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Fishing for Food? Analyzing links between fishing livelihoods and food security around Lake Victoria, Kenya

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Abstract

Food-producing livelihoods have the potential to improve food security and nutrition through direct consumption or indirectly through income. To better understand these pathways, we examined if fishing households ate more fish and had higher food security than non-fishing households around Lake Victoria, Kenya. In 2010, we randomly sampled 111 households containing 583 individuals for a cross-sectional household survey in a rural fishing community. We modeled the associations between fish consumption and food security and fishing household status, as well as socio-economic variables (asset index, monthly income, household size) for all households and also for a subset of households with adult male household members (76% of households). Participating in fishing as a livelihood was not associated with household fish consumption or food security. Higher household fish consumption was associated with higher household income and food security, and was weakly associated with lower household morbidity. Household food security was associated with higher incomes and asset index scores. Our results suggest socioeconomic factors may be more important than participation in food-producing livelihoods for predicting household consumption of high quality foods.

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Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

Keywords

Food Insecurity; Livelihoods; Socio-ecologic Systems; Lake Victoria; Fish; Nile Perch; Animal Source Foods

Introduction

Gains in food production are often assumed to improve household food security and nutrition among people engaged in food-producing livelihoods. However, somewhat paradoxically, the majority of the world's 50 million small-scale fishers and 2.6 billion farmers are food insecure (FAO 2012a). Understanding why those engaged in food production so often are food insecure is complicated by the intricate pathways from fishing nets to dinner plates, and the dynamics of production systems affected by such factors as resource depletion, globalized markets, price fluctuations and climate change.

Fishing livelihoods are of particular concern as 90% of fishers work in small-scale fishing operations and most operate in economically developing countries (FAO 2012b). Fish serves as the primary protein source for 1 billion people worldwide and often contributes the large majority of dietary protein in areas near fisheries, such as the shores of Lake Victoria (FAO 2012b). Fish may serve as both a nutritional safety net and a significant source of calories, protein, and micronutrients (Milner-Gulland et al. 2003; Kawarazuka and Bene 2010). The importance of fishery resources to meet minimum dietary requirements is further exemplified by the fact that fluctuations between availability of fish has driven trade-offs in the consumption of other wildlife resources (Brashares et al. 2004). Complicating access to fish, fisheries worldwide, including Lake Victoria's fishery, are often globalized, gendered, and threatened (Pauly et al. 2005; Geheb et al. 2008; Njiru et al. 2007).

The importance of fishery systems to meet basic needs coupled with the range of threats they face has given rise to livelihood interventions, which often promote fishery management, aquaculture, and agricultural alternatives (Allison 2011; FAO 2010). However, evaluations that measure the effectiveness of fishery interventions, like those of agricultural interventions, have typically shown limited nutritional impact (Girard et al. 2012; Kumar and Quisumbing 2010). Limited benefits for macro- and micro-nutrient intake suggests that participation in food-based livelihoods may not always link directly to increased food consumption.

Further, adverse health events can potentially affect a household's ability to take part in livelihood activities and access fish or other resources. Illness may reduce fishing participation and income, with direct and downstream effects on nutritional status, food production, household income, spending patterns, and, ultimately, food security. High morbidity within a household may also affect natural resource stewardship and inter-generational knowledge transfer about resource use (Salmen 2009; Talman et al. 2012; Fiorella 2013). HIV/AIDS associated morbidity is of unique concern to fishing communities in sub-Saharan Africa (Allison and Seeley 2004), and a formidable challenge in our focal communities on Mfangano Island, Kenya, where HIV prevalence is estimated at over 25% (Kenya Ministry of Health 2013).

While households that rely on fishing for their livelihoods are assumed to consume more fish than other households, this assumption has rarely been tested (Kawarazuka and Bene 2010). In fact, we know of no study that compares fish consumption between fishing and non-fishing households within a fishing community. To begin to understand associations among livelihoods, food consumption and food security, we compared the socioeconomic status and diets of fishing households and non-fishing households on Mfangano Island on Lake Victoria, Kenya. Specifically, we used a cross-sectional household survey to ask whether fishing households consumed more fish or had higher food security, and to quantify how income and morbidity mediated these relationships.

