Public Health Nutrition: 23(10), 1810–1819 doi:10.1017/S1368980019004087

Maternal mental health symptoms are positively associated with child dietary diversity and meal frequency but not nutritional status in Eastern Democratic Republic of Congo

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Submitted 2 March 2019: Final revision received 13 August 2019: Accepted 19 September 2019: First published online 14 April 2020

Abstract

Objective: The objective was to examine the association between symptoms of maternal mental health problems and child diet and nutritional status in South Kivu, Democratic Republic of Congo.

Design: Maternal depression and anxiety symptoms were measured by the Hopkins Symptom Checklist-25 (HSCL-25), and post-traumatic stress was measured by the Harvard Trauma Questionnaire (HTQ). Participants were classified as having high psychological distress if their mean item score was in the upper quartile of both measures. Dependent variables included child dietary diversity, meal frequency, height-for-age z score (HAZ), weight-for-age z score (WAZ), weight-for-height z score (WHZ), stunting and underweight. Bivariate and multivariate regression analyses were conducted.

Setting: The study was nested in a larger quasi-experimental study evaluating Jenga Jamaa II, a food and nutrition assistance project in Uvira and Fizi territories.

Participants: In total, 812 mother–child pairs participated. Children ranged from 2·6 to 5·6 years of age.

Results: HSCL-25 (ß: 0·18, $P < 0·05$) and HTQ (ß: 0·19, $P < 0·05$) were statistically significantly associated with higher dietary diversity scores, and all maternal mental health measures were associated with higher meal frequency (HSCL-25: ß: 0·13, $P = 0·001$; HTQ: ß: 0·12, $P = 0·001$; high distress: ß: 0·15, $P < 0·05$) and consumption of at least three meals/snacks per day (HSCL-25: OR: 2·06, HTQ: OR: 1·93, high distress: OR: 2·68, $P < 0·001$ for all). No significant associations were found with HAZ, WAZ, WHZ, stunting or underweight indicators.

Conclusions: More severe symptoms of maternal mental health problems were positively associated with child diet, but not anthropometry indicators. More research is needed to understand the role of maternal mental health in child feeding practices in food insecure and resource-poor settings.

Keywords
Maternal depression
Mental health
Infant and young child feeding
Stunting

Globally, 149 million children are estimated to be stunted, and Africa is the only region where the number of stunted children has increased between 2000 and 2018[1]. While the causes of stunting are multifactorial, it is well-recognised that sub-optimal infant and young child feeding (IYCF) practices and poor diets contribute to child stunting, as well as child morbidity and mortality[2,3]. There is growing evidence that symptoms of maternal mental health problems, in particular depression, impede mothers' care-taking behaviours, including IYCF practices[4,5]. Evidence from developing countries suggests that maternal mental health problems are associated with an estimated 40 % increased risk of stunting, with sub-optimal IYCF practices representing one of the potential pathways for this association[6].

Most evidence on maternal mental health and child undernutrition comes from South Asia. Studies in sub-Saharan Africa have revealed mixed results. In a study conducted in rural Nigeria with a sample of mothers and children recruited from an immunisation clinic, infants of mothers with depressive symptoms had lower weight-for-age z score (WAZ) and height-for-age z score (HAZ)[7]. Results of a case–control study among children admitted

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to a hospital in Uganda showed that children of mothers with depressive symptoms were more likely to be undernourished compared with those of mothers with no symptoms[8]. In Malawi among children recruited from a child health clinic, length-for-age z (LAZ) scores were associated with maternal mental health symptoms, but there was no association with WAZ[9]. Children recruited from health clinics in Zambia whose mothers had symptoms of mental health problems had lower height and weight measurements compared with those whose mothers did not have symptoms[10]. Another study in Northern Ghana with a facility-based sample found that children were three times more likely to be stunted if their mothers had depressive symptoms[11].

Studies finding no association between maternal mental health and child nutrition include two conducted among population-based samples in Ethiopia, as well as one in which participants were recruited from a peri-urban settlement in South Africa[12–14]. A multi-country study that took place in Ethiopia, Bangladesh and Vietnam found that symptoms of maternal mental health problems were associated with stunting in Bangladesh and with underweight in Vietnam, but Ethiopia was the only country in which maternal mental health problems were not associated with child nutritional status[15].

All of these studies used different mental health measures and criteria to classify participants as 'depressed' based on symptomatology, and differences in study populations (population-based samples *v.* samples recruited from a clinic) make it difficult to draw comparisons between the findings. Most studies assessed children less than 2 years of age, although several included children up to 5 years old. The lack of conclusive evidence indicates a need for further research in sub-Saharan Africa. To our knowledge, no studies have evaluated relations between post-traumatic stress disorder and child nutritional status, and there has been little research on how maternal mental health problems relate to complementary feeding practices. The objective of the present analysis is to examine the association between symptoms of maternal mental health problems and the diet and nutritional status of young children in Uvira and Fizi territories, in South Kivu province, Democratic Republic of Congo (DRC). We hypothesised that more severe symptoms of maternal mental health problems are associated with lower HAZ and WAZ, increased odds of stunting and underweight, and sub-optimal IYCF indicators for dietary diversity and meal frequency.

