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Do household fish ponds improve family nutrition? A study in Nepal

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Abstract

Protein malnutrition and micronutrient deficiencies are major concerns afflicting the people of Nepal and other countries in the region. Fish has been recognized as a good nutritional source of protein, and small-scale fish culture has recently increased in this region with the inclusion of household ponds in rural communities. This study focused on the value of household ponds by comparing fish consumption and indicators of health for children and women in households with fishponds, to those without ponds. In Kathar area of Chitwan district and Kawasoti area of Nawalparasi district, 51 and 55 households, respectively, each including children between the ages of 1 and 5 years and owning at least one fish pond, were recruited for participation in a survey through door-to-door visits. Similarly, 54 households in Majhui area of Chitwan district and 55 in Pragatinagar area of Nawalparasi district that did not own fish ponds were recruited. Results indicated mothers from locations with fish ponds consumed significantly more fish than those without ponds (93% more), and reported 105 percent higher rates of fish consumption by their children. Owners of household ponds also consumed fish more frequently (97% more) than did households without ponds. However, weight-at-height regressions and body growth data were not significantly different between children from households with or without ponds. Health of children evaluated using details on stunting and wasting indicated that there were no significant differences between households with or without ponds. However, children from our study groups averaged 19 percent underweight, 18 percent stunted, and 12 percent wasted. These values are quite low, compared to 2013 estimates for the entire country for underweight (28.8%) and stunted (40.5%), but not for wasted (10.9%) children. Household ponds promoted inclusion of fish in diets of children that may provide essential nutrition to promote healthy growth and development for children in the region.

Introduction

Small-scale aquaculture in developing countries has been identified as a method to generate income, empower women, and increase food availability (Bhujel, Shrestha, Pant, & Buranrom, 2008). Fish has been recognized as a nutritionally beneficial food source around the world, providing high quality protein and important micronutrients, such as Vitamin A, Vitamin D, and iodine, as well as providing a source of phosphorus, fluoride, and calcium if bones are consumed (Castine et al., 2017). Additionally, the benefits of consuming fish for Omega-3 fatty acids are widely documented (Oken & Belfort, 2010). Fish produced by aquaculture are grown

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efficiently and in an environmentally friendly manner, compared to other forms of livestock (Cao, Diana, & Keoleian, 2013). There currently exists a difference in the perceived nutritional gains from fish consumption in developed or developing countries; in the former, individuals, the media, and researchers are primarily concerned with consumption of omega-3 fatty acids (Domingo, Bocio, Falco, & Lobet, 2007; Oken & Belfort, 2010); while in the latter, the primary concerns are protein and micronutrients (Aiga, Matsuoka, Kuriowa, & Yamamoto, 2009; Parajuli, Umezaki, & Watanabe, 2012).

The typical diet in Nepal and other developing countries throughout South Asia consists of rice, vegetable curry, dal (a thick soup made from legumes), pickle, and other fruits and vegetables. Meat and fish are eaten less regularly, resulting in individuals with diets deficient in protein and important micronutrients, such as Vitamin A, iron, and zinc (Parajuli et al., 2012). Chronic malnutrition and micronutrient deficiency are major problems in the region. While recent research and outreach has focused on providing fish culture alternatives to improve the nutrition and health of poor farmers, comparatively little has been done to assess the success of increased fish production on consumption and human health (Diana, 2012).

Many international development programs promote aquaculture and the resultant consumption of fish grown in ponds as one means to overcome the protein shortage found in many countries (Brummett & Williams, 2000). For example, the U.S. Peace Corps has promoted aquaculture as a means to reduce poverty and malnutrition for several decades. NGOs that provide international aid have likewise used fish ponds as an example of a way rural poor can escape issues of poverty and hunger (Lewis, 1997). While such programs commonly promote the use of household ponds in poverty alleviation, few have documented the nutritional and health benefits derived from possession of a household pond (Kawarazuka & Bene, 2010; Pant, Barman, Jahan, Belton, & Beveridge, 2014). It seems logical to assume that fish ponds will increase consumption of fish in the household and improve human health, as long as they are managed well and produce a reasonable crop. The goal of this study is to test this assumption.

