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Household Pond Fish Production Increases Fish Consumption Frequency and Dietary Diversity of Reproductive Age Women in the Southern Ethiopia

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Abstract

Background: In Ethiopia, maternal under nutrition is still one of the public health problems. As one of the options to addressing the problem, fish production using pond has been practiced in the country. For instance, in Southern Ethiopia, farmers are producing fish using constructed ponds on their farms. However, the contribution of the aquaculture initiative in improving nutrition is less documented.

Method: We conducted a study using both quantitative and qualitative methods with multistage sampling technique. Women who are 19 - 49 years of age, from fish producing (FP) [n = 61] and none-fish producing (NFP) [n = 117] households residing in three districts participated. Fish consumption frequency was measured using three consumption patterns (i.e. frequent, occasional and non-fish eaters). Women's dietary diversity score (WDDS) was determined by intake of 9 food group with reference period of 24 hours. Nutritional status of the women was determined using body mass index. In addition, focus group discussion and key informant Interviews were done.

Results: Nile tilapia (*Oreochromis niloticus*) was the most common pond species and most species preferred for sale (i.e. income). Respondents from none-fish producing households were less likely to consume fish frequently (odds ratio = 0.044, $p < 0.001$) than those in fish producing households. The mean (± standard deviation) dietary diversity score in women from fish producing households (5.50 ± 2.16) was significantly higher than their none-fish producing counterparts (4.09 ± 1.98, $p < 0.001$). No differences ($p > 0.05$) in mean height, weight and body mass index were found between women in fish producing and none-fish producing households.

Conclusion: The short period of time (< 5 years) since the introduction of fish-ponds and the simple measure used to assess nutrition status (i.e. Body mass index) may explain the lack of difference observed in the nutrition status of the women. However, aquaculture has great potential in improving the food and nutrition security (e.g. nutrients, income) and the results illustrate some of the benefits of pond-fish production in southern Ethiopia (i.e. more fish consumption and improved dietary diversity score). Further research is necessary to determine the longer-term impact of pond fish production on the nutrition status of women.

Keywords: *Aquaculture; Dietary Diversity; Fish Consumption; Nutrition Status; Reproductive Age; Women*

Abbreviations

BMI: Body Mass Index; FGD: Focused Group Discussions; FP: Fish Producing; NFP: None Fish Producing; PCA: Principal Component Analysis; SNNPR: Southern, Nations, Nationalities and People Region; SPSS: Statistical Packages for Social Sciences; WDDS: Women Dietary Diversity Score

Background

In every country of the world, malnutrition in all its forms is a serious public health burden incurring high economic costs and adding to lower quality of life. Improvements in reducing malnutrition have significant contribution in reducing poverty and achieving better health [1]. In Ethiopia, maternal under nutrition is still one of the major public health problems. Encouragingly, malnutrition has been decreasing in the country over the last two decades. Focusing on food security and scaling up nutrition programs have made tremendous contribution to reducing under nutrition [2]. However, millions of Ethiopians still suffer from chronic and acute malnutrition. The country ranks among the top both in sub Saharan Africa and the world for malnutrition [3]. Although the progress and achievements made so far are commendable, addressing the deep-rooted causes of malnutrition and ending hunger in Ethiopia call for high impact integrated and coordinated interventions. The government's efforts to address malnutrition are mainly through the lifecycle approaches. Women are the most vulnerable population in Ethiopia and that is why the current Ethiopian national nutrition program sought improving the nutritional status of women (18 - 49 years) one of its main targets. Reducing the proportion of women in reproductive age women with body mass index < 18.5 kg/m^2 from 27% to 16% is one of the major focus [2].

Aquaculture is one of the key nutrition sensitive interventions recently promoted as the country has huge aquaculture potentials [4]. For instance, in Southern Ethiopia, farmers are producing fish using constructed ponds on their farms. There are also established research and fish breeding sites near Lake Hawassa (for breeding Nile Tilapia and African Catfish). Fingerlings are produced from the breeding site and disseminated to farmers together with technological advice, continues follow-up and support, leading to substantial increase in fish production in the region. Despite these efforts, there is limited study conducted indicating contribution of aquaculture initiative in improving nutrition security in the area. Therefore, the main objective was to determine the association of household pond-fish production with fish consumption, dietary diversity and nutritional status of reproductive age women.