Methods

Setting and participants

The current study is nested within a larger study evaluating Jenga Jamaa II, a United States Agency for International Development (USAID) Food for Peace multiyear assistance program implemented from 2011 to 2016 in South Kivu province, DRC. The parent study utilised a quasi-experimental community-matched design in which members of the four different Jenga Jamaa II intervention groups were enrolled, along with a control group made up of women from participating villages not enrolled in any intervention. Parent study enrollment occurred between August and October 2012, and eight cross-sectional surveys were implemented every 6 months (to account for seasonal variation in food security) between 2012 and 2016. A total of 1820 households were enrolled in the parent study. There were 1113 households with children born between July 2010 and December 2012; these children (*n* 1385) were also enrolled. The parent study measured household food security, IYCF practices, and child nutritional status. A detailed description of the parent study methods is provided elsewhere[16].

Program interventions in the study zones (Uvira and Fizi territories) were implemented by the non-governmental organisation Adventist Development and Relief Agency (ADRA). The Women's Empowerment Group (WEG) intervention provided access to income-generating activities as well as literacy training. The Prevention of Malnutrition in Children under Two Approach (PM2A) provided rations and behaviour change communication to pregnant women and mothers of children under 2 years of age[17]. The two agriculture interventions included Farmer Field Schools (FFS), which provided inputs of tools and seeds and trained farmers in improved farming techniques, and the Farmer-to-Farmer approach (F2F) in which FFS participants trained their neighbours (F2F members) in the new farming skills they learned.

Data collection

Jenga Jamaa II parent study participants who were mothers of children also enrolled in the parent study were eligible for the present analysis. The present analysis relied on data from the last year of the study in which surveys were conducted in September 2015 and March 2016. A questionnaire collecting data on maternal mental health and maternal background characteristics was added to these two parent study surveys. Questionnaires were administered in Swahili, the predominant local language. Most data in the present analysis were collected during the September 2015 survey (*n* 683 mother/child pairs), but in cases where either the mother or child were absent in September 2015, but both were present in March 2016, data from the March 2016 survey were used (*n* 129). Data were collected by trained ADRA field agents using the mobile data collection application Magpi and Android tablets[18].

Measures

Maternal mental health

Mental health was assessed using an adapted version of the DRC Gender-Based Violence Psychosocial Questionnaire,

https://doi.org/10.1017/S1368980019004087 Published online by Cambridge University Press

which was developed for use in a randomised controlled trial of a cognitive behavioural therapy intervention for Congolese survivors of sexual violence[19]. On the basis of findings from qualitative studies in several Swahili-speaking communities in South Kivu, the questionnaire's developers selected the Hopkins Symptom Checklist-25 (HSCL-25) and the Harvard Trauma Questionnaire (HTQ) to measure symptoms of depression, anxiety (HSCL-25) and post-traumatic stress disorder (HTQ)[20,21]. The questionnaire used a four-point Likert scale, with participants rating the frequency of each symptom in the prior 4 weeks, and mean item scores were calculated. Responses ranged from 1 (not at all) to 4 (a lot). One item on suicidality was excluded from the HSCL-25 due to ethical considerations for the purposes of the present study. The validity of the HSCL-25 and HTQ has been assessed in similar settings, and the HTQ is frequently used among conflict-affected populations[21–25].

Child anthropometry

Weight and height measurements were taken by trained ADRA field agents using standardised protocols[26]. A Model 1582 Tanita Mommy and Baby Infant Scale and a Shorr Productions height/length board were used to measure children. HAZ, WAZ and WHZ were calculated for children 6–59 months of age using the 2006 World Health Organisation (WHO) child growth standards with the user-written Stata program zscore06[27,28]. Anthropometric z scores for children over 5 year of age (*n* 30) were calculated using the 2007 WHO reference for children 5–19 years, using the Stata program zanthro[29,30]. Z scores greater than 6 or less than –6 were considered implausible and treated as missing (*n* 4). Children with HAZ of less than –2 were classified as stunted, and children with WAZ of less than –2 were classified as underweight. Due to the low prevalence of wasting (WHZ < –2) in the sample (0·66 %), wasting was not assessed as an outcome.

