

*Original Research Article***Food Insecurity in Rural Tanzania Is Associated with Maternal Anxiety and Depression**CRAIG HADLEY^{1*} AND CRYSTAL L. PATIL²¹Center for Social Epidemiology and Population Health, University of Michigan, Ann Arbor, Michigan 48104²Population Studies and Training Center, Brown University, Providence, RI 02912

ABSTRACT Food insecurity is a major health problem that has pervasive effects on many human biological outcomes. In particular, there are compelling theoretical and empirical reasons to expect that the relationship between food insecurity may be directly related to mental health morbidities, and may be quantifiable in developing country settings. This preliminary study examined whether caretaker reports of food insecurity were associated with anxiety and depression among four ethnic groups in two communities of rural Tanzania. In-home interviews were conducted in June–August of 2005 among female caretakers ($n = 449$). In addition to collecting household and demographic data, modified versions of the USDA's food security module and Hopkins Symptom Checklist (HSCL) were used to measure food insecurity and anxiety and depression. Consistent with predictions, the results showed a strong positive correlation between a caretaker's score on the food insecurity instrument and her summed response on the HSCL ($P < 0.0001$). This association was maintained in all four ethnic groups, even when controlling for individual-level covariates such as caretaker's age and marital status. Issues of causality and hypotheses that might explain this robust finding are discussed, as are methodological and theoretical implications. *Am. J. Hum. Biol.* 18:359–368, 2006. © 2006 Wiley-Liss, Inc.

Food insecurity is a major problem that has pervasive effects on health. Typically, it is linked to dietary intake, nutritional status, and ultimately to physical health outcomes like child growth morbidity and mortality (Wolfe and Frongillo, 2001). This conceptualization, based on findings from both developed and developing countries, describes ever-increasing evidence on the importance of food insecurity in public health concerns. However, a broader anthropological conceptualization of food insecurity takes into account the possibility that acute or chronic exposure to periods of uncertainty in the food supply can influence mental health as well as physical health outcomes. Some evidence to support this association already exists for populations in North America. In developing countries, primarily in sub-Saharan Africa, where food insecurity remains an important public health issue, the association between food insecurity and psychosocial stress has been studied less (Desjarlais et al., 1995). Indeed, there are compelling theoretical reasons to expect that food insecurity may be directly related to mental health morbidities in developing country settings. Anthropologists have noted this relationship

in many parts of the world, but the focus on physical diseases of women and children often leaves mental health out of the equation. The objective of this study, therefore, was to build on these works and examine the association between food insecurity and maternal anxiety and depression among representative samples from four ethnic groups living in two areas of rural Tanzania.

Food insecurity is defined as uncertain access by all people, at all times, to adequate food for an active and healthy lifestyle (Food and Agriculture Organization (FAO), 2004). Throughout much of sub-Saharan Africa, the prevalence of household-level food insecurity has been on the rise because of declining rates of food production spurred on by interactions

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between economic development and rapid population growth (FAO, 2004). Research in the US links food insecurity and hunger to a wide range of poor health outcomes, including psychological outcomes (Kleinman et al., 1998; Hamelin et al., 1999; Alaimo et al., 2002; Weinreb et al., 2002; Casey et al., 2004; Cook et al., 2004; Heflin et al., 2005). Using a case-control design, Weinreb et al. (2002) showed that mothers ($n = 400$) who reported experiencing hunger were more likely to have been diagnosed with posttraumatic stress disorder at some point in their lifetime. Elevated levels of depression and mental distress were also identified among food-insufficient households in a nationally representative data set from Canada, even after adjusting for a range of possible confounders (Vozoris and Tarasuk, 2003). These studies and others were cross-sectional in nature, a research design that raises issues of causality. However, Siefert et al. (2004) used a longitudinal study to show that among 753 welfare recipients, changes in food sufficiency across a 3-year span were strongly related to changes in a measure of depression. This quantitative evidence complements observations that link food insufficiency and hunger to distress and mental well-being.

