

Article

Socioeconomic Drivers of Fish Consumption in Qatar

Sana Abusin *, Brian W. Mandikiana , Noor Al Emadi and Fahad Al-Boinin

The Social and Economic Survey Research Institute (SESRI), Qatar University, Doha P.O. Box 2713, Qatar

* Correspondence: sabusin@qu.edu.qa

Abstract: The demand and supply gap in local fish production provides opportunities for investment in fish production and processing that are non-artisanal. Accordingly, this paper uses the Qatar Semi-Annual Survey, a nationally representative repeated cross-sectional dataset, to analyze consumers' willingness to consume processed fish and the consumption intensity. Given the ordinal nature of the main outcome variable, namely processed fish consumption intensity, we use the ordered probit model with sample selection. The first part of our analytical strategy helps us to examine determinants of processed fish consumption, while the second part establishes factors associated with processed fish consumption intensity. The findings suggest that the majority of the respondents have a low interest in consuming processed fish. Nonetheless, we find that demographic and socioeconomic factors influence the intensity of consuming processed fish in Qatar. Specifically, consuming processed fish sometimes or very often is positively associated with age, living in a household with no children, and labor force participation. In comparison, Qatari households, tertiary education, and living in a middle-income household are factors that are likely to reduce consuming processed fish sometimes or very often. Our findings have important implications for investment in processed fish in Qatar. Specifically, the results help in targeting different consumer segments given a better understanding of factors associated with processed fish and fishery product consumption and the intensity of consumption among consumers in Qatar. The insights drawn from this study are a fundamental precondition for advancing the processed fish and fishery product industry in Qatar, an industry with the potential to generate by-products with benefits, such as energy and animal feed, prolonging fish and fishery product shelf life and convenience for consumers. Moreover, other countries in the region are likely to benefit from the insights drawn from this study.

Keywords: consumption; econometrics; fish; processed fish; Qatar; sample selection; sustainability



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1. Introduction

Measures to ensure sustainable food production and consumption are now a major concern. Fish and fishery products are a well-known rich source of protein and omega-3 fatty acid [1]. Accordingly, the demand for fish and fish products is experiencing an upward trajectory. The Food and Agricultural Organization (FAO) [2] estimates that global fish and fishery product consumption over the past three decades rose approximately 122%. Moreover, FAO [2] estimates that in 2018, global seafood production was over 170 million metric tons, with human consumption reaching over 20 million tons. Given the average annual fish and fishery product consumption of approximately 20 kg per capita, sustainable fishery management is critical [2].

Several factors influence fish and fishery product consumption. Moreover, factors affecting fresh fish consumption and the consumption of processed fish and fishery products tends to vary. However, if no attention is drawn to safeguarding fishery resources, the livelihoods of households dependent on the fishery industry will be negatively affected. In addition, consumers will lose a local supply of a rich source of nutrients [3]. Recent developments in fishery research suggest that technological advancements in fish and fishery product processing present an opportunity for the industry to benefit in many ways

from the by-products normally discarded [3]. The most prominent ones are biogas and protein supplement production. Moreover, fish processing extends the shelf life as well as the range of food product selection for consumers. Literature suggests that the most used methods of fish preservation are chilling, super-chilling and freezing [4]. Freezing fish and fishery products after the catch stage is an essential method for minimizing biochemical and microbiological reactions. In areas with hot climatic conditions inability to meet optimal temperatures required for freezing fish and fishery products is a threat to fish quality [5]. Thus, to have the best fish and fishery products, short-term cold storage at temperature lower than $-30\text{ }^{\circ}\text{C}$ is among the most important recommended method [6].

Addressing issues concerning fish and fishery product consumption is important for the state of Qatar because like other high-income countries, high purchasing power is likely to influence consumer tastes and preferences. Specifically, the demand for highly nutritious foods such as fresh fish has grown in Qatar. For instance, FAO [7] observed that consuming seafood in Qatar increased to 24.5 kg per capita annually, which is above the global average for seafood consumption. Furthermore, Qatar is experiencing population growth, which is a major contributor to the demand for fish and fishery products. Accordingly, fish and fishery product processing can help curb stock depletion because it helps reduce fish spoilage and in turn lessen overfishing. Moreover, depending on the level of processing, approximately 20 to 80% in fish waste could be produced which could be utilized as fish sauce, fishmeal and fish silage [8].