The most common forms of malnutrition include undernutrition, i.e. insufficient energy and deficiencies of vitamins and minerals, including Vitamin A, iodine, and iron. Undernutrition is defined as "inadequate intake of protein, energy, and micronutrients and by frequent infections and disorders that result (World Health Organization [WHO], 2000)." Growth retardation in children is one consequence typically associated with undernutrition (Lunn, 2002). Child growth retardation is generally manifested in one of three forms: (1) low height-at-age (stunting; Kramer, 1987), (2) low weight-at-height (wasting), or (3) low weight-for-age (underweight; *Ministry of Health and Population* [MoHP], 2012). Mild to moderate forms of malnutrition, resulting from inadequate intake of protein, are believed to be the primary factor responsible for wasting, underweight, and stunting in children (Neumann, Gewa, & Bwibo, 2004). Animal source foods are known to contain high levels of protein and micronutrients lacking in diets of growth restricted children, but animal foods are often limited or unattainable for underprivileged individuals, especially in developing countries. As a result of poor access to animal source protein in Nepal, recent surveys estimated that approximately 41 percent of children less than 5 years of age are stunted (United Nations International Children's Emergency Fund [UNICEF], 2012), and 48 percent are anemic (MoHP, 2012).

The benefits of fish consumption in Nepal have been linked to such outcomes as improved protein intake (Bhujel et al., 2008) and increased Vitamin A and zinc ingestion (Parajuli et al., 2012). The majority of fish currently consumed in Nepal is produced through aquaculture, since nearly all fish sold in markets in Kathmandu and surrounding areas are raised in ponds. The concept of small household ponds was originally introduced to local residents to improve the nutrition of poor families in Nepal. Small ponds of about 50–100 m^2 in size were built behind houses of relatively poor people, and their management was supported by local cooperatives. These ponds were deemed so successful by local residents that the number of ponds increased from approximately 26 constructed with assistance of the Women in Aquaculture Project launched by the Asian Institute of Technology, Thailand, and the Agriculture and Forestry University (AFU), Nepal, in the early stages to over 200, with the additional ponds built with assistance of local owner groups.

We compared fish consumption and indicators of health for children and women in households with fish ponds to those without access to fish ponds in order to fully assess the value of household aquaculture ponds in Nepal. We had two primary objectives. First, we sought to determine the frequency and amounts of fish and meat eaten by children, ages 1–5, as well as women from households with or without fish ponds. Second, we evaluated health characteristics of children from households with or without fish ponds. We hypothesized that individuals from households with fish ponds would consume more animal protein (from fish and meat) than would individuals from households without ponds, and children from these households would exhibit better health in terms of reduced stunting and wasting.

Methodology

Fifty-one households in Kathar area of Chitwan district and 55 in Kawasoti area of Nawalparasi district were recruited for participation by door-to-door visits, insuring each household had children between the ages of 1 and 5 years and owned at least one fish pond. Similarly, 54 households in Majhui area of Chitwan district and 55 in Pragatinagar area of Nawalparasi district, each including children and not owning fish ponds, were recruited. A list of participating households was determined with the help of local village leaders, who randomly selected households from those they considered had children and appropriate conditions, and also guided surveyors to the homes during surveys. All data for this study were collected during October and November 2015. Survey protocols were approved from the University of Michigan (HUM00093052).

After obtaining informed consent, mothers — the traditional care-givers and food preparers in Nepali culture — were specifically asked to respond to survey questions. The fish consumption portion of the survey was modeled after Goodrich et al. (2011), while child nutrition queries were modeled from the USAID Nepal Demographic and Health Survey (NDHS) completed in 2011 (MoHP, 2012). The amount of fish consumed per meal was estimated by survey questions asking the portion size (25, 50, 75, 100, 300, or 400 g) calibrating the amount by indicating that 100 g of fish is equivalent to the size of a deck of cards. Frequency of consumption was asked by species of fish as well as other animal sources, and total consumed was estimated by multiplying portion by frequency for women and children separately. Questions were also asked regarding fish pond information, age and sex of children, socioeconomic details, number of children in the household, and regular dietary intake. Interviews were conducted in the local language with the aid of a skilled Tharu/Nepali translator and cultural "broker," whose duties included ensuring that cultural sensitivities were considered at all times. In order to compensate survey respondents for their time, each participating family was given USD $5.00.

Child measurement data were collected immediately following the interviews. A digital balance, placed on a hard, level surface, was used to determine weight of each child. Parents were asked to remove their children's shoes and any heavy clothing before weighing. If a child was incapable of standing on the balance, the child's mother was asked to stand on the balance while holding the child. She was then weighed without the child, and the child's weight was determined by subtraction. A child's height was determined using a ruler. The parent was asked to remove the child's shoes, bring the child to the plane surface near a straight wall, and to kneel in front so the child remained comfortable and cooperative.