Anthropologists have long studied the impact of seasonal periods of food insecurity on health outcomes and behavioral coping strategies in less developed contexts (Shipton, 1990; Hadley, 2005), and nutritional anthropologists have explicated the processes of a household becoming food insecure, along with some of food insecurity's nutritional sequelae (Leonard, 1991; Panter-Brick and Eggerman, 1997). Household responses to periods of food insecurity include reducing intake of foods, consuming less preferred foods, seeking wild foods, selling off assets, seeking additional and even risky work such as prostitution, and reducing the number of household dependents through migration or fostering (Shipton, 1990). Given the severity of many of these responses, it is not surprising that informants recall periods of food deprivation as periods of intense suffering and stress (Shipton, 1990), and some ethnographers have linked stress and food insecurity by noting that during periods of food deprivation, people show outward signs of stress and that social and many physical activities grind to a halt (reviewed in Shipton, 1990; Dirks, 1980). Others noted marked alterations in behavior and ritual during seasonal periods of food scarcity. In her classic study of the Bemba, for instance, Richards

(1939) noted a precipitous reduction in play-time among children, as well as a reduction in social events in general. Among the Ngisonyoka Turkana of Kenya, several researchers reported that women will sacrifice eating so that their children will not suffer as much (Galvin, 1985; Gray, 1994; Pike, 1999). Pike (2004) also noted that even as violence escalated in the late 1990s, the first item on Turkana women's list of worries was hunger. These ethnographic studies not only document a link between hunger and mental well-being, but suggest a gradient between concern over the food supply and worry and anxiety.

One issue limiting the feasibility of measuring mental health outcomes and food insecurity has been the lack of adequate instruments to quantify mental health outcomes in rural non-Western settings. Considering that by 2020, depression is expected to be a leading cause of disease burden in developing countries, this lack of instruments is a continuing challenge (Murray and Lopez, 1997; World Health Organization, 2003). It is also significant because conditions of uncertainty, including those associated with hunger and poverty, and their influence on mental health are implicitly documented in an extensive social-science literature (Avorti and Walkters, 1999; Rozemberg and Manderson, 1998; Schepers-Hughes, 1992). In the past two decades, significant progress in overcoming these obstacles has been demonstrated. For example, it was shown that in many non-Western contexts, physical symptoms are associated with psychological morbidity (Patel and Mann, 1997; Patel et al., 1999; Simon et al., 1999; Patel, 2001). Several questionnaires were designed for use in developing-country contexts that mirror items seen on Western-based questionnaires (e.g., General Health Questionnaire, Self-Reporting Questionnaire, Primary Care Psychiatric Questionnaire (PPQ), Shona Symptom Questionnaire, Chinese Health Questionnaire, Revised Clinical Interview Schedule, and Indian Psychiatric Survey Schedule). Like Western models, most of these include somatic and psychological components to assess common mental disorders; however, the items are often adapted to the local setting and may include regional idioms or expressions, because culture undoubtedly influences the way in which emotions are expressed and shapes how members of a society could be and are expected to react under certain conditions (Cheng, 2001; Desjarlais et al., 1995; Jenkins and Karno, 1992). Studies using these scales in develop-

ing countries resulted in two primary results: psychosocial burdens are associated with gender and poverty, and a successful way to assess common mental disorders is to use locally validated questionnaires.

Recently, and as part of a larger longitudinal project on barriers to well-being, Pike and Patil (2006) translated, back-translated, and modified a commonly used tool to measure anxiety and depression, the Hopkins Symptom Checklist (HSCL). This instrument is designed to measure symptoms of anxiety and depression by asking respondents to rate on a severity scale whether a number of symptoms are experienced. After many in-depth interviews and several community-based focus groups, the 25-item version was adapted and then pretested on a sample of Datoga ($n = 49$) and Iraqw ($n = 59$) living in rural northern Tanzania. The results showed that the HSCL, once modified, had acceptable internal consistency across groups (Cronbach's $\alpha > 0.8$). The results also suggest that high values on the HSCL score are associated with hunger and food insecurity. Indeed, in a free-listing exercise, more than 75% of women in both groups designated hunger as one of their most important concerns. Given the mounting evidence suggesting that food insecurity and mental health morbidities share a suite of risk factors, we decided to undertake a study examining food insecurity and one dimension of mental health: anxiety and depression.