Realizing the untapped potential in fish and fishery product processing requires a better understanding of fish consumption in general and the demand for processed fish and fishery products. Consequently, this paper aims to:

- Explore the determinants of fish consumption in Qatar,
- Determine the factors associated with consuming processed fish and fishery products in Qatar,
- Provide useful information for policy makers, fishery managers and investors that will help them make the correct decisions.

2. Context

2.1. Food Security and Sustainable Fishery Management (SFM)

The United Nations Sustainable Development Goals (SDGs) 2030 rank food security as one of the top agendas. Nevertheless, supporting food security is interlinked with other sustainable development goals. For instance, responsible food consumption and food production 12.3, is associated with climate change initiative 13, which is clearly linked with SDG number 14, which emphasizes the importance of sustainable fishery management (SFM). In line with the sustainable development goals, the state of Qatar's National Development Strategy highlights the importance of the fishery sector to support the demands of the economy [9]. Providing services and advanced technology to fisheries and fish ports are some of the developments included in the strategy. In addition, the state of Qatar is aiming to raise its food self-sufficiency, a goal that requires a lot of effort [10,11]. Some of the efforts include increasing local production for local perishable food including fish and limiting food waste [9]. Recently, researchers and scientists have been focused on establishing flexible food production techniques and on consumers' food preferences to address production and consumption in ways that limit food waste.

2.2. Determinants of Fish Consumption

Previous studies show that sociodemographic factors influence the demand for fish and fishery products. For example, Nicheva et al. [12] observes that there is a disproportionately high number of males in the European Union fishery sector. Given the fact that fish spoilage is of high concern, participants in the sector are more likely to consume a portion of their catch to avoid fish spoilage. Consequently, there is a high likelihood that middle age and older men with low to medium levels of education consume fish and fishery products the most. Historical evidence highlights that, in Qatar, the older

generations depended on the sea for income and livelihoods [13]. Additionally, fish and fishery product consumption was a major part of their diet because the environment was not well suited to agriculture and animal husbandry. The discovery of fossil fuels, however, has improved Qatar's economic position. Previous studies show that high income per capita is related to a broader range of tastes and preferences [14]. Accordingly, researchers in the field of economics and marketing use such information to evaluate the influence of sociodemographic factors in evaluating the success of marketing campaigns as well as public health policy.

2.3. Hypothesis

Hypothesis 1. *There is a relationship between demographic and socioeconomic variables such as; age, gender, income, household size, education and fish consumption and processed fish consumption frequency.*

Hypothesis 2. *There are unobservable factors associated with fish and fishery product consumption and the frequency of consuming processed fish and fishery products among fish consumers in Qatar.*

Hypothesis 3. *The information provided in this study will help all stakeholders in the agri-business sector such as fisheries, food industry and policy makers, especially for policies related to economic diversity and sustainability.*

3. Materials and Methods

3.1. Estimation Strategy

Collecting self-reported data on frequency of consuming various products is well established in the literature. Researchers in the field of economics and marketing use such information to evaluate the influence of sociodemographic factors in evaluating the success of marketing campaigns as well as public health policy. The estimation strategy for the determinants of processed fish consumption and the intensity of consuming processed fish includes socioeconomic variables such as, age, gender, income, education and marital status as well as attitudes and perceptions towards fish and fishery products.

