malnutrition when compared with girls. Respondents cited potential reasons such as biological differences between sexes, boys having increased exposure to infection, differential care practices for girls and boys, and gendered societal norms.

CONCLUSION

This collaborative effort aimed to develop a deeper understanding of the gendered nature of malnutrition in humanitarian and emergency contexts. This report highlights the need for consistent SADD collection, and standardized gender metrics, across the sector to 1) bolster data quality for gender and 2) provide greater insight into outcomes by sex and gender. This report also highlights the importance of integrating a gender transformative approach into nutrition programming, to challenge entrenched power dynamics and structures that perpetuate gender inequalities. We invite all stakeholders in the fight against hunger and gender inequality to engage with this report's findings and recommendations. Together we can drive meaningful change towards a more equitable and nourished world.

INTRODUCTION

Action Against Hunger is committed to empowering women and girls, and upholding the rights of all women, men, girls, boys and people of diverse abilities, genders and identities both within its organization, and in the communities, they work with to end hunger. With the recent release of its third *International Strategic Plan for 2021-2025*, these analyses align with Action Against Hunger's vision of saving and protecting lives, while ensuring a long-term sustainable impact in the fight against hunger through the prevention, detection, and treatment of undernutrition in humanitarian crises. With social, political, and economic inequalities driving hunger, and in particular gender inequality, understanding the power relations, workloads, cultural systems, as well as the different needs and priorities of men, women, boys, and girls is key to designing impactful programmes that empower those Action Against Hunger serves, in emergency contexts.

There is growing and consistent evidence indicating that gender inequality is positively associated with malnutrition. In response to this evidence, Action Against Hunger has been making efforts to increase the gender responsiveness of its operations and programs, and even striving towards the next level of gender transformation, which involves facilitating shifts in gender norms and structures towards gender equality. In other words, Action Against Hunger aims to integrate a gender-transformative approach into their nutrition programming, with the objective of changing power dynamics and structures that reinforce inequalities, while strengthening organizational and programme capacity to reduce gender inequality at all levels.

The collaboration for this meta-analysis between Action Against Hunger Canada and the University of Toronto leverages complementary expertise and capacity to empower communities and individuals to address gender inequality and provide useful knowledge in fighting malnutrition through gender-transformative approaches across interventions and institutions.

METHODS

This project focused on seven main countries of interest, as identified by Action Against Hunger: Afghanistan, Bangladesh, Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen. These countries were selected based on data availability, Action Against Hunger Canada's own internal review, and country willingness to participate. Hence, countries were suggested, as opposed to individually communicated with by the University of Toronto Meta-Analysis Team to the

country partners. Sub-national retrospective data from 2018 to present was included in the search, to include pre-, during- and post-pandemic data. The Gender Transformative Framework for Nutrition (GTFN) underpinned this project, acting as the main analytical framework.

The Gender-Transformative Framework for Nutrition (GTFN) seeks to address the gap between the recognition of the importance of gender equality in nutrition, and the practical action required to move forward in this space. The GTFN is truly innovative; it equips readers with a role in improving global nutrition to think differently, so that we can act differently. Its conceptual model supported by evidence and practice enables improved gender analysis, solutions design, and monitoring and evaluation of nutrition approaches, as well as interventions promoting women and girls' empowerment. By exploring the complexity of factors across systems that interact and foster or limit empowerment, it helps to identify areas for action that not only improve nutrition outcomes but also transform gender relations, empower women and girls, and create more equitable systems. The GTFN applies systems thinking to help describe the dynamics of multiple factors that interact to limit or advance development/nutrition outcomes. As outlined with its seven domains, addressing these power structures and harmful gender norms requires a multi-sectoral approach which embeds systems thinking into program or policy design and delivery. The GTFN was utilized as the main analytical framework for this project.

This meta-analysis was approved by the University of Toronto Research Ethics Board (REB Protocol #37571) and was comprised of three main components with various analyses: a quantitative meta-analysis, a landscaping exercise, and qualitative interviews. These three components worked in consort to explore the following overarching questions, in pursuit of Action Against Hunger's goal of moving toward gender transformative programming:

- Primary Question: ***Does the status of undernutrition differ between sexes?***
- Secondary Questions:
    - Does the magnitude of the difference in undernutrition between sexes differ between geographic regions?
    - What are the specific gender indicators/metrics that contribute to these differences in nutrition outcomes?
    - Does the access to undernutrition services differ between sexes?
    - Which gender indicators and metrics based on the Gender Transformative Framework for Nutrition contextualize the differences in undernutrition between sexes?

QUANTITATIVE META-ANALYSIS METHODOLOGY

The primary outcome was undernutrition, defined based on various single or combinations of anthropometric measures for children under 5 years of age (typically targeting children aged 6-59 months). Each definition comprised of a separate model:

- Global Acute Malnutrition (GAM): WHZ (weight-for-height z-score) <-2 z-score and/or oedema; MUAC (mid-upper arm circumference) <125mm and/or oedema; and newly added - combined GAM (known as cGAM): WHZ <-2 z-score plus MUAC < 125 mm and/or edema as a combined index;
- Severe Acute Malnutrition (SAM): Presence of bilateral edema; WHZ <-3 z-score and/or oedema; MUAC <115 mm and/or oedema; and newly added – combined SAM (known as cSAM): WHZ <-3 z-score plus MUAC < 115 mm and/or edema as a combined index;
- Chronic malnutrition: Stunting HAZ (height-for-age z-score) <-2.

**Throughout this body of work, both GAM and SAM are based on WHZ.*

The primary exposure was sex, and the probability of undernutrition was compared between sexes using the odds ratio (OR). In other words, *is the odds of undernutrition higher among male children vs female children?*

The formula for an odds ratio is as follows:

OR = (**A**/**B**)/(**C**/**D**) = **AD**/**BC**

Where:

A = # exposed cases (# undernourished boys)
B = # exposed non-cases (# healthy boys)
C = # unexposed cases (# undernourished girls)
D = # unexposed non-cases (# healthy girls)

To interpret the odds ratio:

OR=1 indicated that the exposure does not affect odds of the outcome (being a male child does not affect odds of undernutrition)
OR>1 indicated that the exposure is associated with higher odds of the outcome (being a male child associated with higher odds of undernutrition)
OR<1 indicated that the exposure is associated with lower odds of the outcome (being a male child associated with lower odds of undernutrition)

Using R software (version R-4.0.2), the unit of analysis for each meta-analysis was an individual survey (not a country), as each included country may have more than one survey (with similar design

– 2-stage cluster survey) with sub-national nutrition data. The overall effect (log odds ratio of undernutrition in boys versus girls) was then estimated by pooling the data from all surveys across all countries through a Bayesian meta-analysis model testing two different types of modelling. The fixed effects meta-analysis model assumed that all survey data have arisen from a common overall effect and that each survey, subject to sampling error, produced an estimate of this pooled effect. The random effects meta-analysis model, on the other hand, assumed that each survey produces an estimate of the survey-specific effect. These survey-specific effects were assumed to be exchangeable and thus came from a common distribution, with the mean of the distribution representing the pooled effect of interest.

The results obtained from fitting these Bayesian meta-analysis models should, however, be interpreted with caution as there may be observed covariates among the data sources that interact with the exposure and should be accounted for. This can primarily be explored using a subsequent meta-regression. The magnitude of observed differences in undernutrition between sexes may vary across regions, and the reason(s) for this variation may partly be explained by factors related to gender inequality. The heterogeneity in the observed effects was best addressed by using a Bayesian meta-regression model; and the resulting estimates were a range of pooled effect sizes that depend on the values of the covariates adjusted for in the model.

Subsequently, two Bayesian meta-regression models were fitted for each outcome, a fixed effects meta-regression model and a random effects meta-regression model. The covariate adjusted for was a binary covariate indicating whether the survey respondents are from an African country. Outputs from the Bayesian meta-regression analyses included pooled effect sizes for each type of nutrition measure used as outcome. Model comparisons of the meta-regression models and the meta-analysis models are possible, if we included the same set of surveys for the same undernutrition outcome in both steps. We compared models by examining the deviance information criterion (DIC) value for each model fitted, in addition to checking credible intervals around covariate effect estimates.

LANDSCAPING EXERCISE METHODOLOGY

To complement the quantitative results, a landscaping exercise consisted of a desk review to 1) map the existence of Humanitarian Needs Overviews (HNOs) and Humanitarian Response Plans (HRPs) across the seven countries of interest, 2) identify whether documents contained sex-disaggregated data (SADD) and 3) corroborate these findings further by assessing the Nutrition Cluster and OCHA dashboards per country. Humanitarian needs overview (HNOs) and humanitarian response plans (HRPs) represent the most comprehensive, authoritative, and evidence-based assessment of global humanitarian needs. Given their prominence in identifying, analyzing, and sharing data and evidence on the needs in humanitarian settings (of which all the countries in this project classify).

The goal of this landscaping exercise was to develop a clear understanding of data availability. For programming to effectively take on gender transformative methods, the collection and reporting of SADD is required. Country-level HNO and HRP data and dashboards were reviewed for Afghanistan, Bangladesh, Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen; data from 2018 to present was included in the search, to encompass pre-, during-, and post-pandemic data. Some countries had more than one dashboard, all of which were included. In total, over 80 documents and 9 dashboards were reviewed. HNOs, HRPs, and dashboards were not available for Bangladesh as a whole, rather for the Rohingya Refugees' Joint Multi-Sectoral Needs Assessments and Joint Response Plans given the adjacent foci and the like relevance. Documents and dashboards were accessed from Humanitarian Response, Relief Web, and OCHA.

Each source was examined to identify whether they contained SADD regarding undernutrition status and/or access to nutrition treatment for children under 5 years of age. The data sources referenced in the documents (i.e., SMART surveys, national nutrition surveys) were included in the search. If SADD was available, the source was subsequently reviewed for five specific undernutrition variables: 1) general acute malnutrition by weight-for-height z-score, 2) severe acute malnutrition by weight-for-height z-score, 3) general acute malnutrition by mid-upper arm circumference, 4) severe acute malnutrition by mid-upper arm circumference, and 5) stunting based on height-for-age z-score.

In addition, an internal review of existing SADD programme admission data was done by Action Against Hunger across the seven countries of interest. The following data were available for Ethiopia, Somalia, and South Sudan:

- Number of boys/girls newly admitted into SAM treatment in areas supported,
- Number of boys/girls under-five discharged as cured from SAM treatment,
- Number of boys/girls under-five screened for malnutrition,
- Reach of SAM management for boys/girls' under-five.

QUALITATIVE METHODOLOGY

The qualitative section of this project was conducted to explore the underlying gender-specific factors that might explain why boys appeared to be more malnourished than girls, as indicated by the quantitative analysis. This further investigation was required due to the lack of available standardized metrics on gender-related obstacles and disparities that could affect the differences in malnutrition rates between sexes in the countries being reviewed for analysis (as per the landscape exercise).

QUALITATIVE METHODS & DESIGN

A phenomenological approach was adopted for the qualitative component of the project. This approach facilitated an exploration of the lived experiences, perspectives and socio-cultural dynamics surrounding sex differences in children's nutrition outcomes in the seven countries of interest. By delving into the subjective viewpoints of individual practitioners and experts, we aimed to uncover potential underlying meanings, patterns and context-specific factors that may contribute to the observed disparities. To unpack the secondary set of questions, the qualitative portion of this project aimed to address the following:

1. How can disaggregation within sub-national data systems be utilized to bring practitioners closer to achieving gender transformative programming?
2. What gendered factors may contribute to the contextualization of the 7-country meta-analysis findings?

PARTICIPANT SELECTION & RECRUITMENT

A purposive sampling strategy was employed. Potential participants were identified through a list provided by Action Against Hunger Canada, comprising individuals with diverse backgrounds and experiences in the seven countries of interest (*Table 1)*. Countries of interest remained the same (Afghanistan, Bangladesh, Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen) and diverse backgrounds included: Nutrition, SMART Surveys, Gender Equality, Emergency Management, MEAL, Regional Advisors, Nutrition Cluster Technical expertise, and Information Management & Monitoring. This was defined by Action Against Hunger Canada, and it served as the inclusion criteria. All potential participants received a recruitment email from Action Against Hunger Canada detailing the project's purpose, participant identification process, data usage and contact information – with follow-ups sent by the University of Toronto. Exclusion criteria were established to ensure relevance and coherence with the study's objectives. Individuals under 18 years of age, those who did not speak English or French and individuals with no experience working within the specified countries or neighboring regions were excluded from participation.

Table 1: Key informant demographics

Specialization	Location/Experience	Quote Designation
Technical nutrition	Bangladesh	Country Perspective
Coordination	South Sudan	Country Perspective
Technical gender	Ethiopia	Country Perspective
Coordination	Somalia	Country Perspective

Technical nutrition	East Africa	Country Perspective
Technical gender	Democratic Republic of Congo	Country Perspective
Coordination	Global/HQ	
Technical nutrition	Democratic Republic of Congo	Country Perspective
Technical nutrition	Ethiopia	Country Perspective
Technical assessment/information	Global/HQ	Global/HQ perspective
Technical gender	Global/HQ	Global/HQ perspective
Technical assessment/information	Global/HQ	Global/HQ perspective
Technical gender	Global/HQ	Global/HQ perspective
Coordination	South Asia	Country Perspective
Technical assessment/information	Yemen	Country Perspective
Technical gender/SBC	Global/HQ	Global/HQ perspective
Technical SBC	Global/HQ	Global/HQ perspective

DATA COLLECTION METHODS & PROCEDURES

Qualitative Key Informant Interviews (KIIs) served as the primary data collection method. Semi-structured interview guides were developed, adapted to the two populations of interest: (1) individuals with direct technical or Monitoring, Evaluation, Accountability and Learning (MEAL) experience in conflict-affected regions and (2) experts and practitioners with insights into gender dynamics and/or nutrition.

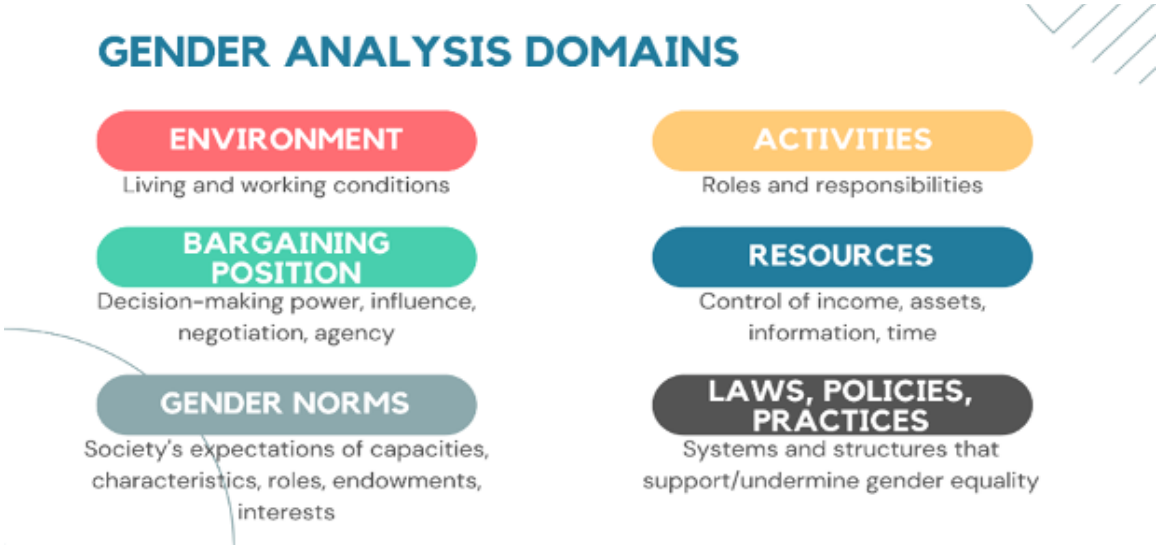
Potential participants received a recruitment email detailing the project's purpose, participant identification process, data usage and contact information. Consent forms were provided in advance, and participants were thoroughly briefed on the interview process during the session. We respected participants' autonomy, allowing them to withhold responses or withdraw their information at any point.

Interviews were conducted using the Zoom platform, with sessions lasting between 45-50 minutes. Interviews were recorded, transcribed, and verified for accuracy by the interviewers. We then conducted deductive thematic content analysis using NVivo statistical software. Interview notes were categorized. Verification of note accuracy was conducted through reviewers' assessment of interview recordings.

QUALITATIVE INTERVIEW GUIDES

The proposed approach relied on an iterative work process based on consultations with relevant Action Against Hunger Canada's headquarter staff. The consultations with Action Against Hunger Canada's headquarter staff identified priority domains of focus (see *Figure 1*) when investigating differences in power/opportunity imbalances for women, men, girls, and boys. This supported the framing and prioritization of gendered factors that may help explain the sex differences in children under-five nutrition outcomes identified by the seven-country meta-analysis statistical findings. Qualitative interview guides are included in *Appendix E*.

Figure 1: Gender analysis domains utilized for interview guide development and qualitative analysis



ALIGNMENT WITH THE GTFN

This meta-analysis' qualitative domains aligned with GTFN domains, facilitating an informed analysis and interpretation of findings. Priority domains identified through consultations with Action Against Hunger Canada's HQ staff guided the exploration of power imbalances and gender dynamics. We worked closely with Dr. Alison Riddle, who provided technical advisory services to the meta-analysis team. The mapping of GTFN "empowerment rings" to the gender analysis domains was not without challenge, and Dr. Riddle provided invaluable expertise by assisting the team in this exercise (*Table 2*). Based on feedback received from Action Against Hunger Canada, the following domains are deemed most relevant for programming purposes: *Resources, Gender Norms, Activities,* and *Bargaining Position*, so the meta-analysis team specifically ensured that questions and probes were included within those domains.

Table 2: Mapping of gender analysis domains onto GTFN empowerment rings.

GTFN empowerment rings	Gender analysis domains
Agency	Bargaining position
Resources	Resources
Opportunity structure	Environment Activities Gender norms Laws, policies, and practices

CODING & THEME DEVELOPMENT

The meta-analysis team used a mixture of inductive and deductive analysis. Pre-set codes were defined (flexible, with allowance for additional codes to be incorporated as needed) and theme development followed. Themes were grouped under the core components of the GTFN, as identified as the empowerment rings above. Coding was primarily led by one UofT project team member, and thematic development by another; however, two UofT project members worked together throughout the process and to come to decisions on the final themes. The NVivo codes are included in Appendix K.

