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Examining the socio-economic characteristics, fishing patterns and challenges of fishermen at James Town in Ghana

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ABSTRACT

This study examined the socio-economic characteristics, fishing patterns and challenges of fishers in Ghana using James Town as the study location. A semi-structured questionnaire was used to obtain information on demographic and socio-economic characteristics, Fishing patterns and characteristics, dynamics of expenditure and catch, Dynamics of distance to fishing grounds/area, catch and selling strategy/mode and practices, investment and financing of fishing activities as well as challenges of fishing from respondents. Data was analyzed using descriptive statistics as well as endogenous switching regression model (ESRM) using Stata version 17. The results shows that 4.0 ± 1.07 people are engaged in onshore activities for an average of 9.45 ± 2.19 h. Also, fishers averagely spend 3.09 ± 1.49 days at sea. Respondents who have not accessed loan over the last 12 months are 78 whilst 23 have accessed same. Similarly, 86 out of 101 respondents representing 85.14% have not insured their operations. Also, no transparency in distribution of pre-mix, high cost of equipment, high cost of premix and dumping of waste in the sea by foreign vessels are the major problems faced by fishers. The results also showed that boat size, repairs and maintenances of boats, household size, boat age and position of respondents on boat (captain or otherwise) are the factors that can likely determine the volume of fish catch among fishermen. The study therefore, concluded that socio-economic characteristics and fishing patterns of fishes are highly variable.

1. Introduction

Demand for sustainable production of foods that are nutritious and rich in protein has increased sharply due to increase in world population (Gephart et al., 2021; Stedt et al., 2022). Globally, fisheries and aquaculture production sectors are significant contributors to food and nutritional security (Hicks et al., 2019; Warren & Steenbergen, 2021) through its supply of rich protein which are highly demanded worldwide. In addition, fisheries and aquaculture are major income generation, livelihood and employment sources for fisher folks (Ameyaw et al., 2021).

Furthermore, poverty reduction, enhanced livelihood, and food security are important roles of fisheries and aquaculture sectors in developing countries (Tran et al., 2021). According to a report by WorldFish (2020), over 90% of fishers and allied workers in the capture

fisheries are employed in the small-scale industry. The fisheries' resources contribute significantly to ensuring food sufficiency in many countries globally. The fisheries sector plays a significant role in the national economies of countries in Sub-Saharan Africa and constitutes the main livelihood for a majority of people living along the coasts and in riparian areas. Also, because small-scale fisheries require low initial (investment) capital as a result of the utilization of manual and labour-intensive harvesting practices as well as serving as a major source of food security for communities along coastal areas, it is considered an important sector (Moreno-Báez et al., 2010; Garcia-Rodriguez & Sosa-Nishizaki, 2020).

Recently, the marine sub-sector of Ghana's fisheries sector has seen a decrease in production from about 420,000 metric tons in 1999 to about 314,053 metric tons in 2017. Similarly, small pelagic species which are very important as it contributes to food security has seen a sharp

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decrease in terms of commercial landings from 250,000 metric tons in 1996 to 44,180 metric tons in 2014 (Lazar et al., 2017, p. 28). This is an indication that small pelagic fishes in Ghana’s marine waters might be overfished.

Fisheries resources are threatened by over-exploitation, habitat degradation, pollution, invasive species, parasites and diseases and more recently, the increasing variability and change in climate (Brander, 2010).

To sustainably harness fisheries resources, there is the need to employ proper fishing practices. Aikins (2018), documented that fishing sustainably could not be considered as an option for the sustainable development of Ghana but a major/integral part of the measures being put in place to ensure food and nutrition security.

The southern coastal communities in Ghana, of which James Town is not an exception are largely reliant on the fishing industry. James Town which is located on latitude 5.5335 and longitude -0.21357 is the home to about 4154 people (Ocloo, 2015). Most of these inhabitants largely rely on fishing for their livelihood. Thus, the aim of this study is to identify the practices employed by fishermen as well as identify the challenges they face at James Town.

2. Methodology

2.1. Study area and data collection

Primary data was collected and used for this study. The data was collected through the administration of questionnaires to 101 artisanal fishermen at James Town located in the Greater Accra Region of Ghana (Fig. 1). The aim of this study was to examine the socio-economic characteristics, fishing practices as well as challenges faced by fishermen in Ghana using James Town as a case study. Relevant data on socio-economic characteristics, fishing pattern activities, income and institutional characteristics were collected from respondents. The questionnaires were administered from February 1 to March 30, 2022.