The purpose of this study is to examine determinants of self-reported processed fish consumption frequency. In this analysis, the outcome variable of interest is the respondents' ranking for the questions; "did you consume fish?", and "how often do you consume processed fish products?". Using Stata software for Statistics and Data Science rank the three response categories of interest. We then recoded the original set of responses based on exploratory data analysis. Furthermore, following Boes and Winkelmann [15], to avoid the problem of small cells because of the high incidence of non-processed fish consumers, we aggregated very often, sometimes into one category. Thus, to facilitate a better understanding of how demographic and socioeconomic factors affect self-reported processed fish consumption and associated consumption intensity, we used the ordered probit model with sample selection estimation strategy [16–18]. In practice, Heij et al. [17] and Boes and Winkelmann [15] showed that we can present the ordinal probit model as a latent variable model. In other words, the choices people make are underpinned on a set of unobservable perceptions which we can represent as a structural model of the form.

$$y_i^* = x_i' \beta + \varepsilon_{1i}, E[\varepsilon_{1i}] = 0. \quad (1)$$

where y is the unobserved choice of the processed fish consumption frequency category, with a range of choices ordered on a continuum from 1 to 3, x is a vector of measurable factors or explanatory variables, β is a vector of the observed outcome of y_i and is linked to the index function y_i^* by means of $(m - 1)$ unknown cut or threshold values $\tau_1 < \tau_2 < \dots < \tau_{m-1}$ in the sense that

$$y_i = \begin{cases} 1 & \Rightarrow & \text{never} & \text{if } \tau_0 = -\infty \leq y_i^* < \tau_1 \\ 2 & \Rightarrow & \text{rarely} & \text{if } \tau_1 \leq y_i^* < \tau_2 \\ 3 & \Rightarrow & \text{always/sometimes} & \text{if } \tau_2 \leq y_i^* < \tau_3 = \infty \end{cases} \quad (2)$$

The index y_i^* is not observed, and the measured response is $y_i = j$ if the index lies between the cut or threshold values τ_{j-1} and τ_j . Unknown parameters to be estimated include β s and the $(m - 1)$ threshold values. Heij et al. [17] showed that dropping constants from explanatory variables enables threshold parameters to be identified.

Given that Φ represents the cumulative distribution function of ε_{1i} , it follows that:

$$p_{ij} = P[y_i = j] = P[\tau_{j-1} < y_i^* \leq \tau_j] = P[y_i^* \leq \tau_j] - P[y_i^* \leq \tau_{j-1}] \\ = \Phi(\tau_j - x_i'\beta) - \Phi(\tau_{j-1} - x_i'\beta), j = 1, \dots, m. \quad (3)$$

Using the notation $\tau_0 = -\infty$ and $\tau_m = \infty$ results in $P[y_i = 1] = \Phi(\tau_1 - x_i'\beta)$ and $P[y_i = m] = 1 - \Phi(\tau_{m-1} - x_i'\beta)$. Additionally, the resulting log-likelihood function that facilitates estimation of parameters for the ordered probit model can be specified as follows:

$$LL = \sum_{i=1}^N 1[y_i = 1] \ln [\Phi(\tau_1 - x_i'\beta)] + 1[y_i = 2] \ln [\Phi(\tau_2 - x_i'\beta) - \Phi(\tau_1 - x_i'\beta)] + 1[y_i = 3] \ln [1 - \Phi(\tau_2 - x_i'\beta)] \quad (4)$$

Moreover, the calculation of average marginal effects or partial effects of changes in the explanatory variables is performed using the following equation:

$$\frac{\partial P[y_i = j]}{\partial x_i} = (f(\tau_{j-1} - x_i'\beta) - f(\tau_j - x_i'\beta))\beta \quad (5)$$

where f is the density function of the disturbance term ε_{1i} .

Given the general practice in estimation of categorical dependent variables, the coefficient vector β is thought to be constant across all categories j . Alternatively, an increase in the value of an independent variable is presumed to cause a shift in the cumulated distribution function (cdf) either to the left or to the right while the slope of the distribution remains fixed. Given that we can only observe the processed fish consumption frequency if the respondents consume fish in general, it is important to understand the different states of respondents in the sample.

Normal ordered probit or logit is a very popular method to analyze frequency of fish consumption and is used by many studies [19–23]. Cantillo et al. [24] extends the traditional model to use a heteroscedastic ordered probit model estimated by maximum likelihood estimation (MLE) and provides one of the basic extensions of the traditional ordered probit models that have been previously used in the context of fish consumption. In our paper, we extend the previous models to an ordered probit model with sample selection.