Child diet

Children's diet was evaluated using WHO indicators for IYCF practices[31]. These indicators were designed to assess the diets of children 6–23 months of age. Although the children in this sample were 2·5–5·5 year of age, comparable indicators have not been developed to assess the diets of older children. Dietary diversity was measured by asking mothers to list all of the meals and foods the child consumed in the previous day, and the foods were then classified into seven food groups. A dietary diversity score (range 0–7) was calculated from the sum of food groups consumed. The seven food groups were starchy staples (grains, roots and tubers), legumes and nuts, dairy products, flesh foods, eggs, Vitamin A-rich fruits and vegetables, and other fruits and vegetables. Children consuming at least four of the seven food groups were classified as having achieved the Minimum Dietary Diversity indicator.

Meal frequency was calculated by asking mothers how many meals or snacks their children consumed the previous day. Almost all children in this sample were not currently breastfed; the WHO defines minimum meal frequency for non-breastfed children 6–23 months as having consumed at least four solid, semi-solid or soft foods or milk feeds the previous day. However, since children in this sample were older than the age group for which this indicator was developed, we also explored an indicator for minimum meal frequency with a threshold of three meals per day. Minimum Acceptable Diet, a composite indicator identifying children having achieved both minimum dietary diversity and minimum meal frequency, was not assessed due to the low prevalence of children achieving this indicator in the sample (1·32 %).

Demographic and socioeconomic measures

Household-level variables were collected as part of the Jenga Jamaa II survey. Household size and food insecurity were assessed. Severe food insecurity was classified based on the Household Food Insecurity Access Scale (HFIAS)[32]. The HFIAS has been found to distinguish between food secure and food insecure households in a variety of cultural contexts[33]. Data on household income in the past month were collected but not evaluated as a potential confounding variable, because in this context income may have been more representative of selling assets due to hardship rather than socio-economic status. Five indicator variables for each of the four intervention groups and the control group were created, as well as variables for geographic region (Uvira or Fizi territory) and livelihoods zone (plains, mountains or lakeside). Data on maternal background characteristics included maternal age, years of education, ethnic group, marital status, currently living in territory of origin, currently pregnant, maternal self-reported health status (poor, average, good, very good/excellent), number of children, and having had a child who died. Maternal education was recoded as a categorical variable with three categories: no education, completed at least some primary school and completed at least some secondary school.

Statistical analysis

Sample size and power calculations were conducted under the assumption that at least 40 % of mothers would have elevated symptoms of mental health problems based on prior research in Eastern DRC, and 65 % of children would be stunted, based on Jenga Jamaa II parent study data[34,35]. The following formula was used: $N_1 = [Z_\alpha + \exp(-\theta^{*2}/4)Z_\beta]^2(1 + 2P\delta)/(P\delta^{*2})$, where P = the estimated prevalence of stunting, θ^* = the log OR and $\delta = [1 + (1 + \theta^{*2})\exp(5\vartheta^{*2}/4)[1 + \exp(-\vartheta^{*2}/4]^{-1}$[36]. With α of 0·05 and 80 % power ($\beta = 0{\cdot}2$), a sample of 393

https://doi.org/10.1017/S1368980019004087 Published online by Cambridge University Press

mother–child pairs would be sufficient to detect the association between high levels of maternal mental health symptoms and child stunting by a factor of 1·4 in univariate logistic regression. This sample size would be sufficient to detect results similar to those reported elsewhere for the association between symptoms of maternal mental health problems and child stunting[6].

The dependent anthropometry variables were continuous HAZ, WAZ and WHZ and indicator variables for stunting (HAZ < –2) and underweight (WAZ < –2). The dependent child diet variables were continuous dietary diversity score and meal frequency and variables for achieving Minimum Dietary Diversity and Minimum Meal Frequency.

Maternal mental health independent variables were mean item HSCL-25 score measuring symptoms of depression and anxiety, mean item HTQ score measuring PTSD symptoms and a binary variable identifying mothers with what we considered high psychological distress who had mean scores in the upper quartile of both measures (mean item HSCL-25 score ≥ 2·7 and mean item HTQ score ≥ 2·6).

Exploratory data analysis included assessing distributions of continuous variables and frequencies of categorical variables. Bivariate regression analysis was used to test for associations between background variables, independent variables and dependent variables. Univariate regression analyses were conducted for each combination of independent and dependent variables, followed by multivariate regression analyses controlling for potential confounding variables. Separate analyses were conducted for the three independent variables due to multicollinearity.

Results

Participant characteristics

In total, there were 1113 mothers and 1312 children under five enrolled in the parent study who were eligible for participation in the current study. Maternal mental health data were collected from 932 mothers of children under five who were present during one or both of the data collection periods for the present study. There were 120 participants with no data on child diet or anthropometry. These participants were excluded from the analysis. There were 138 participants who had multiple children enrolled in the study and present for data collection. Among 13 sets of twins, one child was randomly selected for inclusion in the analysis. Among the remaining pairs of siblings, the older sibling was excluded (n 56). Overall, there were 812 mother–child pairs included in the analysis, of which 683 were present for the September 2015 survey, and an additional 129 were present for the March 2016 survey. There were 671 children with complete anthropometry and diet data, 63 with only diet data and 78 with only anthropometry data.