2.2. Sampling and ethical consent

Respondents were selected using random sampling. In order to avoid interference from other informants, fishers were individually interviewed. Prior to the interview, fishermen were made aware the objectives of the study. Fishermen were given the option to be part of the study or otherwise. Fishermen were informed of possibility of policy makers using the information gathered from the survey for the development of management plans. Consent of the fishermen were obtained verbally prior to the interview.

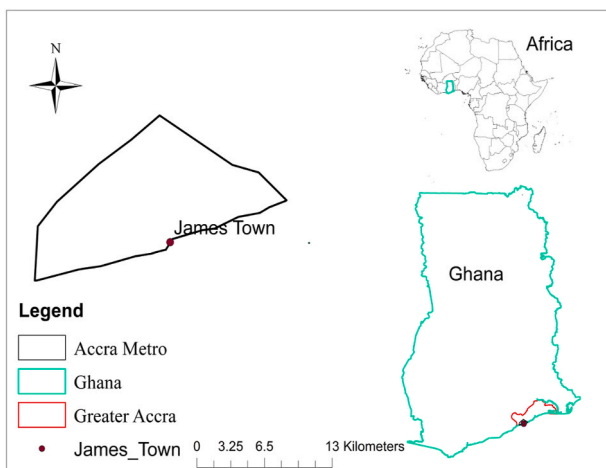


Fig. 1. A map of study area.

2.3. Data analysis

The data was analyzed using descriptive statistics to help get a better understanding of socio-economic characteristics, fishing practices as well as challenges faced by fishermen while the endogenous switching regression model (ESRM) (Lokshin and Sajaia, 2004) was used to analyze the determinants of the volume of fish catch among fishers. Stata version 17 was used for the analysis.

2.4. Analytical framework

Landing high volume of fish catch is an endogenous variable since it is not independently determined. This is because it suffers from issues of self-selection bias. This selection is more likely to be grounded on the selectors expected gains or utility of landing high volume, which is positive for high volume and negative or zero for low volume. Thus, analytical technique, which control for self-selection is required to cater for self-selection.

There are numerous econometric techniques to control self-selection, notable among them is Heckman model, Propensity Score Matching (PSM), inverse probability weighted regression adjustment (IPWRA), and endogenous switching regression model (ESRM) (Morgan and Winship, 2015). This study favoured the ESRM because of its outstanding benefits (1) it accounts for selection bias informed by observed and unobserved variation between control and treatment groups; (2) it provides more information by estimating both a selection equation and two outcome equations for the treatment and control groups; (3) it estimates average treatment effect on the treated (ATT) of landing high volume of fish catch on the value of fish catch (Li et al., 2020).

The ESRM is a two-step estimation approach. In the first stage, a probit model is estimated with a binary dependent variable which shows whether a fisher land high volume or low volume with factors influencing high volume of catch as the independent variables.

$$I_i^* = \alpha K_i + \mathcal{E}_i \text{ with } I_i^* = \begin{cases} 1 & \text{if } I_i^* > 0 \\ 0 & \text{if otherwise} \end{cases} \quad (1)$$

Where I_i is 1 for all fishers who expect that they would benefit from high volume of catch in fishing, α is the parameter to be estimated, \mathcal{E}_i is the error term, whereas K is a vector that includes variables that affects high volume of catch decision of fishers (Di Falco et al., 2011). The selection equation also includes a selection instrument that influences the fisher’s decision to land high volume of fish catch but not the value of fish catch (Khonje, 2015). The instrument could be validated by a falsification test. They must be jointly statistically significant in the selection equation but insignificant in the outcome equation.

The second stage is the outcome equation. High volume of fish catch also influences the value of fish catch. Stage two involves specification of two linear regressions, one for fishers who catch high volumes and the other for low volume of catch. Thus, the outcome equations can be specified as.

$$V_1 = \gamma_1 X_1 + u_1 \text{ if } I_i = 1 \quad (2a)$$

$$V_0 = \gamma_0 X_0 + u_0 \text{ if } I_i = 0 \quad (2b)$$

where V_1 and V_0 are the estimated value of fish catch scores for fishers who land high volumes and fishers who land low volumes respectively, and X_0 , X_1 are $n \times k$ matrices of covariates, and γ_0, γ_1 are parameters to be estimated and are the $n \times 1$ vectors of normally distributed error terms with a zero mean and non-zero covariance matrix.

$$\Omega = \begin{bmatrix} \sigma_{\mathcal{E}}^2 & \sigma_1 & \sigma_0 \\ \sigma_1 & \sigma_1^2 & \cdot \\ \sigma_0 & \cdot & \sigma_0^2 \end{bmatrix}$$

Where σ_ε^2 is the error term in the σ_0^2 selection equation, and σ_1^2, σ_0^2 are the error variances of the outcome equations (2a) and (2b) is a covariance of and is the covariance of. The covariance between σ_0 and σ_1 is undefined, as such are never observed simultaneously. We assumed that is estimated only up to a scalar factor. The model is identified by construction through non-linearities.