3.2. Measures to Account for Potential Sample Selection Bias

The underpinning measure of the conceptual framework used to correct for the potential sample selection bias can be illustrated as shown in Figure 1 below. Specifically, in the first stage, a respondent can be either a fish consumer or a non-consumer (5). Then only respondents who consume fish in general provide answers regarding their consumption of various forms of processed fish products. As a result, we found that there is a group of valid non-responses (4) because we do not observe the consumption frequency of non-fish consumers. Furthermore, for fish consumers, we group their responses into three ordinal response categories: very often and sometimes, rarely, and never.

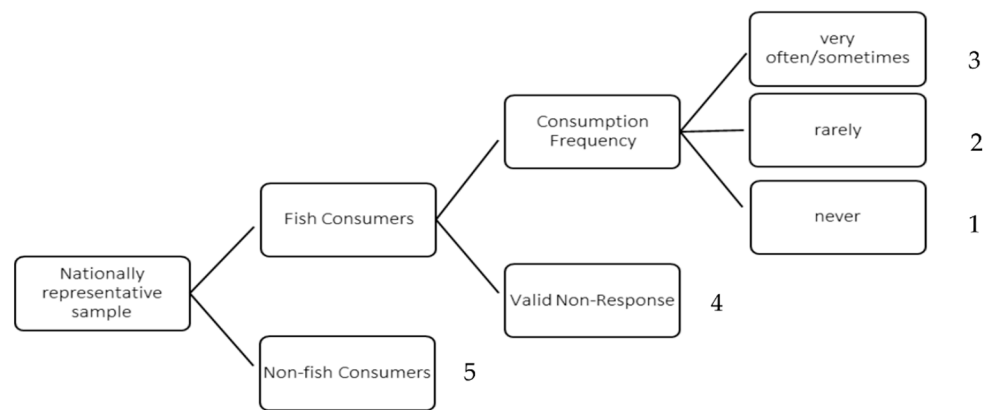


Figure 1. Fish consumption states.

Given the conceptual model above, we hypothesize that there are unobservable variables that increase the likelihood of consuming fish and our outcome of interest, that is, processed fish consumption frequency. While it is possible to observe education level, gender, income, nationality and age, it is impossible to observe consumer tastes and preferences that influence consumption and in turn consumption frequency. Consequently, any partial correlation between the included explanatory variables and the unobserved variable may lead to biased coefficient estimates. Heckman [25] proposed a two-stage econometric strategy that aims to address sample selection bias. De Luca and Perotti [26] adapt the Heckman two-stage sample selection strategy to make a selection correction for the ordered probit model as follows:

$$s_j = 1(\omega_j\gamma + \varepsilon_{2i} > 0) \tag{6}$$

where $s_j = 1$ in the scenario that we observe the ordinal outcome variable y_i and 0, otherwise, ω_j is the vector of explanatory variables for the selection stage, γ is the vector of coefficients for the selection stage, and ε_{2i} is a random error term. Consequently, $(\varepsilon_{1i}, \varepsilon_{2i})$ have a bivariate normal distribution with a zero mean and variance matrix shown below

$$\begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}$$

where ρ is the correlation coefficient.

The log-likelihood (LL) for the simultaneous observation of the selection and outcome equations can be specified as shown below.

$$LL = \sum_{j \neq S} \ln [\Phi(-\omega_j\gamma)] + \sum_{h=1}^H \sum_{\substack{j \in S \\ y_j = v_h}} \ln \{ \Phi_2(\omega_j\gamma, k_h - x'_i\beta, -\rho) - \Phi_2(\omega_j\gamma, k_{h-1} - x'_i\beta, -\rho) \} \tag{7}$$

Using Bayes rule

$$P(y_i = \tau_m | s_j = 1) = \frac{P(y_i = \tau_m, s_j = 1)}{P(s_j = 1)} \tag{8}$$

We derive the average marginal effect conditional on selection as shown above.