Materials and Methods

The study was conducted in Dara, Dila Zuria and Wensho Districts in southern Ethiopia. A cross-sectional study, using standard women dietary diversity guideline and fish consumption patterns was done.

Study population

A total of 178 women aged 19 - 49 years of age, 61 from fish producing (FP) and 117 from non-fish producing (NFP) households participated in the study.

Dietary diversity assessments

Dietary diversity was measured using the guideline of Food and Agricultural Organization [5]. Diet Diversity was estimated based on a 24-hour recall as a reference period with 9 food groups. The consumed foods were allocated to the following food groups as composed by the guideline, these were: 1) Cereals, Grains, White Roots and Tubers, 2) Vitamin A Rich Fruits and Vegetables, 3) Vitamin A Rich Dark Green Leafy Vegetables, 4) Other Fruits and Vegetables, 5) Organ Meat, 6) Flesh foods (Fish and Sea food), 7) Eggs, 8) Pulses, Nuts and Seeds, 9) Milk and Milk Products. Fish consumption frequency was measured using a five-point category scale and coded in descending order as follows: frequent eaters (respondents that consumed fish and/or seafood as per the recommendation of 2 or more servings per week), occasional eaters (respondents that consumed fish and/or seafood less than twice per week) and non-fish eaters [6]. The original questionnaire for dietary diversity and fish consumption frequency was applied after translation to local language.

Anthropometric measurements

Nutritional status of women was crudely assessed by measuring body mass index (BMI). Weight and height of participants was measured using a digital electronic scale (SECA 760) and a stadiometer (SECA 206) and height was measured shorr height measuring board. Body Mass Index (BMI) was calculated using the formula (BMI = weight (kg)/height m^2). Nutritional status of women was defined based on BMI cut-off values for reproductive age women. According to this cut-offs, subjects were divided into groups: overweight/obese, underweight and normal weight.

Qualitative data collection

Focused group discussion with a total of 24 women (12 in each group) from pond fish producing (FP) and none fish producing (NFP) households were involved. In-depth interviews were conducted among regional Livestock and Fishery Office, Hawassa University and Hawassa Agricultural Research Center who are taking part in the aquaculture initiative in the study area.

Data analysis and management

Data was compiled into a spreadsheet and analyzed using SPSS version 20. Means, standard deviations for the continuous data and frequency distributions for nominal variables, were determined. Continuous data was checked for normality using the Kolmogorov-Smirnov test and histogram. Household wealth index was constructed using household assets (radio, television, mobile, horse, or donkey cart), animals, land size owned, ownership of improved water and via a Principal Components Analysis (PCA). Chi-square test was used to check the association between the nominal explanatory and outcome variables. Independent sample t-test and multiple linear regressions were used to see the mean difference of continuous variables. Ordinal regression model was used assess the associations of the socio-economic, demographic and fish production variables with fish consumption frequency. Significance was set at $p < 0.05$. The focused group discussions and key informant interviews were analyzed using thematic analysis techniques.

Results

Socio demographic and economic characteristics of the respondents

The study participants were from Fish Producing (FP) and None Fish Producing (NFP) Households. The overall mean age of the women was 30.50 ± 6.92 (FP 31.13 (± 7.45) vs. NFP 30.17 (± 6.65)) years. There was no significant difference ($P < 0.05$) in mean age between the groups. The majority (46%) of the respondents were illiterate, (38%) can only read and write. The rest (15.7%) had attended elementary or secondary school. Nearly three quarter (73%) of the respondent's main occupations were housewife. The rest 18%, 7.3%, 1.7% were petty trade, agriculture and others, respectively. The majority of the respondents (89.8%) were married, 7.9% were divorced or widowed, and 2.2% were single. Significant difference ($p < 0.05$) was noted in marital status between fish producing and non-producing women. The households were headed by husband (85.4%) and wife (14.6%). The overall mean of family size in the households was 5.5 ± 1.9 (FP 6.16 ± 2.1 vs. NFP 5.2 ± 1.6). The difference between fish producing and non-producing households in family size was statistically significant ($p < 0.05$). Regarding wealth index, 30.8% of the women were in the poor category; 35.9% were in the middle while the rich category constitutes 33.1%. There was no significant difference ($p < 0.05$) in wealth index between pond fish producing and non-producing households (Table 1).