Background and demographic characteristics of the study sample are reported in Table 1. Over half (52·8 %) lived in Uvira territory, and the majority lived in the plains livelihoods zone (55·7 %) followed by the lakeside (31 %) and mountains zones (13 %). Approximately one-third (35 %) were enrolled in the PM2A intervention group, 19·3 % in the control group, 18·1 % in WEG, 14·7 % in FFS and 13·2 % in F2F. Average household size was 7·9 people, and the majority of households (65·9 %) were classified as severely food insecure according to the HFIAS. Median household income reported in the past month was 22 500 Congolese francs, or approximately $23 (IQR: 9500, 45 000).

Mean maternal age was 30·1 years, and 89·9 % of participants were married. About 32 % of participants had never been to school, 48·5 % had received at least some primary schooling and 19·8 % at least some secondary schooling. Most participants were from the Mubembe (42·4 %) or Mufuliro (47·6 %) ethnic groups. Seventy-five percent of participants lived in their territory of origin. Participants had an average of five children (range: 1–11), and 17·9 % were

Table 1 Background characteristics of 812 mother–child pairs

	Mean or *N*	SD or %
Territory		
Uvira	429	52·8
Fizi	383	47·2
Livelihoods zone		
Mountains	108	13·3
Plains	452	55·7
Lakeside	252	31·0
Intervention group*		
WEG	147	18·1
PM2A	282	34·7
FFS	119	14·7
F2F	107	13·2
Control	157	19·3
Household size	7·9	2·8
Household income, median (IQR)†	22 500	9500, 45 000
Severely food insecure‡	530	65·9
Maternal age (years)	30·1	7·2
Education level		
None	257	31·7
Some primary school	393	48·5
Some secondary school	160	19·8
Married	729	89·9
Ethnic group		
Mubembe	319	42·4
Mufuliro	358	47·6
Murundi	15	2·0
Mushi	25	3·3
Muvira	11	1·5
Other	24	3·2
Living in territory of origin	609	75·0
Number of children	5·48	2·4
Experienced death of a child	248	30·5
Pregnant	145	17·9
Child sex (female)	425	52·3
Child age		
2–3 years	81	10·0
3–4 years	390	48·0
4–5 years	311	38·3
Over 5 years	30	3·7
Currently breastfed	16	2·1

*WEG: Women's Empowerment Groups, PM2A: Preventions of Malnutrition in Children under 2 Approach, FFS: Farmer Field Schools, F2F: Farmer to Farmer.
†Past month, Congolese francs.
‡Household Food Insecurity Access Scale category.

https://doi.org/10.1017/S1368980019004087 Published online by Cambridge University Press

pregnant at the time of data collection. Almost one-third (30·5 %) had at least one child who died. Only 16 (2·1 %) children were still breastfed, and slightly over half (52·3 %) of children were female. Thirty children (3·6 %) were over 5 years of age, and children's mean age was 46·2 months (range 32·1–68·1).

Descriptive statistics

Maternal mental health

Descriptive statistics for the independent variables are shown in Table 2. Participants' average mean score on the HSCL-25 scale was 2·31, and their average mean score on the HTQ scale was 2·15. There were 132 participants (16·3 %) whose mean scores were in the upper quartile of both measures and were considered to have high psychological distress. Cronbach's coefficient α was 0·92 for the HSCL-25 items and 0·91 for the HTQ items, indicating good internal consistency reliability[23,37]. Mean item scores for depression and anxiety subscales in the HSCL-25 were highly correlated ($r(810) = 0{\cdot}72$, $P < 0{\cdot}001$). The HSCL-25 and HTQ scales were also highly correlated ($r(810) = 0{\cdot}81$, $P < 0{\cdot}001$).

Statistically significant associations were found between maternal mental health variables and background characteristics. HSCL-25 score was positively, but weakly associated with household size (β: 0·02, $P < 0{\cdot}05$). The control group had a lower HSCL-25 score on average compared with WEG (β: –0·18, $P < 0{\cdot}05$), which may be because WEG women were recruited from particularly vulnerable, female-headed households. Having at least some secondary education was associated with lower HSCL-25 score (β: –0·12, $P < 0{\cdot}05$). Number of children was positively associated with HSCL-25 (β: 0·03, $P < 0{\cdot}05$), and living in one's territory of origin was negatively associated with HSCL-25 (β: –0·16, $P = 0{\cdot}001$). Participants with self-reported health status of average, good or very good/excellent had lower HSCL-25 scores than those reporting poor health ($P < 0{\cdot}001$ for all).