2.5. Conditional expectation and average treatment effects (heterogeneity effects)

The ESRM can be applied to compare the value of fish catch of fishers that land high volume in fishing as against those who land low volumes. It can also be used to compare the expected value of catch that is fishers value of catch in the counterfactual hypothetical cases that the high-volume fishers and the low volume fishers. The conditional expectation of the outcome variables in the four mentioned scenario are specified below.

Observed for high volumes of catch in fishing

$$E(V_1|I_i = 1) = \gamma_1 X_i + \sigma_{u_{1\varepsilon}} \lambda_{1i} \tag{3}$$

Observed for low volumes of catch in fishing

$$E(V_0|I_i = 0) = \gamma_0 X_i + \sigma_{u_{0\varepsilon}} \lambda_{0i} \tag{4}$$

Counterfactual for high volumes of catch in fishing

$$E(V_0|I_i = 1) = \gamma_1 X_i + \sigma_{u_{0\varepsilon}} \lambda_{1i} \tag{5}$$

Counterfactual for low volumes of catch in fishing

$$E(V_1|I_i = 0) = \gamma_0 X_i + \sigma_{u_{1\varepsilon}} \lambda_{2i} \tag{6}$$

To obtain the average treatment effect on the treated, that is those who land high volume of fish catch, we examined the actual observation of fishers who land high volume of fish catch against the counterfactual if the same group had landed low volume of fish catch in fishing.

ATT measures the effect on the value of fish catch of a fisher due to his/her high volume of fish catch. It is the gains a fisher makes if a fisher land high volume of fish catch in fishing. This can be specified as.

$$ATT = E(V_1|I_i = 1) - E(V_1 = 0) = X_i(\gamma_1 - \gamma_0) + \sigma_{u_{1\varepsilon}}(\lambda_{1i} - \lambda_{0i}) \tag{7}$$

In a similar vein, an average treatment effect on the untreated can be estimated by comparing the observed low volume of fish catch in fishing as against the counterfactual, that is if the fishers who land low volume of fish catch, had landed high volume of fish catch in fishing.

$$ATT = E(V_0|I_i = 1) - E(V_0 = 0) = X_i(\gamma_1 - \gamma_0) + \sigma_{u_{0\varepsilon}}(\lambda_{1i} - \lambda_{0i}) \tag{8}$$

3. Results and discussion

3.1. Demographic characteristics

The demographic characteristics of respondents are shown in Table 1. All respondents (101) were males. Out of 101 respondents, 24 representing 23.77%, were single whilst 67, representing 66.33%, were married. Also, 9 respondents representing 8.91% were divorced whilst 1 representing 0.99% was widowed. This suggests that a higher proportion of fishers in the James Town community were males, which is consistent with studies by Ayisi (2015) and Aminu (2017) that found men predominate in the fishery sub-sector. The lack of female engagement in such off-shore fishing operations may be due to the inherent risk involved. It implied that fishing in the research area’s water bodies was energy-draining. Since 67% of the respondents were married, those who are most likely to be married will offer the least expensive labor because their families will be able to provide it.

Fifty (50) respondents representing 49.50% had no formal education. Respondents with primary, JHS, and SHS education were 37 (36.64%), 9 (8.91%) and, 5 (4.95%), respectively. Respondents aged

Table 1 Demographic characteristics of respondents.