ETHNOGRAPHIC SETTING

This study took place in the Rukwa and Manyara regions of Tanzania. Both study areas are predominantly rural and are marked by a highly seasonal ecology and high population growth rates (3.6 in Rukwa, and 3.8 in Manyara). Despite the many similarities, there are potentially important differences that may influence the lives of the study participants. Analysis of nationally representative data from these two regions shows that women are more likely to attend school and achieve higher educational levels in the Manyara region compared to the Rukwa region. Households also appear to be wealthier in the Manyara region. For instance, compared to Rukwa, households in Manyara are more likely to own a radio and a bicycle, and have electricity and tin roofs, compared with Rukwa households. These regional-level differences are reflected in the everyday lives of women in the study sites, which play out in terms of greater exposure to,

and participation in, the market economy among women in the Manyara sample. However, this also places women in a position of greater relative inequality, as they are daily exposed to a range of goods and services, many of which they are unable to purchase or utilize. For this reason, we expected that scores on the HSCL would be higher among women in the northern study site.

The Rukwa region study site focused on two ethnic groups, the Sukuma and the Pimbwe. The Pimbwe are horticulturalists who are the historical inhabitants of the area. In contrast to the Pimbwe, the more recent arrivals, the Sukuma are agropastoralists with highly diverse economic portfolios. As a group, the Sukuma have lower levels of food insecurity during the peak wet season, and previous research suggests that these differences have their root in social, cultural, and economic differences. At a proximate level, the greater vulnerability to the wet season appears to be linked to lower asset holdings and lower economic diversity, a widely touted strategy to limit losses. We expected therefore that the Pimbwe would show higher levels of food insecurity, although the difference was expected to be small, given the season of the study (immediate postharvest). The two groups also differ widely in their social and family structure, with the Sukuma group practicing polygyny and living in large extended-family compounds, whereas the Pimbwe live in densely settled villages in households that are typically comprised of a single, usually monogamous family. If food insecurity is linked to anxiety and depression, we expected to observe higher scores on the HSCL among Pimbwe caretakers.

The Haydom site is located in the Manyara region of north-central Tanzania. Although members of the four African language families live in close proximity to one another (Afro-Asiatic, Khoisan, Nilo-Saharan, and Niger-Kordofanian), at this time, only responses from Iraqw (Afro-Asiatic) and Datoga (Nilo-Saharan)-speaking peoples are included.¹ The Iraqw homeland is located in the Mbulu district of the Arusha region, just north of the field site. Since colonization, the Iraqw population has grown rapidly, partly fueled by European administrators who encouraged them to occupy and plant on grazing lands (Snyder, 2005). The Datoga, on the other hand, were

¹The Iraqw are sometimes referred to as Wambulu, and for the Datoga, others have referred to this group as the Datooga, Tatooga, Totog, Barabaig, and Manyati.

considered to be hostile and aggressive, and their pastoral lifeway was viewed as threatening to colonial rule. Since colonization, the Datoga have been disadvantaged, as their grazing lands have been transformed into agricultural fields, and their pastoral lifeway has been stigmatized (Blystad, 2000). As a consequence of these social and ecological changes, many Datoga have migrated southward toward more fertile grazing lands. Many of those who stayed in the Haydom area lost their cattle and have become more integrated into the Iraqw community (Blystad, 2000). Although these two groups live side-by-side and often intermarry, tension exists in the relationship. Like the Rukwa field site, the Haydom area often experiences localized hunger due to crop failure, usually associated with a shortage of rain or unpredictable timing of the rains. If food insecurity is linked to anxiety and depression, we expected higher scores on the HSCL among Datoga caretakers relative to the Iraqw.