DATA SATURATION

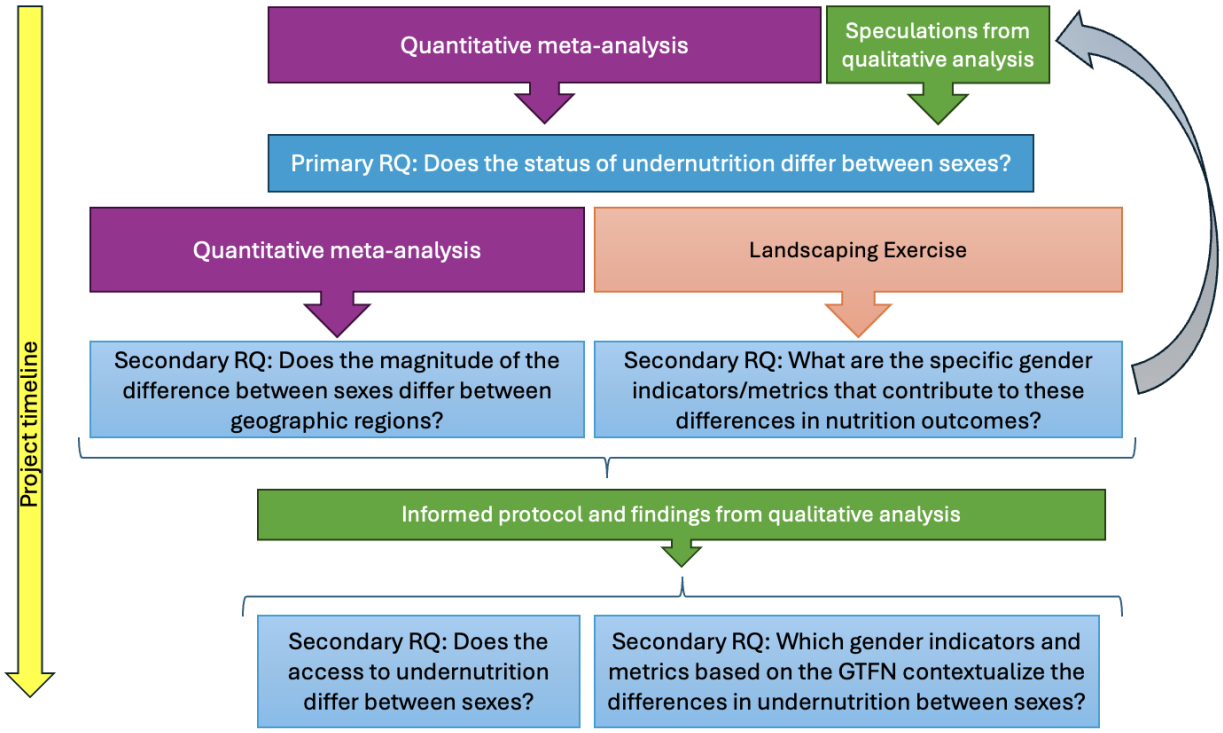
A point was reached rather early in the interview process (in which themes derived from the interviews were consistent, and the meta-analysis team did not hear anything significantly different. The themes were similar, but given contextual variation, comments may have been framed differently, but the overall themes were similar. For example, there were a lot of gender beliefs about boys' and girls' nutritional needs identified, and the exact needs just varied by context. From there, it was evident which thematic areas needed to be explored (i.e., gendered beliefs about nutrition needs in children U5) and address, regardless of where the work is being conducted.

INTEGRATION THROUGH MIXED-METHODS

The meta-analysis integrated these three main components - a quantitative meta-analysis, a landscaping exercise, and a qualitative study – to address the overarching meta-analysis questions, in pursuit of Action Against Hunger's goal of moving toward gender transformative programming – see *Figure 2* below. *Figure 2* illustrates which component supported which questions, whether being primary or secondary in nature, and the degree of its contribution. For example, the quantitative meta-analysis played a larger role in assessing whether the status of undernutrition differs between

sexes, compared to the speculations identified in the qualitative component given the small sample size of participants

Figure 2: Project integration of mixed methods.



LIMITATIONS

While this meta-analysis has contributed valuable insights into the understanding of the association between nutrition, sex differences, and gender metrics using the GTFN as an analytical framework, several noteworthy limitations were encountered throughout the evolution of this meta-analysis which contribute to potential challenges in the interpretation and application of the results.

HETEROGENEITY IN SUB-NATIONAL SURVEY DATA

The analysis incorporated data from multiple surveys, not all of which were the same. There were notable variances in metrics, sample sizes and likely data collection methods. Despite the sample size being over 100, the inherent heterogeneity of sources could impact the robustness of the findings. Additionally, the reliance on sub-national data, rather than national-level data should also be noted.

UNIT OF ANALYSIS AND DATA AGGREGATION

The unit of analysis for the meta-regression was the survey, and therefore data were aggregated. While this approach allows for trends to be explored at a higher level and provides insights as to some of the broad patterns, it has potential to mask some of the underlying nuances or individual-level dynamics that may contribute to sex differences in nutrition.

MEASUREMENT BIAS & INTERPRETATION

The UofT team identified measurement bias and subsequent results as a limitation, vis-à-vis the reliance on specific anthropometric measurements including WHZ and MUAC within varying contexts. Firstly, a variability in measurement practices (especially in conflict-affected settings) may have introduced discrepancies that could have affected the results. Additionally, with the knowledge that certain measurement styles have different assumptions, the results should be read accordingly. For example, MUAC is not adjusted for age, while WHZ is. Similarly, MUAC is often cited to detect more malnutrition in younger girls, while also favoring female children (Tessema et al., 2020).

INTERPRETATION, GENERALIZABILITY & FRAMING

Our results are framed within the context of agro-pastoral, semi-arid conflict zones, which inherently restricts the scope of our interpretations to specific geographical and social settings. Additionally, given the unique social and cultural characteristics, not to mention the geopolitical and organizational realities, the applicability of these results to other humanitarian settings (either different conflict settings or higher-resourced areas) might be limited.

SAMPLING

Qualitatively, the use of purposive sampling for KII participants serves as a limitation, as this sampling method can be prone to bias. Since [almost] all interview participants came from a list prepared by Action Against Hunger, subjectivity of the process is worth noting, as is the potential resultant observer bias. Additionally, the response rate from this list was roughly 68%, with 17 individuals agreeing to partake in an interview, after roughly 25+ invites were extended.

As a result of sample size and a demographic dispersion of interviewees, we did not conduct a self-positionality declaration. As we do not want to make assumptions, nor do we want to risk the potential of identifying respondents, quotes have been attributed to simply whether the speaker entered the interview with a Global/HQ-based Perspective or a Country Perspective (as opposed to gender, positions, etc.).

PROCESS OF THEME SUMMATION ACROSS A DIVERSE RESPONSE GROUP

We employed a thematic synthesis method focused on common themes, defined as those recurring across a significant majority of the data. This approach was chosen to distill the central, shared experiences pertinent to our meta-analysis questions, ensuring a coherent narrative. Themes that

were unique to one respondent were documented but not included in the final reporting. This methodological decision was made to highlight the most prevalent patterns in the data, providing clear insights relevant to similar contexts, while acknowledging the exclusion of less common, divergent perspectives.

PROCESS LIMITATIONS

From the outset, the meta-analysis took a highly iterative approach. This was necessitated by what was being uncovered along the way; or rather, the lack thereof, which limited the covariate meta-analysis. Initially, the meta-analysis team intended to incorporate covariates into the meta-regression models, but many important potential confounders were not universally available, and therefore were not able to be included. Even for countries and years that did have data on the indicators, it was evident that several indicators exhibited recurring values over consecutive years, suggesting the "Last Observation Carried Forward" effect was in place. This was a limitation, because the covariate estimation and precision thereof were severely hindered by the lack of variation in these indicators. Although originally intended to be part of the second phase of analysis (meta-regression), the implementation of a multilevel model or controlling for country-level effects was not feasible for this meta-analysis project. While this may have limited our ability to account for clustered trends or identify meaningful relationships, we did model a meta-regression with aggregate data in which we adjusted for a binary covariate: non-African and African countries, to identify some higher-level regional trends. The challenges experienced while endeavoring to identify gender metrics really highlighted the need for and led to the qualitative component.

As another process limitation, we had originally planned to conduct a case study for three specific countries: Ethiopia, Somalia, and South Sudan, as Action Against Hunger had SADD programme data for this country trio. However, there were very few surveys available from 2021 onwards that we needed to align with, leading to a notably small sample size. With this, we could only adjust for a single covariate at a time, which yielded unreliable effect estimates due to the limited sample size and the lack of covariate data at the individual level. Additionally, the availability of count data alone proved inadequate for analysis, as it lacked the relevant denominators to imbue context (i.e., not just number of boys admitted for malnutrition, data need to be presented as a ratio for comprehensive analysis, thus requiring the number of boys in the catchment area would have been needed as an example).

RESULTS

The results presented as follows have been broken down and categorized within the most relevant question for these analyses. As such, quantitative and qualitative data have been presented in consort, in the interest of best sharing the narrative.

DOES THE STATUS OF UNDERNUTRITION DIFFER BETWEEN SEXES?

For the purposes of this analysis, sub-national survey data were utilized. The total number of children analyzed per country, per year, (including the totals) from these surveys is summarized in *Table 3* below.

Table 3: Number of children included in the analysis (out of the totals), by country and undernutrition outcome.

	GAM (WHZ)				GAM (MUAC)				cGAM			
Country	**# boys**	**Total**	**# girls**	**Total**	**# boys**	**Total**	**# girls**	**Total**	**# boys**	**Total**	**# girls**	**Total**
Afghanistan	255	2302	204	2278	235	2329	332	2302	382	2330	409	2330
Bangladesh	134	964	97	926	21	971	32	928	136	971	104	928
DRC	1656	10868	1296	10592	1449	11071	1533	10713	2275	11075	2118	10717
Ethiopia	344	3219	279	3155	157	3248	187	3174	224	1747	243	1704
Somalia	881	4545	710	4483	530	4627	621	4563	549	2169	532	2169
South Sudan	745	3730	588	3809	364	3781	429	3881	848	3787	757	3874
Yemen (South)	515	3695	394	3529	169	3736	253	3568	572	3739	514	3750
	SAM (WHZ)				**SAM (MUAC)**				**cSAM**			
Country	**# boys**	**Total**	**# girls**	**Total**	**# boys**	**Total**	**# girls**	**Total**	**# boys**	**Total**	**# girls**	**Total**
Afghanistan	57	2302	35	2278	83	2329	111	2302	113	2330	127	2303
Bangladesh	12	802	5	757	0	569	3	531	12	631	5	574
DRC	552	10868	374	10592	528	11071	556	11152	818	11075	712	10743
Ethiopia	28	2021	25	2014	22	1747	35	1703	41	1747	51	1704
Somalia	191	4545	143	4483	100	4627	120	4563	138	2169	130	2169
South Sudan	146	3730	96	3809	51	3781	66	3881	176	3787	142	3874

Yemen (South)	81	3695	53	3529	43	3734	53	3561	108	3739	95	3570

	Stunting			
Country	**# boys**	**Total**	**# girls**	**Total**
Afghanistan	1116	2275	946	2240
Bangladesh	314	958	263	922
DRC	4799	10881	3576	10563
Ethiopia	713	3199	543	3123
Somalia	934	4031	630	3970
South Sudan	506	2982	462	3017
Yemen (South)	1404	3684	1176	3532

A Bayesian fixed effects meta-analysis (FEMA) model and a Bayesian random effects meta-analysis (REMA) model were fitted to sub-national survey data for each of seven outcomes: GAM, SAM, GAM based on MUAC, SAM based on MUAC, stunting, cGAM, and cSAM. The deviance information criterion (DIC) was used as the main criterion by which the goodness-of-fit of different models for the same outcome were compared – in other words, the model with the lowest value of DIC is considered the best-fitting model for the data, although a difference in DIC less than 3 is not considered important. Comparisons of DIC values indicated that there was little to choose between FEMA and REMA models for the outcomes GAM, SAM, GAM based on MUAC, SAM based on MUAC, and cSAM as differences in DIC values were less than 3 in these cases. However, for the remaining two outcomes of stunting and cGAM, due to the greater degree of heterogeneity across numerous surveys, DIC comparisons indicated that the REMA model provided a better fit to the data than the FEMA model. Consequently, as the REMA model provided the better fit for two of the seven outcomes and fitted essentially equally well as the FEMA model (according to DIC) for the other five outcomes, only the REMA results were reported here (see *Appendix F for* FEMA results, for reference only).

Table 4 summarizes the odds ratios for the seven outcomes of interest and their 95% credible intervals (CrI) obtained by exponentiating the posterior mean and the 95% CrI lower and upper limits of the log odds ratios under the REMA model.

Table 4: Odds ration estimates and their 95% credible intervals under Bayesian random effects meta-analysis.

Outcome	Odds Ratio	95% Credible Interval
GAM	1.30	(1.23, 1.38)
SAM	1.47	(1.33, 1.63)
GAM based on MUAC	0.82	(0.77, 0.87)
SAM based on MUAC	0.87	(0.78, 0.97)
stunting	1.45	(1.37, 1.53)
cGAM	1.06	(1.01, 1.12)
cSAM	1.10	(1.01, 1.20)

An odds ratio greater than 1, factoring in the limits of the 95% CrI, suggests that the odds of a particular outcome are higher among boys under five years of age than girls under five years of age. For example, for GAM, an odds ratio of 1.30 implies that the odds of GAM were 1.30 times higher among boys under five than girls under five. There was also a 95% probability that the odds of GAM for boys under five were between 1.23 to 1.38 times the odds for girls under five. On the other hand, an odds ratio less than 1, factoring in the limits of the 95% CrI, suggests that the odds of a particular outcome are lower among boys under five years of age than girls under five years of age. For example, for SAM based on MUAC, an odds ratio of 0.87 implies that the odds of SAM based on MUAC were 0.87 times lower among boys under five than girls under five. As well, there was a 95% probability that the odds of SAM based on MUAC for boys under five were between 0.78 to 0.97 times the odds for girls under five. All other outcomes can be interpreted in a similar manner. Note that the odds of undernutrition are higher among boys under five than girls under five using the outcomes GAM and SAM by WHZ, but not the outcomes based on MUAC for both GAM and SAM. This suggests that although the combined outcomes cGAM and cSAM do feature associated odds ratios that are greater than 1 with statistical significance, the statistical significance may not translate to clinical significance in practice.

UNVEILING INSIGHTS: QUALITATIVE NARRATIVES TO INTERPRET QUANTITATIVE FINDINGS

Some of the disparities in malnutrition levels between boys and girls have been posited by respondents to stem from complex contextual, care practices and feeding patterns. It is important to note that given societal norms and cultural realities, there is a lot of variance by context;

sometimes even manifesting as directly contradictory. The results from perspectives across our seven countries of interest [and beyond] clearly connoted this dichotomy.

Care practices were attached to deeply entrenched concepts of societal valuation; leading to biased resource allocation, emotional and physical care and support provided. Boys may be provided with better care as they were seen as future family legacies or providers, and therefore held more value (especially in rural areas). As a result, not only were they brought to care more readily and having their health concerns addressed more promptly that those of girls; for whom household remedies might have been a first line effort:

> *"Relative value is placed higher on males – there is an understanding that they will take on responsibility when they grow up – especially in rural areas. Even by the time they are five, they are already attending to small animals such as goats – there is a real belief that he [boy children] need the energy."* – Country Perspective

> *"In some governorates, prevalence – more in girls than boys: local culture among families, any household has the first-born daughter, second daughter, and third daughter and one boy: families give boy more love and more interest and more care than daughters, even if it is just the one boy. If the girls are sick, parents do not care in comparison with the boy – they do care. Girls are generally more affected by malnutrition."* – Country Perspective

Paradoxically, given the belief that boys were stronger and thus more able to fight off illness and as a result of the freedom of movement they were afforded (in comparison to girls), less attention may have been paid to their nutritional needs and health status, which may have led to a delay in receiving care.

> *"Boys are considered stronger than girls, so maybe there is less attention given to their nutrition status, or if they are unwell."* – Global/HQ Perspective

> *"Cultural stereotypes of boys' ability to withstand disease versus girls being weaker and brought to the clinics faster."* – Global/HQ Perspective

As it relates to their freedom of movement, there were repeated comments as to boys roaming further afield as compared with girls, who were mandated to stay in compounds, thus further exposing boys to different pathogens, parasites and were more likely to have health impacts accordingly, such as diarrhea.

> *"Boys play outside vs. girls stay inside with women and help with her chores – this affects exposure to contamination and what they eat."* – Global/HQ Perspective

> *"More boys than girls get diarrhea for example – more boys went outside the home, yard street, and therefore have greater exposure to parasites because they are moving farther afield than girls, who were typically kept in the house or just the compound."* – Global/HQ Perspective

> *"The social norm of not allowing as much freedom of movement was a protective mechanism for girls."* – Global/HQ Perspective

In some contexts, female children were prioritized, which may explain some of the malnutrition discrepancies in boys under five. Girl children spend more time with their mother, and as a result, being closer to the cooking process, their health status was more well known, and therefore treatment is sought quicker when needed.

> *"Not surprised at all with this finding – boys are not taken to the clinic as quickly, as there is less proximity to the mothers than girls; girls are closer also to the cooking areas in matriarchal societies."* – Global/HQ Perspective

In resource constrained areas, girls may also be prioritized, given their ability to bring money with marriage; if a girl is well fed, tall, and healthy, their family will receive more by way of a marriage dowry.

> *"In some of these countries, girls are money-maker; girls get sold for money, so as it relates to dowries and whatnot, maybe there would be some economic considerations for taking better care of girl children."* – Global/HQ Perspective

In dowry-based societies, there has also been discussion surrounding the concept of overfeeding girls, to have them appear bigger and more "marriable".

> *"Women are being over-nourished based on their status as property – trying to get them to appear bigger and more marriable."* – Global/HQ Perspective

Feeding practices also may have varied by context, with boys sometimes being favoured and other times not. These practices were influenced in large part by gender norms and misinformation. On one hand, to discourage attachment to the mother, boys might be weaned off breastfeeding earlier, leading to greater levels of malnutrition. Additionally, a suggestion was raised that there may be a belief system that indicates male children need to start eating real foods earlier to be big and strong, but this early introduction of solid foods may be harmful.

> *"In _____, [it is common to] stop breastfeeding earlier with boys so that they do not get too attached to the mother."* – Global/HQ Perspective

> *"If you're in a setting where there is a belief system that male children need to start eating real foods earlier, to be big and strong, but maybe this compromises their*

health because we're introducing those types of foods too early." – Global/HQ Perspective

Girls, who tend to stay at home more often, may have had better access to nutrition and less exposure to health risks compared to their boy counterparts. On the other hand, in some societies where males tend to be breastfed for longer, eating preferences were often skewed towards men and boys, as were treatment practices.

"Males do typically tend to breastfeed for longer." – Country Perspective

There was also a stated belief that girls can handle more hunger and fast longer than boys; and given the male inability to tolerate hunger, special care was afforded. Lastly, while not gender-specific, it was interesting to note that a new pregnancy often led to the discontinuation of breastfeeding, because of the belief that it will harm the fetus.

"Pregnancy stops breastfeeding – cultural belief that says that if you continue breastfeeding in pregnancy, you are killing the small baby inside of the stomach." – Country Perspective

DOES THE MAGNITUDE OF THE DIFFERENCE IN UNDERNUTRITION BETWEEN SEXES DIFFER BETWEEN GEOGRAPHICA REGIONS?

A Bayesian fixed effects meta-regression (FEMR) model and a Bayesian random effects meta-regression (REMR) model were also fitted to the same sub-national survey data for each of seven outcomes: GAM and SAM based on WHZ Z-scores, GAM and SAM based on MUAC, stunting, cGAM, and cSAM. In each meta-regression model, the covariate that has been adjusted for indicates whether the survey has been conducted in an African country. Comparisons of DIC values showed that there was little to choose between FEMR and REMR models for the outcomes GAM, SAM, GAM based on MUAC, SAM based on MUAC, and cSAM. For the outcomes stunting and cGAM, DIC comparisons indicated that the REMR model also fitted the data better than the FEMR model. Similarly, as the REMR model provides the better fit for two of the outcomes and fits essentially equally well as the FEMR model for the remaining five outcomes, FEMR results were provided in *Appendix F,* for reference only.

Table 5 displays the odds ratios and their 95% credible intervals (CrI) for the seven outcomes of interest for a non-African country (Afghanistan, Bangladesh, and Yemen South), as well as the odds ratios and their 95% credible intervals (CrI) for the seven outcomes of interest for an African country (Democratic Republic of Congo, Ethiopia, Somalia, South Sudan). These estimates were obtained by

exponentiating the posterior mean and the 95% CrI lower and upper limits of the log odds ratios under the REMR model.

Table 5: Odds ratio estimates and their 95% credible intervals for African and non-African countries under Bayesian random effects meta-regression.