Category	Frequency (N = 120)	Percentage (%)
Gender		
Male	101	100
Female	0	0.00
Marital status		
Single	24	23.77
Married	67	66.33
Divorced	9	8.91
Widowed	1	0.99
Education		
No formal education	50	49.50
Primary	37	36.64
JHS	9	8.91
SHS	5	4.95
Tertiary	0	0.00
Age categories		
20–30	15	14.85
31–40	28	27.73
41–50	35	34.65
51–60	18	17.82
61–70	5	4.95
71 and above	0	0.00
Years of fishing experience		
Less than 5 years	15	14.85
5–10	32	31.68
11–15	30	29.70
Above 15 years	24	23.77
Household size		
1–5	46	45.54
6–10	43	42.58
11–15	5	4.95
16–20	5	4.95
20+	2	1.98
Number of people fishing in household		
1	26	25.74
2	27	26.73
3	38	37.62
4	9	8.91
5	1	0.99
Member of fishing association		
Yes	22	21.78
No	79	78.22

between 20 and 30 were 15 representing 14.85% whilst respondents aged between 31 and 40 was 28 representing 27.73%. Respondents in the age brackets of 41 and 50, 51 and 60 as well as 61 and 70 were 35 (34.65%), 18 (17.82%), and 5 (4.95%), respectively.

This suggests that the respondents had a fair level of education, which would have a good impact on their ability to take advantage of latent opportunities in the fishing industry and help them adopt new technology which supports the findings of Aminu et al. (2017). This result contradicted claims by Olaoye et al. (2022) that a higher proportion of fishermen were ignorant, as well as the widespread belief that the majority of fishermen are illiterate or semi-illiterate and have mostly left the educational system.

In terms of experience, 15 respondents representing 14.85% has less than 5 years experience in fishing whiles, 32 respondents representing 31.68% had experience between 5 and 10 years. Also 30 representing 29.70% and 24 respondents representing 23.77% had experience between 11 and 15 years and above 15 years respectively.

Whereas 79 respondents representing 78.22% does not belong to fishing associations, 22 respondents representing 21.78% belong to fishing associations.

This implies that respondents had considerable years of fishing experience in the study area. This is substantiated by the findings of Aminu et al. (2017), who noted that the amount of profit earned by artisanal fishermen depends on their level of fishing experience; the more experience they have, the better they grasp the market, conditions, trends, and prices. According to Agbekpomu et al. (2016), experience lowers management risk.

3.2. Fishing patterns and characteristics

Fishing pattern and characteristics of fishermen at the study area is shown in Table 2. On the average, fishermen spend 3.09 ± 1.49 days at sea per trip with a minimum of 1 day and maximum of 6 days. The number of vessels, boats or canoes owned by fishermen is 1.10 ± 0.82 with a minimum and a maximum of 1 and 5, respectively.

Number of people engaged in onshore activities ranged between 2 and 10 with an average of 4.0 ± 1.07 people. Fishermen on the average work for 9.45 ± 2.19 h/day onshore. The minimum number of hours fishermen work on shore is 5hrs whilst the maximum is 15hrs.

The extended fishing period may be a result of the need to keep the trap safe from poachers. The increased hours are another indication of the declining fish stock. Fishermen report a poor catch as well as a recent reduction in size, which is in line with the earlier work of Agbekpomu et al. (2016). The number of crew members aboard fishing vessels may be responsible for their typical length.

The minimum length of vessel used by fishermen at the study area is 12 feet with the maximum length being 22 ft with an average length of 18.82 ± 1.84 ft.

Vessels/boats at James Town have been used for an average duration of 6.18 ± 3.27 years. The number of years the vessels/boats have been used range between 1 year (minimum) and 15 years (maximum).

3.3. Dynamics of income and expenditure

Dynamics of catch, income, and expenditure of fishermen are shown in table Fig. 2(a and b). Fishermen made investment in fuel, food, ice, and water per fishing cycle. On the average, GH¢ 189.3 ± 105.3 (min: 100; max: 700) and GH¢ 50.59 ± 18.81 (min: 10; max: 200) were spent on fuel and food, respectively whilst GH¢ 14.57 ± 11.90 (min: 0; max: 100) and GH¢ 13.16 ± 3.20 (min: 3; max: 18) were spent on ice and water respectively (Fig. 2a).

Due to the high cost of fuel and the declining catch, this may indicate that the majority of their revenue is spent on food and fuel. Because fishing requires a lot of energy, fishers must also spend a lot of money on food in order to do their daily fishing activities which supports the findings of Ikeogu et al. (2022) who observed much revenue spent on fuel and food by fishers in the Anambra state.

The average cost of a vessel is GH¢ 8734 ± 1325 (min: GH¢ 1200; maximum: GH¢ 12000) is whilst the amount spent on repairs and maintenance on yearly basis is GH¢ 410.1 ± 150.3 (min: GH¢ 150; maximum: GH¢ 700). Outboard motor is purchased at an average cost of 268.91 ± 42.21 (min: GH¢ 150; maximum: GH¢ 350) (Fig. 2b).