Similar trends were found when evaluating the association between HTQ and high psychological distress and background characteristics, with a few exceptions. The F2F (β: –0·19, $P < 0{\cdot}05$) group, in addition to the Control (β: –0·21, $P = 0{\cdot}005$) group, had significantly lower mean HTQ compared with WEG. Having had at least one child that died was associated with higher HTQ score (β: 0·11, $P < 0{\cdot}05$). Participants had decreased odds of being classified as having high psychological distress if they lived in the plains (OR: 0·55, $P < 0{\cdot}05$) or lakeside (OR: 0·42, $P < 0{\cdot}05$) livelihoods zones. Severe food insecurity was associated with decreased odds of high psychological distress (OR = 0·65, $P < 0{\cdot}05$), but not with continuous HSCL-25 or HTQ score.

Table 2 Maternal mental health, child diet and child nutritional status descriptive statistics

	Mean or *N*	SD or %
Maternal mental health (*n* 812)		
HSCL-25*	2·31	0·60
HTQ†	2·15	0·63
High distress‡	132	16·3
Child diet		
Dietary diversity score (*n* 734)	3·09	1·42
Min. dietary diversity§	229	40·7
Meal frequency (*n* 714)	2·17	0·62
Min. meal frequency of 4 meals/d	14	2·0
Min. meal frequency of 3 meals/d	174	24·4
Child nutritional status		
HAZ (*n* 749)	–2·38	1·18
Stunting	478	63·8
WAZ (*n* 753)	–1·32	0·94
Underweight	168	22·3
WHZ (*n* 753)	0·17	0·92
Wasting	5	0·66

*24 items from the Hopkins Symptom Checklist-25 measuring depression and anxiety symptoms, range of scale scores 1–4.
†16 items from the Harvard Trauma Questionnaire measuring post-traumatic stress symptoms, range of scale scores 1–4.
‡Participants with mean item scores in the upper quartile of both measures (≥2·7 for the HSCL-25 and ≥2·6 for the HTQ).
§Consuming at least 4 of 7 food groups the previous day.

Child diet

Descriptive statistics for the diet-dependent variables are shown in Table 2. Children's diets were poor; average dietary diversity score was 3·09. Minimum dietary diversity (consuming at least four of seven food groups) was achieved by 40·7 % of children. Children were fed on average 2·17 meals or snacks the previous day. Only fourteen children, or 1·9 % of the sample, achieved minimum meal frequency of four meals/snacks per day. However, if the threshold for achieving minimum meal frequency is lowered to three meals/snacks per day (which may be appropriate for this older age group), 24·4 % of the children would achieve this indicator.

Consumption of starchy staples was highly prevalent, with 83 % of children consuming food from this group. More than half (65 %) of children consumed flesh foods, and 80 % consumed Vitamin A-rich foods. Almost half (46·3 %) of children consumed pulses, and 26·5 % of children consumed other fruits or vegetables. Very few children consumed eggs (2·4 %) or dairy (7·6 %). The sample children were between 2·5 and 6 years of age, an age by which they were likely to be eating family foods. Common meals consumed in this area of DRC consist of *fufu*, made from corn or manioc flour, as well as *sombé*, which are manioc leaves. Small, dried fish (*ndagala*) are also popular and may contribute to the high prevalence of flesh food consumption in this sample.

Child anthropometry

Children had low HAZ scores and stunting was highly prevalent (Table 2). Mean HAZ was –2·38, and 63·8 % of children were stunted (HAZ < –2). Mean WAZ was –1·31, and 22·3 % of children were underweight (WAZ < –2).

https://doi.org/10.1017/S1368980019004087 Published online by Cambridge University Press

Mean WHZ was 0·17, and only 0·7 % of children were wasted (WHZ < –2). Wasting was not assessed in the analysis because of its low prevalence.

Bivariate and multivariate analyses

Maternal mental health and child diet

Crude and adjusted results of the regression analyses evaluating the associations between maternal mental health variables and child diet variables are displayed in Table 3. Multivariate analyses adjusted for maternal age, education, intervention group, livelihoods zone and number of children. Child age and child sex were not identified as potential confounding variables in the exploratory analyses, thus were not included as covariates.

In the crude analysis, higher mean item HSCL-25 score (higher scores indicating more severe symptoms) was associated with an increase of 0·17 in dietary diversity score ($P < 0·05$), and in the adjusted analysis it was associated with an increase of 0·18 in dietary diversity score ($P < 0·05$). Higher mean item HTQ score was associated with an increase of 0·18 in dietary diversity score ($P < 0·05$) in the crude analysis and with 0·19 increase in dietary diversity ($P < 0·05$) in the adjusted analysis. High psychological distress was not associated with dietary diversity. No mental health variable was associated with