Materials and Methods

Study Site

Our research focuses on Mfangano, an island of 65km^2 in Lake Victoria, located within Homa Bay County in Nyanza Province, Kenya. The 1960's introduction of non-native Nile perch into Lake Victoria precipitated a crash in the lake's biodiversity and caused the broad decline of cichlid species (Witte et al. 1992). While the growth of an export industry for Nile perch spurred economic development, the people of Nyanza province continued to experience the highest poverty rates in Kenya (Kenya National Bureau of Statistics and ICF Macro 2010). The Nile perch fishery expanded quickly through the 1990s, but recent data suggest a decline in fish catches in Kenya, despite sustained fishing effort (LVFO 2012). Within lakeside communities, households today remain reliant on artisanal fishing and are vulnerable to fish declines. On Mfangano, involvement in the fishery, both for trade of fish and subsistence use, is widespread. Mfangano has limited health infrastructure and electricity, and no running water or paved roads. Food insecurity is common throughout Mfangano and ubiquitous among people living with HIV/AIDS (Nagata et al. 2012; Nagata et al. 2013).

Survey Methods

In August–October 2010, we conducted a cross-sectional survey in three villages on Mfangano Island. Mfangano has a network of government trained Community Health Workers and each is assigned to provide health outreach to a group of households. Household assignment to community health workers is exhaustive and mutually exclusive, providing for representative sampling within these communities. We stratified our sampling by community health worker and randomly sampled 111 households with 583 individuals, or approximately one third of all households.

We approached female and male heads of household to provide consent for study participation. All of the households we approached consented to participate in the study. A trained enumerator visited participating households to complete a one-hour questionnaire covering the following domains: 1) household and demographic features; 2) measures of food, water, and income security; 3) household morbidity via reports of illness frequency. Female heads of household responded to all questions in these domains.

We developed the survey through a compilation of validated behavioral and social science instruments and made modifications for the local context (Appendix I). We translated the survey into Dholuo and back-translated into English to ensure consistency of meaning. We administered the survey in Dholuo. The Committee on Human Research at the University of California, San Francisco and the Ethical Review Committee at the Kenya Medical Research Institute approved this research. We obtained written consent from study participants prior to enrollment.

Characterization of Variables

We characterized a household as engaged in fishing as a livelihood activity if the household mother reported the occupation of any household member as fisher or reported Nile perch fishing as a primary income earning activity (Appendix I). Adult males dominate Nile perch fishing, and a relatively large percentage (22%) of households did not contain an adult male, thus, we conducted separate analyses for the subset of households with an adult male and all the households combined.

We characterized household socioeconomic status based on reported monthly income, an asset scale, highest level of maternal education and household size. Monthly income was log-transformed to approximate a normal distribution. Three outlying monthly income data points, determined by the interquartile outlier rule and representing a near doubling of the next closest incomes, were omitted. Models created with these outliers included show similar patterns of significance and contribution of other variables, but with inflated odds ratios for monthly income. We conducted a principle component analysis (PCA) of an 11-item asset scale to develop a single asset measure among several potentially collinear predictors. Our results determined that all 11 predictors were necessary in explaining variance so all items were included in the scale (Vyas and Kumaranayake 2006). We assessed food security with a subset of the Household Food Insecurity Access Scale (HFIAS; Coates et al. 2007). HFIAS scoring methods were used to categorize households as food secure/mildly food insecure or moderately/severely food insecure (Coates et al. 2007).

We measured levels of fish consumption by reported frequency of household consumption of fish. For multivariate logistic regression, we coded fish consumption as a binary variable such that households consuming fish never or rarely were scored as zero and households consuming fish sometimes, often or frequently were scored as one.

We assessed morbidity based on reporting from the household mother on whether any adult household member was too sick to go to work or school on any day in the month preceding the survey. We calculated both adult morbidity and adult male morbidity as binary household variables.