3.4. Dynamics of distance to fishing grounds/area, catch and selling strategy/mode and practices

Fig. 3 a-e shows the dynamics of distance to fishing grounds/area, catch and selling strategy/mode and practices. Fifty (50) respondents sell their catch to fish processors whilst 23, 14, 6, and 8 respondents sell

Table 2

Mean \pm SD, minimum and maximum measures of fishing pattern and characteristics at James Town.

Characteristics	Mean + SD	Minimum	Maximum
Number of days spent at sea	3.09 ± 1.49	1	6
Number of people engaged in onshore activities	4.0 ± 1.07	2	10
Number of vessels/boat/canoes owned	1.10 ± 0.82	1	5
Working hours onshore per day	9.45 ± 2.19	5	15
Length of vessel (ft)	18.82 ± 1.84	12	22
Age of Vessel (years)	6.18 ± 3.27	1	15
Horse power of vessel engine	26.16 ± 12.49	15	40

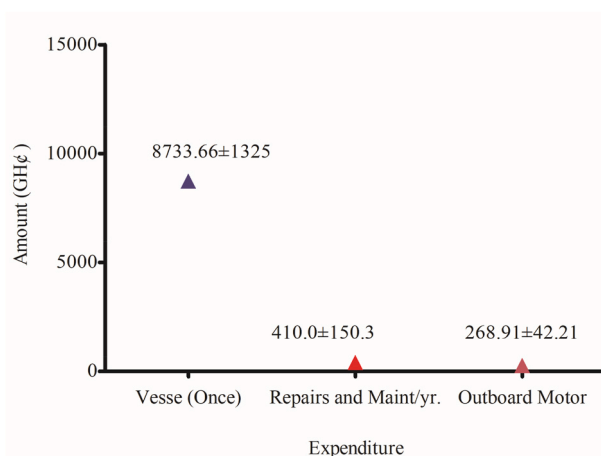
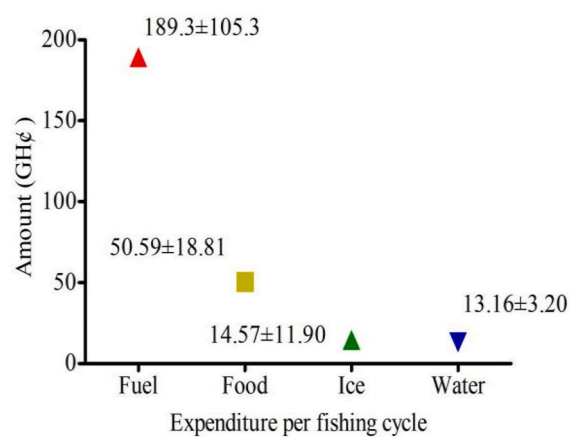


Fig. 2. Expenditure of fishermen per fishing cycle at James Town. (a) Fuel, food, ice and water (b) cost of vessel, repairs and maintenance and outboard motor.

to final consumers, restaurants, retailers and wholesalers, respectively (Fig. 3a). Fig. 3b shows the dynamics of catch over the last 12 months. Respondents who reported catch to be the same were 43 whilst those that reported increase and decrease were 26 and 32 respectively. Majority of the fishers (77) preserve their catch with ice whilst 15 and 9 preserve their catch either by covering with net or use of pelagic freezer (Fig. 3c).

The study observed that fishers go to fishing with ice to prevent spoilage and increase profit from their catches due to the increase in fuel prices and longer hours of fishing. After landing of fish, the fishers either call their clients to arrange a purchase or they wait further for clients to arrive. Fish is sold to processors, wholesalers, retailers and other consumers. Women involved either handle their catches or sell them directly this agrees with the findings of Aminu et al. (2017).

Catch was reported to be abundant in October–December by 47 respondents whilst 23 reported catch to be abundant in July–September. Twenty-One (21) respondents reported catch to be abundant during April–June with Ten (10) reporting catch to be abundant during January–March (Fig. 3d).

Fifteen (15) respondents representing 14.85% catch <100 kg of fish every cycle of fishing whilst 41 respondents representing 40.60% catch between 100 kg and 199 kg. Also, 42 and 3 respondents representing 41.58% and 2.97% catch 200–299 kg and >300 kg of fish respectively (Fig. 3e).