Table 3 Associations between maternal mental health symptoms and child diet

Dietary diversity score (*n* 724)	Crude			Adjusted*		
	β	95 % CI	*P* value	β	95 % CI	*P* value
HSCL-25†	0·17	0·00, 0·34	**0·047**	0·18	0·01, 0·36	**0·036**
HTQ‡	0·18	0·02, 0·34	**0·029**	0·19	0·02, 0·35	**0·026**
High distress§	0·10	0·16, 0·37	0·447	0·15	0·12, 0·42	0·283
Meal frequency (*n* 714)	**Crude**			**Adjusted***		
	β	95 % CI	*P* value	β	95 % CI	*P* value
HSCL-25†	0·14	0·06, 0·22	<**0·001**	0·13	0·05, 0·21	**0·001**
HTQ‡	0·13	0·06, 0·20	<**0·001**	0·12	0·05, 0·20	**0·001**
High distress§	0·16	0·04, 0·27	**0·010**	0·15	0·03, 0·27	**0·014**
Minimum dietary diversity (consumed ≥4 food groups) (*n* 724)	**Crude**			**Adjusted***		
	OR	95 % CI	*P* value	OR	95 % CI	*P* value
HSCL-25†	1·08	0·52, 1·03	0·521	1·09	0·84, 1·40	0·523
HTQ‡	1·06	0·84, 1·33	0·629	1·06	0·83, 1·34	0·640
High distress§	1·06	0·73, 1·56	0·748	1·09	0·74, 1·62	0·659
Minimum meal frequency (consumed ≥4 meals) (*n* 714)	**Crude**			**Adjusted***		
	OR	95 % CI	*P* value	OR	95 % CI	*P* value
HSCL-25†	1·17	0·48, 2·84	0·724	omitted		
HTQ‡	1·20	0·52, 2·77	0·662	omitted		
High distress§	omitted			omitted		
Minimum meal frequency (consumed ≥3 meals) (*n* 714)	**Crude**			**Adjusted***		
	OR	95 % CI	*P* value	OR	95 % CI	*P* value
HSCL-25†	2·04	1·53, 2·75	<**0·001**	2·06	1·52, 2·81	<**0·001**
HTQ‡	1·98	1·50, 2·61	<**0·001**	1·93	1·45, 2·58	<**0·001**
High distress§	2·71	1·81, 4·04	<**0·001**	2·68	1·77, 4·05	<**0·001**

P values set in boldface indicate statistical significance.
*Adjusted for maternal age, education, intervention group, livelihoods zone, and number of children.
†24 items from the Hopkins Symptom Checklist-25 measuring depression and anxiety symptoms, range of scale scores 1–4.
‡16 items from the Harvard Trauma Questionnaire measuring post-traumatic stress symptoms, range of scale scores 1–4.
§Participants with mean item scores in the upper quartile of both measures (≥2·7 for the HSCL-25 and ≥2·6 for the HTQ).

https://doi.org/10.1017/S1368980019004087 Published online by Cambridge University Press

achieving minimum dietary diversity (consuming at least four of seven food groups).

Small but significant associations were found between all mental health indicators and higher meal frequency. In the crude analysis, HSCL-25 score was associated with an increase of 0·14 in meal frequency ($P < 0·001$), HTQ score was associated with an increase of 0·13 in meal frequency ($P < 0·001$) and high psychological distress was associated with an increase of 0·16 in meal frequency ($P < 0·05$). In the adjusted models, HSCL-25 score was associated with an increase of 0·13 in meal frequency for every unit increase in the score ($P = 0·001$). HTQ score was associated with an increase of 0·12 in meal frequency ($P = 0·001$). Children of mothers with high psychological distress had an increase of 0·15 in meal frequency compared with mothers with less distress ($P < 0·05$).

There was no significant association between maternal mental health and odds of achieving minimum meal frequency (≥4 meals) in the crude analysis. The model failed to converge in the adjusted analysis due to the low prevalence of children achieving this indicator (1·9 %). When minimum meal frequency was calculated based on children consuming three meals/snacks per day, both crude and adjusted analyses showed statistically significant relations. In the crude analyses, all mental health measures were associated with increased odds of minimum meal frequency (HSCL-25: OR = 2·04, HTQ: OR = 1·98, high distress: OR = 2·71, $P < 0·001$ for all). In the adjusted analyses, the results were similar (HSCL-25: OR = 2·06, HTQ: OR = 1·93, high distress: OR = 2·68, $P < 0·001$ for all).

Maternal mental health and child anthropometry

Crude and adjusted results of the regression analyses evaluating the associations between maternal mental health variables and child anthropometry variables are shown in Table 4. Multivariate analyses included maternal age, education, intervention group, livelihoods zone and number of children as covariates. Small negative but non-statistically significant associations were found between all maternal mental health variables and HAZ, WAZ and WHZ. Maternal mental health variables were associated with 17–29 % increased odds of stunting in the adjusted models, but the associations were not statistically significant. There was no association between any mental health variable and odds of underweight.