3.3. Field Work and Data Collection

In this study, we use the 15th Qatar Semi-Annual Survey (QSAS) gathered in May 2020. The Social and Economic Survey Research Institute (SESRI) at Qatar University fields the QSAS survey to gather nationally representative data on key issues in the Qatari context. Nevertheless, we mainly focus on the Fish Consumption Module data and Sociodemographic Module for modelling purposes. The 15th round of the QSAS survey focused on

Qataris and white-collar expatriates. Prior to fielding the main survey, SESRI conducted a pre-test Computer Assisted Telephone Interview (CATI) survey and gathered data from 51 respondents. Insights from the pre-test were used to inform revisions made to the survey instrument and data quality control. Moreover, the study was approved based on the Institutional Review Board in Qatar University under the project identification code QU-IRB 264-E_13.

The questionnaire collected information on the demographic characteristics (e.g., education, gender, employment, age, nationality, income, etc.) of individuals, followed by different questions in the fishery sector, such as if respondents consume fish and fish products, frequency of buying processed fish, the reasons fish get spoiled, types of processed fish (fish ball, samosa and sausage), frequency of consuming processed fish, if fish is good for health, if the fish price affects the consumption preferences of respondents, where they buy fish and the type of fish they consume (fresh, canned, frozen and salted) and the method of preparation interesting to eat.

3.3.1. Description of the Sample

A total of 1549 complete survey responses were gathered. The sample used for analysis is based on two filter questions that focus on households' fish consumption. In the Qatar Semi-Annual Survey general fish consumption is measured using the statement: "Do you eat fish and other fishery products?" The respondents gave a binary response, that is, "yes" or "no". Respondents with missing data on this dummy variable were dropped from the analysis. The follow-up question asked respondents "How often do you buy processed fish, such as fish snacks?" In addition, we exclude respondents with missing data on this ordinal outcome variable from the analysis. Furthermore, we use Stata software for data science and statistics for additional data management and analysis operations. Lastly, the clean version of the data was weighted to take into account the probability sampling survey design. In particular, we adjusted for probability of selection and non-response. Out of the 1549, we excluded observations with missing data. Accordingly, the first stage of the model, that is, the selection process, includes 1421 participants. Furthermore, Stage 2 of the model, that is, the ordered probit with sample selection, includes 1249 respondents who indicated that they are fish and fishery product consumers.

3.3.2. Dependent Variable

The outcome variable in this study is the self-reported processed fish and fishery products consumption frequency. The descriptive statistics of household level and self-reported fish consumption frequency for Qataris and non-Qataris are shown in Table 1.

Table 1. Descriptive statistics for dependent variable.

Self-Reported Processed Fish Consumption Frequency Category	Groups	
	Qataris	Non-Qataris
	Observations	Observations
3 = Very Often/Sometimes	95 (18.80%)	159 (20.81%)
2 = Rarely	148 (29.84%)	224 (30.07%)
1 = Never	251 (51.36%)	372 (49.12%)
Total	494	755

Consumption frequency. The dependent variable of interest is processed fish consumption frequency. In the Qatar Semi-Annual Survey, processed fish consumption frequency is measured using the statement: "How often do you buy fish snacks?" Respondents with missing data on this dummy variable were dropped from the analysis.

Fish Consumption. An additional dependent variable of interest is the binary outcome for general fish consumption. In the Qatar Semi-Annual Survey, general fish consumption is measured using the statement: "Do you eat fish and other fishery products?" The

respondents gave a binary response, that is, “yes” or “no”. Respondents with missing data on this dummy variable were dropped from the analysis.

3.3.3. Independent and Control Variables

The empirical specification for this study specifies a number of control variables. These include age (agecon), gender (female = 0, male = 1), whether the respondent has education equivalent or above a university degree or higher (eductert = 1, otherwise = 0), marital status (marstt = 1, otherwise = 0) and a binary variable indicating the household’s fish price affordability.