3.5. Investments and financing of fishing and insurance

Dynamics of investments, financing of fishing and insurance are shown in Fig. 4(a and b). In the last 12 months, 93 respondents

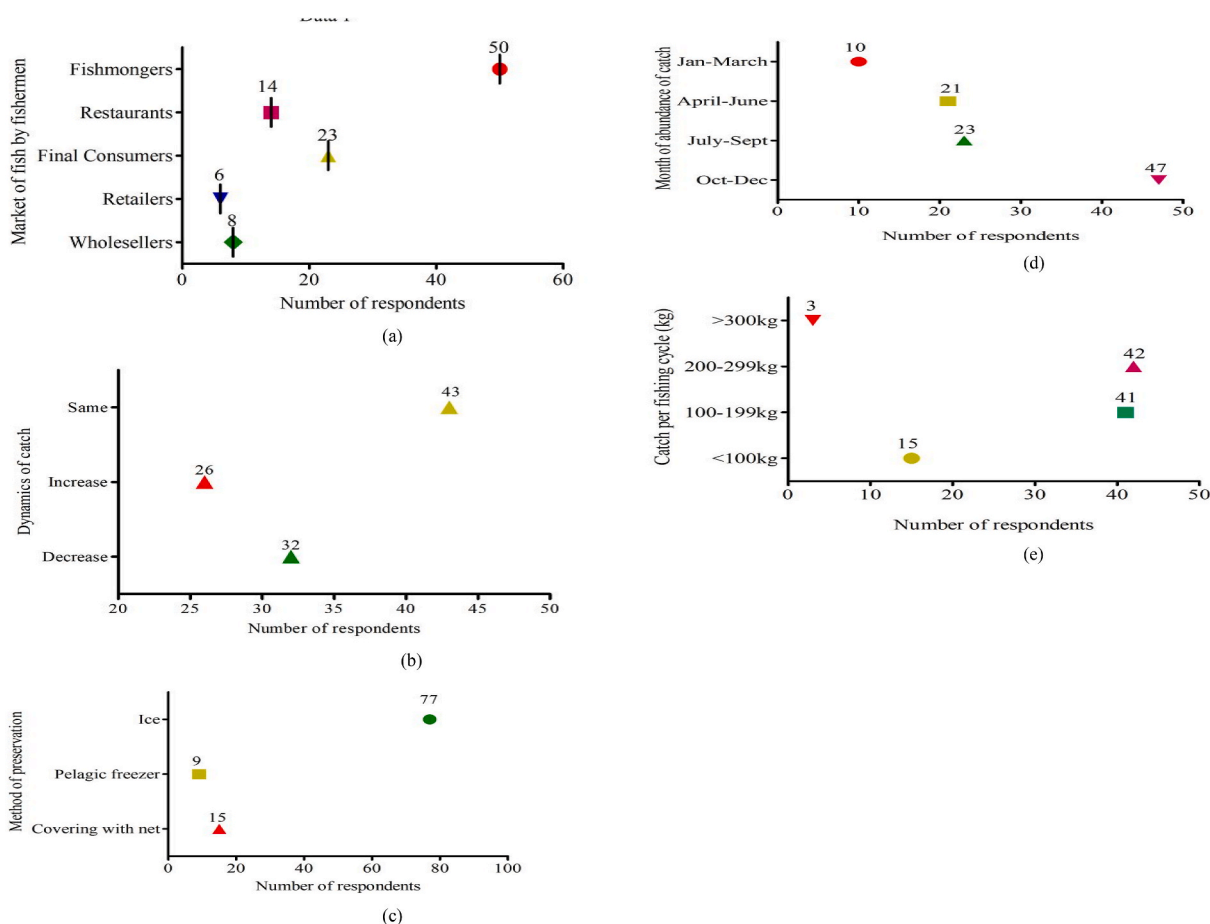


Fig. 3. Market of fish by fishermen (a), Dynamics of fish catch (b), Methods of preservation (c), Months of abundance of catch (d) and Catch per fishing cycle (e) of fishermen at James Town.