The 2006 World Health Organization (WHO) growth standard charts were used to determine height-at-age, weight-at-height, and weight-at-age trends among the children sampled (Grummer-Strawn, Reinold, & Krebs, 2010). Using WHO growth charts as a guide, stunting in children was estimated by comparing height-at-age with country-wide values, and a child was considered stunted if their height was more than two standard deviations below the country median (UNICEF, 2015). Underweight values were determined similarly, except using values of weight-at-age. Wasting in children was estimated by comparing weight-at-height with country-wide values, using similar comparisons.

We determined the number of wasted, underweight, and stunted children in each of our populations and compared those using Chi-square tests. A One-Tailed T-Test was used to compare the amount and frequency of fish consumed by women and children in households with or without fish ponds. A linear regression analysis was performed to compare weight-at-height data between children from varying households. Alpha levels were set at .05. All statistics were done using SPSS V 16.0.

Results

People from households with ponds consumed a higher total mass of fish and ate fish more often than people from households without ponds. Mothers with ponds reported eating fish significantly more often (10.9 times per month) than those without ponds (5.7 times per month), although individual serving sizes (141 g) were similar for both groups. This resulted in mothers with ponds consuming 93 percent more fish (1548 g/month), compared to mothers without ponds (802, Figure 1). Similar results were found for children. Children from households with ponds ate fish significantly more often (9.5 meals per month) than those without ponds (4.6 meals per month). Individual servings were similar in the two groups (49.5 g), resulting in a significantly higher monthly consumption (106% higher) for the group with ponds (472 compared to 230 g/month). Small Indigenous Species (SIS) were the most frequently eaten fish, followed by carp, and this trend held for all locations (Figures 2 and 3). Children from families with ponds consumed SIS significantly more often (3.2 times per month) than families without ponds (2.6 times per month).

In addition to fish, households also reported consuming mutton (goat), pork, and chicken as sources of animal protein. While the amount and frequency of fish consumed in meals was significantly higher in households with ponds, neither the amount nor frequency of meat consumed was significantly different between household types (One-Tailed T-Test, $p > .05$). On average, women ate meat 9.5 times per month, while children ate meat 8.4 times per month. Serving sizes were similar to those of fish. The interviewed Nepali families that consumed more fish also ate as much meat as families that had no ponds and consumed less fish, but households without fish ponds consumed animal protein around 13 times per month.

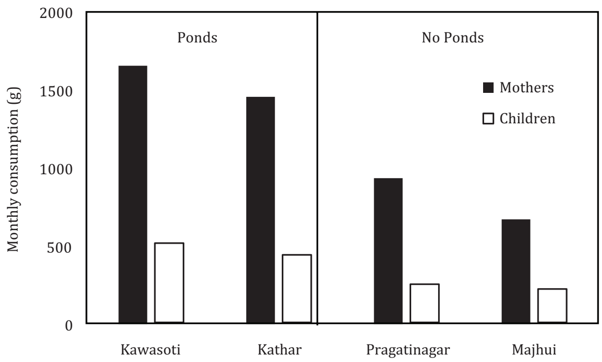

Figure 1 Monthly estimates of fish consumption by mothers and children from households with ponds and without ponds in four locations in Nepal

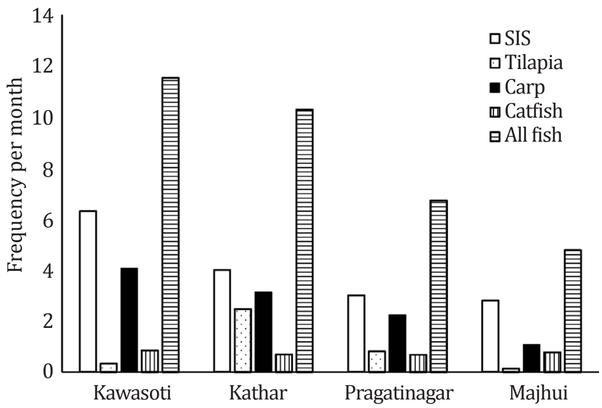

Figure 2 Reported mean frequencies of mothers consuming fish from four species groups for households with or without ponds

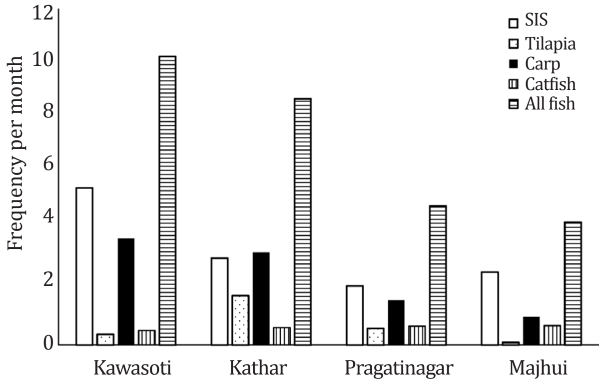

Figure 3 Reported mean frequencies of children consuming fish from four species groups for households with or without ponds