Variables	Household fish production		Total	*p*-value
	Fish producing	Non-fish-producing		
Age category in years				0.067
19 - 24	12 (19.67%)	19 (16.2%)	31 (17.4%)	
25 - 34	23 (37.7%)	65 (55.5%)	88 (49.4%)	
> 34	26 (42.6%)	33 (28.2%)	59 (33.1%)	
Mean	31.13 (± 7.45)	30.17 (± 6.65)	30.50 ± 6.92	0.382
Religion				0.828
Protestant	53 (86.88%)	99 (84.6%)	152 (85.4)	

Orthodox	4 (6.55%)	12 (10.2%)	16 (9%)	
Muslim	3 (4.9%)	4 (3.4%)	7 (3.9%)	
Catholic	1 (1.63%)	2 (1.7%)	3 (1.7%)	
Ethnicity				0.253
Sidama	54 (88.5%)	85 (72.6%)	139 (78%)	
Amhara	2 (3.2%)	12 (10.2%)	14 (7.9%)	
Gedeo	4 (6.5%)	9 (7.7%)	13 (7.3%)	
Oromo	1 (1.6%)	5 (4.3%)	6 (3.4%)	
Other	0 (0%)	6 (5.1%)	6 (3.4%)	
Educational status				0.462
Illiterate	28 (45.9%)	54 (46.1%)	82 (46%)	
Read and write	26 (42.6%)	42 (35.89%)	68 (38.2%)	
Formal education (Above Primary school)	7 (11.47%)	21 (17.94%)	28 (15.7%)	
Marital Status				0.038*
Single	2 (3.27%)	2 (1.7%)	4 (2.2%)	
Married	58 (95.08%)	102 (87.1%)	160 (89.9)	
Divorced/Widowed	1 (1.63%)	13 (11.1%)	14 (7.9%)	
Main Occupation				0.548
Housewife	46 (75.4%0	84 (71.7%)	130 (73%)	
Petty trade	10 (16.39%)	22 (18.8%)	32 (18%)	
Agriculture	3 (4.9%)	10 (8.4%)	13 (7.3%)	
GOs/NGOs employee/ others	2 (3.27%)	0 (0%)	2 (1.1%)	
Head of household				0.028*
Husband	57 (93.4%)	95 (81.2%)	152 (85.4)	
Wife	4 (6.5%)	22 (18.8%)	26 (14.6%)	
Family size				0.037*
≤ 5	21 (34.4%)	71 (60.68%)	92 (51.7%)	
> 5	34 (55.7%)	46 (39.3%)	80 (44.9%)	
Mean	6.16 (± 2.1)	5.21 (± 1.63)	5.5 ± (1.9)	0.003*
Wealth Index				0.089
Poor	13 (21.3%)	42 (35.9%)	55 (30.8%)	
Middle	25 (40.98%)	39 (33.3%)	64 (35.9%)	
Rich	23 (37.7%)	36 (30.76%)	59 (33.1%)	

Table 1: *Socio-demographic and economic characteristics of the respondents by Fish Producing and Non-Fish Producing, 2016 (n = 178).*

**: Significant at p-value = 0.05.*

Household pond fish production, marketing and related information

Household pond average size was 10 m^2 whereas Nile Tilapia (*Oreochromis niloticus*) was the most species produced and preferred in the market. The mean amount of fish produced among the producing households was found to be 95.8 kg ± 43.2 kg per year. The estimated mean income from fishery was 975.4 ± 1553.4 ETB per year (Table 2).