	Overall	Non-African Country Afghanistan, Bangladesh, Yemen (South)	African Country Democratic Republic of Congo, Ethiopia, Somalia, South Sudan
GAM WHZ	1.30 (1.23, 1.38)	1.29 (1.15, 1.46)	1.30 (1.23, 1.39)
SAM WHZ	1.47 (1.33, 1.63)	1.56 (1.18, 2.05)	1.45 (1.30, 1.63)
GAM MUAC	0.82 (0.77, 0.87)	**0.63 (0.54, 0.72)** *	**0.87 (0.82, 0.93)** *
SAM MUAC	0.87 (0.78, 0.97)	0.73 (0.56, 0.95)	0.90 (0.80, 1.01)
Stunting	1.45 (1.37, 1.53)	**1.29 (1.17, 1.41)** *	**1.52 (1.43, 1.61)** *
cGAM	1.06 (1.01, 1.12)	1.04 (0.93, 1.16)	1.07 (1.01, 1.14)
cSAM	1.10 (1.01, 1.20)	1.00 (0.82, 1.23)	1.13 (1.03, 1.24)

*Step 2 significantly different across country groupings

When examining *Table 5,* the only 95% credible intervals that do not overlap for a given outcome are the CrI for GAM based on MUAC and the CrI for stunting. In other words, this important observation suggests that the effect of the covariate indicating whether a country is African was only significant for the outcomes of GAM based on MUAC and stunting. For both outcomes, comparisons of DIC also showed that the REMR model provided a better fit over the REMA model. Thus, for the outcomes of GAM based on MUAC and stunting, the estimates from *Table 5* are to be preferred over the estimates from *Table 4*. Additionally, instead of relying on the estimates from *Table 5* and *6* for the outcomes of GAM and SAM by WHZ Z-scores, SAM based on MUAC, cGAM, and cSAM, it may be more appropriate to use the corresponding estimates from *Table 4* despite the DIC comparisons showing no preference for either model in the case of these five outcomes. For these five outcomes, since the covariate effect is not significantly different from zero, the simpler REMA model (without adjustment for the covariate) is preferred over the REMR model.

A similar interpretation of REMR results can be done as was done for REMA results captured in *Table 4*. For instance, when looking at GAM based on MUAC, *Table 5* shows that the odds ratio was 0.63, meaning that the odds of GAM based on MUAC were 0.63 times lower among boys under five than girls under five for a non-African country. There was also a 95% probability that the odds of GAM based on MUAC for boys under five were between 0.54 to 0.72 times the odds for girls under five for a non-African country. As another example, the point estimate of the odds ratio for cGAM in *Table 5*

was 1.04, suggesting that the odds of cGAM were 1.04 times higher among boys under five than girls under five for a non-African country. Nevertheless, since the 95% CrI (0.93, 1.16) covers 1.00, the uncertainty around the estimate for the odds ratio is such that the odds of cGAM for boys under five may be equal to the odds for girls under five for a non-African country. Therefore, amidst this uncertainty, it is advisable to interpret the cGAM results from *Table 4* rather than *Table 5.* This uncertainty, however, should not present an issue here, as it is advisable to interpret cGAM results from *Table 4* rather than *Table 5*.

WHAT ARE THE SPECIFIC GENDER INDICATORS/ METRICS THAT CONTRIBUTE TO THESE DIFFERENCES IN NUTRITION OUTCOMES?

Originally, the inception plan (*Appendix A*) aimed to build on the meta-analysis with a meta-regression beyond geographic scope but rather gender metrics. However, the lack of consistency in the type of gender metrics identified based on the GTFN's domains and the varying availability data across the seven countries of interest, and the general lack of disaggregated data were found. Since data are not consistently collected across gender indicators, nor is it sufficiently requested at higher levels, data could not be analyzed to produce a finding. Consistency for one country, and not others, means a conclusion cannot be drawn. Even though consistent data were available across all seven countries although not necessarily consistent metrics existed for the following GTFN domains: *Economic Inclusion* (particularly for Care Burden); *Health & Nutrition Systems* (Gender Gap subdomain); *Opportunity Structure* (Organization/Policies/Norms/etc.); and *Social Protection* (Violence subdomain). For example, a multitude of varying metrics were found to capture Care Burden as illustrated in *Figure 3*.

Figure 3: Metrics pertaining to "Care Burden" and their availability 9in green) across the 7 countries of interest.

Specific Metric	Care Burden: Data available or unavailable? Green = available; red = unavailable						
	DRC	Ethiopia	Somalia	South Sudan	Afghanistan	Bangladesh	Yemen
Proportion of people whose time allocated to unpaid domestic and care work increased since the spread of COVID-19, by sex and intensity (percentage) - at least 1 activity, at least 3 activities							
Proportion of people whose partner helps more with household chores and care work since the spread of COVID-19, by sex (percentage) -> women and men total, women and men in employment							
Proportion of people whose time spent collecting firewood and fetching water increased since the spread of COVID-19, by sex (percentage)							
Qual: increased workload during COVID				*			**
Qual: women and girls primarily responsible for caring for sick and managing household prevention (re: Ebola)							
Qual: women and girls increased care burden due to Ebola, e.g. b/c of more frequent fetching of water							
Qual: men are responsible for financially supporting family							
Focus groups: all focus groups noted women and girls responsible for household work, 2 included men, and 2 included boys							
Number of groups thinking that men vs females are responsible for hygiene practices							
Female to male ratio of average time spent on unpaid domestic, care and volunteer work in a 24-hour period							
Female to male ratio of time spent on unpaid care work							
Proportion of unpaid work per day, female/male ratio							
Qual: moving into paid labour, feeling overwhelmed with growing workload							
Qual: moving into paid labour, lightened women's workload							
Qual: who is responsible for collecting firewood/wood?							
Qual: boys vs girls free time (partly due to household tasks/lack thereof)							
Qual: who is responsible for water collection?							
Qual: who is primary caretaker?							
Qual: who is responsible for health and hygiene in home?							
Qual: in general, who is responsible for household chores?							
Qual: daily routine: men vs women							
Qual: info about if gender roles are changing/household responsibilities distribution changing							
Qual: who is responsible for domestic animals?							
Qual: in addition to above, looked at various responsibilities of females vs females + males vs males							
Qual: overwhelming workload of pregnant women							
Qual: number of hours women engaged in household responsibilities			***				
Percent of husbands participating in household chores							
Qual: impact of education and wealth of women on husband participation in household chores							
Qual: workload during pregnancy decreases							
Qual: workload increases after childbirth							
Qual: do men help with workload if asked to?							
Quantitative: percent young men in unpaid agriculture/paid family agriculture; percent of women participating in paid family agriculture; unpaid domestic, care, and family agriculture/enterprise work for women (odds ratios)							
Quantitative: % men helping wives with household chores regularly							
Quantitative: allocation of household chores							
Qual: geographic areas where the share of men engaged daily in household chores was largest							
Quantitative: percent of women/men responsible for different tasks,							
Quantitative: time spent on unpaid work, main breadwinner (%)							

Excluded data on Rohingya refugee camps; Qual – qualitative; * increased water collection responsibilities for girls; ** men forced women to carry out household errands outside of home in addition to normal duties; *** data may not be available for all regions

Yes, we need to account for care burden, access to nutrition services, access to reproductive health, education, etc., by sex. But without first consistently mandating data collection at program and higher levels, we are unable to develop a deeper understanding of implications or needs by gender via quantitative means to mitigate speculation and assumptions.

DOES THE ACCESS TO UNDERNUTRITIION SERVICES DIFFER BETWEEN SEXES?

The supplementary landscaping exercise identified a substantial knowledge gap for gender differences in undernutrition and SADD on the access to nutrition treatment. None of the Nutrition Cluster dashboards for the seven countries of interest [except for one of Ethiopia's] contained any SADD. Indeed, only Ethiopia's Nutrition Cluster dashboard had one variable that was presented by sex (number of children with moderate acute malnutrition reached). Although many of the seven countries' available HNOs and HRPs referred to data sources that contained SADD for undernutrition (*Figure 4)*, these documents did not present any of this data themselves. Most of the undernutrition data used to inform these HNOs and HRPs was also at sub-national level stemming from SMART surveys.

Although there was a noticeable consistency between the data sources for HNOs and HRPs, not all data sources referenced in the HNOs and HRPs were publicly available and therefore cannot be properly utilized. In addition, some of the countries reviewed included People in Need (PiN) targets disaggregated by sex, yet there was a lack SADD around access to treatment making it difficult to determine whether these targets have been met. Overall, there was some SADD for access/outcomes to nutrition programming, however, there is still a sizeable gap that must be filled. More on this can be referenced in *Appendix J.*

Figure 4: Availability of gender data within HNO/ HRP documents, per country, per indicator – with green indicating data availability, yellow limited data availability and red no data availability.

	HNO		HRP						
	Present?	Sex-Disaggregated Data?	Present?	Sex-Disaggregated Data?	GAM based on WHZ	SAM based on WHZ	GAM based on MUAC	SAM based on MUAC	Stunting based on HAZ
Afghanistan	2022		2022						
Bangladesh									
Rohingya Refugees	2021 J-MSNA		2022 JRP						
Flash Floods			2022						
DRC	2022		2022						
Ethiopia	2021		2022						
Somalia	2022		2022						
South Sudan	2023		2023						
South Yemen*	2022		2022						

Legend: Green = Data available | Yellow = Some available | Red = No data

Furthermore, consistency of potential metrics was not the only issue identified by the Landscaping Exercise, but also the amount of information available across the seven countries of interest influenced their potential integration into the meta-regression. To determine how potential metric(s) of gender inequality would affect the log odds ratio of undernutrition among boys and girls, sufficient information per year surveys (with the associated seven nutrition outcomes) was required to assign covariate value per survey in each country. In cases where there was only data on a covariate for a single year, that same value would then be assigned to all surveys in the same country for the meta-regression even if the surveys were conducted in a different year, rendering it effectively useless in terms of interpretation. This finding limited any possibility of doing country-focused analysis for the

meta-regression, for instance in the shape of a case study based on the availability of some programming admission and treatment data by Action Against Hunger country offices in Ethiopia, Somalia, and South Sudan. For example, only nine surveys from 2021 and three from 2022 were included in the meta-analysis for Ethiopia, Somalia, and South Sudan (*Table 6)*. This sample size was deemed insufficient to adjust for countries as covariates in addition to any of the programming factors treated as covariates for the meta-regression.

Table 6: Number of surveys {units} available per country, per year (with one survey in Ethiopia spanning 2019/ 2020).

Year	DRC	Ethiopia	Somalia	South Sudan	Afghanistan	Bangladesh	Yemen (South)	Total Surveys Used
2018	9	1	5	5	3			23
2019	9	3	2	6	2	3		25
2020	8		2	1				11
2021	5	5	2	2		2	14	30
2022			1	3				4

This realization of the inadequate SADD availability from the Landscaping Exercise of gender data and the review of the admissions criteria within the available HNOs and HRPs necessitated a shift in the inception plan, by delving into this issue of data disaggregation and gendered factors via a qualitative analysis.

UNPACKING THE COLLECTION OF SADD

When asking respondents of their knowledge of admissions and discharge criteria in their respective countries of expertise, a prevalent trend emerged across various countries: the utilization of both WHZ Z-scores and MUAC as both admissions and discharge criteria. The COVID-19 pandemic led to a temporary shift towards MUAC-only measurements because of associated patient-proximity; but this shift was not uniform nor was it sustained, as countries are moving back towards their standardized dual means of measurement as pandemic recovery progresses. It is worth acknowledging that this qualitative discussion was in reference to all children under 5, while the meta-analysis component did not include children under 6 months of age; so, we cannot speak conclusively to the connection between these encompassing statements and the statistical findings.

In general, the collection of SADD emerged as an assessment-based process that was in many cases underscored by deliberate, systematic efforts for baseline disaggregation. Sex and age were the principal categories systematically disaggregated, with varying degrees of consistency. Sex was

usually included, age had a certain level of variance, and the inclusion of disability data were sporadic and often limited in scope (although certain organizations have imbued the collection thereof within their strategic commitments for data collection on children under-five):

> *"Generally, sex is usually included, age more or less, disability much, much less."* – Country Perspective

More specific demographic disaggregation within the age category also was cited to have limited representation within the scope of data collection efforts, such as distinctions between elderly or adolescent populations. Conversely, respondents cited that ethnicity or citizenship status (host, refugee, displaced populations) might be more readily captured in routine data systems.

There was also an identified agreeance that the capture of multi-layered disaggregation is resoundingly important as a facilitator of awareness-raising efforts and the tailoring of programming and projects to the diverse needs of varying groups of the population.

> *"Regular disaggregated data provide us the real situation between boys and girls, the magnitude of the problem, different types of population groups – [which is] important for planning to meet the needs of the population."* – Country Perspective

ENABERS AND BARRIERS TO THE COLLECTION OF SADD

Enablers to such disaggregated data collection included assessments like SMART at sub-national level wherein differential nutrition outcomes are presented by sex from the outset:

> *"They use the data to encourage the partners, specialists, etc., to ensure that there is awareness among communities."* – Country Perspective

Nevertheless, the identification of barriers to the process of effective collection of SADD was unfortunately a much more fruitful [and therefore telling] line of conversation among respondents. When asked explicitly about data collected on the caregivers who bring children to receive care, it was repeatedly highlighted that very little was required; and if anything was collected, it would be regarding the caregiver's pregnancy or lactation status, their relationship to the child, and on occasion the caregiver's age.

Capacity constraints were also identified as a recurring barrier to the collection of SADD, compounded by the challenge of a generalized lack of understanding as to the added value of such information. With country-based implementers already strapped for time, resources, and capacity, to demand an additional layer of specificity without providing a clear and comprehensive education on the value-added was received with reluctance at best, but often frustration.

> *[The general sentiment is]: "We must [collect it] because we have to report on it. I want to see the answer of how to transition to 'we must because this is the impact that this sort of data would have on programming, implementation, etc."* – Country Perspective

> *"We need to understand why we are collecting the data – this is much more important because everything else will follow after."* – Country Perspective

The domains of nutrition and gender, more specifically the area of responsibility around gender-based violence, were stated to have a lack of synchronization. Disjointed efforts or lack of collaboration occurring between organizations and countries alike were cited as the source of issues impacting the efficacy of data collection efforts.

> *"If you look at nutrition and gender/GBV AORs, they are not necessarily connected or aligned. Different organizations don't always work in collaboration in an effective manner."* – Country Perspective

Negotiation with authorities was raised as another barrier, with data collection sometimes being contingent upon securing necessary permissions from government officials; often leading to turnover-related disruptions in the process:

> *"If authorities are aware of important data for donors/citizens, they often agree to give the data. Turnover of government officials many times [impacts this], for example if the Director of the MoH changes every 2 months, the coordination process has to start from the beginning. Negotiation and meetings are super important before collecting any data, in my experience."*– Country Perspective

Similarly, a key identified barrier to holistic disaggregation was the reliance of organizations, implementers and practitioners on funding bodies, larger agencies, or donors:

> *"With regards to age, sometimes you will have MoH disaggregation that isn't the same as the donor reports, or even the ACF standard indicators; and it makes things more difficult for the field teams. This is seen as an additional burden, not for the added value it presents."* – Country Perspective

Building off the above discordance between reporting requirements and standardized indicators, donor dynamics have emerged as a factor that presented some duality in the context of SADD collection; with a lack of consensus reached as to whether or not this particular factor served as a barrier or an enabler. In some cases, donors were put forth by respondents as the impetus for disaggregated data collection, while others identified their requirements as being less than helpful, in the grand scheme of the programmatic landscape:

> *"We kind of have an automatic tendency to say: 'if donors ask for it, it will happen' versus 'some donor requests are not always the most helpful way of getting organizations to implement in a thoughtful, consistent, and quality manner.' Sometimes it is just a scramble to find a way to get a number in a box, as opposed to collectively thinking through what is going to be feasible, realistic and contribute to the quality of programming."* – Global/HQ Perspective

Donor-centricity emerged as a significant factor of influence on the data collection process, as did the on the ground realities of 1) country focus and 2) social/political norms at play:

> *"There are some regions that have more of a focus on gender than others, due to national policies/government norms (which donors don't want to disrupt) and societal focus (for example, if looking at difference in gender minorities in EAC versus the Middle Eastern region)."* – Country Perspective

AGGREGATION AND UPTAKE OF SADD

The discussion surrounding the process of data aggregation [and therefore subsequent utilization] revealed a distinct lack of systemic alignment within the existing data infrastructure. Respondents identified a common pattern in which the data is diligently captured during program implementation, but not effectively taken forward and aggregated within higher-level data systems.

This discrepancy poses a challenge for implementers and practitioners to understand the dynamics at play in the setting of interest, hindering their abilities to make informed programming decisions. Given that data can be presented as more of an aggregate, or lump-sum of information, respondents identified how generalized information can serve as an impediment to truly impactful, tailored programming. One respondent provided an illustrative example, in which data on individuals with disabilities were included within HRPs, but data tracking and monitoring were not effectively pursued: rendering the data static and, therefore, difficult to utilize.

Similarly, within the Nutrition Cluster System, we found that annual reports were often disaggregated by intervention type, but not necessarily by sex, which has been stated to pose a challenge. Notably, while data disaggregation was often conducted at the facility level, the translation of this data to the national and collated levels was where challenges ensued:

> *"Nutrition surveillance data doesn't provide information at the national level. [While GNC is] more reliable and monitored sub-nationally, this is not disaggregated. National reporting templates are not sex-disaggregated, although it is available at the sub-national level."* – Country Perspective

While the Nutrition Cluster does exhibit greater reliability, there was a comprehensive lack of data disaggregation, indicating an opportunity for refinement. Respondents cited this disparity as the impetus for a comprehensive re-evaluation of the data aggregation/reporting structure, calling for a systemic shift:

> *"Re-visit system, starting from the reporting templates [at the] facility, up to national level. Dashboards at a national level should have this kind of disaggregated data displayed, so that partners and donors can use it for decision making. [This] could definitely be a quick win, since it is already done at the facility level, but lost at national levels."* – Country Perspective

In addition to the identified aggregation limitations of nutrition surveillance data at the Cluster and national levels, respondents identified the District Health Information Software (DHIS2) systems as a highly pertinent platform for data aggregation; one that poses both potential and limitations. While DHIS2 systems tend to effectively prompt the capture of disaggregated data at the facility level, again, challenges persisted in translating this degree of disaggregation to the national level:

> *"DHIS tool captures disaggregated data from Ministry of Health – the issue is more the quality of the data; disaggregated data is available at facility-level, but not at the national level."* – Country Perspective

Similar issues were raised in an Action Against Hunger-specific capacity, with attempts to capture disaggregated data within its programmatic data using Activity Progress Reports presenting a challenge. In the absence of systematic or automated aggregation occurring at the country level, MEAL teams have dealt with the daunting task of estimation; introducing the potential for inaccuracies and resultant priorities that may be misaligned.

The utilization of disaggregated data, specifically in the context of children under five, also revealed a breadth of insights regarding the recognition of disparities, and the translation of this recognition into reception, interpretation, and subsequent impactful action. Respondents stated the common identification of disparities within any disaggregated data that exists, but the gap that exists between this identification and concrete follow-through action:

> *"[For children under-five] they'll look at results, see a significant difference; but nothing is done, no follow through or recommendation."* – Global/HQ Perspective

This failure to either 1) meaningfully present or 2) actively utilize what the data is showing to build and act on recommendations was a significant limitation when it comes to the utilization of disaggregated data:

> *"If it is not disaggregated and presented, most people won't ask for it or look for it. So, if any disparities are there, they won't be seen. Also, if they are presented, but there*

isn't a dedication to translating that into action, uptake will still be less likely." – Global/HQ Perspective

Donors, the global nutrition community, and the organizational politics in the sector have all been raised by respondents as factors within the conversation regarding the utilization of disaggregated data. When examining the role that donors must play in data utilization, respondents repeatedly noted the tie between the requirements that donors have regarding quantitative data and the lack of comprehensive understanding that ensues:

> *"Donor is interested in numbers, metrics, and it ends there. There is no sort of need or initiative to go in depth of trying to assess the 'why' of what the data is showing."* – Country Perspective

This lack of detailed analysis existed at both the donor and the implementer level. In many cases, respondents stated a lack of resources or capacity at the implementer/Country Office level, leading to a degree of frustration as to why donors ask organizations to conduct intensive data collection, if they do not plan to utilize it meaningfully:

> *"Once you've ticked the boxes, then they [donors] just move on. [A shift] would then come back to not just putting the responsibility on organizations, but also on the donors: What are the objectives, and second rate of objectives of asking for and having this data, and how to stand behind them."* – Country Perspective

Moreover, respondents identified that in many cases, donors are an impeding factor in terms of the type and quality of data they are able to collect and aggregate for eventual utilization. The desire to go beyond quantitative requirements, to mandate qualitative methods to bolster the depth of analysis and utilization of disaggregated data were also identified as key needs and something that donors, in their instrumental capacity, could promote:

> *"Really up to partners, depending on the funding, and whether more qualitative research can be conducted."* – Country Perspective

In both cases, the lack of depth of analysis often led to a disconnect between the implications that come from the data, and the analysis of underlying causes; and therefore, interventions that respond to such root issues.