Statistical Analyses

We conducted statistical analyses using Stata Version 12.1 (StataCorp LP; Texas, USA). We compared demographic characteristics between fishing and non-fishing households using Welch unequal *T*-tests. We performed bivariate and multivariate logistic regressions to assess the variance explained by each independent variable (monthly income, asset scale, household size, fishing household, household morbidity, and fish consumption/food

security) on each outcome variable (fish consumption, food security). We selected multivariate models through the evaluation of variables proposed and retention of those variables that improved model performance. We confirmed model selection with likelihood ratio tests. We checked all variables for multicollinearity and confirmed a variance inflation factor <2.

We modeled logistic regressions separately for all households in the sample, and for households containing an adult male. We calculated 95% confidence intervals (CIs) for all odds ratios and report the *p*-value for the associated regression coefficient.

Results

Descriptive statistics of the 111 households sampled are found in Table I. Fishing households did not report increased fish consumption or food security in comparison to non-fishing households (Table II). This remained true when our analysis included only households with an adult male present (Table III).

In multivariate analyses, high household fish consumption was associated with monthly income (Odds Ratio [OR] 2.40, 95% Confidence Interval [CI] 1.45 – 3.98) and food security (OR 1.18, 95% CI 1.00–1.39) compared to households with low fish consumption. Adult morbidity (OR 0.48, 95% CI 0.19 – 1.16) was retained in our model predicting fish consumption, but was not statistically significant. Household food security (food secure / mildly food insecure) was associated with the asset index (OR 1.37, 95% CI 1.04 – 1.82) and monthly income (OR 1.67, 95% CI 1.02 – 2.74) compared to households who were moderately or severely food insecure.

In households with an adult male member, high fish consumption was positively associated with monthly income (OR 2.67, 95% CI 1.48 – 4.82) compared to households with low fish consumption. In households with an adult male member, food security was positively associated with an increased asset index score (OR 1.48, 95% CI 1.07 – 2.04) and monthly income (OR 2.16, 95% CI 1.12 – 4.18) compared to food insecure households.

Discussion

We found consistent associations among food security and fish consumption and socioeconomic indicators, as well as tentative evidence of a negative association between fish consumption and morbidity. We found, however, no association between participation in fishing livelihoods and either fish consumption or food security.

Although Lake Victoria has sufficient fish to feed an international export market, fishers who regularly catch these fish do not eat more fish than their non-fishing neighbors. For many households around Lake Victoria, fish species and size dictate whether a fish represents a “cash crop” or a food resource. Complex political economies appear to separate fishing livelihoods from fish consumption while positioning income as a key driver of both fish consumption and food security. Our findings may reflect a truly absent relationship, gendered differences in fishing and food preparation, and/or the limitations of our study to fully capture households’ livelihood activities. All of these potential causes have broad

implications for how we understand livelihoods connection to food security and natural resources.

Fishing Households, Fish Consumption and Food Security

There may, in fact, be no association in this community between whether a household fishes for its livelihood and fish consumption or food security. Worldwide, the percentage of catch retained by small-scale fishers ranges from nearly 100% to less than one fifth (Garaway 2005; Friedman K 2008; Kawarazuka and Bene 2010). Around Lake Victoria, reports suggest fishing households have higher mean incomes (Allison 2004), but command only a fraction of the total value of the fish caught (Johnson 2010). The extensive export of Nile perch has driven questions of whether food security is reconcilable with the exclusionary export market of Lake Victoria and to associate the growth of the Nile Perch fishery with local hunger (Abila 2003; Geheb et al. 2008; Johnson 2008; Salmen 2009).

As demonstrated in our results, income may overwhelm fishery participation as the driver of fish consumption. This result is corroborated by reports of people living around Lake Victoria sometimes being relegated to consumption of low value fish and by-products from processing (Kabahenda et al. 2011). In Lake Victoria, there are currently three primary species fished and consumed: Nile perch (*Lates niloticus*), Nile tilapia (*Oreochromis niloticus*) and dagaa (locally called omena, *Rastrineobola argentea*). The focus of this research was on Nile perch fishers and consumption. Access to alternative fish species, particularly dagaa, a sardine-like fish with more limited international export potential but a prominent place in the culinary customs of lakeside communities, may contribute to fishers propensity to sell rather than consume Nile perch.