Variables	Responses	n (percentage)	Mean (SD)
Types of fish produced	Nile Tilapia (*Oreochromis niloticus*)	20 (32.8)	_
	African Catfish (*Clarias gariepinus*)	0 (0)	_
	Do not know	41 (67.2)	_
Preferred species of fish fin the market	Nile Tilapia (*Oreochromis niloticus*)	20 (32.8)	_
	African Catfish (*Clarias gariepinus)*	0 (0)	_
	Do not know	41 (67.2)	_
Annual fish production	_	23 (37.7)	95.8 kg ± 43.2 kg
Annual income from fish	_	23 (37.7)	975.4 ± 1553.4 ETB

Table 2*: Pond fish production and related information of respondents by Fish Producing households, in Sidama and Gedeo of Southern Nation Nationalities and People Region (n = 61), 2015/2016.*

Fish consumption and dietary diversity distribution

The major source of the fish for the consumer (68%) was their own production and the rest (32%) was from the market. Differences ($p < 0.05$) in fish consumption and its frequency was noted between Fish Producing (FP) and None Fish Producing women. From consumers, majority (91.5%) consumed occasionally, while only 8.5% consumed frequently.

The overall mean dietary diversity was 4.57 ± 2.1 (FP 5.5 (± 2.16) vs. NFP 4.09 (± 1.98)). Difference ($p < 0.05$) was noted between Fish Producing (FP) and None Fish Producing (NFP) women. The majority of the respondents (55.6%) had below the mean, while only 44.4% of respondents had greater than mean of the women dietary diversity score out of the nine food groups. The majority (89.9%) of the study participant eat at least three times per day. Only 3.9% of the respondents eat less than three times per day, while 6.2% eat greater than three times per day across both groups. Overall, only 26.4% (FP 55.7% vs. NFP 11.1%) of the respondent consumed a fish in the past one year (Table 3).

Variables	Household fish production		Total	*p*-value
	FP	NFP		
Frequency of meal per day				0.694
≤ 2 times per day	2 (3.3%)	5 (4.3%)	7 (3.9%)	
3 times per day	54 (88.5%)	106 (90.6%)	160 (89.9%)	
≥ 3 times per day	5 (8.2%)	6 (5.1%)	11 (6.2%)	
Women Dietary Diversity Score				0.002*
≤ 5	24 (39.3%)	75 (64.1%)	99 (55.6%)	
> 5	37 (60.6%)	42 (35.9%)	79 (44.4%)	
Mean	5.5 (± 2.16)	4.09 (± 1.98)	4.57 (± 2.1)	< 0.001*
Ever consumed fish in the past one year				< 0.001*
Yes	34 (55.7%)	13 (11.1%)	47 (26.4%)	
No	27 (44.3%)	104 (88.9%)	131 (73.6%)	
Frequency of fish consumption in the past one year				< 0.001*
Frequent eaters	3 (4.9%)	1 (0.85%)	4 (2.2%)	
Occasional	31 (50.8%)	12 (10.2%)	43 (24.1%)	
Never (Non-fish eaters)	27 (44.3%)	104 (88.9%)	131 (73.5%)	
Source of fish for consumption (n = 47)				< 0.001*
Own Production	32 (68%)	0 (0%)	32 (68%)	
Market	2 (4.3%)	13 (27.7%)	15 (32%)	

Table 3*: Fish consumption, dietary diversity and related information of Fish Producing and None Fish Producing respondents, 2015/2016 (n = 178).*

**: Significant at p-value = 0.05.*

Association of household pond fish production with women dietary diversity, fish consumption frequency and nutritional status

The mean (± SD) Women Dietary Diversity Score (WDDS) among fish producers 5.5 (± 2.16) was higher than the non-fish producers 4.09 (± 1.98) (P < 0.001). The mean difference was 1.34 (95% CI: 0.76 - 2.036). In the linear regression model adjusted for head of household, Educational status, mother's occupation, family size, Household wealth index, Credit access, Religion and Age category of the women, the WDDS was significantly higher among fish producers. The adjusted mean difference in WDDS was 1.31 (95% CI: 0.686 - 1.934) (Table 4).