When discussing the utilization of disaggregated data within the specific context of HRPs, respondents referred to these documents more so as box-ticking, summative efforts, versus an in-depth analysis. Despite the collection of data through MEAL processes, the effective utilization of the data was cited as a challenge, highlighting the siloed efforts of data collection, program implementation and reporting:

> *"MEAL is collecting data separate from the program, then Programs do not use it; they don't see it, or only see it at the end of the program."* – Global/HQ Perspective

There was also a noted disconnect between data being utilized for reporting alone, versus being wrapped into programmatic planning, decision-making and implementation:

> *"There is more effort in collecting the data – reporting goes upstream, and not to lead the program. There is a push for quantity and numbers, and less for the quality of the program."* – Global/HQ Perspective

This discrepancy was especially highlighted in reference to the lack of feedback incorporated into the usability of the data. There is a notable gap between the data being generated and the practicality of its application at the field level.

> *"Less data is being collected, it is more standard and doesn't necessarily fit the needs."* – Global/HQ Perspective

Interestingly, this was highlighted as a time-bound shift, with one respondent mentioning that data collection used to be a more concerted effort to bolster programming when they were in the field, but now, there is essentially no feedback loop to demonstrate what is working and what isn't.

Overall, respondents identified utilization as a rate-limiting step for many organizations. While many organizations demonstrated the ability and the commitment to the collection of data, the focus on application and utilization post-collection remains a challenge:

> *"Overall, it is built into the information management systems, proposals, and strategies. Most organizations do have MEAL strategies, and other beautiful documents, so it is imbued. The reality comes though – is it 100% collected? For a lot of organizations, yes. So, the question is more so, after collection, then what?"* – Country Perspective

The pivotal step flagged was the need to shift from data collection for data collection's sake (either as an organizational or donor mandate), to rendering it actionable; and utilizing it in such a manner. Respondents identified three significant barriers to this transition, highlighting the fact that it may be easier said than done: 1) the question of "so what", and how to translate numbers into impactful strategy, 2) resource constraints, and 3) the need for organizational buy-in:

> *"Say you get data with numbers of how many boys/girls access programming – then comes the 'so what'? What do we do next?"* – Country Perspective

> *"The team is eager, but there is the HR reality – in any given country…they know it's something they need to focus on, they just aren't sure exactly how."* – Global/HQ Perspective

"Organizational buy-in is required – let's pause and re-think our priorities. Yes, we want evidence-based gender programming, [but often] no one asks how." – Global/HQ Perspective

WHICH GENDER INDICATORS AND METRICS BASED ON THE GENDER TRANSFORMATIVE FRAMEWORK FOR NUTRITIION CONTEXTUALIZE THE DIFFERENCES IN UNDERNUTRITION BETWEEN SEXES?

GENDER DRIVERS OF MALNUTRITION

To contextualize the quantitative results the meta-analysis team embarked upon qualitative interview discussions with respondents regarding speculative explanations for some of the potential gender drivers of malnutrition.

AGENCY

The dynamics surrounding malnutrition were heavily influenced by multiple factors that align directly with the core of the Gender Transformative Framework for Nutrition: Agency. More specifically, respondents identified multi-faceted factors related to decision-making power (mobility, control) and knowledge (education, awareness).

Household decision-making power varied by context and circumstance, but there was a general agreement among interviews that men and elders generally hold significant influence and power. Elders can impact feeding practices (i.e., breastfeeding), while men are often in control of the household resources, and therefore decide what foods to purchase and what to allocate spending to (i.e., Food or care expenses), despite their minimal responsibility on food, caregiving, or household related matters.

"[There is an] interesting bi-directional pathway – power dynamics in the house & decision making (etc.), how that plays a role in what food actually reaches the children, how the female caregiver does or doesn't have the ultimate say in that." – Global/HQ Perspective

As it relates directly to access to nutrition care and services, the lack of voice and autonomy in both decision-making and mobility played a key role.

> *"Restriction to women's freedom of movement results in women not being able to take the child alone to the facility. It will be the woman with someone OR with permission of husband/male in house OR simply father – differs by context."* – Global/HQ Perspective

However, in many contexts being discussed, it was not socially acceptable for a father to bring a child to access services, rendering it the role of a female family member, with potential ramifications on her opportunities.

> *"If it is not socially acceptable for the male caregiver to take the child to access services, then it would default to older girl – cousin, sister, etc. …then have to consider all domino effects for her, and the ability to access education, etc."* – Global/HQ Perspective

Given the expenses expected to be incurred, women needed to seek permission or accompaniment to access health services for children. Even if the services were free, permission was needed to be obtained to 1) travel to health facilities, 2) stay overnight at stabilization centers with sick children, 3) where and from whom she is seeking services.

> *"If the women have to take the children to nutrition services/sites, they need permission from male partners to access services."* – Country Perspective

> *"Some stabilization centers require overnight stays – see the gender power dynamics coming into play with that – men don't want their wife staying away from home alone with child, which can be a barrier for sickest children to get treatment."* – Global/HQ Perspective

Further restrictions inhibited women's ability to go to markets (having a choice in the way they feed their family), to work freely (blocking their ability to make and control their own income), or to make decisions regarding family planning or immunization (inability to control fertility).

> *"Women cannot go to markets – cannot work, and some companies do not pay and give much lower salary."* – Country Perspective

> *"They may have a level of control over resources with respect to what to cook for example, but not what to buy to have on hand for cooking."* – Global/HQ Perspective

> *"Family planning is another thing too – very much controlled by the men's decision."* – Country Perspective

Respondents identified caregivers' lack of education and knowledge on the subject of malnutrition as a challenge in many cases, hindering informed decision-making. A deficient understanding of the causes and consequences of malnutrition has been noted to seriously influence caregivers' ability to make educated choices about children's nutrition or care.

> *"Literate mothers can have knowledge on different types of food to feed child and feeding practices."* – Country Perspective

> *"The lack of information/inclusion is detrimental, and it is known in a lot of communities they work in."* – Country Perspective

In the case that mothers have been educated on malnutrition, an additional barrier remains: most decisions are made by elders, and husbands will align with these decisions versus the views of their wives. So, if the elders oppose ideas brought forth to mitigate malnutrition, they do not materialize into tangible change patterns.

> *"Mostly decision-making is done by the elders, so mothers are getting educational practices – but are failing to implement because of the elders, just following the cultural practices. For example, exclusive breastfeeding is not done properly, since the elders do not support it."* – Country Perspective

RESOURCES

Various aspects contributed to the intricate relationship between children's nutrition and women's resource control and workload. While women may be able to control modest amounts of resources (from sources such as kitchen gardens or savings groups), this amount was often nominal; and they still required permission to utilize resources to access health services for their children. In all seven countries of interest, women bore the double burden of a heavy workload and caregiving responsibilities.

Time is a profoundly valuable resource unto itself. Women's heavy workload impacted their caregiving practices and their ability to provide good nutrition to themselves and their children.

> *"Getting enough water at home to drink and wash homes is a burden of women; as is improving hygiene, cooking, and bringing water; cannot have one person do it. Breastfeeding, bringing firewood…time and workload [is too much with caregiving]. Women don't have time!"* – Global/HQ Perspective

The attempt to balance childcare, household tasks, and income-generating activities created the challenge of multiple competing priorities for women. There were many routes through which the type of work undertaken by women may inadvertently impact children's nutrition. The nature of women's work itself, such as agriculture and water gathering, can expose both women and children

alike to health risks, including illness, malaria or even gender-based violence. Intensive workloads can lead to interruptions in childcare, with impacts going one of two ways. Work outside the home, like agricultural or market activities, can either separate mothers from their children (interrupting breastfeeding routines and inhibiting regular feeding practices) or expose children to potentially harmful environments (potentially dangerous environmental exposure in fields, pathogens in markets, etc.).

> *"For example, when casava is the primary substance, women leave the sons home earlier with another caregiver and possibly disrupting breastfeeding, in order to be in the fields. Or the inverse, taking children to the literal field earlier and keeping them with them, but not in ideal [healthy] conditions while in the field."* – Global/HQ Perspective

In fragile and conflict-affected settings, female-headed households faced even greater work demands and reduced autonomy in resource allocation.

> *"Female-headed households [in conflict settings] – many men went to war and are killed and some disabled – women take charge of the household and spend more time with children. Women's responsibilities have increased before the conflict and before relied on men, now all of sudden women now need to take care of everything – workload now completely on women and skills and tasks, roles with outside family."* – Country Perspective

OPPORTUNITY STRUCTURE

When it comes to opportunity structure within the Gender Transformative Framework for Nutrition, we thought about the formal and informal systems in place affecting both women's and girls' agency and access to resources. In this case, these systemic and institutional realities interacted to affect children's nutrition.

Gender norms dictated mobility patterns, which in turn affected access to health services. Cultural beliefs about men's responsibilities led to limited involvement in household tasks, including caregiving and nutrition. This placed a double burden on women.

> *"No challenge – women take children to access care, not considered as a responsibility of the man."* – Country Perspective

Gender-based violence (GBV) was another example that was mentioned by many respondents, to highlight the intricate pathways that exist between gender dynamics, violence, and nutrition. The first way this interplay was highlighted was in the light of repercussions. Women may have experienced GBV within the home if they were not meeting household duties at the behest of attempting to seek or achieve better nutrition for children.

> *"Women and girls having to make tough choices about searching for food, firewood, preparing food for ENTIRE family vs taking one sick child to nutrition services maybe 3h away – tough call to make if you possibly don't have childcare, or you may run the risk of getting beaten when you return for the lack of prepared food on the table, etc."* – Global/HQ Perspective

Similarly, women and girls may have been exposed to GBV or stigmatized in the process of seeking better nutrition (when travelling to clinics or at clinics themselves).

> *"GBV in centers, no one talks about it – during delivery, women with sick children – insults, abuse, immediate breastfeeding after birth – health center takes baby away, blaming targeting women – a lot of work to do empathy with health workers."* – Global/HQ Perspective

Secondly, child marriage was a form of gender-based violence – in poverty, the dowry system could be seen as a coping mechanism for food insecurity that may lead to girls being more prioritized and less food and attention being afforded to boy children.

> *"Early child marriage and girls getting married at a very young age has been uncovered as a coping mechanism when there is food insecurity in the girls' household (because dowry comes from the boys' family)."* – Country Perspective

GBV was notably worse in conflict settings, exemplified in camp or refugee settings, for example. This prevalence was often linked to men's exposure to violence and unassisted mental health, leaving women and girls indirectly impacted. Conflict destabilized family dynamics, and the inability to fulfill traditional male roles or expectations (providers, decision-makers, etc.), can impact men's self-perceptions –sometimes leading to hostility and aggression.

> *"War and insecurity and mental health in terms of GBV – top of the list in terms of causes and consequences. Women could be considered 'property', then when living in a situation where there is hunger, emergency, insecurity, etc., that adds to the situation."* – Global/HQ Perspective

> *"One of the consequences of the conflict is that the male "protection" role has been impacted. They have a very high level of psychological distress. They have noted with mental health activities that sometimes victims of violence exist, and that existence puts those "protector of household" roles into a feeling of worthlessness. Very much impacting relations within the household. Could be connected to some malnutrition as family dynamics are very much destabilized and women are in a very difficult position with care practices for children."* – Country Perspective

The systems and dynamics in place also produced a trickle-down effect to significantly influence child nutrition outcomes; particularly as it relates to seeking and receiving appropriate care. Cultural norms affect the utilization of health facilities, with gendered sanitation facilities and considerations of what constitutes appropriate interactions within families or communities can restrict women's ability to seek or access healthcare. Moreover, discrimination and abuse within health services themselves also incurred a detrimental impact on child nutrition. Respondents shared that unmarried or adolescent girls can face stigmatization, blame, or be made to feel guilty in facilities, discouraging them from wanting to bring their children to receive care.

> *"Unmarried and adolescent girls face the stigmatization and guilt of bringing a malnourished child and then you don't breastfeed; medical discourse to blame women, worst because of the power of men or doctors, but women/nurses are tough with them too."* – Global/HQ Perspective

Ethnic discrimination, as seen against the Pygmy population in DRC, can be another factor resulting in unequal and inequitable treatment of subpopulations, directly influencing children's health in these groups. However, it can often go unnoticed.

> *"Ethnic piece – DRC: Pygmy population – couldn't see any children any treatment center, don't see it all the time, but ethnic slavery is still prominent. There are caste aspects at play – they are not explicit and cannot see it in [treatment or access] reports."* – Global/HQ Perspective

DISCUSSION

This collaboration set an ambitious and worthy goal in its attempt to understand the relationship between sex and undernutrition among children under-five from seven of Action Against Hunger's country programs. As an organization, Action Against Hunger has rightly recognized that there are likely gender-related drivers of discrepancies in undernutrition prevalence between boys and girls and that identifying some of these drivers would be a valuable contribution to the nutrition sector.

However, given 1) methodological choices based on the GTFN as an analytical framework, 2) findings that led to additional exploration and 3) the iterative nature of the project, challenges were inherent to the overall process.

GTFN AS AN ANALYTICAL FRAMEWORK

As a conceptual framework that is supported by both research and practice, the GTFN presented extensive opportunities for impact across nutrition and gender programming, research, and beyond, making it a highly attractive analytical framework for this project (see *Appendix G)*. Nevertheless, the application of the GTFN as the analytical framework was a challenge – in both the quantitative and

qualitative portions of the meta-analysis project. Quantitatively, many of the challenges encountered were contextually grounded, pertaining to the applicability and comparability of data consistently available across multiple countries and GTFN domains. With seven inherently interconnected domains, challenges were encountered in identifying existing gender metrics to use in the modeling process as independent covariates of the sex-undernutrition relationship. While unsurprising given the general lack of valid and reliable global metrics/data on gender (Data2X, 2021; World Bank, 2022; Center on Gender Equity and Health, n.d.), this presented a challenge to the meta-analysis; one that was ever more evident while looking specifically for sub-national data.

Qualitatively, challenges were also present when preparing the interview guides as well as when preparing for analysis. Figuring out a means of asking a wide range of respondents about gender metrics in alignment with the GTFN's domains and empowerment rings proved challenging. Without expert gender advice, the GTFN does not inherently allow for the superimposition of other frameworks or how questions regarding gender analysis may map onto the GTFN for analysis purposes. Acting as a consulting Gender Expert for the project and for the GTFN Coalition, Dr. Alison Riddle provided the team with various gender analysis domains from which questions were derived and then mapped onto the GTFN for analysis purposes (Riddle, 2023). Without this high-level technical insight on the GTFN, there would be difficulty when trying to understand what gender information is truly being unpacked. It is important to highlight that this does not preclude the use of the GTFN as an analytical framework for such work going forward, but it does indicate that additional guidance and support are needed to ensure that the framework is being applied appropriately.

Taking a step back, before embarking upon the effort of applying the GTFN as an analytical framework, the importance of SADD must be understood. While often challenging to source, for these types of analyses, the value of disaggregated data was [and will continue to be] second to none (PAHO, 2020 & WHO, 2021). SADD provides important insights into inequities in service access and outcomes and is integral to developing robust gender responsive and transformative approaches. For organizations interested in such analyses, prior to any statistical work, appropriate gender metrics must be identified based on the gender-related concepts that align most with the work being undertaken (programming, advocacy, activities, etc.). The first step is unpacking these goals and answering different questions on the domains of implementation and desired change. From there comes the question of whether or not valid metrics currently exist for the identified areas, if they are being collected, and what resources are available should the existing data be insufficient. This meta-analysis found that the latter is most often the case: existing gender data is insufficient, which leads to an upsetting inability to act in an evidence-informed manner. As stated in CARE's recent *Sex, age (and more) still matter report on data collection, analysis and use in humanitarian practice* report: "Impartiality is not possible without an evidence-based approach that aims to collect, analyze, and use disaggregated data. Without an emphasis on disaggregated data, we risk discriminating against 'invisible' populations and providing assistance that is not needs-based" (Muzurana et al., 2022).

UNDERNUTRITION FINDINGS AMONG BOYS AND GIRLS UNDER-FIVE

We wish to preface this discussion of the first primary question grounding this entire project by stating our recognition that the quantitative findings are based on a specific sub-national data subset, and the qualitative findings are derivative of the lived experiences and professional opinions of our respondents. As such, we will not be making generalized statements one way or the other, but rather discussing outcomes, potential reasoning as posited by our respondents and supported by literature, as well as the recommendations that have ensued.

Based on the subnational data being utilized, our statistical analyses found that under 5 boys are, in fact, more chronically and acutely malnourished than their counterparts of the opposite sex [in the seven countries of interest]. Although MUAC did not show the same trends as just WHZ, their combined caseload (cGAM/cSAM) demonstrates that this is still something to be aware of and concerned about. This finding has been supported in recent literature with a 2020 systematic review and meta-analysis led by Thurstans and colleagues that examined wasting, stunting and underweight estimates for children 0-59 months, using a random-effects model (much like the model developed for this project). The analysis found that boys had higher odds of being wasted than girls (as assessed by WHZ), higher odds of stunting than girls, and higher odds of being underweight than girls (Thurstans et al., 2020). Of relevance, it was also noted that the magnitude of differences varies and is contextual; much akin to what we heard from our respondents. Moreover, while examining the effect of socioeconomic factors on malnutrition among children in Pakistan, it was also found that both wasting status and underweight status had close correlations with male children (Ahmad et al., 2020).

When exploring this observed effect qualitatively, multiple respondents were not surprised with our findings, citing potential factors such as biological differences, increased exposure to infection, differential care practices and gendered societal norms as potential reasons why under five boys might experience higher rates of malnutrition than under five girls – thus further helping to interpret our findings. It is widely accepted that myriad factors impact children's growth and nutrition in their early and developmental stages: poverty, mother's age at marriage, suboptimal breastfeeding practices, cultural practices and myths and SES, to name a few (Ali, 2021). In a narrative review conducted to complement the systematic review and meta-analysis, Thurstan et al. (2022) endeavored to explore early life mechanisms that may underlie the observed differences. This review cited a complex interplay of social, environmental, and genetic factors that may contribute to this underlying discrepancy. It was also found that despite greater birth weights and bigger size during infancy, this discrepancy in the experience of undernutrition begins as early as the fetal period. For example, boy fetuses grow faster than girl fetuses in the womb, and because of larger placentas with less reserve capacity, they are at greater risk of being undernourished as a fetus (Eriksson et al.,

2010); leading to smaller size at birth and health conditions later in life. Biologically, the review posits that because of differing immune and endocrine systems, boys may be more vulnerable or susceptible to infectious disease, posing a disadvantage nutritionally. In contexts of socioeconomic vulnerability, differing sociological factors or care practices, observed differences could be further exacerbated (Thurstans et al., 2022).

Though comparatively fewer, other respondents did state that such an effect was not as applicable in their context due to contrasting societal norms that may propagate a preference for, and greater protection of male children or gender roles that subject female children to greater risk of malnutrition; thereby rendering girl children more malnourished. Respondents also identified that irrespective of the sex of the child, the quality of services and provider behaviour has a direct impact on whether treatment is sought, adhered to, and whether people return to facilities [with their children]. Overall, when quality services are provided, the number of individuals seeking malnutrition care for their children increases.

Considering these limitations and overarching data constraints, this meta-analysis project points to critical calls to action for various stakeholders. They suggest valuable avenues for future analysis and development to build upon and enhance our understanding of sex differences in malnutrition in conflict-affected zones, and importantly, demonstrate how Action Against Hunger can take on an important leadership role to advocate for improved gender data collection practices (i.e., *Appendix H*). This brings us to again recognize that the qualitative inputs are based upon the individual experience and expertise of our respondents. As such, while we are not conclusively stating the effect, our analysis shows that regardless, equal attention must be given to both boys and girls when looking at SADD and understanding gender metrics that could play a role in how nutrition and nutrition-adjacent programming needs to be planned, delivered, monitored, and evaluated.