METHODS

The study took place between June–August 2005. At that time, 206 households were reinterviewed from the Rukwa site as part of an ongoing study in the area. At the Haydom site, 234 caretakers were interviewed, some of whom took part in an earlier study (Patil, 2004). The total sample included 449 women from randomly selected households in four ethnic groups living in two rural areas of Tanzania. Interviews were carried out by trained interviewers who conducted face-to-face interviews, using a pretested instrument. The following variables were included in the analysis: food insecurity in the dry season of 2005 (June–August), maternal age, household size, marital status, whether the respondent had any education, and summed responses to the Hopkins Symptoms Checklist-25. The analytic strategy was to examine whether food insecurity in the dry season was associated with summed responses to the HSCL, and then to assess in a multivariate model whether this relationship was modified by the inclusion of caretaker-specific covariates.

The food-insecurity instrument used was a modified version of the USDA's core food security module (Bickel et al., 2000). This instrument assesses the severity of a household's food-insecurity situation by asking mothers a series of statements about anxiety over the

food supply, changes in the food supply, and alterations in food choice and portion size. These 15 items included questions such as, "In the last 3 months, because food or money to buy food was not enough, have you had to consume fewer meals than usual?" We modified the tool to avoid redundancy and reduce respondent burden by converting the statements into questions, and skipping three questions on the frequency with which certain events occurred (e.g., frequency of skipped meals). We also used a 3-month recall period to match the recall period used in previous studies in the area. Affirmative responses were then summed into a single-unit free score across caretakers, to produce a single score. Scores of 2 or less were considered indicative of food security, and scores of 3 or more were considered indicative of food insecurity. Food security is primarily used as a dichotomous variable in the analyses below, because the number of individuals who fell into the most food-insecure categories was small, given that this study occurred during the food-abundant postharvest season. These modifications are similar to those used by others when adapting the tool to a developing-country setting, and the cutoff follows closely the standard scoring scheme for the USDA instrument (Bickel et al., 2000).

The history and creation of the HSCL were described in more detail elsewhere (Derogatis et al., 1974). For this study, a 25-item published Swahili version of the HSCL was used (Kaaya et al., 2002). This instrument is used as a screening tool for depression and anxiety, allowing for responses of severity from 1 (not at all) to 4 (extremely). Caretakers are read each statement and asked if they have experienced each item in the prior 2 weeks and, if so, they then rank the severity of the symptom (2, 3, or 4). Items include statements such as, "I have had many thoughts" and "I have felt alone." The responses to items on the HSCL are unit-free and can take on values between 25–100. Average scores are used to assess the severity of symptoms associated with anxiety and depression. The scale was used successfully in a variety of settings, including primary-care facilities, family-planning clinics, and among refugee populations, and was translated into several languages (Mollica et al., 1987; Hansson et al., 1994; Hinton et al., 1994). Higher total scores on the HSCL are correlated with emotional distress. For comparative purposes, average scores for immigrants in Norway, displaced persons in Nepal during armed conflict, and for Vietnamese mental health patients

TABLE 1. Characteristics of study sample by ethnic group

	Pimbwe (n = 110) mean ± SD	Sukuma (n = 98) mean ± SD	Iraqw (n = 177) mean ± SD	Datoga (n = 66) mean ± SD	P
Mother, year born	27.4 ± 6.5	29.1 ± 6.9	29.5 ± 6.9	28.4 ± 5.9	<0.073 ¹
% any schooling	80	20	70	60	<0.001 ²
House size	5.5 ± 2.2	8.2 ± 4.4	6.7 ± 2.7	6.6 ± 2.4	<0.001 ¹
% polygynous	10	52	12	16	<0.001 ²
Food insecurity	2.2 ± 3.2	1.9 ± 2.7	3.7 ± 5.3	6.3 ± 5.9	<0.001 ¹
% food-secure, site		70		59	0.01 ²
% food-secure, group	69	73	65	44	<0.001 ²
HSCL, site		35.6 ± 10.1		41.1 ± 11.9	<0.001 ¹
HSCL, group	34.2 ± 9.3	36.7 ± 10.9	41.3 ± 12.3	40.5 ± 10.8	<0.001 ¹

¹Statistical significance assessed by analysis of variance.