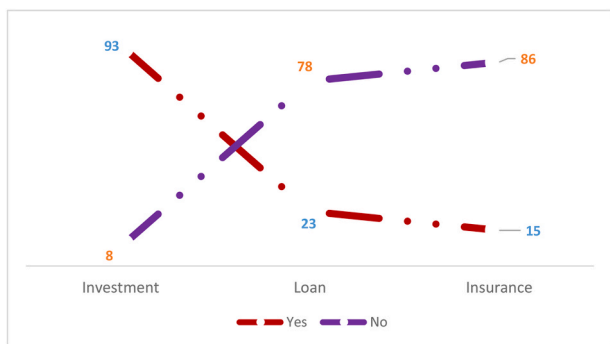


Fig. 4a. Dynamics of investments, loan acquisition and insurance.

representing 92.08% have invested in the form of either boat or vessel purchase, outboard motor or nets and other equipment whilst 8 respondents representing 7.92% have not made any investments during same period (Fig. 4a). Seventy-five (75) representing 81% out of the 93 respondents invested in the fishing business through self-financing whilst 12 and 6 representing 13% and 6% respectively invested through loans and family help respectively (Fig. 4b).

Whereas 23 respondents representing 22.54% have acquired loan over the last 12 months, 78 respondents representing 59.46% have not accessed loans within the same period (Fig. 4a). Majority of the respondents (86) representing 85.15% have no insurance whilst 15 respondents representing 14.85% have insurance (Fig. 4a).

According to the study’s findings, the majority of fishers obtain their

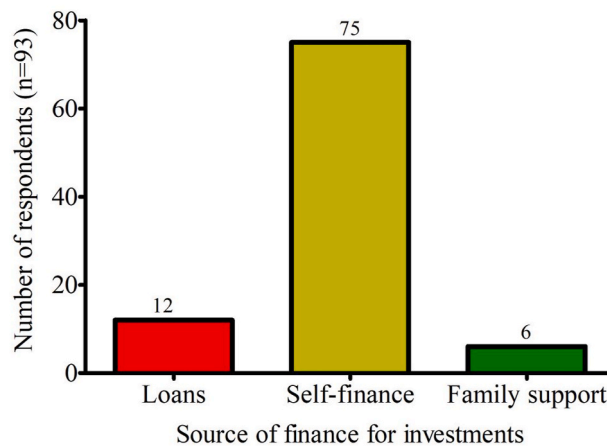


Fig. 4b. Sources of finance for investments by fishermen at James Town.

financial resources from personal savings, 13% from cooperatives, and 6% from friends and family. This suggests that just 13% and 6% of fishers were members of cooperative associations, which has an impact on their capacity to access loans agreeing to the earlier findings of Aminu et al. (2017).

3.6. Challenges

Four main challenges were reported by the respondents (Fig. 5). These are high cost of fishing equipment, high cost of premix fuel, no

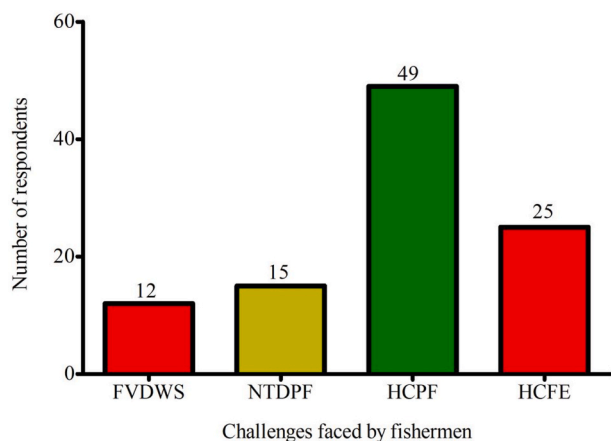


Fig. 5. Challenges faced by fishermen at James. Note: FVDWS: Foreign vessels dumping waste in the sea; NTDPF: No transparency in distribution of pre-mix fuel; HCPF: High cost of pre-mix fuel; HCFE: High cost fishing equipments.

transparency in distribution of pre-mix fuel as well as foreign vessels dumping waste in the sea. Twelve (12) representing 11.88% of the respondents prioritized foreign vessels dumping waste in the sea as the pressing challenge whilst fifteen (15) representing 18.84% of the respondents prioritized no transparency in distribution of pre-mix fuel as the pressing challenge. Forty-nine (49) respondents representing 48.51% mentioned high cost of pre-mix fuel as the major challenge whilst twenty-five (25) representing 24.75% mentioned high cost of equipments as the major challenge.

The interviews also revealed that the low number of youth as fishers were caused by the high cost of premix fuel. Because the cost of pre-mix fuel has increased and is occasionally unavailable for purchase, fishers are no longer able to fish as regularly as they once did. This high cost of pre-mix fuel has forced some fishers out of fishing and drained the profits of those still fishing. Freduah et al. (2017) noted fishers complained that fishing has become ‘a hand-to-mouth’ livelihood activity rather than a profit making one. This poses a significant obstacle to fisheries’ ability to generate money, help the poor escape poverty, and act as a welfare system for the really poor.