Discussion

The current study contributes to a growing body of literature on maternal psychosocial factors and their relations with child care and feeding practices, health and nutritional status. The study found that maternal mental health problems were not associated with child nutritional status, but that children whose mothers had more severe symptoms of mental health problems actually had better diets, with small but significantly higher dietary diversity scores and meal frequency.

Descriptive analyses revealed other unexpected findings; members of the parent study control group had less severe mental health symptoms compared with mothers enrolled in any intervention group. One would expect that participation in an intervention to improve food security and nutrition would have a positive effect on maternal mental health. However, they were differences in enrollment criteria for each intervention which may explain this contrary finding. For example, mothers in WEG were recruited from vulnerable, female-headed households. Among agriculture interventions (FFS and FFS), the mother was not necessarily the direct beneficiary of the intervention, often it was her husband or another member of the household. The prevalence of severe food insecurity among the study sample was 65 %, even though 80 % of the study participants were enrolled in an intervention. Severe food insecurity was associated with lower odds of high psychological distress (scores in the upper quartile of both mental health measures), but not continuous measures of depression/anxiety and PTSD symptoms. It is possible that community or social support mechanisms existed to support households experiencing the most severe food insecurity, which could have a protective effect on maternal mental health. However, no data on social support are available to support this hypothesis, and the cross-sectional design prevents us from being able to understand the direction of relations between food insecurity, maternal mental health and child nutritional status.

The findings with regard to child nutrition are consistent with other studies enrolling community-based samples in sub-Saharan Africa, which have also found no association between maternal mental health symptoms and child nutritional status[12–15]. Nguyen *et al.* found that among populations assessed in Bangladesh, Vietnam and Ethiopia, Ethiopia was the only setting where maternal mental health was not associated with any indicator of nutritional status[15]. The authors noted that the Ethiopian sample was also more food insecure and had lower maternal education compared with Bangladesh and Ethiopia, but they found no evidence of interaction between mental health and socio-economic status and food insecurity variables. Unmeasured psychosocial variables may play a role in the context of Ethiopia and other sub-Saharan Africa studies, such as the role of community and social support, and the way women spend their time (e.g. working away from home/children).

To our knowledge, this is the first study to find a positive association between maternal mental health symptoms and several indicators of child diet quality. In Vietnam, mothers with maternal depression symptoms were less likely to have children consuming Minimum Acceptable Diet, a composite indicator of both dietary diversity and meal frequency, but no association was found among study populations in Bangladesh and Ethiopia[15]. A study in Uganda assessed

https://doi.org/10.1017/S1368980019004087 Published online by Cambridge University Press

Table 4 Associations between maternal mental health symptoms and child anthropometry

	Crude			Adjusted*		
Height-for-age Z score (*n* 746)	β	95 % CI	*P* value	β	95 % CI	*P* value
HSCL-25†	–0·07	–0·21, 0·07	0·307	–0·07	–0·21, 0·08	0·356
HTQ‡	–0·03	–0·17, 0·10	0·624	–0·03	–0·17, 0·10	0·618
High distress§	–0·13	–0·36, 0·09	0·245	–0·13	–0·36, 0·10	0·265
Weight-for-age Z score (*n* 750)						
HSCL-25†	–0·03	–0·15, 0·08	0·557	–0·02	–0·14, 0·09	0·689
HTQ‡	–0·01	–0·12, 0·09	0·797	–0·00	–0·11, 0·10	0·956
High distress§	–0·10	–0·28, 0·08	0·291	–0·08	–0·26, 0·10	0·398
Weight-for-height Z score (*n* 753)						
HSCL-25†	0·03	–0·08, 0·14	0·602	0·04	–0·07, 0·15	0·510
HTQ‡	0·04	–0·07, 0·14	0·480	0·05	–0·05, 0·16	0·316
High distress§	0·02	–0·16, 0·19	0·863	–0·08	–0·26, 0·10	0·398
Stunting (*n* 746)						
HSCL-25†	1·17	0·91, 1·50	0·232	1·17	0·90, 1·52	0·241
HTQ‡	1·19	0·94, 1·51	0·152	1·20	0·94, 1·54	0·151
High distress§	1·30	0·86, 1·96	0·218	1·29	0·84, 1·98	0·246
Underweight (*n* 750)						
HSCL-25†	0·98	0·74, 1·31	0·899	0·95	0·71, 1·29	0·761
HTQ‡	0·96	0·73, 1·27	0·797	0·93	0·70, 1·24	0·638
High distress§	1·09	0·69, 1·72	0·713	1·05	0·65, 1·69	0·836

*Adjusted for maternal age, education, intervention group, livelihoods zone and number of children.
†24 items from the Hopkins Symptom Checklist-25 measuring depression and anxiety symptoms, range of scale scores 1–4.
‡16 items from the Harvard Trauma Questionnaire measuring post-traumatic stress symptoms, range of scale scores 1–4.
§Participants with mean item scores in the upper quartile of both measures (≥2·7 for the HSCL-25 and ≥2·6 for the HTQ).

relations between four dimensions of maternal 'capabilities' (social support, psychological health, decision making and empowerment) and found that higher social support and empowerment were positively associated with child dietary diversity and meal frequency, but mothers with higher psychological satisfaction were more likely to have a stunted child[38]. This further indicates that relations between maternal mental health, child diet and nutritional status and other psychosocial factors are complex and not yet well understood, especially in sub-Saharan Africa.