²Statistical significance assessed by chi-square test.

range between 37.5–82.5 (Hinton et al., 2004; Thapa and Hauff, 2005a,b).

In order to make the instrument locally and culturally appropriate, we followed procedures used by Pike and Patil (2006) to ensure that the instrument would assess depression and anxiety. Team members at both study sites read the instruments, and made comments and suggestions about question content, wording, and response categories. Together, the team read each question aloud, and as a group commented on wording and question content. They were also asked to explain the meaning of each question. In a round-table format, each team member explained the meaning of each item on the instrument, and locally appropriate examples were given to be used by everyone consistently. Interviewing techniques were covered, and the importance of reading the entire question as written, not assuming answers, and recording all answers in the proper fashion was stressed. In addition to preliminary work conducted in 2002, several focus groups were conducted at both field sites to confirm that the symptoms described on the HSCL were experienced by individuals, and that the instrument would capture distress.

Analysis of variance and the chi-square test were used to examine between-group differences in group responses to the HSCL and in the prevalence of household food insecurity, as well as other household-level measures. The Wilcoxon two-sample test was used to test for differences in HSCL scores (and other covariates) between food-secure and food-insecure households. Spearman's correlation test was employed to examine the association between a respondent's food-insecurity score and her HSCL score. A logistic regression model was used to examine predictors of household food security, and analysis of variance was used to

compare HSCL scores across ethnic groups. A general linear model was then used to examine the independent effects of food insecurity on caretaker HSCL scores while controlling for other covariates. In the multivariate model, the HSCL was log-transformed to meet the assumptions of normality. We employed a manual backward stepwise regression procedure, and removed variables that had a *P*-value greater than 0.15. Where missing values occurred in the outcome variable of interest (HSCL), a dummy variable was created. This variable was entered into a multivariate model to adjust for any potential impact this might have on the final results. The internal consistency of the food-security scale and HSCL was assessed using Cronbach's α . The 0.05 level was chosen as the criterion for statistical significance, and SAS 9.1 was used for analysis of data. Study procedures were approved by the appropriate Institutional Review Boards and the Tanzanian Commission for Science (COSTECH).

RESULTS

Sample characteristics

Characteristics of caretakers and their households are shown in Table 1. There was significant variation across all variables measured, except for maternal age. Mean age was approximately 28 years, with Pimbwe mothers being slightly younger than the rest of the sample. Schooling varied widely across the sample, with a high of 80% among the Pimbwe to a low of 20% among the Sukuma. Approximately 60–70% of Datoga and Iraqw women had at least 1 year of schooling. The between-group differences in schooling were not due to slight differences in maternal age across groups. Household size also differed between commun-

ities, with Sukuma households being the largest, and Pimbwe households the smallest. Datoga and Iraqw households were similar in size, with approximately 6–7 members. More than half of Sukuma women were in a polygynous marriage, compared with 10% of Pimbwe women, 12% of Iraqw women, and 16% of Datoga women.