Morbidity and Fish Consumption

Our results suggest a relationship between fish consumption and morbidity that merits further research. For households with adult morbidity in the preceding month, the odds of regular fish consumption are halved. Among households with adult males, male rather than adult morbidity seems to drive this relationship. High household morbidity may make it more difficult for households to earn money or fish, and poverty, low income, and low fish consumption make higher morbidity levels likely. HIV/AIDS prevalence, estimated at over 25%, and endemic tropical diseases drive high levels of morbidity at the study site where 48% of adult males were ill at least one full day during the last month and 21% were ill for a week or more. Both the reported frequency of illness and the large number of households headed by grandparents or without an adult male reflect extensive morbidity and mortality. The possible association between fish consumption and morbidity warrants further study of the pathways through which morbidity affects fishers' ability to catch fish, or consume their catch. At the same time, the impact of morbidity on food insecurity may have cyclical effects on economic and health decision making, potentially leading to increased risk of HIV acquisition (Mojola 2010).

Socioeconomic Associations With Fish Consumption and Food Security

An increase in monthly income was associated with 2.40–2.67 times the odds of high fish consumption compared to low fish consumption and 1.67–2.18 the odds of food security

compared to moderate or severe food insecurity. The relatively strong association between income and food security is expected, given established relationships between income and food security (Geheb and Binns 1997). These associations exist despite the narrow range of income levels represented in the study, suggesting that even modest improvements in income could substantially improve food security or fish consumption. Ninety five percent of households reported a monthly income under 12,000KES ($150), or less than $1/person/day given the mean household size of 5 members. Even within this narrow range, modest increases in income were associated with meaningful increases in fish consumption and food security.

The asset scale, another measure of socio-economic status, is retained in models for associations with food security, but not fish consumption. The relative strength of the association between fish consumption with monthly income, indicative of short-term socio-economic status, compared to assets which is reflective of long term financial security, further suggests that fish may largely be procured through purchase rather than associated with particular livelihoods.

Measuring Livelihoods and Study Limitations

A livelihood comprises a household's capabilities and means of living, including its access to food (Chambers and Conway 1992). A household's livelihood is challenging to measure, and our analysis has several limitations. We accounted for only the main ways that households earn an income or the occupation that defines each individual. Consequently, we could not examine the role of subsistence fishing in food security and fish consumption, and could not capture information about illegal fishing, fishing by children, and other methods of obtaining fish, all of which likely remain important ways households access fish (LVFO 2012). Similarly, we were unable to account for the effort each household puts into fishing or women's engagement in selling and processing fish, non-fishing livelihoods that interact with fish. Further analysis explicitly considering gendered vantage points in decision-making and accessing fish would expand our understanding of how food-producing livelihoods interact with consumption and food security.

Gendered differences in livelihoods and household responsibilities also likely affect whether households consume fish. In Lake Victoria, the harvest of fish, and of Nile perch in particular, remains a male-dominated activity (Geheb et al. 2008; Nadel-Klein and Davis 1988). Yet, women remain broadly responsible for procuring food, preparing meals, and budgeting for these activities; decisions about whether to sell fish or bring them home for dinner are often made by men, without the immediate counsel of their partners (Whyte and Kariuki 1991). The gendered nature of fishing and food preparation may also drive a disconnect between fishing livelihoods and consumption in these communities.

The cross-sectional nature of our study limits our ability to make causal inferences regarding the observed associations. In particular, the absence of temporality makes it difficult to distinguish whether fish consumption or food security precedes the other. Further, our study was not powered to detect small differences between fishing and non-fishing households, and these may exist.