The present study has several limitations. It took place within the context of a larger, quasi-experimental study that evaluated the impact of several types of food security and nutrition interventions. Although the current analysis controlled for the study group assignment, it is not clear how the findings might have been influenced by the unique context, and it prevents them from being generalisable to other populations. The age of the children in the cohort is a limitation for both the diet and anthropometric outcomes assessed. The majority of children were between 3 and 5 years old; they were likely to be feeding themselves, consuming family meals, or left in the care of older siblings, likely reducing the accuracy of the maternal-reported diet indicators which were designed to assess diets of children 6–23 months of age. The first thousand days of life from conception to 2 years of age is the window

https://doi.org/10.1017/S1368980019004087 Published online by Cambridge University Press

in which stunting occurs, and it is not possible to know whether mothers with current high levels of symptoms had the same levels of symptoms when the child was younger than two, when symptoms would have the most potential to impact child care, feeding and growth.

Another limitation of the study is the measures used for maternal mental health. Although the HSCL-25 and HTQ are commonly used to measure mental health in conflict-affected and refugee populations[21,22,39,40], other measures such as the Self Reporting Questionnaire (SRQ) are more frequently used to assess symptoms of maternal mental health. The measures in the mental health questionnaire were selected originally for use with a sample of sexual violence survivors[19]; thus, they may not have been an appropriate measure for a sample that had not experienced recent traumatic events. There are no locally validated cut-off points for diagnosis of probable depression, anxiety and PTSD using these or other measures; therefore, it is not possible to estimate the prevalence of any mental health problem in this sample. Despite the majority of participants being enrolled in a large-scale food security and nutrition project, this was a particularly nutritionally deprived group with an extremely high prevalence of stunting and food insecurity. The lack of dietary choices available and the little variation in child nutritional status makes it unlikely that maternal mental health would have been a major determinant of either of these outcomes.

More research is needed to explore the role of community and family mechanisms that may be supporting distressed mothers in different socio-cultural contexts and other variables such as women's work burden, that may represent confounding factors in relations between maternal mental health, child diet, and child nutritional status. Additionally, there is little research on how PTSD symptoms may be related to maternal care and feeding practices in developing country settings. To our knowledge, this is the first study to evaluate maternal PTSD symptoms and child nutritional status and to evaluate relations between maternal mental health and child nutrition in a post-conflict setting.

We found that more severe maternal mental health symptoms were positively associated with children's dietary diversity and meal frequency, but not with child nutritional status. The reasons for these findings are unclear based on available data, but there were a number of methodological limitations that may have played a role in the unexpected findings. Most study participants and their households took part in 4-year long interventions designed to improve their income and food security, yet they remained food insecure and nutritionally deprived, and mental health symptoms were pervasive. This indicates that more intensive interventions are needed in similar post-conflict and highly food insecure settings to improve the mental and physical health and well-being of vulnerable populations.

Acknowledgements

Acknowledgements: The authors would like to thank the staff of the Adventist Development and Relief Agency (ADRA), in particular Jenga Jamaa II Chief of Party Joseph Menakuntuala, for their support for this research and are grateful to the mothers who participanted. *Financial support*: The parent study was funded by ADRA. This funding was made available through a USAID Office of Food for Peace Cooperative Agreement (AID-FFP-A-11-00006). Jillian Emerson received support from the Harry J. Prebluda Fellowship, Bacon Field Chow Memorial Fellowship and tuition support from the Human Nutrition Program in the Department of International Health, Johns Hopkins Bloomberg School of Public Health. *Conflict of interest:* The authors have no conflicts of interest to declare. *Authorship:* J.A.E. designed the study, performed the analyses and led the drafting of the manuscript. L.E.C. and S.D. designed the parent study and contributed to the design of the present study and the interpretation of findings. E.M.K. and J.P.N. helped design the study and participated in data collection. All authors read and approved the final version of the manuscript. *Ethics of human subject participation*: The current study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving research study participants were approved by the Institutional Review Board of the Johns Hopkins Bloomberg School of Health. Verbal informed consent was obtained from all subjects. Verbal informed consent was requested from participants at each data collection encounter for the parent study, and additional consent detailing potential risks and benefits of participation in the present study was requested prior to the maternal mental health assessment. Verbal consent was witnessed and formally recorded.

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