MOVING FORWARD

The goal of this meta-analysis was to develop a deeper understanding of the gendered nature of nutrition and nutritional needs within the global humanitarian response landscape, and to assist Action Against Hunger in adopting a gender transformative approach. The primary objective was to determine the differences in undernutrition among children under five years of age between sexes, across ACF's programming contexts; and the association between these differences and gender norms within the same contexts. Given the current landscape, insufficient progress towards reaching the 2025 WHO global nutrition targets and SDG Target 2.2 (UNICEF, 2023), and estimates that over a quarter of a billion people were acutely food-insecure and required urgent food assistance (FSIN and Global Network Against Food Crises, 2023), it is apparent that Action Against Hunger undertook this meta-analysis at a poignant juncture.

In embarking upon such an exercise, Action Against Hunger took a very important first step in the process of adopting a gender transformative approach: organizations need to know where they are at, before they can figure out where they need to go, and how to go about that journey. Different organizations are at different levels and ascertaining an understanding of where one's organizations stand will assist as key groundwork to situate work and thus understand the gender-related metrics that are needed to support gender transformative approach to its programming, especially given the inherent challenge of seeking structural change in humanitarian settings where structures are constantly in flux (Daigle, 2022). As a result, recommendations have been developed and are presented in the following pages.

CONCLUSION

In conclusion, this collaborative effort between Action Against Hunger Canada and the University of Toronto aimed to address the critical issue of gender inequality's association with malnutrition and to pave the way for gender-transformative approaches within nutrition programming. Through a comprehensive analysis using the GTFN, we sought answers to pressing questions about the differences in child undernutrition between sexes in seven countries of interest.

The findings of these analyses underscored a concerning trend, with boys under the age of five being more likely to be malnourished than their female counterparts across multiple nutrition outcomes analyzed. Exception exists, however, for nutrition outcomes based on MUAC, which show boys under five being less likely to be malnourished than girls under five. Thus, extra care is required in interpreting the results of the combined measures for clinical purposes. Our qualitative analysis further delved into the possible reasons behind this discrepancy, highlighting a variety of potential drivers that were context specific, including boys having an increased exposure to infection, differential care practices for girls and boys, and gendered societal norms. Moreover, our landscaping analysis of gender metrics and mapping of HNOs/HRPs/dashboards revealed a lack of consistently collected and standardized gender metrics as well as a stark inadequacy of SADD.

It is important to note that these findings are not just the product of academic exercise: they have direct implications for the work of Action Against Hunger and other similar organizations striving to reduce malnutrition and promote gender equality. Understanding the nuanced differences in undernutrition between sexes is crucial for developing targeted interventions and policies that can serve to address these disparities. Furthermore, the scarcity of reliable and comparable gender data underscores the urgent need for improved data collection and reporting mechanisms in humanitarian, development, and crisis contexts.

RECOMMENDATIONS

This report serves as a call to action, highlighting the importance of integrating a gender transformative approach into nutrition programming; with equal attention paid to both boys and girls. We invite all stakeholders in the fight against malnutrition and gender inequality to engage with this report's findings and recommendations, to come together and drive meaningful change:

1. **Share Lessons Learned**

   This meta-analysis emphasized that the GTFN can certainly be utilized as a relevant analytical framework, however its application is not inherently straightforward. An iterative and adaptive process is required to holistically make use of the broad scope of this tool. As such, for organizations like Action Against Hunger Canada that aim to integrate a gender-transformative approach into their programming, intentionality and collaboration are required to overcome emerging challenges and move towards the successful application of this analytical framework. Moreover, Action Against Hunger's experience in applying the GTFN to the meta-analysis will provide invaluable insights to the GTFN Coalition in their efforts to develop guidance for the operationalization of the GTFN. Specifically, this project highlighted 1) the need for guidance on the application of the GTFN as an analytical framework, and 2) how measuring the concepts represented in the framework has potential but is not intuitive.

2. **Importance of SADD**

   A. **Organizational level**

      For all organizations seeking to move towards gender transformative action, there is a need to clarify their respective goals and objectives regarding the adoption of a gender transformative approach. To do so, it is recommended that organizations intentionally define under what circumstances and toward which objectives a gender transformative approach makes the most sense and aligns with the organization's overall mandate. Organizations like Action Against Hunger can use the GTFN, and the lessons learned from the meta-analysis as starting points for this reflection process. Once organizations have clarified their gender transformative approach and goals, it is recommended that a process be undertaken to develop a suite of appropriate gender metrics (quantitatively) and/or a bank of gender questions (qualitatively) to have on hand to measure gender transformative change. It will be necessary that these quantitative and qualitative banks be incorporated into the organization's existing MEAL systems. To the extent possible, existing, validated measures with high psychometric properties should be adopted. However, given the current paucity of valid metrics

in several gender equality domains, it may be necessary for organizations to develop and validate its own metrics, in relation to the work being undertaken.

B. **Sector-Wide**
The dearth of consistent SADD available is not a finding specific to individual organizations, nor is it necessarily a new finding; but it does add to the body of work highlighting this issue. This issue of consistency exists at higher levels throughout the sector (i.e., DHIS, MICS, GNC, HNO/HRP, etc.), the collection of gender data metrics and consistency in SADD a pervasive issue across the sector, within global bodies and organizations alike. To ensure specific needs are not missed, and to meaningfully fulfil donor requirements and to allow organizations to tailor programming accordingly, consistent SADD collection must be emphasized across all bodies.

3. **Digitization of Data Processes**

Amidst the identified challenges at the aggregation level, a transition towards the digitalization of resources and materials was posited as a promising avenue to be pursued. Such a shift could address the demands and resultant challenges at the aggregation level, bridging the gap between facility and national levels, as well as between different channels and actors in the space (i.e., DHIS2, Nutrition Cluster, governments, etc.). Such an evolution would bolster utilization potential and increase the capacity for informed decision-making.

4. **Consider Methodological Lines of Inquiry for Future Analysis.**

Given the limitations associated with this specific process, the meta-analysis team [led in large part by the fruitful responses from interview respondents] has identified various future lines of inquiry which should be explored in further studies, to provide more insights into this nutrition-sex relationship.

5. **Don't Forget the Boys!**

Organizations like Action Against Hunger must ensure equal attention is afforded to both boys and girls when looking at SADD and understanding gender metrics that could play a role in how nutrition programming needs to be planned, delivered, monitored, and evaluated.

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APPENDEXES

APPENDIX A: INCEPTION PLAN

1. **Rationale:**

Action Against Hunger is committed to empowering women and girls, and upholding the rights of all women, men, girls, boys and people of diverse abilities, genders, and identities both within our organization, and in the communities, they work with to end hunger. With the recent release of its third *International Strategic Plan for 2021-2025*, this meta-analysis aligns with Action Against Hunger's vision of saving and protecting lives, while ensuring long-term sustainable impact in the fight against hunger through the prevention, detection, and treatment of undernutrition in humanitarian crises. With social, political, and economic inequalities driving hunger, and in particular gender inequality, understanding the power relations, workloads, cultural systems, as well as the unique needs and priorities of men, women, boys, and girls is key to designing impactful programmes that empower those Action Against Hunger serves, in emergency contexts.

Action Against Hunger aims to integrate a gender-transformative approach into their nutrition programming, with the objective of changing power dynamics and structures that reinforce inequalities, while strengthening organizational and programme capacity to reduce gender inequality at all levels.

This collaboration between Action Against Hunger and the University of Toronto leverages complementary expertise and capacity to empower communities and individuals to address gender inequality and provide useful knowledge in fighting malnutrition through a gender-transformative approach across interventions and institutionally.

2. **Goal and objectives:**

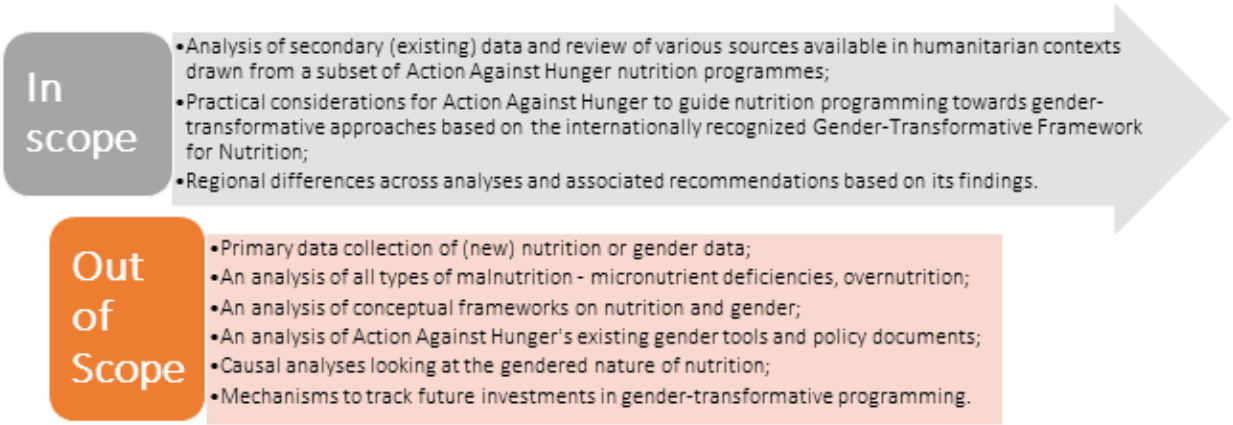
Goal: To develop a deeper understanding of the gendered nature of nutrition and nutritional needs within the global humanitarian response landscape.

Primary Objective: To determine the differences in undernutrition between sexes across Action Against Hunger's programming contexts and the association between these differences and different gender norms within the same contexts.

The assessment of gender data availability across Action Against Hunger's programming contexts will also be summarized with associated recommendations.

3. **Meta-analysis primary and secondary questions**
    1. Does the status of undernutrition differ between sexes?
        1. Null Hypothesis: There are no significant differences of undernutrition between sexes.
    2. What are the specific gender indicators/metrics that contribute to these differences in nutritional outcomes?
        1. Null Hypothesis: There are no specific gender indicators/metrics that contribute to these differences of undernutrition between sexes.

        2. Secondary Questions:
            1. Does the magnitude of the differences in undernutrition between sexes differ between geographic locations?
            2. Does the access to undernutrition services differ between sexes?
            3. Is the sex balance in programme admissions reflective of the population's undernutrition burden[1]?
            4. Which gender indicators and metrics based on the Gender-Transformative Framework for Nutrition contextualize the differences in undernutrition between sexes?



Based on these questions, the scope of these analyses will entail the following breakdown:

4. **Methods**
    1. ***Differences in undernutrition between sexes***
        1. Brief review of current literature per country included to raise greater awareness of undernutrition differences between sexes within the field of

nutrition[1] and Action Against Hunger's programming contexts across world regions.

2. Secondary data analysis on programming target groups (on boys, girls, women, men, and caregivers) at national and sub-national levels from aggregate data (i.e., reports) dating from 2018 onwards:

    - Prevalence of undernutrition in children aged 6-59 months, women of reproductive age from 15-49 years old, and pregnant and lactating women based on weight-for-height z-score (WHZ); height-for-age z-score (HAZ); weight-for-age z-score (WAZ); mid-upper arm circumference (MUAC) using SMART, MICS, DHS, other representative two-stage cluster sampling surveys (e.g. Multi-sector Emergency Team pre-assessment household survey from South Sudan).
    - Number of people in need based on Needs Analysis Results (Humanitarian Needs Overview, Integrated Phase Classification Acute Malnutrition).
    - Coverage estimates (point coverage, period coverage, single coverage) using single coverage from SQUEAC.
    - Number of "reached individuals of severe acute malnutrition management"(terms used in Action Against Hunger's ISP3 monitoring), number of "reached individuals of targeted supplementary feeding programmes" using routine data from its programmes (facility-based reports / Activity Progress Reports/Reach lists), including but not limited to: number of new admissions[2] (excluding relapses and re-admissions), number of discharged (by MUAC<115mm or WHZ<-2[3]), number of deaths, number of defaults, length of stay in days.

2. ***Gender norms contextualization***
    1. Landscape analysis to identify which secondary gender data is available per Action Against Hunger programming context.
    2. Analysis of qualitative data from semi-structured interviews with key informants based on the landscape analysis findings.
    3. Primary analysis of past data (both quantitative and qualitative) on gender norms available at national-level and from Action Against Hunger programming efforts, including but not limited to:

- Metrics focusing on Gender Equality from national-level surveys DHS, MICS.
- Maternal and child health care, including but not limited to the health insurance coverage for men and women, content, and coverage of antenatal and postnatal care, and vaccination.
- Women and men literacy, women, and men with secondary education or higher.
- Child learning/education, early child development.
- Women and men employment; women's employment and earnings, control over earnings.
- Gender-based violence measures from national-level surveys (i.e., DHS, MICS):
    - Women's experience of assault, physical or sexual violence;
    - Women's feelings of safety;
    - Harmful practices (i.e., early child marriage, polygamy, etc.).
- Gender-related barriers to service access and uptake of treatment in malnutrition programs based on evidence gathered from coverage assessments[4] or LinkNCAs[5];
- Findings from the Gender Inequality Index, Global Gender Gap Report, and other relevant UN agencies (i.e., UN Women, UNFPA):
    - Reproductive health index comprised of adolescent birth rate and maternal mortality ratio;
    - Female and male population with at least secondary education, educational attainment;
    - Economic participation and opportunity, female, and male labour force participation rates.
- Women's access to resources, decision-making, gender roles, and responsibilities, etc.
- Findings from Action Against Hunger program-level gender analyses and relevant data from Knowledge, Attitude, Practice (KAP) surveys.

The Gender-Transformative Framework for Nutrition (GTFN) is the primary analytical framework that will be used for these analyses. This conceptual model is supported by research and practice enabling improved gender analysis, solutions design, and monitoring and evaluation of nutrition approaches, as well as interventions promoting women and girls' empowerment. The GTFN applies systems thinking that examines the multi-sectoral drivers of malnutrition using a gender equality and empowerment lens. The main domains of the GTFN used for the meta-analysis include *Gender and Adolescent Responsive Health and Nutrition Systems and Economic Inclusion* and *Equitable Education.*

Quantitative analyses using R or STATA software will be used to detect significant differences between sexes in undernutrition and treatment outcomes, and whether these differences vary across countries/regions. Descriptive frequencies will be used to compare the availability of sex and gender specified data – for example: the percentage of nutrition assessments that include GBV-related questions, the percentage of nutrition assessments that inquires for SADD throughout the questionnaire.

Qualitative analyses using NVivo software include deductive thematic content analysis, and a phenomenological approach based on the key informant interviews.

Target Populations include children aged 6-59 months (male, female), adults (male, female), pregnant and lactating women (female), adolescents (female) in the following countries: Venezuela (SP), Nigeria, Chad (FR), Burkina Faso (FR), Ethiopia, Somalia, South Sudan, Yemen, Myanmar, Bangladesh. For 2023, the following four countries will likely be included: Colombia (SP), DRC (FR), Myanmar (for an additional year), and Venezuela (SP-for an additional year).

Methods are dependent on the amount of available and sufficient data from Action Against Hunger. Depending on the time by which data is received, analysis looking at the effects of the COVID-19 pandemic will also be explored.

5. Expected outcomes

All outputs of this collaboration would be relevant for Action Against Hunger humanitarian response staff, including technical Nutrition, Health, WASH and Gender staff Practitioners, Gender Advisors, Gender Champions, and other relevant stakeholders involved in Action Against Hunger's nutrition programming. These outputs include:

- Report of meta-analysis' findings on the gendered nature of nutrition and nutritional needs, stratified by country and by region;
- Report on landscape analysis of gender measures and metrics coupled with qualitative findings from key informant interviews;
- Roadmap derived from the findings from the meta-analysis and landscape analysis with associated recommendations to advance the design and delivery of Action Against Hunger's gender-transformative approaches across its programming contexts, including responses to humanitarian crises;
- Question bank of gender gendered aspects (i.e., decision-making authority, control and violence, gender equality context, child protection, etc.) for prospective data collection based on the recommendations from the roadmap and suggestions from the meta-analysis team;
- Knowledge generation outputs capturing the learnings of this collaboration for a wide range of audiences.

APPENDIX B: CONSENT FORM

BACKGROUND: Action Against Hunger Canada, in collaboration with the University of Toronto, has commissioned a meta-analysis project to gain a deeper understanding of the gendered nature of nutrition, nutritional needs, and access to nutrition services. This meta-analysis is investigating differences in undernutrition between sexes in children under-five years of age across seven countries: Afghanistan, Bangladesh, the Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen (South). While preliminary statistical findings have emerged, this qualitative element of the meta-analysis aims to shed light on our understanding of overlooked factors and drivers of disparity based on the unique personal insights and professional experiences of staff who work and support ongoing efforts at the country-, regional- or headquarter-level.

GOALS: This work aims to explore how sex and age data in existing sub-national data systems can be utilized to improve nutrition programming that supports gender transformative change in children under-five, and to further assess the confounding factors that may provide context to the preliminary statistical findings from the project.

PROCEDURES: Interviews will be conducted in English (or French) by two members of the University of Toronto's meta-analysis team and recorded over the ZOOM platform. Interviews will last approximately 1 hour.

WHO CAN PARTICIPATE?: Global/National Cluster staff and humanitarian practitioners working for Action Against Hunger, World Vision or CARE currently working/advising on nutrition-specific/gender programming and its information management (i.e., data systems) at headquarter, regional- and country-level for Afghanistan, Bangladesh, the Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and/or Yemen (South) and its neighbouring countries, are welcome to participate in the qualitative component of this project.

RISKS: No anticipated risks related to participation in this project – participation is completely voluntary and anonymous. You may decline to answer any or all questions and you may terminate your involvement at any time if you choose without repercussion.

BENEFITS: No direct benefit by participating in this project. Information obtained from this meta-analysis aims to support improved nutrition information systems and programming that support gender transformative change.

CONFIDENTIALITY AND PROJECT OUTPUTS: All interview responses will remain secure and confidential; only aggregate findings (i.e., no individual responses) will be reported. Findings will be used to support and assess the statistical findings of the meta-analysis to further evidence on the gendered nature of nutrition. A final report on the gendered nature of nutrition/nutritional needs

within the global humanitarian response landscape will be prepared and available for review upon request before it is shared with research and nutrition communities of practice.

CONSENT: Participation is completely voluntary. You may refuse to participate and/or decline to answer any question during the interview without any negative consequences. Participation in this evaluation will not affect your access or ability to participate in University of Toronto or Action Against Hunger programs and activities.

This project has been reviewed and approved by the University of Toronto Research Ethics Board (REB# 37571). If you have any questions, please contact the Principal Investigator, Daniel Sellen at dan.sellen@utoronto.ca or (416)-388-3430. You may also contact the Research Oversight and Compliance Office – Human Research Ethics Program at ethics.review@utoronto.ca or 416-946-3273, if you have questions about your rights as participant.

Do you consent to participate in the qualitative portion of this meta-analysis project? *

Yes

No

Sign your full name* _____

APPENDIX C: ONE-PAGER FOR POTENTIAL INTERVIEWEES

Leading the Meta-Analyses for Action Against Hunger Canada's Multi-Year Humanitarian Nutrition Program

Please read the following information carefully. Do not hesitate to discuss any questions you may have with the University of Toronto Project Team.

BACKGROUND

Action Against Hunger Canada, in collaboration with the University of Toronto, has commissioned a meta-analysis project to gain a deeper understanding of the gendered nature of nutrition, nutritional needs, and access to nutrition services. This meta-analysis project is investigating differences in undernutrition between sexes in children under-five years of age across seven countries: Afghanistan, Bangladesh, the Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen (South). While preliminary statistical findings have emerged, this qualitative element of the meta-analysis aims to shed light on our understanding of overlooked factors and drivers of disparity based on the unique personal insights and professional experiences of staff who work and support ongoing efforts at the country-, regional- or headquarter-level.