There were no significant differences in socioeconomic indicators between households with ponds or with no ponds. Pond owners indicated that they sold about 50 percent of the fish grown in their ponds and consumed about the same amount. Few fish were traded and none given away. They also reported that 66 percent of the fish they ate came from their own or community ponds, with another 25 percent coming from either their own ponds or fish they traded for or purchased. Annual income from fish sales was USD 324. Families without ponds reported that 75 percent of the fish they ate were bought, 4 percent traded for, and 3 percent from community ponds. Overall, there were no significant differences in household income (average USD 273 per month) or the amount spent on medical care of infants (USD 101 per year) between the two groups. There were also no significant differences in details on children from each type of household. Sex ratio of children was about even (43% female), average age of children under 5 was 38 months, and the mean number of children in the household was 1.6. Over 90 percent of the households surveyed had only 1 child under the age of 5.

Two-hundred-twenty-four children were weighed and measured to evaluate health characteristics of children. Stunting and wasting of children in our sample showed no significant differences between households with or without ponds (Chi-square, $p > .05$; Table 1). Overall, children from our study groups averaged 19 percent underweight, 18 percent stunted, and 12 percent wasted (Table 1). These values are quite low compared to 2013 estimates for the entire country for stunted (40.5%) and underweight (28.8%), but similar to estimates for wasted (10.9%) children (UNICEF, 2015). Additionally, weight-at-height regressions were not significantly different between children from households with or without ponds (Linear Regression, $p > .05$). While children in households with fish ponds ate significantly more fish than did children in households without ponds, it does not appear that this increased access to fish directly resulted in major differences in growth characteristics of children in the regions.

Discussion

Overall, women and children from households with ponds ate more fish and ate fish more frequently than comparable groups from households without ponds, supporting our hypothesis that mothers and children with fish ponds would eat more fish than those without fish ponds. Carp constituted a large percentage of the fish consumed in all households. In contrast, small indigenous species (SIS) are largely wild caught, and those with ponds would normally not have greater access to them than those without ponds. However, farmers indicated that SIS found their way into ponds inadvertently by way of constructed waterways, which led to their growth and production in the ponds, resulting in households with ponds consuming SIS more frequently than any other fish. This is consistent with other studies that indicate many South Asian consumers prefer SIS, as they are small in size so will not be wasted in a meal, and they are available regularly throughout the year (Castine et al., 2017).

In spite of higher consumption rates of fish, children from households with ponds were no healthier than those from households without ponds. Therefore, our hypothesis that children in fish farming households would exhibit higher weight-at-age, height-at-age, and weight-at-height than of those from non-fish farming households was not supported. It is difficult to detect significant differences in growth patterns of children without large sample sizes or large differences in the populations being tested, so generally, studies have been unable to link aquaculture to improvements in child health through increased fish consumption. However, it is clear that in our case, there was no major difference in the health status of the two populations, regardless of sample size, since the values for both communities were almost identical.

Virtually all socioeconomic indicators were similar for households with ponds or with no ponds, indicating that families without ponds found other means to maintain their households. This is also consistent with the lack of major differences in child health indicators between these two types of households. The differences between household pond ownership in this study was estimated by comparing different communities for each category. An alternative would be to

Table 1 Frequency and overall percentage for children under five in the study populations that were underweight, stunted, and wasted

	Underweight	Stunted	Wasted
Kawasoti	26.7% (16/60)	20% (12/60)	16.9% (10/59)
Kathar	19.6% (10/51)	21.6% (11/51)	8.3% (4/48)
Total	23.4% (26/111)	20.7% (23/111)	13.1% (14/107)
Pragatinagar	12.7% (7/55)	20.7% (12/58)	3.5% (2/57)
Majhui	16.4% (9/55)	12.7% (7/55)	20% (11/55)
Total	14.5% (16/110)	16.8% (19/113)	11.6% (13/112)
Overall total	19.0% (42/221)	18.8% (42/224)	12.3% (27/219)
WHO values	28.8%	40.5%	10.9%

evaluate the differences between these categories for households in the same community, but the prevalence of ponds in Kathar and Kawasoti made it impossible to find enough households without ponds to complete the survey. We believe that most differences found in consumption here would be the same for either type of comparison, although economic indicators might be lower for non-pond owners in the same community, as the poorest residents would likely not have the wherewithal to build and maintain ponds.