4. Econometric Results

Chi-square test revealed that there was association between fish consumption and self-reported processed fish and fishery product consumption frequency in sample households: Pearson $\chi^2(2) = 3.15$; $Pr = 0.0762$. The chi-square test suggests the ordered probit model with sample selection is preferred to the ordered probit model ($p = 0.00$). Thus the discussion below focuses on the results from the ordered probit model with sample selection estimation but will conclude with a brief description of the findings observed using this model compared to the ordered probit alternative.

Table 2 presents several insights that enable us to better understand the relationship between the outcome variables and the explanatory variables in the model. The results suggest that males are more likely to consume fish compared to females. Moreover, we note that gender is not significantly different from zero at the 5% level in the fish and fishery product consumption component of the model but significant at the 1% level in the processed fish consumption component. The marginal effects suggest that men are 5.49% more likely to consume fish and fishery products compared to women. Interestingly, we observe a statistically significant relationship between processed fish and fishery product consumption and age. The results suggest that consuming processed fish and fishery products very often or sometimes is associated with a 1.21% decrease as consumer age increases by one year. Nevertheless, the age squared term suggests that there is a trend reversal as consumers get much older. Both explanatory variables for age are statistically significantly different from zero at the 5% level. We also observed that having an additional child in the household is associated with a 1.11% lower likelihood of consuming processed fish and fishery products very often or sometimes. In line with a priori expectations, respondents who consider fish to be affordable have a 6.10% higher chance of consuming processed fish and fishery products very often or sometimes. Overall, our findings are consistent with public health literature, which highlight the importance of consuming high quality proteins and fats that are found in fish and fishery products.

Table 2. Coefficients of ordered probit model with sample selection.

Variable	Coeff	Robust S.E.	z	p-Values
Processed fish consumption				
If gender is male	0.16710 **	0.0802145	2.08	0.037
Age as continuous var.	−0.03681 ***	0.0129749	−2.84	0.005
agesq100 “squared”	0.0316 **	0.0157762	2.01	0.045
Marital status	−0.12802	0.0911601	−1.40	0.160
No Kids	−0.03392 *	0.0195267	−1.74	0.082
Nationality “Qataris”	0.05322	0.0808667	0.66	0.510
Eductert	0.1032	0.0753449	1.37	0.171
hh income1	0.05727	0.082517	0.69	0.488
hh income2	0.06242	0.0865547	0.72	0.471
Fish affordability	0.18557 ***	0.0592718	3.13	0.002

Table 2. Cont.

Variable	Coeff	Robust S.E.	z	p-Values
Processed fish consumption intensity				
Male	0.07823	0.1225922	0.64	0.523
Agecon	0.01423 **	0.0059051	2.41	0.016
Marstt	0.13331	0.1290355	1.03	0.302
Nkids	0.07918 **	0.0328267	2.41	0.016
Qatari	−0.29648 ***	0.1025794	−2.89	0.004
Eductert	−0.20365 *	0.1143164	−1.78	0.075
hhincad1	−0.06951	0.1158728	−0.60	0.549
hhincad2	−0.21438 *	0.123501	−1.74	0.083
Work	0.25133 ***	0.0963027	2.61	0.009
_cons	0.53528	0.1971053	2.72	0.007
/cut1	−0.90835	0.2724506	−3.33	0.001
/cut2	−0.17781	0.2794597	−0.64	0.525
/athrho	−1.569	0.8847289	−1.77	0.076
Rho	−0.91687	0.1409789		
Wald test of indep. eqns. (rho = 0):			Chi ² (1) =	3.15
			Prob > chi ² =	0.0762

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

To identify precisely the determinants of fish consumption, the marginal effect of the previous model is calculated for outcome 3 (Very Often/Sometimes). The results of the marginal effect are presented in Table 3 below.

Table 3. Marginal effects of ordered probit model with sample selection for outcome 3.