The internal consistency of the food-insecurity module was acceptable, with a Cronbach's α of 0.87 for the Rukwa site, and 0.96 for the Manyara site. As expected on the basis of the ethnographic data, severe food insecurity appeared to be low during this dry and postharvest season, when food insecurity is not generally expected to be problematic. The average food insecurity score was 3.4 (SD 4.7). According to the cutoffs explained in Methods, approximately 64% of respondents were categorized as food-secure, and 36% as food-insecure. Also, as expected, Datoga households had the highest prevalence of food insecurity, followed by the Pimbwe, with Iraqw and Sukuma households having the lowest levels of food insecurity. In bivariate tests, there were few associations between household- or caretaker-level variables and food-insecurity status. Food-insecure households tended to be somewhat larger, although the difference was small and not significant. Education ($P = 0.18$) and marriage type ($P = 0.77$) were not associated with food insecurity. In a logistic regression model, ethnicity remained a significant predictor of whether a household was food-insecure or not, and individuals living in larger households were somewhat more likely to be food-insecure ($P < 0.054$), as were younger caretakers ($P = 0.045$), but education ($P = 0.79$) and marital status ($P = 0.66$) had no measurable effect (full-model $\chi^2 = 22.7$, df 6, $P = 0.001$, $r^2 = 6.9$).

As indicated in Table 1, there were significant between-group differences in maternal responses to the HSCL instrument, indicating between-group variation in anxiety and depression. Iraqw women presented with the highest mean score on the HSCL, and Pimbwe presented with the lowest. Sukuma women scored significantly lower on the HSCL than the Iraqw ($P = 0.002$) and Datoga ($P = 0.031$), but higher than the Pimbwe ($P = 0.048$). Iraqw women were comparable to the Datoga on the HSCL ($P = 0.076$), but significantly higher than the Pimbwe ($P < 0.0001$). In bivariate analyses, there was only one individual-level covariate that was a significant predictor of HSCL scores, and this was maternal age ($P < 0.0001$), which was positively associated with HSCL score. A

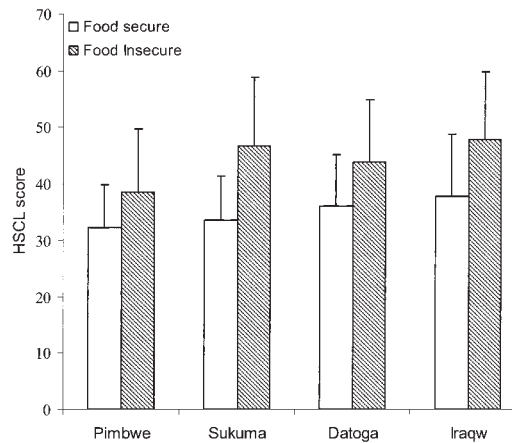


Fig. 1. Respondent HSCL score by food-security status and ethnicity. Differences between food-secure and food-insecure groups are significantly different for each ethnic group ($P < 0.005$).

mother's marital status, however, was not ($P = 0.80$), nor was any educational level ($P = 0.52$) or household size ($P = 0.40$).

There was also a striking positive correlation between a caretaker's score on the food-insecurity instrument and her summed response on the HSCL ($P < 0.0001$). Overall, caretakers classified as food-secure presented with an average HSCL score of 35.1 (SD, 9.5), compared to an average HSCL score of 44.7 (SD, 12.0) for caretakers in food-insecure households. As shown in Figure 1, the same association held when examined in each ethnic group individually (all $P < 0.005$). There are many observable and unobservable differences among these ethnic groups; because the groups varied in their responses to the HSCL and to the food-insecurity scale, the following variables were entered into a general linear model to identify their independent effects on women's HSCL score: ethnicity, maternal age, education level, household size, and food security. In this model, household size ($P = 0.90$) was not significant, whereas food security ($P < 0.0001$) and maternal age ($P = 0.025$) remained significant predictors of HSCL, and any education (having more than one year of education) was marginally significant ($P = 0.09$). We then refit the model, excluding the household-size variable. The final model explained about 24% of the variation in maternal HSCL responses. Maternal age and household food insecurity were all highly significant predictors, and any education remained marginally significant ($P = 0.078$) (Table 2). Some ethnic-

TABLE 2. Predictors of maternal HSCL scores ($n = 449$, $F = 23.11$, $P < 0.0001$)¹