Simple linear regressions			Multiple linear regression*		
β coefficient	t statistic	*P* value	β coefficient	t statistic	*P* value
1.398	4.325	< 0.001	1.310	4.143	< 0.001*

***Table 4**: Association of household pond fish production with the women dietary diversity score of respondents, 2016 (n = 178).*

**: Adjusted for head of household, educational status, mother's occupation, family size, household wealth index, credit access, religion and age category.*

Respondents from non-fish producing households using ponds in their farm were less likely to consume fish frequently (OR = 0.044, p < 0.001). The covariates, educational level of the women, fish production and wealth index were significantly associated to fish consumption frequency of the respondents. The likelihood of consuming frequently was less likely for illiterate (OR = 0.20, p = 0.021) and read/write (OR = 0.136, p = 0.004) compared with their counterparts. Significant association of wealth index was evident with middle category (OR = 0.29, p = 0.033) when compared with those in the rich category. Respondents in the middle wealth index were 71% less likely to frequently consume a fish than in the richer quintiles. However, the effects of age of the women, religion, marital status, main occupation of the women, and head of the household and family size were not significantly associated with the frequency of the fish consumption (Table 5).

Variables	Odds Ratio	Std. error	*p*-value	95% CI
Age category				
19 - 24	0.437	0.830	0.319	0.086 - 2.23
25 - 34	0.97	0.521	0.959	0.35 - 2.70
> 34	1			
Religion				
Christians	1			
Muslim	2.8	0.96	0.285	0.424 - 18.59
Educational status				
Illiterate	0.20	0.698	.021	0.051 - 0.79*
Read and write	0.136	0.687	.004	0.035 - 0.52*
Formal education	1			
Marital Status				
Single	0.322	1.880	0.547	0.008 - 12.84
Married	0.445	0.960	0.399	0.068 - 2.92
Divorced/Widowed	1			
Main Occupation				
Housewife	0.898	0.499	0.830	0.338 - 2.39
Petty trade/agriculture/GO/NGOs	1			
Head of household				
Husband	0.335	0.725	0.131	0.081 - 1.39
Wife	1			

Family size				
≤ 5	1.146	0.486	0.780	0.442 - 2.97
> 5	1			
Wealth Index				
Poor	0.325	0.661	0.089	0.089 - 1.12
Middle	0.293	0.576	0.033	0.095 - 0.91*
Rich	1			
Producing Fish				
No	0.044	0.544	0.000	0.015 - 0.13*
Yes	1			
Credit access				
No	3.946	.625	0.028	1.158 - 13.44*
Yes	1			
Thresholds				
Threshold (cut-off) 1	0.033	1.161	0.003	0.003 - 0.325*
Threshold (cut-off) 2	1.311	1.195	0.821	0.126 - 13.633

***Table 5**: Association of household pond fish production with fish consumption frequency of respondents, 2015/2016 (n = 178). 1 = reference, *- Significant at p-value = 0.05.*

Table 6 indicates the anthropometric measurements of the respondents. The overall mean height, weight and BMI of the respondents were 156.0 ± 6.1 cm (NFP 156.4 ± 6.23 vs. FP 155.3 ± 5.8), 51.86 ± 6.5 kg (NFP 52.1 ± 6.1 kg vs. FP 51.3 ± 7.3 kg) and 21.26 ± 2.1 kg/m^2 (NFP 21.28 ± 2.5 kg/m^2 vs. FP 21.2 ± 1.94 kg/m^2), respectively. No significant statistical difference in mean height, weight and BMI was noted between the two groups of reproductive women. The overall prevalence of underweight (BMI < 18.5 kg/m^2) in both groups was 15.7% (NFP 15.4% vs. FP 16.4%). Regarding overweight/obesity (≥ 25 kg/m^2), the overall prevalence was 4.5% (NFP 9.8% vs. FP 1.7%). No significant statistical difference in overall BMI classification between the groups.