Conclusion

Livelihood strategy has implications for both how households use fishery resources and how patterns of use are related to income, food security, and morbidity (de Sherbinin et al. 2008). That we saw no effect of household engagement in fishing on their consumption of fish or on food security suggests that the complexity of these relationships demands a more rigorous and ideally longitudinal study. Additional research is needed to assess seasonal changes, gendered effects of participation in the livelihood, and relative differences in household investment and success in the livelihood activities. Moreover, the frameworks with which we evaluate interventions to improve livelihoods and assess their effects on food security, dietary consumption, nutritional status, and morbidity face similar challenges in accounting for livelihoods within complex political economies. Food, as a biological necessity, cultural symbol, and economic resource, remains literally at the center of household wellbeing for rural communities around the globe. By further untangling the lines that lead from the fish net to the plate, we can design better measures to assess relationships between food production and food security, and better target effective livelihood interventions for poor families who need them most.

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Appendix

Appendix I:

Variable definitions and references.

Variable	Type	Definition	Reference
Fishing Household	Binary	Occupation designated as fisher Nile perch or tilapia fishing designated as a primary income-earning activity	
Food Security	Binary	Moderate and severe food insecurity categories: frequency of any household member taking smaller meals, fewer meals, go to sleep hungry, go a whole day and night without eating	Household Food Insecurity Access Scale – Q5, 6, 8, 9 (Coates et al. 2007)
Fish Consumption	Binary	Frequency of household fish or meat consumption; ethnographic experience confirms meat consumption is extremely rare	
Income	Continuous	Past month's income	
Asset Scale	Categorical	11-item asset scale	Asset scale (Vyas and Kumaranayake 2006); Ethnographic Research (Salmen 2009)

Variable	Type	Definition	Reference
Household Size	Categorical	Number of members in the household, binned at upper end	
Education	Categorical	The highest level of maternal education attained; recorded as some primary, primary, some secondary, etc.	
Adult Morbidity	Binary	Characterizes whether an adult household member (≥16 years) was too sick to attend work or school at least one day in the past month	
Male Morbidity	Binary	Characterizes whether an adult male household member (≥16 years) was too sick to attend work or school at least one day in the past month	

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Table I:

Comparison of household characteristics for each of the measured variables, for all households, fishing households, and non-fishing households. Fishing and non-fishing households were compared using Welch two-sample t-tests for unequal variances; only adult morbidity was significantly different among the households sampled (t = −1. 98, p = 0.05).

Variable	Range	All Households (111 households) n (%) or N (SD)	Fishing Households 38 (34%) n (%) or N (SD)	Non-Fishing Households 73 (66%) n (%) or N (SD)
Food Insecurity	0-moderate/severe insecurity 1-food secure/mild insecurity	67 (60%) 44 (40%)	21 (55%) 17 (45%)	46 (63%) 27 (37%)
Fish Consumption	0- rarely consumed 1-regularly consumed	55 (50%) 56 (50%)	18 (47%) 20 (53%)	37 (51%) 36 (49%)
Monthly Income (n=108) * Monthly Income	KES 100 – 18,000 USD $1.25 – 225 KES 100 – 31,000 USD $1.25 – 387.5	KES 3506 (48.5) USD $43.82 ($0.61) KES 4258 (5530) USD $53.22 ($69)	KES 3292 (20.3) USD $41.15 ($0.25) KES 3292 (2618) USD $41.15 ($32.73)	KES 3619 (40.60) USD $45.24 ($0.51) KES 4748 (6493) USD $59.35 ($81.16)
Asset Index	11 item scale	4.23 (1.78)	4.47 (1.99)	4.18 (1.66)
Number in Household	1–12	5.27 (2.40)	5.79 (2.24)	5 (2.46)
Adult Male	0-no male age 16 or older 1-at least one male age 16 or older	24 (22%) 87 (78%)	0 (0%) 38 (100%)	24 (33%) 49 (67%)
Adult Morbidity	0-never ill 1-male or female head of household too ill to work at least one day last month	49 (44%) 62 (56%)	12 (32%) ** 26 (68%)	37 (51%) ** 36 (49%)
Male Morbidity	0-never ill 1-male head of household too ill to work at least one day last month	53 (61%) 34 (39%) n=87	17 (45%) 21 (55%)	36 (73%) 13 (27%)

* Outliers were removed – three values from 30,000–31,000KES were removed with validation by the inter-quartile range rule for outliers.