Although our results did not directly support the link between child health status and household fish ponds, similar studies have shown fish ponds provide external benefits for child health. Several studies have found increases in fish consumption among households with fish ponds. Kumar and Dey (2006) found that Indian families with ponds consumed 10 percent more total energy than those without ponds, while in Malawi, Dey et al. (2006) determined that families with fish ponds ate fresh and dried fish much more commonly than those without ponds. Additionally, Castine et al. (2017) determined that integrating SIS with carp polyculture in homestead ponds of Bangladesh dramatically contributed to vitamin and micronutrient needs of families. In some cases, aquaculture has not been shown to increase fish consumption, due to sale of fish (such as carp) rather than consumption or to the larger availability of wild caught fish, even for households with fish ponds. Aiga et al. (2009) found that children in Malawi were better nourished in fish-farming households, but this improved nutrition was not directly linked to fish consumption. Instead, the authors suggested that income generated by fish farming allowed households to purchase additional food items that benefitted child health and growth (Aiga et al., 2009).

There were no significant differences in the amount and frequency of meat consumption between households with and without ponds, indicating sampled families had access to several animal protein sources and could transition to non-fish alternatives when fish was scarce. Rivera, Hotz, Gonzalez-Cossio, Neufeld, and Garcia-Guerra (2003) studied nutrition in Peru and Mexico and suggested that "relatively small increases in the intake of animal source foods may reduce the prevalence of growth stunting in populations at risk". Children from households without ponds consumed fish about four times a month and meat about eight times a month (compared to ten meals per month for fish and eight for meat in households with fish ponds), and this consumption of animal protein approximately every other day likely provided sufficient nutrients to grow at a similar rate as children with fish ponds. The consumption of fish and meat by all children in this survey is also likely responsible for their overall better health compared to country-wide averages. One limitation of our study was that households were surveyed during peak harvest times when pond fish were relatively abundant for pond owners, as well as for households without ponds to buy or trade for fish. While this would affect consumption estimates, it would not result in any differences as far as growth of children was concerned, as these growth patterns develop over years.

The nutrients available to children from fish raised in the Terai also differ among species of fish consumed. Carp, tilapia, and catfish — the most common fish purposely reared in aquaculture ponds— are mostly beneficial for the high value protein they provide. In contrast, SIS occur incidentally in these ponds and also contain high amounts of Vitamin A, calcium, and zinc (Kawarazuka & Bene, 2010). These nutrients are known to affect physical growth and the lack of any one of these can be responsible for retarded growth (Rivera et al., 2003). We found the health status of children in the Terai region to be much better than the estimated status determined by national surveys. This may indicate that current health indicators used by the Nepali government and the WHO to access child health may not be fully appropriate for this region.

Overall, the percent of undernourished Tharu children surveyed in this study was lower than that estimated by the NDHS, except for average weight-at-height, which was similar to country-wide averages (MoHP, 2012). However, several factors may have influenced this finding. First, our sample size is somewhat low (n= 224 children) and may have been too small to reflect overall population trends across both a regional and national scale. However, even increased samples would likely not alter the percentages of stunted or wasted children in our study area, as the overall averages were quite similar in both groups and also quite different from country-wide values. Another issue related to nutrition is that we only examined physical growth (height and weight) as a measure of a child's nutritional status. While growth is recognized as an effective indicator for child nutrition, it cannot be used to directly measure micronutrient deficiencies or anemia. Rather, retarded growth may be only one side-effect of a diet deficient in micronutrients (Kawarazuka & Bene, 2010). The use of biochemical indicators is one method that would directly measure the amount and types of micronutrients found in diets and should be incorporated in future studies to access the availability and uptake of micronutrients from fish and other animal proteins from diets.

Conclusion

Nutrient-rich foods such as fish can help improve the health of children who suffer from a limited diet lacking in important nutrients, and small-scale aquaculture serves as an effective way to provide fish to households in locations where the creation and maintenance of family ponds is feasible. However, it is challenging to link improvements in nutrition to benefits provided solely by aquaculture, given that child undernutrition is a complex condition resulting from a combination of dietary, health, and socioeconomic factors. From individuals surveyed in the Terai region of Nepal, no definitive relationship was found between aquaculture and child nutrition. However, the health status of children surveyed in this study — all of whom had access to fish — was found to be better than that of average children in Nepal. The improvement in child diet provided by a nutritious food source such as fish cannot be overlooked, and aquaculture can serve as at least one method to provide food security and help obtain a balanced diet for families including women and children.

Conflict of Interest

Threr is no conflict of interest.

Acknowledgments

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