Variable	β	SE	P
Ethnicity			<0.0001
Datoga	0.0025	0.0419	
Iraqw	0.0533	0.0343	
Pimbwe	-0.113	0.038	
Sukuma (reference)			
Food-secure?	-0.231	0.025	<0.0001
Respondent age	0.003	0.001	0.029
Any schooling?	0.04	0.027	0.078

¹See text for explanation of ethnic differences.

group differences in HSCL scores remained as well. Model-adjusted values showed that Iraqw and Datoga women had similar HSCL scores ($P = 0.11$), but that Iraqw HSCL scores were significantly elevated over Sukuma and Pimbwe scores. The Datoga had HSCL scores comparable to both the Iraqw and Sukuma. The Sukuma adjusted HSCL scores were significantly greater than the Pimbwe scores ($P = 0.01$), and the Pimbwe had HSCL scores significantly lower than for all other groups. Adding the dummy variable for missing data did not influence the conclusions drawn from the final model.

DISCUSSION

The key contribution of this paper is to show that food insecurity is strongly associated with a measure of mental health morbidity in four ethnic groups living in two diverse rural subsistence communities of Tanzania. This finding has important implications, particularly in sub-Saharan Africa, where per capita food production is falling in many countries (FAO, 2004). The usual limits inherent in cross-sectional and observational studies apply here, and we plan a follow-up study to examine how these associations change across seasons, and how they might vary with ethnicity and household-level factors. An additional limitation of this study is that we used a 3-month recall on the food-insecurity measure, and a 2-week recall on the measure of anxiety and depression, which raises concerns over causality. While this is a limitation, the bidirectional nature of the relationship between food insecurity and anxiety and depression should not be overlooked, and future studies should aim to link food insecurity and anxiety and depression in a tighter temporal sequence to enhance causal inference. Further, while the issue of direction and causality is an important one in one sense, in another sense it is overwhelmingly clear that both food insecurity and

maternal anxiety and depression have shared roots in much larger structural factors that operate through gender and poverty (Desjarlais et al., 1995; Farmer, 2003). To attempt to identify or “disentangle” the causal direction between food insecurity and anxiety and depression overlooks the much greater structural factors that prevent women in these communities from achieving food security and economic opportunities. Rather, these women are either excluded from participating in markets or operate on the edge of these markets, as appears to be the case in the Manyara site. We focus our discussion on study limitations and on specifying hypotheses that might plausibly explain the observed association.

It should be reiterated that the present survey occurred during the immediate postharvest dry season, when food availability is generally at its peak. This partially explains why Pimbwe and Sukuma values on the food-insecurity score were so similar, despite large differences in wet-season food insecurity (Hadley, 2005).² The postharvest season is typically a time of food abundance, and most individuals are food-secure. This likely explains why few bivariate measures were significant predictors at this time period. It also suggests that the association between food insecurity and mental health may indicate particularly acute deprivation for those individuals who are food-insecure in this generally food-abundant time period. This hypothesis suggests that the associations identified here may not be causal, but reflect deeper confounding at the individual level. The planned follow-up will enable a test of this hypothesis: if food insecurity increases across all groups, then we should observe a concomitant increase in HSCL scores. If the association observed here reflects confounding, then rising food-insecurity scores are unlikely to be associated with elevated HSCL scores. It is also noteworthy that the Datoga had the lowest levels of food security, a finding that is consistent with other literature on the Datoga showing high levels of entrenched poverty (Sieff, 1997). This lends support to the claim that food insecurity is causally related to HSCL scores.

²Importantly, this also seems to imply that poor wet-season food insecurity does not necessarily lead to low food insecurity in the dry season (or at least early in the dry season), which suggests that the “cycle of poverty” argument in its simplest form is unlikely to hold without additional assumptions. Based on our ethnographic data, we suspect that this is not necessarily true, and that the food-security effect among the Pimbwe is temporary. We are currently planning to undertake a survey of food insecurity in the 2006 wet season that will allow a further test of this hypothesis.