Variables	**Household pond fish production**		**Total**	***p*-value**
	FP	**NFP**		
Height				0.569
≤ 145 cm	1 (1.6%)	1 (0.9%)	2 (1.1%)	
> 145 cm	60 (98.4%)	116 (99.1%)	176 (98.9%)	
Mean ± SD	155.3 (± 5.79 cm)	156.4 (± 6.23 cm)	156.0 ± 6.1 cm	0.246
Weight				0.762
≤ 45 kg	11 (18%)	19 (16.2%)	30 (16.8%)	
> 45 kg	50 (82%)	98 (83.8%)	148 (83.2%)	
Mean ± SD	51.3 (± 7.3 kg)	52.1 (± 6.1 kg)	51.9 (± 6.5 kg)	0.42
BMI				0.302
< 18.5 kg/m^2	10 (16.4%)	18 (15.4%)	28 (15.7%)	
18.5 - 24.99 kg/m^2	45 (73.8%)	97 (82.9%)	142 (79.8%)	
≥ 25 kg/m^2	6 (9.8%)	2 (1.7%)	8 (4.5%)	
Mean ± SD	21.2 (± 1.94)	21.3 (± 2.5)	21.3 ± (2.1 kg/m^2)	0.913

***Table 6**: Anthropometric measurements of the respondents, 2016 (n = 178).*

Qualitative findings

In-depth information data was collected to support evidence from quantitative data and to gather information's about fish production, consumption practices focused group discussion. In addition, key informant interview was conducted to explore national and regional plans and status related to fish production activity, consumption and overall information about fishery in the region and the study area.

Focused Group Discussions

Fish availability and sources

According to the discussants the community residing nearby Dila town obtains fresh fish from the household ponds and market where as in Dara and Wensho districts, it's obtained from only from household ponds.

38 years Fish Producing (FP) woman said, "...we started producing fish, we had a chance to consume the fresh fish from our pond. However, we harvest the fish twice a year and we sometimes consume only during the harvesting time. We do not have access to material to harvest the fresh fish from the pond for own consumption. During the harvest time, the fresh fish is available for one or two days since the harvested fish is sold. There is no available fresh fish or canned fish in the local market".

Another 40 years old None-Fish Producing(NFP) woman added saying, "…there is no available fresh or canned fish in the market however, some of our neighbors started producing a fish at least some of us had a chance to consume a fresh fish in a year but this is a rare".

Contribution of household pond fish production for the women's diet diversity and fish consumption

The Focused Group Discussion (FGD) discussants from fish producers were asked whether fish production using own pond has contributed to their dietary diversity, fish consumption and other nutritional benefits. They pointed out the following benefits for the women. The production has various benefits for the women and the whole members of the households. Since they started producing they harvest the fish twice a year. Additional income increased their purchasing power for other food groups for the households and women. Using the water from the ponds they started to grow different vegetables which indirectly increase consumption of other food groups.

Forty years FGD discussant said as, "…Since we started producing the fish our income has increased compared with when we were not producing. It helped us to fulfill my household need. In addition, I and other household member has been consuming the fresh fish. We started to plant vegetables nearby the pond using water from it".

Another 45 years old woman told as, "Previously, we have not been producing the fish in the community. Since we started the fish we did get more benefits from it. My children are consuming the fresh fish which is a vital for their health and optimal growth. Since there is extra income from the fish production I can afford foods and other commodities from the market".

The FGDs were asked whether they consume fish for nutritional benefits and medicinal values. Almost all discussants said that fish has different health benefits. Consuming fish makes the body strong since it is a protein rich. In the fish fillet there is different vitamin and minerals which in turn has a role to prevent illness. Fish is consumed as a raw fillet or making a soup by adding onion, oil, salt and chili. The soup which is made from the fish has a medicinal value according to the participants.