Variables in the Model	dy/dx	Delta-Method S.E.	Z	p-Values
Male	0.05489 **	0.0257723	2.13	0.033
Agecon	−0.0120925 ***	0.0042745	−2.83	0.005
agesq100	0.0104003 **	0.0051964	2.00	0.045
Marstt	−0.0420532	0.0299069	−1.41	0.160
Nkids	−0.0111436 *	0.0064539	−1.73	0.084
Qatari	0.0174814	0.0265423	0.66	0.510
Eductert	0.0339198	0.0246646	1.38	0.169
hhincad1	0.0188131	0.0271081	0.69	0.488
hhincad2	0.0205036	0.0284839	0.72	0.472
Fishaff	0.0609569 ***	0.0195082	3.12	0.002
Work	0	(omitted)		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The marginal effects calculation shows good and significant results that are presented in Table 4. Results show that the frequency of consumption of processed fish increased if the consumer is a male and processed fish is affordable and decreased with more children per household and among elders in the state of Qatar.

There is a positive association between age and fish consumption. The marginal effects suggest that a one-year increase in age is associated with a 2.51% increase in the likelihood of consuming fish at the 5% level of statistical significance. In addition, the results show that there is a positive relationship between the number of children in the household and fish consumption. The marginal effects indicate that having one more child in the household is associated with a 1.40% increase in the likelihood of consuming fish. Interestingly, while we expected nationality to be positively associated with fish consumption, the association between the variables was negative instead. The results suggest that Qatari households are 5.24% less likely to consume fish at the 1% level of statistical significance compared to expatriates. Surprisingly, given the location of the State of Qatar, our a priori expectation was that fish and fishery products are easily accessible to

the locals, and fish consumption should be more biased towards them. Moreover, the results suggest that tertiary education is negatively associated with fish consumption. Specifically, participants with a university degree or higher are 3.60% less likely to consume fish at the 10% level of statistical significance. The negative association is surprising given that fish is a good source of omega-3, a nutrient associated with improving brain functioning. In line with a priori expectations, middle income earners are less likely to consume fish compared to the reference group, that is, high income households. Additionally, employment is associated with fish consumption. Specifically, having a job is positively associated with a 4.45% chance of consuming fish at the 1% level of statistical significance.

Table 4. Marginal effects of fish consumption intensity with sample selection.

	dy/dx	Delta-Method Std. Err.	Z	p-Values
male	0.0138377	0.0216836	0.64	0.523
agecon	0.0025179 **	0.0010332	2.44	0.015
agesq100	0	(omitted)		
marstt	0.0235784	0.0228636	1.03	0.302
nkids	0.0140056 **	0.005878	2.38	0.017
qatari	−0.0524376 ***	0.0174948	−3.00	0.003
eductert	−0.0360188 *	0.0201362	−1.79	0.074
hhincad1	−0.0122953	0.0205527	−0.60	0.55
hhincad2	−0.0379179 *	0.0220588	−1.72	0.086
fishaff	0	(omitted)		
work	0.0444517 ***	0.0170962	2.60	0.009

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

5. Discussion of Results

Based on the findings, overall our estimation strategy improves inference compared to the ordered probit model. The application of the ordered probit model with sample selection presents strong evidence that there is an association between consumption of fish and fishery products and demographic and socioeconomic factors. In addition, our findings are consistent with the notion that fish and fishery products are a significant component of healthy diets. There is a non-linear association and statistically significant association between age and consumption of processed fish and fishery products (FAPs). Not surprisingly, we find that processed fish consumption intensity increases with age. Our results are consistent with Can et al. [27] who observed similar results in which age groups had significant differences in fish consumption; they reported that younger respondents would consume fish more than the older ones. Yet, Verbeke, and Vackier [28] in their study showed that increasing age positively influences fish consumption.

Other determinants of fish and fishery products are related to the number of children in the household, high income and high level of education. This finding corroborates Zhou et al. [29] who found that having teenagers would increase fish consumption, owing to its health benefits in children. However, the Verbeke and Vackier [28] study showed that the presence of children lowers the rate of fish consumption. Results also show that consumers with a household size of three persons or more are more likely to consume FAPs more frequently. The same result was also found by Islam et al. [30], Myrland et al. [19] and Yousuf et al. [31]. Our results also show that there is a higher frequency of FAPs consumption with more children per household.