GOALS

This work aims to explore how sex and age data in existing sub-national data systems can be utilized to improve nutrition programming that supports gender transformative change in children under-five, and to further assess the confounding factors that may provide context to the preliminary statistical findings from the project.

META-ANALYSIS PROCEDURES

Interviews will be conducted in English (or French) by two members of the University of Toronto's meta-analysis team using the ZOOM platform. Interviews will last approximately 1 hour.

WHO CAN PARTICIPATE?

Global/National Cluster staff and humanitarian practitioners working for Action Against Hunger, World Vision or CARE currently working/advising on nutrition-specific/gender programming and its information management (i.e., data systems) at headquarter, regional- and country-level for Afghanistan, Bangladesh, the Democratic Republic of Congo, Ethiopia,

Somalia, South Sudan, and/or Yemen (South) and its neighboring countries, are welcome to participate in the qualitative component of this project.

Exclusion Criteria for potential participants:

- Individuals under 18 of age;
- Individuals who do not speak English or French;
- Individuals who have previously worked or are working outside the seven countries of interest: Afghanistan, Bangladesh, Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, Yemen.

RISKS: No anticipated risks related to participation in this project– participation is completely voluntary and anonymous. You may decline to answer any or all questions and you may terminate your involvement at any time if you choose without repercussion.

BENEFITS: No direct benefit from participating in this project. Information obtained from this meta-analysis aims to support improved nutrition information systems and programming that support gender transformative change.

CONFIDENTIALITY AND PROJECT OUTPUTS

All interview responses will remain secure and confidential; only aggregate findings (i.e., no individual responses) will be reported. Findings will be used to support and assess the statistical findings of the meta-analysis to further evidence on the gendered nature of nutrition. A final report on the gendered nature of nutrition/nutritional needs within the global humanitarian response landscape will be prepared and available for review upon request before it is shared with research and nutrition communities of practice.

CONTACT INFORMATION

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Research Officer
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APPENDIX D: RECRUITMENT SCRIPT

Dear _____

I hope you have been keeping well since we last met!

Action Against Hunger Canada, in collaboration with the University of Toronto, is conducting a meta-analysis to gain a better understanding of the gendered nature of nutrition by investigating sex differences in undernutrition among children under five in Afghanistan, Bangladesh, Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen. This meta-analysis contains both a quantitative and qualitative component, with the latter seeking to contextualize our statistical findings. I have attached an information sheet with additional details.

Given your experience, we were hoping to speak with you to explore how sex and age data in existing sub-national data systems can be used to improve nutrition programming that supports gender transformative change in children under five years of age. Would you be willing and available to speak with our team sometime between _____?

If so, kindly provide **3 time slots (1 hour) between** _____ that are agreeable with the EST time zone). A consent form will be sent upon confirmation of your willingness to participate. We are also open to having multiple respondents per interview, so if there is someone you feel should join, do let us know. Please let us know if you have any questions.

Looking forward to hearing from you.

Best,

ACF Staff Member

APPENDIX E: INTERVIEW GUIDES

1. Interview guide – Gender or Nutrition technical advisors

Introduce yourself and explain the purpose of the interview:

Thank you for seeing me today and offering to take part in this meta-analysis project. I would like to outline the focus and purpose of the project so you can decide if you would like to take part.

Recently, Action Against Hunger Canada undertook a statistical meta-analysis using sub-national survey data from seven countries (Afghanistan, Bangladesh, Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen (South)) to examine sex-related differences in undernutrition outcomes for boys and girls under five. The meta-analysis found significant differences in the odds of being undernourished by sex. The objective of the current project is to explore potential reasons for these differences with humanitarian practitioners currently working/advising on nutrition in the seven meta-analysis countries. In addition, we are gathering information on how disaggregated data is currently being used by humanitarian practitioners in the design and delivery of nutrition programs for children under five.

If you would like to go ahead with our chat today, I will ask that you sign this consent form (recap consent form). I will take notes and record while we speak, in case I want to come back to something later – will that be, okay?

Today I would like to discuss two topics. The first is your organization's practices regarding the collection and use of data disaggregated by sex, age, or other factors in the design and delivery of nutrition programs for children under five. In the second half of our interview, I would like to explore potential reasons for differences in nutrition outcomes for boys and girls under five, with a focus on identifying potential gender-related drivers behind these differences.

As we progress, I may ask you additional (clarifying) questions to further my understanding of your point of view. It will take approximately 1 hour to complete. Does that sound reasonable?

You are welcome to stop this interview at any time. Furthermore, you can refuse to answer any question, for any reason. There will be no consequence or penalty of any kind for skipped or unanswered questions, or for ending the interview early. Feel free to ask questions at any stage during the interview. If you have any questions after this interview, or if you would like to talk further about any of these topics, please do not hesitate to reach out to myself or a member of the team.

Can we begin?

Q1. Can you tell us a little about your role as a __(position)_____ at ____(org)_____ in _____(location)_____?

Q2. To the best of your knowledge, does your organization and its partners collect sex-disaggregated data for children under five who participate in your programs? For example, is sex-disaggregated data available regarding the number of children under five receiving services?

- Are data disaggregated by other factors? Such as age, disability, ethnicity, or language?

Q3. To the best of your knowledge, does your organization collect any data on the caregiver who accompanies the child? For example, caregiver sex, age, marital status, education level?

Q4. In your role as _____, do you collect or use disaggregated data in your work?

- **If No – go to Q5 (and skip Q7).**
- **If Yes – go to Q7.**

Q5. Are you aware of other roles in your organization that use disaggregated data in their work?

Q6. What would be the potential value of having disaggregated data to inform your work? What types of disaggregation would be of the most use to you and why? Sex? Age? Ethnicity? Etc.

Q7. Can you tell us how you use disaggregated data in your work? What has been the benefit of having disaggregated data to inform your work?

Q8. What improvements would you like to see in the way your organization and its partners collect and use disaggregated data?

Q9. More specifically, if disaggregated data was to be universally scaled and made available or accessible in dashboards, Humanitarian Needs Overview and Humanitarian Response Plans, how would that impact your day-to-day work?

Q10. Are you aware of the admissions criteria for nutrition services in your country (WHZ, MUAC, etc.)?

If yes, what is the nutrition admissions criteria? Same for discharge? Is this national level or is it an individual org/entity-based choice?

Q11. What difference does disaggregated data make in the way you use admissions or discharge data?

Q12. Based on the preliminary findings from ACF's meta-analysis that I mentioned earlier, it was found that boys are generally more acutely malnourished than girls.

In your experience, what are some potential reasons that boys and girls under five may (or may not) have differential nutrition outcomes in (country)? Can you share any examples from your professional experience?

Prompts:

- Biological reasons?
- Could gender norms and the relative value placed on boys and girls by society play a role? Can you elaborate?
- Could the roles and responsibilities of primary caregivers play a role? Can you elaborate?
- Could household decision-making practices play a role? Can you elaborate?
- Could primary caregivers' access to resources play a role? Can you elaborate?
- Could the quality of nutrition services play a role? Can you elaborate?

Q13. How can your organization begin to better understand and address some of the gender-related challenges to tackling undernutrition in children under five?

Q14. Would you like to share any further reflections on the subject of disaggregated data and gender-related barriers to improved nutrition for children under five?

2. Interview guide – MEAL Info Management

Introduce yourself and explain the purpose of the interview:

Thank you for seeing me today and offering to take part in this meta-analysis project. I would like to outline the focus and purpose of the project so you can decide if you would like to take part.

Recently, Action Against Hunger Canada undertook a statistical meta-analysis using sub-national survey data from seven countries (Afghanistan, Bangladesh, Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen (South)) to examine sex-related differences in undernutrition outcomes for boys and girls under five. The meta-analysis found significant differences in the odds of being undernourished by sex. The objective of the current project is to explore potential reasons for these differences with humanitarian practitioners currently working/advising on nutrition in the seven meta-analysis countries. In addition, we are gathering information on how disaggregated data is currently being used by humanitarian practitioners in the design and delivery of nutrition programs for children under five.

If you would like to go ahead with our chat today, I will ask that you sign this consent form (recap consent form). I will take notes and record while we speak, in case I want to come back to something later – will that be, okay?

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As we progress, I may ask you additional (clarifying) questions to further my understanding of your point of view. It will take approximately 1 hour to complete. Does that sound reasonable?

You are welcome to stop this interview at any time. Furthermore, you can refuse to answer any question, for any reason. There will be no consequence or penalty of any kind for skipped or unanswered questions, or for ending the interview early. Feel free to ask questions at any stage during the interview. If you have any questions after this interview, or if you would like to talk further about any of these topics, please do not hesitate to reach out to myself or a member of the team.

Can we begin?

Q1. Can you tell us a little about your role as a __(position)_____ at ____(org)_____ in _____(location)_____?

Q2. To the best of your knowledge, does your organization and its partners collect sex-disaggregated data for children under five who participate in your programs? For example, is sex-disaggregated data available regarding the number of children under five receiving services?

- Are data disaggregated by other factors? Such as age, disability, ethnicity, or language?

Q3. To the best of your knowledge, does your organization collect any data on the caregiver who accompanies the child? For example, caregiver sex, age, marital status, education level?

Q4. In your role as _____, do you collect or use disaggregated data in your work?

- **If No – go to Q5 (and skip Q7).**
- **If Yes – go to Q7.**

Q5. Are you aware of other roles in your organization that use disaggregated data in their work?

Q6. What would be the potential value of having disaggregated data to inform your work? What types of disaggregation would be of the most use to you and why? Sex? Age? Ethnicity? Etc.

Q7. Can you tell us how you use disaggregated data in your work? What has been the benefit of having disaggregated data to inform your work?

Q8. What improvements would you like to see in the way your organization and its partners collect and use disaggregated data?

Q9. More specifically, if disaggregated data was to be universally scaled and made available or accessible in dashboards, Humanitarian Needs Overview and Humanitarian Response Plans, how would that impact your day-to-day work?

Q10. Are you aware of the admissions criteria for nutrition services in your country (WHZ, MUAC, etc.)?

If yes, what is the nutrition admissions criteria? Same for discharge? Is this national level or is it an individual org/entity-based choice?

Q11. What difference does disaggregated data make in the way you use admissions or discharge data?

Q12. Based on the preliminary findings from ACF's meta-analysis that I mentioned earlier, it was found that boys are generally more acutely malnourished than girls.

In your experience, what are some potential reasons that boys and girls under five may (or may not) have differential nutrition outcomes in (country)? Can you share any examples from your professional experience?

Prompts:

- Biological reasons?
- Could gender norms and the relative value placed on boys and girls by society play a role? Can you elaborate?
- Could the roles and responsibilities of primary caregivers play a role? Can you elaborate?
- Could household decision-making practices play a role? Can you elaborate?
- Could primary caregivers' access to resources play a role? Can you elaborate?
- Could the quality of nutrition services play a role? Can you elaborate?

Q13. How can your organization begin to better understand and address some of the gender-related challenges to tackling undernutrition in children under five?

Q14. Would you like to share any further reflections on the subject of disaggregated data and gender-related barriers to improved nutrition for children under five?

APPENDEX F: BAYESIAN FIXED-EFFECTS META-ANALYSIS RESULTS

Table 7. Odds ratio estimates and their 95% credible intervals under Bayesian fixed effects meta-regression.

Outcome	Odds Ratio	95% Credible Interval
GAM	1.30	(1.24, 1.37)
SAM	1.47	(1.33, 1.61)
GAM based on MUAC	0.83	(0.78, 0.87)
SAM based on MUAC	0.87	(0.79, 0.96)
stunting	1.45	(1.40, 1.51)
cGAM	1.06	(1.01, 1.11)
cSAM	1.10	(1.02, 1.19)

Table 8. Odds ratio estimates and their 95% credible intervals for non-African countries under Bayesian fixed effects meta-regression.

Outcome	Odds Ratio	95% Credible Interval
GAM	1.29	(1.24, 1.37)
SAM	1.57	(1.21, 2.04)
GAM based on MUAC	0.63	(0.56, 0.72)
SAM based on MUAC	0.73	(0.57, 0.92)
stunting	1.29	(1.20, 1.38)
cGAM	1.03	(0.94, 1.13)
cSAM	0.99	(0.82, 1.20)

Table 9. Odds ratio estimates and their 95% credible intervals for African countries under Bayesian fixed effects meta-regression.

Outcome	Odds Ratio	95% Credible Interval
GAM	1.31	(1.24, 1.38)
SAM	1.45	(1.31, 1.61)
GAM based on MUAC	0.87	(0.82, 0.92)
SAM based on MUAC	0.90	(0.81, 1.00)
stunting	1.52	(1.45, 1.59)
cGAM	1.07	(1.02, 1.13)
cSAM	1.13	(1.03, 1.23)

APPENDIX G: USING GTFN AS AN ANALYTICAL FRAMEWORK UTLITIZING THE GENDER TRANSFORMATIVE FRAMEWORK FOR NUTRITION AS A MECHANISM OF ANALYSIS

There is growing and consistent evidence indicating that gender inequality is positively associated with malnutrition. Gender transformative change calls us to address the root causes of gender inequality; moving beyond the individual, to encompass the societal and the structural drivers. Exploring gender and nutrition through analyses has immense potential to be catalytic in promoting structural change, movement building, and the reduction of gender inequalities.

Action Against Hunger Canada aims to integrate a gender-transformative approach into their nutrition programming, with the objective of changing power dynamics and structures that reinforce inequalities, while strengthening organizational and program capacity to reduce gender inequality at all levels. As such, in collaboration with the University of Toronto, Action Against Hunger Canada has set out to gain a deeper understanding of the gendered nature of nutrition and nutritional needs within the global humanitarian response landscape; specifically, the extent to which gender norms may affect under-five boys' and girls' nutritional status. A multi-country meta-analysis using observational data has been undertaken utilizing the Gender Transformative Framework for Nutrition (GTFN) as the guiding mechanism of analysis.

The GTFN is a conceptual model that is supported by both research and practice, presenting extensive opportunities for impact across nutrition and gender programming, research, and beyond. With seven inherently interconnected domains, the GTFN applies a systems-thinking approach that examines the multi-sectoral drivers of malnutrition through the lens of gender equality and empowerment. For these reasons [among others], it was a highly attractive analytical framework for this project. The application of the GTFN in an analytical capacity has proven to be more complex than originally anticipated. Many of the challenges encountered have been contextually grounded; specifically pertaining to the applicability and comparability of data consistently available across multiple countries and GTFN domains.

Emerging learnings regarding the application of the GTFN as an analytical framework include: 1) a lack of availability of information (gender disaggregated data across target populations and countries) to support the analytical use of the GTFN for programming purposes; and at more micro-level, 2) a lack of consistency among metrics and indicators within the available data, with additional inconsistencies in how metrics are being measured across regions,

KEY TAKEAWAYS

When attempting to utilize the GTFN as a primary analytical framework, take heed of the following considerations:

- Commit to an iterative, evolving and exploratory process when using the GTFN as an analytical framework
- Define key GTFN domains of interest a priori the analysis, as the GTFN is a wide-reaching tool and requires groundwork to be set in advance
- Clearly define associated questions per GTFN domain of interest
  - Consider mapping data availability per GTFN domain of interest prior to analysis, as there are inconsistencies across metrics

In conclusion, the GTFN can certainly be utilized as a relevant analytical framework, however its application is not inherently straightforward. An iterative and adaptive process is required to holistically make use of the broad scope of this tool. As such, for organizations like Action Against Hunger Canada that aim to integrate a gender-transformative approach into their programming, intentionality and collaboration are required to overcome emerging challenges and move towards the successful application of this analytical framework.

This brief presents findings and recommendations from the meta-analysis project between University of Toronto and Action Against Hunger Canada. Brief drafted by Jenna Hickey. The opinions, findings, interpretations, and conclusions expressed in this brief do not necessarily reflect the views of the University of Toronto or Action Against Hunger Canada or the partners who financed this work. For further information, please consult contact Victoria.zaruvepane@utoronto.ca

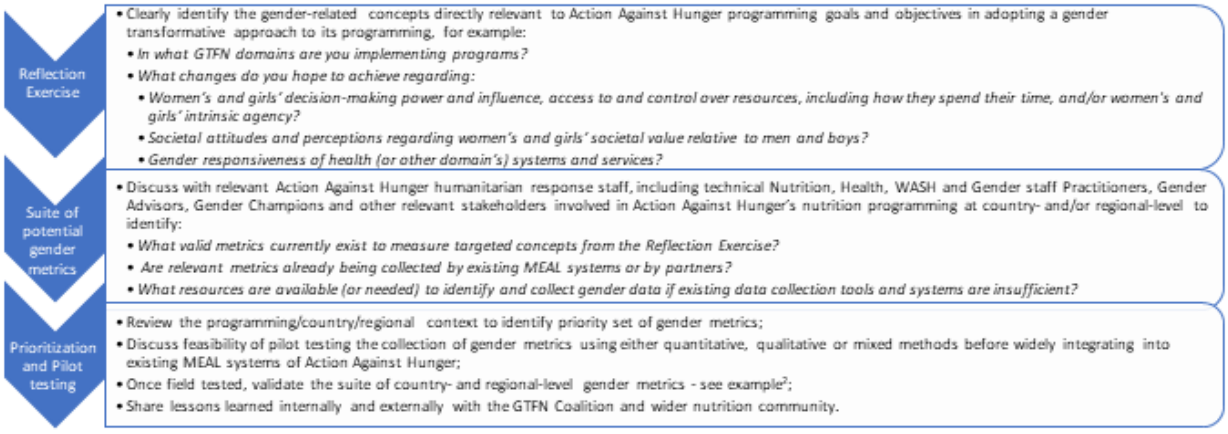
APPENDIX H: INSIGHTS FOR A BANK OF GENDERED QUESTIONS

Action Against Hunger aims to integrate a gender-transformative approach into their nutrition programming, with the objective of changing power dynamics and structures that reinforce inequalities, while strengthening organizational and programme capacity to reduce gender inequality at all levels. A deeper understanding of the gendered nature of nutrition and nutritional needs within the global humanitarian response landscape has been developed based on the findings of the collaboration.

The Gender-Transformative Framework for Nutrition (GTFN) was the meta-analysis project's primary analytical framework. This conceptual model is supported by research and practice enabling improved gender analysis, solutions design, and monitoring and evaluation of nutrition approaches, as well as interventions promoting women and girls' empowerment. The GTFN also applies systems thinking that examines the multi-sectoral drivers of malnutrition using a gender equality and empowerment lens.

Over the course of its collaboration with Action Against Hunger, the University of Toronto has identified several lessons learned throughout the design and implementation of the meta-analysis. Specifically, the meta-analysis' qualitative component explored the gendered nature of nutrition and insights on the meta-analysis' statistical findings given the lack of quantitative gender metrics consistently available across the seven countries of interest included in the meta-analysis. The lessons learned from this qualitative component of the project, coupled with the grounded recommendations from an external Gender Expert (Dr. Alison Riddle[6]), provide invaluable insight when developing a question bank of gendered aspects (i.e., decision-making authority, control and violence, gender equality context, child protection, etc.) for prospective data collection.

Suggested steps when developing a question bank on gendered aspects:



APPENDIX I: FUTURE LINES OF INQUIRY

Throughout the course of the interview process, qualitative respondents identified specific future lines of inquiry that could be explored in pursuit of a deeper understanding and more nuanced insights into the complex interplay of gender, malnutrition, and adjacent health outcomes among children under five. There are several promising avenues for future investigation that could enhance comprehension and inform more targeted and effective intervention strategies.

Exploring Biological Factors

Respondents identified a need to explore the biological underpinnings of gender disparities in malnutrition under five. There are a couple of avenues within this specific category that may necessitate further investigation, including whether protective hormones in girls may play a role in their lower susceptibility to malnutrition. Additionally, interviews stated the importance of this avenue of inquiry, to mitigate the risk of conflating gender-specific or contextualized practices with what could be more of a biological phenomenon, and not to make assumptions that what we are seeing is simply related to poor practices, for example. To explore this biological phenomenon, future analyses should extend beyond humanitarian contexts and incorporate a wide range of studies and surveys to encompass broader health and nutrition data.