35 years old woman from FP said as, "…the fish from our pond has benefited us. We are feeding our children since it is a good source protein and make our children good cognitive skill; we prepare a soup from the fish and we use to treat a person with a cough. Once the person drunk a soup immediately relieves from the illness".

Additionally, 30 years old FP woman stressed as, "Fish soup can be used treat the typhoid fever, common cold and dry cough".

Key informant interview

Information from the key informant was obtained from the Regional and District Livestock and Fishery Office and Hawassa Agricultural Research Center who are taking part in the aquaculture activities in the study area. The obtained information is summarized below.

Historical background, status and objectives of aquaculture in southern nation nationalities people region

According to the aquaculture expert of Dara, the aquaculture activities were initiated in 2002 E.C with one model farmer in the district. During the first time the fish pond was constructed on the model farmer with $10m^2$ on farm. 500 fingerlings of Nile tilapia fish from Hawassa fish production site was stocked in the pond. According to the regional fishery expert, different stakeholders like the south nation, nationalities and people region, Hawassa Agricultural research center, Hawassa University have been supporting the aquaculture activities in the study area. Currently, there are two established a research and fish breeding site in the region. These sites are at nearby Lake Hawassa and Lake Chamo at Arba-Minch. These sites have been providing a sustainable fish source for continuous research and for fish farmers in the lowland and mid lowland areas of the region. Currently, it is on the way to establish the breeding site at Arbegona district of Sidama zone for sustainable sources for the farmers of highland areas of the region.

As stated by the regional senior fishery expert; the aquaculture activities were initiated initially with the objectives of income generation for the households. Beside this, it was aimed to reduce protein energy malnutrition of women and children. "…the aquaculture activity in the region was initiated to increase the income of the producers and reduce protein energy malnutrition in the local farmers".

Opportunities and challenges for the community to produce a fish

The key informants are agreed as aquaculture activities are very essential for the community's food and nutrition security through increasing the income and consumption of the fish.

According to the regional senior fishery expert, the region has the potential to produce fish. "The region has a huge natural water bodies and manmade (aquaculture) for fish production. The community's initiation for fish production in their own farm is increasing. Again, the government has given a special attention for livestock and fishery sector". The expert has also added the most challenges, "… however, the potentials of the region, technology inputs like the feeds and awareness of fishery benefits for the household food and nutrition security are the main challenge in current producing District's (i.e. Dara, Wensho and Dila Zuria) of the region". The Dara district aquaculture expert told as, "The district has a potential of aquaculture. However, still there are a deficit of handling materials for market and unavailability of credit to the farmers for construction of ponds is the crucial challenges".

The key informants raised fish consumption factors in the study areas. Unavailability of the fish in the market, Community awareness on fish consumption, Unavailability of fishing materials is the main factors of fish consumption of the women. Sustainable unavailability of fish and fish products in the market is the major problem of fish consumption. Almost all key informants believe this is the major factor. The regional senior fishery expert said as, "…however, increased demands of fish consumption, the aquaculture activities are at infancy stage. There is no more produced and available fish in the market. This has imposed a huge problem for the consumption".

Community awareness about the fish benefit is very low. The producing farmers tend to sell rather consuming at home. The Dara district aquaculture expert said as, "The community's awareness is currently very low with regards to fish consumption, cooking method and overall nutritional benefits". The fish expert from Wensho district said, "Now, a number of farmers in the district started producing a fish. Nevertheless, the community's awareness about the nutritional and overall benefit is still not sound". Farmers have started to produce a fish, nevertheless, materials for collecting a fish from the pond is another major problem. All key informants agreed with this issue that there are no available materials for fishing. The producing farmers harvest twice a year. They do not avail for themselves at home.