The mechanisms linking food insecurity with anxiety and depression, and with mental health morbidity more generally, have not been fully elucidated. However, it is well-known that food insecurity is a stressful life event, and stressful life events and anticipation of uncertainty or stressful events were shown to influence the hypothalamic-pituitary-adrenocortical axis (Sapolsky, 1998). Hypothalamic dysfunction was in turn linked to the onset and recurrence of depression (Rubin, 1989). A second hypothesis links food insecurity with dietary inadequacy, which in turn is linked to anxiety and depression. There is mounting evidence to support this hypothesis. Food insecurity was linked to specific nutrient deficiencies, some of which were also linked to depressive symptoms, mood, and immune function (Bodnar and Wisner, 2005; Coppen and Bolander-Gouaille, 2005). Thus, food insecurity may influence anxiety and depression through deficiencies in energy, vitamin B₁₂, or folic acid. These are common nutrient deficiencies in many developing countries (Administrative Committee on Coordination/Sub-Committee on Nutrition, 2000).

Food insecurity may also be experienced relatively, and subjective comparisons with other households which might not be experiencing food insecurity may provoke anxiety and depressive symptoms, as would be expected under the income-inequality hypothesis (Wilkinson, 1996). Finally, in self-reported data, both food insecurity and anxiety and depression may signal maternal need and deprivation, as indicated in another study of the HSCL (Pike and Patil, 2006). In that study, hunger was commonly noted by women despite the presence of what appeared to the researchers as adequate amounts of food and few overt indications of undernutrition. Expressions of hunger may be used by women to express more pervasive deprivation and need, which may or may not actually entail food security. If this finding holds more broadly, then it acts as a cautionary tale against using experientially based measures of food insecurity to monitor and evaluate food insecurity. Future studies should involve longitudinal study designs and the collection of a richer set of covariates to test these competing hypotheses, using more rigorous statistical techniques.

We also identified site-level differences in HSCL scores which agreed with initial expectations, although these disappeared when controls for food insecurity were included. In bivariate analyses, caretakers in the Rukwa site scored lower than caretakers in the Haydom site. However, introducing the food-insecurity meas-

ure led to an increase in the model-adjusted Sukuma HSCL score. Although we initially expected a site-level effect due to the close proximity of the northern site to a market economy, site-level differences might also be a result of differences in interviewers, settlement patterns, or other contextual or compositional variables. Distinguishing between these explanations will involve further data collection, including community-level data on site characteristics and on individual exposure to the market economy. Clearly the measures we employed here do not capture the full range of individual- and household-level variables that likely influence women's experiences of anxiety and depression. Anxiety and depression are linked to mastery and control over personal lives, and covariates which captured these domains might be useful in explaining some of the residual variation. Along these lines, it is interesting that the Pimbwe, who are noted as at least historically having relatively high levels of female autonomy (Willis and International African Institute, 1966), scored lowest on the HSCL. Consistent with the literature, it is also of interest that we identified an age effect (Bahar et al., 1992; Desjarlais et al., 1995; Patel et al., 1999).

CONCLUSIONS

We show that women who are food-insecure in the postharvest season score higher on a measure of anxiety and depression, and that this holds across a range of study groups living in diverse areas of Tanzania. We suggest that the mechanisms underlying this association lie in one or more of the following explanations. First, food insecurity may be linked to poor diets, which in turn influence anxiety and depression. Second, food insecurity, *especially* during the dry season, may lead to feelings of relative inequality, which in turn may lead to elevated anxiety and stress. Finally, women in this sample may use expressions of hunger and food insecurity as a way to express their anxiety and depression. Which, if any, of these hypotheses is correct has implications for community-based interventions and, more importantly, for measuring and monitoring food insecurity. As women are often the primary caregivers, these findings may also have important implications for patterns of child care as well.

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