Population-Based Analysis

An analysis grounded in the realities of the population in question was repeatedly cited as an important area for future analysis, and something that is needed to fully contextualize future findings. There were three main components to this line of inquiry: overall population counts, sex ratio at birth, and under five mortality scores. Examining the proportion of malnutrition rates proportionate to the overall population counts of boys and girls within a specific country is necessary, because it could be possible that malnutrition affects all children equally, but maybe there are more boys in one specific area: rendering statistically varying representation and emphasizing the importance of considering the relative number of boys and girls within any given population. In a similar vein, given the preference for sons in many countries in crisis contexts, delving into the cultural and societal norms as they relate to sex ratio at birth (SRAB) in each region could be another factor of relevance. A strong preference for sons was posited as a potential factor that may lead to forced abortion or female infanticide, rendering the population disproportionate and contributing to gender-specific malnutrition trends. Lastly, it would be very interesting to compare the sex disaggregated under 5 all-cause mortality against malnutrition rates. Again, if for example it was identified that more girls were dying young (under the age of 5), that would give us a broader perspective on the issue, highlighting why it might make sense that boys under 5 are more malnourished; simply because they are staying alive in greater quantities.

Positive Deviance Analysis

Exploring cases where children are thriving despite varying gendered practices would offer valuable insights. Studying such cases could assist in the identification of various factors that may contribute to positive outcomes; potentially guiding more effective and contextually tailored interventions.

Decoloniality and Gender Dynamics

Examining the link between entrenched gender norms and the legacy of colonialism presents an opportunity to contextualize gender dynamics in different societies. For example, examining how colonial ideologies have shaped the creation of the gender binary, the imposition of gender norms, and the concept of the "nuclear family" could unearth some interesting dynamics. Additionally, it will be important to ascertain an understanding of how colonial ideals permeate a lot of the work conducted from the Global North and how [nutrition] programming is shaped accordingly. This could lead to more concerted efforts in decoloniality at large, perhaps even promoting a restoration of decolonized structures and beliefs.

Disaggregating Stages of Admission

Respondents also identified the importance of attempting to break down the stages of admissions and the impact it had on the data we are seeing. Investigating gender disparities at different stages of the admission process could unveil gendered variations in health-seeking behaviours and healthcare access that could contribute to gender-specific outcomes. For example, if one sex is consistently being admitted at the Transition from Supplementary Feeding Program (TSFP) stage versus stabilization centers; that is something that we need to know.

Adjacently, understanding how gender norms influence choices and impact health-seeking pathways is crucial. For example, by examining the gender dynamics in stabilization centers, where overnight stays may be required, we could get an insight into family decision-making processes and barriers that may prevent access to care. Some stabilization centers for example, require overnight stays; some men don't want their wife staying away from home alone with the child, which would restrict the child from receiving care. Moving beyond decision making authority, another dynamic that could be at play is the level of shame or embarrassment that exists for parents (particularly fathers) regarding having a child seen to be in any such facility, and the impact on willingness to seek and stay for care in a public setting.

APPENDIX J: MAPPING ON SADD

MAPPING THE AVAILABILITY OF SEX- AND AGE-DISAGGREGATED DATA IN SEVEN HUMANITARIAN RESPONSE LANDSCAPES

There is growing and consistent evidence indicating that gender inequality is positively associated with malnutrition. Gender transformative change calls us to address the root causes of gender inequality; moving beyond the individual, to encompass the societal and the structural drivers. Evidence-informed programming has immense potential to be catalytic in promoting structural change, movement building, and the reduction of gender inequalities. Sex and age disaggregated data (SADD) is one such body of evidence that is profoundly important when discussing the intersection of gender and nutrition. In collaboration with the University of Toronto, Action Against Hunger Canada has set out to gain a deeper understanding of the gendered nature of nutrition and nutritional needs within the global humanitarian response landscape; specifically, the extent to which gender norms may affect under-five boys' and girls' nutritional status.

As a supplementary exercise within a larger meta-analysis project, a mapping was conducted of Humanitarian Needs Overviews (HNOs), Humanitarian Response Plans (HRPs) and dashboards for each of the seven countries of interest (Afghanistan, Bangladesh, the Democratic Republic of Congo, Ethiopia, Somalia, South Sudan, and Yemen). Reviewing over 80 HNOs and HRPs and 9 Nutrition Cluster dashboards from 2018-present, the team scanned for 1) the presence of these resources and 2) the existence of SADD for 5 malnutrition variables: GAM and SAM based on WHZ, GAM and SAM based on MUAC, and stunting based on HAZ. Qualitative interviews were also done with 17 Nutrition Cluster staff and partners to further unpack the process of SADD collection and utilization, and its associated gaps.

KEY TAKEAWAYS: The mapping found a limited status of available SADD in HNOs, HRPs and dashboards. As such, to further unpack this occurrence, the process, and the gaps, the following takeaways emerged from the qualitative interviews:

Bolster the Availability of SADD for Outcome Related Data at the National Level

Sex and age disaggregated outcome related data (i.e., treatment or admissions data) is currently not available in dashboards, and is unreliably present across HNOs/HRPs. Respondents raised the fact that this data is relatively present at subregional levels, positing that the gap may lie within the aggregation and utilization stages. There is immense value in aggregation, and having this collated information available at the national level would be highly beneficial.

Prioritize the Accessibility and Transparency of Data

HNOs and HRPs don't explicitly contain SADD, but rather often reference out to data, surveys, or reports that 1) are not always accessible and 2) also do not always contain SADD. Being such high-level documents/resources, the lack of presentation of SADD is a real missed opportunity. To move beyond SADD, the inclusion of additional intersectional data (i.e., disability status, caregiver information, etc.) will enable programs to be developed to be more effectively catered to specific and actualized needs. Data collection is only beneficial if the results are representative, and readily available to those requiring it for decision-making.

Future Proofing Data Collection Methods

Global disruptions will continue to have a sizeable impact on both the type and the quantity of data being collected. For example, the COVID-19 pandemic led to a temporary shift towards MUAC-only measurements, as a result of the associated patient-proximity; but this shift was not uniform, nor was it sustained. The quantity of data collection itself also dropped off significantly during the peak-pandemic years, highlighting the need to both standardize and future-proof data collection systems. Further, in pursuit of future gender transformative programming, we must have systems that are resilient and equipped to collect SADD [and beyond] as an essential starting point: intersectional data provides invaluable insight, and is completely integral to the development of robust gender responsive and transformative approaches/programming.

APPENDIX K: NVIVO CODEBOOK

NODES

Name	Description	Files	References
Activities	How do the separate roles and daily activities of men, women, boys, and girls prevent or promote their risk of malnutrition?	12	19
Admissions - discharge criteria	WHZ/MUAC/WHZ and MUAC	8	14
Area of expertise	Gender, Implementation, M&E, Emergency Response, etc.	15	18
Awareness & knowledge	Local populations	7	10
Bargaining position	Who in the household typically decides where and when to access nutrition programming or services? Are certain household members prioritized?	12	20
Benefits of disaggregated data	Potential for the collection/utilization of disaggregated data in design/programming/decision-making/day-to-day work	12	25
Biological	Potential/speculated gendered biological factors	9	11
Capacity of (sub-)national data systems	Support or lack thereof for disaggregated data systems from policymakers, government partners	2	2
Care practice	Gendered care-oriented practices that may impact health and nutrition status	5	5
Disaggregated data barriers	Factors that prohibit collection/utilization of disaggregated data	12	43
Disaggregated data enablers	Factors that enable collection/utilization of disaggregated data	14	43
Donor pressure	Donor requirements influence organizations' collection/utilization of disaggregated data in design/programming/decision-making/day-to-day work	8	10
Environment	How does the quality of nutrition programming or services encourage or discourage women, men, boys, and girls to access them?	13	20
Future lines of inquiry	Things to explore in subsequent efforts	6	13

Gender norms	Relative value of boys and girls in a household - where do girls and boys fall on the priority list?	16	46
Laws, policies & practices (inc. health services)	Are there accepted cultural norms or practices that affect boys' and girls' vulnerability to malnutrition, or women's and men's ability to access nutrition programming or services?	9	13
Level of measurement	Headquarter/global/regional/national/sub-national levels	10	22
Perspective	Anything derivative of personal or professional lens (seniority, field vs headquarters, target populations)	3	4
Relationship	GNC Staff, Action Against Hunger, World Vision, etc.	15	15
Resources	Not including donor funding, all other aspects of resources	2	3
Resources (HH-level)	Who in the household typically controls the resources needed to access nutrition programming or services? How does this affect the decisions made? How are decisions affected when resources are limited?	10	13
Staff capacity	Knowledge and capacity of staff to utilize disaggregated data into design/programming/decision-making	6	10
Stakeholder support	Support or lack thereof for a gender transformative/intersectional approach from partner organizations (excluding donors, policymakers)	8	10
Ways forward regarding disaggregated data	Improvements that may influence organizations' collection/utilization of disaggregated data in design/programming/decision-making/day-to-day work	15	38
Ways forward regarding gender-related challenges	Improvements that may influence organizations' understanding of gender-related challenges in design/programming/decision-making/day-to-day work	14	29