Discussions

The study revealed that respondents from fish producing households were more likely to consume fish frequently than none producing households. The present study is supported by the study done in Kenyan at coastal households revealing fishing households consumed more fish than non-fishing households [7]. Similarly, study done in Malawi showed frequency of fresh fish and dried fish consumption is higher in households with fish ponds [8]. Another study done by Zachary Stepan [9] in Nepal also found significantly greater percentage of mothers and children with fish ponds consumed carp species and tilapia compared to mothers and children without fish ponds. This can be explained that fish production using own pond does have a positive impact on women fish consumption through availing fresh fish in

the household. However, the study done by Nora [10] in Kenya which examines the potentials of fish farming for the livelihood of farmers found contradicting finding with the current study. After starting aquaculture, fish from the own ponds were rarely used for home consumption in the study. A possible explanation for this disagreement could be that fish produced in the present study was used for home consumption and as well as for the market.

In the current study, the overall mean women dietary diversity score was 4.57 which is comparable with the study result done in Ethiopian demographic and health survey which is 4.03 [11] and it is higher than the study conducted in Aksum, northern Ethiopia which was 3.4 [12]. With regards to the contribution of household pond fish production, the current study revealed that mean women dietary diversity score in the fish producing household was higher than non-producing household women. This could be explained that producing fish using household ponds has a positive effect on dietary diversity of the women. A study by Kawarazuka [13] reported that fish can be sold for cash income to purchasing sufficient staple foods, and can also be used for consumption or purchase of non-staple foods which directly improve dietary intake beyond energy intake. In addition, a study done in Kenya by Nora [10] documented that overall diet diversity increased for all farmers since starting aquaculture.

There was no statistical difference in mean BMI of the reproductive women between fish producing households and non-producing households. Most nutrition sensitive aquaculture interventions didn't document significant impact of aquaculture on nutritional status in Ethiopia. However, the current study is supported by the study done in Malawi which states that there was no association in fish consumption and malnutrition [14]. Another study done to identify the association between pond fish production and nutritional status of the children by Zachary A Stepan [9] in Nepal also supports the current result which states no significant difference was found between children whose families had ponds and those whose families did not have ponds for any category of stunted, underweight. This can be elucidated as producing fish using ponds in the study area was not linked to the nutritional status of the reproductive women rather than availing for the market as an income generation to purchase for other food group rather home consumption. It seems to be also difficult to see nutritional outcomes in short term activity focusing on aquaculture alone without addressing other factors which determine nutritional status [13].

According to the qualitative information obtained both from focused group discussion and key informant interview, the current study shows that availability of the fresh fish in the market was the main abstaining factors for the fish consumption in the area, however, pond fish production has contributed to the fish consumption the pond fish producers. This finding is supported by study done by Alemu and his colleagues [15] conducted in Tigray, Ethiopia which states fishing activities has contributed to fish consumption. On the other hand, the demand for the pond fish production is increasing in the study area, however, community awareness on fish consumption, financial constraints, shortage of technology for fishing and preservation are the main factors for fish production and consumption. Again these factors were addressed by the same study which states lack of demand for the fish products, Shortage of technology for preservation, financial constraints to buy the technologies and lack of skills.

Conclusions

Our finding shows that household pond fish production was associated with better fish consumption and dietary diversity. There was no statistical mean difference between household pond fish producing and none producing in terms of nutritional status of women. A demand for fish production using ponds is increasing among the community members. We recommend further longitudinal studies covering wider area and seasonal variations related to association between household pond fish production and nutritional status of woman since causal relationship is not easily identified using cross sectional study.

Conflict of Interests

"The authors declare that they have no competing interests".

Ethics Approval and Consent to Participate

Ethics approval was obtained from the "Institutional Review Board (IRB) of Hawassa University, College of Medicine and Health Science" before starting the study. All participants agreed to participate voluntarily in the study and signed a consent form after receiving explanation about the objectives and the process of the study. Data collection was anonymous and confidentiality and privacy were respected.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Authors' Contributions

DT conceived of the study, participated in its design, acquisition of data, analysis and interpretation of data, and drafted the manuscript. GZ, KZ and MD participated in the design of the study, acquisition of data and helped to draft the manuscript. FR participated in the design of the study, performed the statistical analysis, helped to draft the manuscript and given final approval of the version to be published. TK participated in the design of the study, helped to draft the manuscript and revised it.

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