Moreover, we observe that perceptions concerning affordability of processed fish and fishery products are positively associated with moderate to high levels of processed fish and fishery product consumption. Our findings are plausible given results in previous studies [12,32].

Given that understanding patterns in fish and fishery product consumption is integral to the subsequent investment in the fish and fishery product processing industry, our suggestion is that significant investment in this industry can facilitate its untapped potential to

support sustainability. Although consumer tastes and preferences are biased towards fresh fish and fishery product consumption, previous studies show that the by-products from fish and fishery product consumption are essential inputs in renewable energy production. However, Qatari and low income discouraged fish consumption.

In line with the government's economic diversification initiatives, provision of incentives to investment in fish processing could contribute positively to sustainable economic development. Moreover, other complementary investments for the fish and fishery product processing industry should include improving logistics infrastructure as a strategy to limit fish spoilage along the value chain, investment in training facilities and skills development and limiting overfishing. For instance, non-artisanal production techniques such as aquaponics as well as fish farming can increase production and help reduce the supply gap. Keeping in mind the national targets of sustainable agricultural expansion, investing in fish processing also generates by-products that are also useful inputs beyond fish farming, such as crop production, gelatin manufacturing and poultry production. Above all, our findings and associated policy recommendations can contribute to sustainable management of fishery resources as well as an avenue to achieve Qatar's food self-sufficiency targets.

6. Conclusions

This study evaluates the factors associated with processed fish and fishery product consumption and the intensity of consumption among fish consumers in Qatar. The fish processing industry has the potential to improve sustainability. Across the globe, many governments are strategizing ways to meet their sustainable development commitments. The findings of this study can help policymakers improve their understanding of factors associated with processed fish and fishery product consumption and the intensity of consumption among fish consumers in Qatar. The insights drawn from this study are a fundamental precondition for advancing the processed fish and fishery product industry in Qatar. Moreover, other countries in the region are likely to benefit from the insights drawn from this study.

Our theoretical and analytical frameworks propose and test the argument that there are unobservable factors associated with fish and fishery product consumption and the intensity of consuming processed fish and fishery products among fish consumers in Qatar. Accordingly, we applied the ordered probit model with sample selection to account for the unobservable consumer tastes and preferences that are associated with the sample selection process.

The results suggest that factors that promote consumption of processed fish in Qatar include being male, labor force participation and having positive perceptions concerning fish affordability. In contrast, the evidence suggests that living in a household with no children decreases processed fish consumption. Furthermore, the findings suggest that there is a non-linear association between processed fish consumption and age. In line with our a priori expectations, we find that demographic and socioeconomic factors influence the intensity of consuming processed fish in Qatar. Specifically, consuming processed fish sometimes or very often is associated with age, living in a household with no children, and labor force participation. In comparison, Qatari households, tertiary education, and living in a middle-income household are factors that are likely to reduce consuming processed fish sometimes or very often.

Lack of publications in the public domain concerning sustainable fishery management in Qatar limit the sources cited. In addition, to the best of our knowledge, this is the first empirical attempt which we hope to be a source for future studies in Qatar.

The evaluation of Qatar's fish and fishery product market could benefit from more research. Future research may include the role of technology in the treatment of fish waste, evaluation of the by-products market, assessment of the fish production supply chain and evaluation of the national quality and safety system. Additionally, fish species conservation studies could contribute towards safeguarding the fish supply. Overall, the above efforts

help support the goals of achieving economic diversity and the long-term sustainability of fish markets in Qatar.

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Abbreviations

SESRI	Social and Economic Survey Research Institute
QSAS	Qatar Semi-Annual Survey
CATI	Computer Assisted Telephone Interview
NDS	The second National Development Strategy
QNFSS	Qatar National Food Security Strategy
FQS	Food Quality and Safety
FAO	Food and Agriculture Organization
MME	Ministry of Municipality and Environment
MPH	Ministry of Public Health

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