ANNEX 1: META-ANALYSIS AND META-REGRESSION R CODE

```
library(rjags)
library(tidyverse)
options(scipen = 999)
setwd('~/nutrition MA/')
set.seed(1357)

# function to create summaries of posterior samples
nice.summary <- function(samples, digits=3){
 results <- summary(samples)
 means <- results$statistics[,'Mean']
 medians <- results$quantiles[,'50%']
 sd <- results$statistics[,'SD']
 quartiles <- results$quantiles[,c('2.5%','97.5%')]
 summarytable <- cbind(mean=means,median=medians,sd=sd,quartiles)
 colnames(summarytable)[3:5] <- c('SD','lower 95% CrI','upper 95% CrI')
 round(summarytable, digits=digits)
}

# import GAM data
gam.raw <- read.csv('GAM_dat.csv', header=T)

# sum survey data from all regions for report 1
temp <- gam.raw %>%
 slice(1:6) %>%
 group_by(Country) %>%
 summarize(Report.Number=1, epos=sum(epos), etot=sum(etot), upos=sum(upos), utot=sum(utot))

# process GAM data
gam.dat <- gam.raw %>%
 slice(7:nrow(gam.raw)) %>% # remove report 1 sub-report rows
 mutate(Report.Number=as.numeric(Report.Number)) %>%
 add_row(temp,.before=1) %>% # add to 1st row summarized report 1
 mutate(uneg=utot-upos,eneg=etot-epos,ua=1,ea=2,or=(epos*uneg)/(eneg*upos),lor=log(or),
      cil=lor-1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),ciu=lor+1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),
           african=ifelse(Country %in% c('Ethiopia','South Sudan','Somalia','DRC'),1,0)) %>%
 filter(!is.na(lor))

# import SAM data
sam.raw <- read.csv('SAM_dat.csv', header=T)

# process SAM data
sam.dat <- sam.raw %>%
 slice(7:nrow(sam.raw)) %>% # remove report 1 sub-report rows
 mutate(Report.Number=as.numeric(Report.Number)) %>%
 mutate(uneg=utot-upos,eneg=etot-epos,ua=1,ea=2,or=(epos*uneg)/(eneg*upos),lor=log(or),
      cil=lor-1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),ciu=lor+1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),
           african=ifelse(Country %in% c('Ethiopia','South Sudan','Somalia','DRC'),1,0)) %>%
 filter(!is.na(lor))

# import GAM based on MUAC data
gammuac.raw <- read.csv('GAMMUAC_dat.csv', header=T)
```

```
# sum survey data from all regions for report 1
temp <- gammuac.raw %>%
 slice(1:6) %>%
 group_by(Country) %>%
 summarize(Report.Number=1, epos=sum(epos), etot=sum(etot), upos=sum(upos), utot=sum(utot))

# process GAM based on MUAC data
gammuac.dat <- gammuac.raw %>%
 slice(7:nrow(gammuac.raw)) %>% # remove report 1 sub-report rows
 mutate(Report.Number=as.numeric(Report.Number)) %>%
 add_row(temp,.before=1) %>% # add to 1st row summarized report 1
 mutate(uneg=utot-upos,eneg=etot-epos,ua=1,ea=2,or=(epos*uneg)/(eneg*upos),lor=log(or),
      cil=lor-1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),ciu=lor+1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),
           african=ifelse(Country %in% c('Ethiopia','South Sudan','Somalia','DRC'),1,0)) %>%
 filter(!is.na(lor))

# import SAM based on MUAC data
sammuac.raw <- read.csv('SAMMUAC_dat.csv', header=T)

# process SAM based on MUAC data
sammuac.dat <- sammuac.raw %>%
 slice(7:nrow(sammuac.raw)) %>% # remove report 1 sub-report rows
 mutate(Report.Number=as.numeric(Report.Number)) %>%
 mutate(uneg=utot-upos,eneg=etot-epos,ua=1,ea=2,or=(epos*uneg)/(eneg*upos),lor=log(or),
      cil=lor-1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),ciu=lor+1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),
           african=ifelse(Country %in% c('Ethiopia','South Sudan','Somalia','DRC'),1,0)) %>%
 filter(!is.na(lor))

# import stunting data
stunt.raw <- read.csv('stunt_dat.csv', header=T)

# sum survey data from all regions for report 1
temp <- stunt.raw %>%
 slice(1:6) %>%
 group_by(Country) %>%
 summarize(Report.Number=1, epos=sum(epos), etot=sum(etot), upos=sum(upos), utot=sum(utot))

# process stunting data
stunt.dat <- stunt.raw %>%
 slice(7:nrow(stunt.raw)) %>% # remove report 1 sub-report rows
 mutate(Report.Number=as.numeric(Report.Number)) %>%
 add_row(temp,.before=1) %>% # add to 1st row summarized report 1
 mutate(uneg=utot-upos,eneg=etot-epos,ua=1,ea=2,or=(epos*uneg)/(eneg*upos),lor=log(or),
      cil=lor-1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),ciu=lor+1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),
           african=ifelse(Country %in% c('Ethiopia','South Sudan','Somalia','DRC'),1,0)) %>%
 filter(!is.na(lor))

# import cGAM data
cgam.raw <- read.csv('cGAM_dat.csv', header=T)

# process cGAM data
cgam.dat <- cgam.raw %>%
 slice(7:nrow(cgam.raw)) %>% # remove report 1 sub-report rows
 mutate(Report.Number=as.numeric(Report.Number)) %>%
```

```
 mutate(uneg=utot-upos,eneg=etot-epos,ua=1,ea=2,or=(epos*uneg)/(eneg*upos),lor=log(or),
      cil=lor-1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),ciu=lor+1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),
           african=ifelse(Country %in% c('Ethiopia','South Sudan','Somalia','DRC'),1,0)) %>%
 filter(!is.na(lor))

# import cSAM data
csam.raw <- read.csv('cSAM_dat.csv', header=T)

# process cSAM data
csam.dat <- csam.raw %>%
 slice(7:nrow(csam.raw)) %>% # remove report 1 sub-report rows
 mutate(Report.Number=as.numeric(Report.Number)) %>%
 mutate(uneg=utot-upos,eneg=etot-epos,ua=1,ea=2,or=(epos*uneg)/(eneg*upos),lor=log(or),
      cil=lor-1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),ciu=lor+1.96*sqrt(1/upos+1/uneg+1/epos+1/eneg),
           african=ifelse(Country %in% c('Ethiopia','South Sudan','Somalia','DRC'),1,0)) %>%
 filter(!is.na(lor))


##### META-ANALYSIS #####

### Fixed Effects Meta-Analysis Model ###
FEMAmodel <- "model{
for(i in 1:ns){
 mu[i] ~ dnorm(0,0.0001)
 for (k in 1:2) {
           r[i,k] ~ dbin(p[i,k],n[i,k])
           logit(p[i,k]) <- mu[i] + d[a[i,k]] - d[a[i,1]]
           rhat[i,k] <- p[i,k] * n[i,k]
           dev[i,k] <- 2 * (r[i,k] * (log(r[i,k])-log(rhat[i,k])) +
                (n[i,k]-r[i,k]) * (log(n[i,k]-r[i,k]) - log(n[i,k]-rhat[i,k])))
 }
 rdev[i] <- sum(dev[i,])
}
rdevtot <- sum(rdev[])
d[1] <- 0
d[2] ~ dnorm(0,0.0001) # vague prior for exposure effect
}"

cat(FEMAmodel, file='FEMAmodel.txt')

### Random Effects Meta-Analysis Model ###
REMAmodel <- "model{
for(i in 1:ns){
 delta[i,1] <- 0
 mu[i] ~ dnorm(0,0.0001)
 for (k in 1:2) {
           r[i,k] ~ dbin(p[i,k],n[i,k])
           logit(p[i,k]) <- mu[i] + delta[i,k]
           rhat[i,k] <- p[i,k] * n[i,k]
           dev[i,k] <- 2 * (r[i,k] * (log(r[i,k])-log(rhat[i,k])) +
                (n[i,k]-r[i,k]) * (log(n[i,k]-r[i,k]) - log(n[i,k]-rhat[i,k])))
 }
 rdev[i] <- sum(dev[i,1:2])
 delta[i,2] ~ dnorm(d[2],tau) # survey-specific LOR dist
```

```
}
rdevtot <- sum(rdev[])
d[1]<- 0
d[2] ~ dnorm(0,0.0001) # vague prior for exposure effect
sd ~ dunif(0,5) # vague prior for between-survey SD (Standard Deviation)
tau <- pow(sd,-2)
}"

cat(REMAmodel, file='REMAmodel.txt')

### GAM analysis ###
r <- gam.dat %>%
 select(upos,epos)
n <- gam.dat %>%
 select(utot,etot)
a <- gam.dat %>%
 select(ua,ea)

## FEMA for GAM ##
data.list <- list(ns=nrow(gam.dat), r=r, n=n, a=a)

# create jags model object
FEMAmodel <- jags.model(file = 'FEMAmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMAmodel, n.iter = 30000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','rdevtot')

# collect 60000 samples from each of the 3 chains
FEMAsamples <- coda.samples(FEMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC
dicFEMAmodel1 <- dic.samples(FEMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMAsamples)

# summary of posterior samples
FEMAres1 <- nice.summary(FEMAsamples)
FEMAres1

## REMA for GAM ##
data.list <- list(ns=nrow(gam.dat), r=r, n=n)

# create jags model object
REMAmodel <- jags.model(file = 'REMAmodel.txt',
                        data = data.list,
                        #inits = inits.list,
```

```
                    n.chains = 3)

# update model object, burn-in
update(REMAmodel, n.iter = 30000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','sd','rdevtot')

# collect 60000 samples for each of 3 chains
REMAsamples <- coda.samples(REMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC (deviance information criterion)
dicREMAmodel1 <- dic.samples(REMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMAsamples)

# summary of posterior samples
REMAres1 <- nice.summary(REMAsamples)
REMAres1

### SAM analysis ###
r <- sam.dat %>%
  select(upos,epos)
n <- sam.dat %>%
  select(utot,etot)
a <- sam.dat %>%
  select(ua,ea)

## FEMA for SAM ##
data.list <- list(ns=nrow(sam.dat), r=r, n=n, a=a)

# create jags model object
FEMAmodel <- jags.model(file = 'FEMAmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMAmodel, n.iter = 30000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','rdevtot')

# collect 60000 samples from each of the 3 chains
FEMAsamples <- coda.samples(FEMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC (deviance information criterion)
dicFEMAmodel2 <- dic.samples(FEMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
```

```
plot(FEMAsamples)

# summary of posterior samples
FEMAres2 <- nice.summary(FEMAsamples)
FEMAres2

## REMA for SAM ##
data.list <- list(ns=nrow(sam.dat), r=r, n=n)

# create jags model object
REMAmodel <- jags.model(file = 'REMAmodel.txt',
                        data = data.list,
                        #inits = inits.list,
                        n.chains = 3)

# update model object, burn-in
update(REMAmodel, n.iter = 30000)

# create a vector with the names of the parameters
# we wish to track
variables.to.watch <- c('d','sd','rdevtot')

# collect 60000 samples for each of 3 chains
REMAsamples <- coda.samples(REMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC (deviance information criterion)
dicREMAmodel2 <- dic.samples(REMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMAsamples)

# summary of posterior samples
REMAres2 <- nice.summary(REMAsamples)
REMAres2

### GAM based on MUAC analysis ###
r <- gammuac.dat %>%
  select(upos,epos)
n <- gammuac.dat %>%
  select(utot,etot)
a <- gammuac.dat %>%
  select(ua,ea)

## FEMA for GAM based on MUAC ##
data.list <- list(ns=nrow(gammuac.dat), r=r, n=n, a=a)

# create jags model object
FEMAmodel <- jags.model(file = 'FEMAmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
```

```
update(FEMAmodel, n.iter = 30000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','rdevtot')

# collect 60000 samples from each of the 3 chains
FEMAsamples <- coda.samples(FEMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC (deviance information criterion)
dicFEMAmodel3 <- dic.samples(FEMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMAsamples)

# summary of posterior samples
FEMAres3 <- nice.summary(FEMAsamples)
FEMAres3

## REMA for GAM based on MUAC ##
data.list <- list(ns=nrow(gammuac.dat), r=r, n=n)

# create jags model object
REMAmodel <- jags.model(file = 'REMAmodel.txt',
                        data = data.list,
                        #inits = inits.list,
                        n.chains = 3)

# update model object, burn-in
update(REMAmodel, n.iter = 30000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','sd','rdevtot')

# collect 60000 samples for each of 3 chains
REMAsamples <- coda.samples(REMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC (deviance information criterion)
dicREMAmodel3 <- dic.samples(REMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMAsamples)

# summary of posterior samples
REMAres3 <- nice.summary(REMAsamples)
REMAres3

### SAM based on MUAC analysis ###
r <- sammuac.dat %>%
  select(upos,epos)
n <- sammuac.dat %>%
```

```
 select(utot,etot)
a <- sammuac.dat %>%
 select(ua,ea)

## FEMA for SAM based on MUAC ##
data.list <- list(ns=nrow(sammuac.dat), r=r, n=n, a=a)

# create jags model object
FEMAmodel <- jags.model(file = 'FEMAmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMAmodel, n.iter = 30000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','rdevtot')

# collect 60000 samples from each of the 3 chains
FEMAsamples <- coda.samples(FEMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC (deviance information criterion)
dicFEMAmodel4 <- dic.samples(FEMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMAsamples)

# summary of posterior samples
FEMAres4 <- nice.summary(FEMAsamples)
FEMAres4

## REMA for SAM based on MUAC ##
data.list <- list(ns=nrow(sammuac.dat), r=r, n=n)

# create jags model object
REMAmodel <- jags.model(file = 'REMAmodel.txt',
                        data = data.list,
                        #inits = inits.list,
                        n.chains = 3)

# update model object, burn-in
update(REMAmodel, n.iter = 30000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','sd','rdevtot')

# collect 60000 samples for each of 3 chains
REMAsamples <- coda.samples(REMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC (deviance information criterion)
```

```
dicREMAmodel4 <- dic.samples(REMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMAsamples)

# summary of posterior samples
REMAres4 <- nice.summary(REMAsamples)
REMAres4

### stunting analysis ###
r <- stunt.dat %>%
 select(upos,epos)
n <- stunt.dat %>%
 select(utot,etot)
a <- stunt.dat %>%
 select(ua,ea)

## FEMA for stunting ##
data.list <- list(ns=nrow(stunt.dat), r=r, n=n, a=a)

# create jags model object
FEMAmodel <- jags.model(file = 'FEMAmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMAmodel, n.iter = 30000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','rdevtot')

# collect 60000 samples from each of the 3 chains
FEMAsamples <- coda.samples(FEMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC (deviance information criterion)
dicFEMAmodel5 <- dic.samples(FEMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMAsamples)

# summary of posterior samples
FEMAres5 <- nice.summary(FEMAsamples)
FEMAres5

## REMA for stunting ##
data.list <- list(ns=nrow(stunt.dat), r=r, n=n)

# create jags model object
REMAmodel <- jags.model(file = 'REMAmodel.txt',
                        data = data.list,
                        #inits = inits.list,
                        n.chains = 3)
```

```
# update model object, burn-in
update(REMAmodel, n.iter = 30000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','sd','rdevtot')

# collect 60000 samples for each of 3 chains
REMAsamples <- coda.samples(REMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=60000)

# calculate an estimate of DIC (deviance information criterion)
dicREMAmodel5 <- dic.samples(REMAmodel, n.iter=60000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMAsamples)

# summary of posterior samples
REMAres5 <- nice.summary(REMAsamples)
REMAres5

### cGAM analysis ###
r <- cgam.dat %>%
  select(upos,epos)
n <- cgam.dat %>%
  select(utot,etot)
a <- cgam.dat %>%
  select(ua,ea)

## FEMA for cGAM ##
data.list <- list(ns=nrow(cgam.dat), r=r, n=n, a=a)

# create jags model object
FEMAmodel <- jags.model(file = 'FEMAmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMAmodel, n.iter = 80000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','rdevtot')

# collect 100000 samples from each of the 3 chains
FEMAsamples <- coda.samples(FEMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC
dicFEMAmodel6 <- dic.samples(FEMAmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMAsamples)
```

```
# summary of posterior samples
FEMAres6 <- nice.summary(FEMAsamples)
FEMAres6

## REMA for cGAM ##
data.list <- list(ns=nrow(cgam.dat), r=r, n=n)

# create jags model object
REMAmodel <- jags.model(file = 'REMAmodel.txt',
                        data = data.list,
                        #inits = inits.list,
                        n.chains = 3)

# update model object, burn-in
update(REMAmodel, n.iter = 80000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','sd','rdevtot')

# collect 100000 samples for each of 3 chains
REMAsamples <- coda.samples(REMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC (deviance information criterion)
dicREMAmodel6 <- dic.samples(REMAmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMAsamples)

# summary of posterior samples
REMAres6 <- nice.summary(REMAsamples)
REMAres6

### cSAM analysis ###
r <- csam.dat %>%
  select(upos,epos)
n <- csam.dat %>%
  select(utot,etot)
a <- csam.dat %>%
  select(ua,ea)

## FEMA for cSAM ##
data.list <- list(ns=nrow(csam.dat), r=r, n=n, a=a)

# create jags model object
FEMAmodel <- jags.model(file = 'FEMAmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMAmodel, n.iter = 80000)
```

```
# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','rdevtot')

# collect 100000 samples from each of the 3 chains
FEMAsamples <- coda.samples(FEMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC
dicFEMAmodel7 <- dic.samples(FEMAmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMAsamples)

# summary of posterior samples
FEMAres7 <- nice.summary(FEMAsamples)
FEMAres7

## REMA for cSAM ##
data.list <- list(ns=nrow(csam.dat), r=r, n=n)

# create jags model object
REMAmodel <- jags.model(file = 'REMAmodel.txt',
                        data = data.list,
                        #inits = inits.list,
                        n.chains = 3)

# update model object, burn-in
update(REMAmodel, n.iter = 80000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','sd','rdevtot')

# collect 100000 samples for each of 3 chains
REMAsamples <- coda.samples(REMAmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC (deviance information criterion)
dicREMAmodel7 <- dic.samples(REMAmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMAsamples)

# summary of posterior samples
REMAres7 <- nice.summary(REMAsamples)
REMAres7


##### META-REGRESSION #####

### Fixed Effects Meta-Regression ###
FEMRmodel <- "model{
for(i in 1:ns){
```

```
 mu[i] ~ dnorm(0,0.0001)
 for (k in 1:2){
            r[i,k] ~ dbin(p[i,k],n[i,k])
            logit(p[i,k]) <- mu[i] + d[a[i,k]] - d[a[i,1]] + (beta[a[i,k]]-beta[a[i,1]]) * (x[i,])
            rhat[i,k] <- p[i,k] * n[i,k]
            dev[i,k] <- 2 * (r[i,k] * (log(r[i,k])-log(rhat[i,k])) +
            (n[i,k]-r[i,k]) * (log(n[i,k]-r[i,k]) - log(n[i,k]-rhat[i,k])))
 }
 rdev[i] <- sum(dev[i,])
}
rdevtot <- sum(rdev[])
d[1] <- 0
beta[1] <- 0
d[2] ~ dnorm(0,0.0001) # vague prior for exposure effect
beta[2] <- B # cov effect
B ~ dnorm(0,0.0001) # vague prior for cov effect
lor.afr <- d[2] + B # LOR for African country
}"

# write the model to a file
cat(FEMRmodel, file='FEMRmodel.txt')

### Random Effects Meta-Regression ###
REMRmodel <- "model{
for(i in 1:ns){
 delta[i,1] <- 0
 mu[i] ~ dnorm(0,0.0001)
 for (k in 1:2) {
            r[i,k] ~ dbin(p[i,k],n[i,k])
            logit(p[i,k]) <- mu[i] + delta[i,k] + (beta[a[i,k]]-beta[a[i,1]]) * (x[i,])
            rhat[i,k] <- p[i,k] * n[i,k]
            dev[i,k] <- 2 * (r[i,k] * (log(r[i,k])-log(rhat[i,k])) +
            (n[i,k]-r[i,k]) * (log(n[i,k]-r[i,k]) - log(n[i,k]-rhat[i,k])))
 }
 rdev[i] <- sum(dev[i,])
 delta[i,2] ~ dnorm(d[2],tau) # survey-specific LOR dist
}
rdevtot <- sum(rdev[])
d[1]<- 0
beta[1] <- 0
d[2] ~ dnorm(0,0.0001) # vague prior for exposure effect
beta[2] <- B # cov effect
B ~ dnorm(0,0.0001) # vague prior for cov effect
sd ~ dunif(0,5) # vague prior for between-survey SD
tau <- pow(sd,-2)
lor.afr <- d[2] + B # LOR for African country
}"

# write the model to a file
cat(REMRmodel, file='REMRmodel.txt')

### GAM analysis ###
r <- gam.dat %>%
 select(upos,epos)
```

```
n <- gam.dat %>%
 select(utot,etot)
a <- gam.dat %>%
 select(ua,ea)
x <- gam.dat %>%
 select(african)

## FEMR for GAM ##
data.list <- list(ns=nrow(gam.dat), r=r, n=n, a=a, x=x)

# create jags model object
FEMRmodel <- jags.model(file = 'FEMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','lor.afr','rdevtot')

# collect 100000 samples from each of the 3 chains
FEMRsamples <- coda.samples(FEMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC
dicFEMRmodel1 <- dic.samples(FEMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMRsamples)

# summary of posterior samples
FEMRres1 <- nice.summary(FEMRsamples)
FEMRres1

## REMR for GAM ##
data.list <- list(ns=nrow(gam.dat), r=r, n=n, a=a, x=x)

# create jags model object
REMRmodel <- jags.model(file = 'REMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(REMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','sd','lor.afr','rdevtot')

# collect 100000 samples for each of 3 chains
REMRsamples <- coda.samples(REMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)
```

```
# calculate an estimate of DIC (deviance information criterion)
dicREMRmodel1 <- dic.samples(REMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMRsamples)

# summary of posterior samples
REMRres1 <- nice.summary(REMRsamples)
REMRres1

### SAM analysis ###
r <- sam.dat %>%
 select(upos,epos)
n <- sam.dat %>%
 select(utot,etot)
a <- sam.dat %>%
 select(ua,ea)
x <- sam.dat %>%
 select(african)

## FEMR for SAM ##
data.list <- list(ns=nrow(sam.dat), r=r, n=n, a=a, x=x)

# create jags model object
FEMRmodel <- jags.model(file = 'FEMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','lor.afr','rdevtot')

# collect 100000 samples from each of the 3 chains
FEMRsamples <- coda.samples(FEMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC
dicFEMRmodel2 <- dic.samples(FEMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMRsamples)

# summary of posterior samples
FEMRres2 <- nice.summary(FEMRsamples)
FEMRres2

## REMR for SAM ##
data.list <- list(ns=nrow(sam.dat), r=r, n=n, a=a, x=x)

# create jags model object
```

```
REMRmodel <- jags.model(file = 'REMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(REMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','sd','lor.afr','rdevtot')

# collect 100000 samples for each of 3 chains
REMRsamples <- coda.samples(REMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC (deviance information criterion)
dicREMRmodel2 <- dic.samples(REMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMRsamples)

# summary of posterior samples
REMRres2 <- nice.summary(REMRsamples)
REMRres2

### GAM based on MUAC analysis ###
r <- gammuac.dat %>%
  select(upos,epos)
n <- gammuac.dat %>%
  select(utot,etot)
a <- gammuac.dat %>%
  select(ua,ea)
x <- gammuac.dat %>%
  select(african)

## FEMR for GAM base on MUAC##
data.list <- list(ns=nrow(gammuac.dat), r=r, n=n, a=a, x=x)

# create jags model object
FEMRmodel <- jags.model(file = 'FEMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','lor.afr','rdevtot')

# collect 100000 samples from each of the 3 chains
FEMRsamples <- coda.samples(FEMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)
```

```
# calculate an estimate of DIC
dicFEMRmodel3 <- dic.samples(FEMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMRsamples)

# summary of posterior samples
FEMRres3 <- nice.summary(FEMRsamples)
FEMRres3

## REMR for GAM based on MUAC ##
data.list <- list(ns=nrow(gammuac.dat), r=r, n=n, a=a, x=x)

# create jags model object
REMRmodel <- jags.model(file = 'REMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(REMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','sd','lor.afr','rdevtot')

# collect 100000 samples for each of 3 chains
REMRsamples <- coda.samples(REMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC (deviance information criterion)
dicREMRmodel3 <- dic.samples(REMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMRsamples)

# summary of posterior samples
REMRres3 <- nice.summary(REMRsamples)
REMRres3

### SAM based on MUAC analysis ###
r <- sammuac.dat %>%
  select(upos,epos)
n <- sammuac.dat %>%
  select(utot,etot)
a <- sammuac.dat %>%
  select(ua,ea)
x <- sammuac.dat %>%
  select(african)

## FEMR for SAM base on MUAC##
data.list <- list(ns=nrow(sammuac.dat), r=r, n=n, a=a, x=x)

# create jags model object
FEMRmodel <- jags.model(file = 'FEMRmodel.txt',
```

```
                    data = data.list,
                    n.chains = 3)

# update model object, burn-in
update(FEMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','lor.afr','rdevtot')

# collect 100000 samples from each of the 3 chains
FEMRsamples <- coda.samples(FEMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC
dicFEMRmodel4 <- dic.samples(FEMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMRsamples)

# summary of posterior samples
FEMRres4 <- nice.summary(FEMRsamples)
FEMRres4

## REMR for SAM based on MUAC ##
data.list <- list(ns=nrow(sammuac.dat), r=r, n=n, a=a, x=x)

# create jags model object
REMRmodel <- jags.model(file = 'REMRmodel.txt',
                    data = data.list,
                    n.chains = 3)

# update model object, burn-in
update(REMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','sd','lor.afr','rdevtot')

# collect 100000 samples for each of 3 chains
REMRsamples <- coda.samples(REMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC (deviance information criterion)
dicREMRmodel4 <- dic.samples(REMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMRsamples)

# summary of posterior samples
REMRres4 <- nice.summary(REMRsamples)
REMRres4

### stunting analysis ###
```

```
r <- stunt.dat %>%
  select(upos,epos)
n <- stunt.dat %>%
  select(utot,etot)
a <- stunt.dat %>%
  select(ua,ea)
x <- stunt.dat %>%
  select(african)

## FEMR for stunting ##
data.list <- list(ns=nrow(stunt.dat), r=r, n=n, a=a, x=x)

# create jags model object
FEMRmodel <- jags.model(file = 'FEMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','lor.afr','rdevtot')

# collect 100000 samples from each of the 3 chains
FEMRsamples <- coda.samples(FEMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=100000)

# calculate an estimate of DIC
dicFEMRmodel5 <- dic.samples(FEMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMRsamples)

# summary of posterior samples
FEMRres5 <- nice.summary(FEMRsamples)
FEMRres5

## REMR for stunting ##
data.list <- list(ns=nrow(stunt.dat), r=r, n=n, a=a, x=x)

# create jags model object
REMRmodel <- jags.model(file = 'REMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(REMRmodel, n.iter = 60000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','sd','lor.afr','rdevtot')

# collect 100000 samples for each of 3 chains
REMRsamples <- coda.samples(REMRmodel,
```

```
                variable.names=variables.to.watch,
                    n.iter=100000)

# calculate an estimate of DIC (deviance information criterion)
dicREMRmodel5 <- dic.samples(REMRmodel, n.iter=100000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMRsamples)

# summary of posterior samples
REMRres5 <- nice.summary(REMRsamples)
REMRres5

### cGAM analysis ###
r <- cgam.dat %>%
 select(upos,epos)
n <- cgam.dat %>%
 select(utot,etot)
a <- cgam.dat %>%
 select(ua,ea)
x <- cgam.dat %>%
 select(african)

## FEMR for cGAM ##
data.list <- list(ns=nrow(cgam.dat), r=r, n=n, a=a, x=x)

# create jags model object
FEMRmodel <- jags.model(file = 'FEMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMRmodel, n.iter = 80000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','lor.afr','rdevtot')

# collect 120000 samples from each of the 3 chains
FEMRsamples <- coda.samples(FEMRmodel,
                variable.names=variables.to.watch,
                    n.iter=120000)

# calculate an estimate of DIC
dicFEMRmodel6 <- dic.samples(FEMRmodel, n.iter=120000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMRsamples)

# summary of posterior samples
FEMRres6 <- nice.summary(FEMRsamples)
FEMRres6

## REMR for cGAM ##
data.list <- list(ns=nrow(cgam.dat), r=r, n=n, a=a, x=x)
```

```
# create jags model object
REMRmodel <- jags.model(file = 'REMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(REMRmodel, n.iter = 80000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','sd','lor.afr','rdevtot')

# collect 120000 samples for each of 3 chains
REMRsamples <- coda.samples(REMRmodel,
                    variable.names=variables.to.watch,
                        n.iter=120000)

# calculate an estimate of DIC (deviance information criterion)
dicREMRmodel6 <- dic.samples(REMRmodel, n.iter=120000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMRsamples)

# summary of posterior samples
REMRres6 <- nice.summary(REMRsamples)
REMRres6

### cSAM analysis ###
r <- csam.dat %>%
 select(upos,epos)
n <- csam.dat %>%
 select(utot,etot)
a <- csam.dat %>%
 select(ua,ea)
x <- csam.dat %>%
 select(african)

## FEMR for cSAM ##
data.list <- list(ns=nrow(csam.dat), r=r, n=n, a=a, x=x)

# create jags model object
FEMRmodel <- jags.model(file = 'FEMRmodel.txt',
                        data = data.list,
                        n.chains = 3)

# update model object, burn-in
update(FEMRmodel, n.iter = 80000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','lor.afr','rdevtot')

# collect 120000 samples from each of the 3 chains
FEMRsamples <- coda.samples(FEMRmodel,
                    variable.names=variables.to.watch,
```

```
                    n.iter=120000)

# calculate an estimate of DIC
dicFEMRmodel7 <- dic.samples(FEMRmodel, n.iter=120000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(FEMRsamples)

# summary of posterior samples
FEMRres7 <- nice.summary(FEMRsamples)
FEMRres7

## REMR for cSAM ##
data.list <- list(ns=nrow(csam.dat), r=r, n=n, a=a, x=x)

# create jags model object
REMRmodel <- jags.model(file = 'REMRmodel.txt',
                    data = data.list,
                    n.chains = 3)

# update model object, burn-in
update(REMRmodel, n.iter = 80000)

# create a vector with the names of the parameters we wish to track
variables.to.watch <- c('d','B','sd','lor.afr','rdevtot')

# collect 120000 samples for each of 3 chains
REMRsamples <- coda.samples(REMRmodel,
                variable.names=variables.to.watch,
                    n.iter=120000)

# calculate an estimate of DIC (deviance information criterion)
dicREMRmodel7 <- dic.samples(REMRmodel, n.iter=120000, type='pD')

# check with diagnostic plots that we are sampling from the posterior
plot(REMRsamples)

# summary of posterior samples
REMRres7 <- nice.summary(REMRsamples)
REMRres7
```