** p<0.05, Welch's two-sample t-test for unequal variance

Table II:

Determinants of fish consumption and food security, all households (N=108). Odds ratios for bivariate models and adjusted odds ratios for full models. Models include all households and predict fish consumption (left) and food security (right).

Determinants of Fish Consumption Odds ratio (95% confidence interval)					**Determinants of Food Security Odds ratio (95% confidence interval)**				
Determinant	**Bivariate**	***p*-value**	**Full Model**	***p*-value**	**Determinant**	**Bivariate**	***p*-value**	**Full Model**	***p*-value**
Asset Index	1.47 (1.14 – 1.88)	0.003	--	--	Asset Index	1.52 (1.18 – 1.95)	<0.001	1.37 (1.04 – 1.82)	0.03
Monthly Income (Log)	2.58 (1.59 – 4.19)	<0.001	2.40 (1.45 – 3.98)	0.001	Monthly Income (Log)	2.08 (1.30 – 3.31)	<0.01	1.67 (1.02 – 2.74)	0.04
Number in Household	1.15 (0.98 – 1.36)	0.08	--	--	Number in Household	0.97 (0.83 – 1.14)	0.74	--	--
Education	1.33 (0.96 – 1.84)	0.09	--	--	Education	1.18 (0.87 – 1.61)	0.28	--	--
Fishing Household	1.18 (0.53 – 2.59)	0.69	--	--	Fishing Household	1.46 (0.65 – 3.26)	0.36	--	--
Food Security	1.22 (1.05 – 1.41)	0.01	1.18 (1.00 – 1.39)	0.04	Fish Consumption	2.60 (1.17 – 5.78)	0.02	--	--
Adult Morbidity	0.47 (0.22– 1.01)	0.054	0.48 (0.19 – 1.16)	0.10	Adult Morbidity	0.63 (0.29 – 1.38)	0.25	--	--

Table III:

Determinants of fish consumption and food security in households with adult males (N=84). Odds ratios for bivariate models and adjusted odds ratios for full models are reported. Models include only households with adult male members and predict fish consumption (left) and food security (right).

Determinants of Fish Consumption Odds ratio (95% confidence interval)					**Determinants of Food Security Odds ratio (95% confidence interval)**				
Determinant	**Bivariate**	***p*-value**	**Full Model**	***p*-value**	**Determinant**	**Bivariate**	***p*-value**	**Full Model**	***p*-value**
Asset Index	1.44 (1.10 – 1.88)	0.008	--	--	Asset Index	1.62 (1.21 – 2.15)	0.001	1.48 (1.07 – 2.04)	0.02
Monthly Income (Log)	2.67 (1.47 – 4.82)	0.001	2.66 (1.46 –4.84)	0.001	Monthly Income (Log)	2.87 (1.52 – 5.45)	0.001	2.16 (1.12 – 4.18)	0.02
Number in Household	1.12 (0.93 – 1.35)	0.25	--	--	Number in Household	1.05 (0.87 – 1.29)	0.61	--	--
Education	1.30 (0.90 – 1.89)	0.17	--	--	Education	1.18 (0.84 – 1.66)	0.35	--	--
Fishing Household	0.85 (0.36 – 2.03)	0.72	--	--	Fishing Household	0.95 (0.79 – 1.15)	0.60	--	--
Food Security	1.15 (0.97 – 1.37)	0.10	--	--	Fish Consumption	2.17 (0.88 – 5.31)	0.09	--	--
Adult Morbidity	0.44 (0.18 – 1.08)	0.072	--	--	Adult Morbidity	0.75 (0.31 – 1.81)	0.52	--	--
Male Morbidity	0.58 (0.24 – 1.39)	0.23	0.46 (0.17 – 1.24)	0.12	Male Morbidity	0.86 (0.34 – 2.09)	0.73	--	--