3.7. Determinants of the volume of fish catch among Fishers at James Town, Ghana

The results presented in Table 3 Column 3 represent the determinants of the volume of fish catch. From the results, household size, boat size, age of boat use, crew size, repairs and maintenance, insurance and the position on boat were the key factors influencing the volumes of fish catch among the sampled respondents in the study area.

The positive and significant coefficient for household size implies a positive relationship between household size and volumes of fish catch. Thus, an increase in household size will increase the probability of the household landing high volume of fish catch as against low volumes of catch. This finding make sense because bigger household size could mean higher responsibilities which may trigger fishers to put more efforts to land high volumes to generate enough revenue to meet the basic needs of their families. Again, the members could contribute to meeting the labour demand of fishing since fishing is labour demanding. This result is consistent with those of Inoni and Oyaide (2007) who reported household size to be important in explaining the level of fish catch among fishers.

Also, boat size according to the analysis has negative impact on the volumes of fish catch and this was significant at 5 percent. This implies that all else equal, an increase in boat size will decrease the probability of landing high volumes of fish catch. This does not meet prior expectations because it is expected that bigger boats will have wider coverage

Table 3
Determinants of the volume of fish catch among fishermen at James Town, Ghana.

VARIABLES	(1)	(2)	(3)
	Value per catch_1	Value per catch_0	Volume of Catch
household size	17.17** (7.389)	-0.679 (24.94)	1.281*** (0.405)
Boat size	-2.592* (1.409)	3.312 (3.002)	0.141** (0.0695)
Age	-0.373 (0.230)	0.429 (0.301)	-0.000975 (0.0121)
Boat age	1.332* (0.744)	0.952 (1.921)	0.103*** (0.0394)
Number of days spent at sea	2.461 (2.448)	2.941 (5.397)	-0.187 (0.131)
Crew size	-1.063 (2.485)	-6.365 (5.034)	0.529** (0.257)
Working hours on shore	-0.902 (1.347)	-0.0832 (1.569)	0.000110 (0.0939)
Repairs and Maintenance	0.0615*** (0.0182)	-0.0325 (0.0319)	0.00199** (0.000941)
Insurance	-4.463 (6.725)	-13.02 (19.94)	-1.008*** (0.379)
Position on Boat (captain or otherwise)	11.27* (6.464)	15.21 (18.54)	0.979*** (0.336)
Married	3.061 (6.423)	-0.720 (9.707)	0.404 (0.315)
Vessel working capacity (no. people working)			-0.414 (0.325)
lnFishing experience (in years)			0.0265 (0.234)
Constant	43.15 (34.84)	-0.603 (95.71)	-6.394*** (1.790)
lns1			3.007*** (0.0961)
lns2			2.735*** (0.134)
r1			5.683*** (1.952)
r ²			-0.0538 (1.826)
Observations	101	101	101

Standard errors in parentheses.

***p < 0.01, **p < 0.05, *p < 0.1.

and by extension increases the chances of landing good catch. But it’s understandable given that the size of the boat significantly influences the speed and operations of the boat. Again, bigger boats are likely to carry large crew and inefficiency/diminishing returns may set in which by implication can limit fish catch.

Again, the coefficient of boat age was positive and significant to fish catch. Implying the older the boat the higher the probability of catching high volumes of fish. Boat age has implications on the fitness and smooth operation of the boat. Older boats are likely to have weaker engines as compared to new ones. Again, the technology attachment of boats differ according to the age. Thus, older boats may affect the speed, and travelling capacity of the boat and by extension the quantity of fish catch. But the positive coefficient also make sense, because fishers ability and operational skill of a boat relates to how long they use the boat and therefore they may become more efficient with the operation of the boat with time, thus, the positive coefficient.

Crew size was found to be positively and significantly related to the volume of fish catch. This means that an increase in crew size will increase the probability of landing high volume of fish catch holding all other factors constant. This results in consistent with prior expectations and consistent with the finding of Almeida (2001)

Furtherance to the above, repairs and maintenance which assess whether fishers repair and maintain their boats or not was positive to fish catch and significant at 5 percent. This implies that fisher who repair and maintain their boats are more likely to catch high volumes of fish as

compared to their counterparts who do not, all else equal. This is consistent with prior expectations because repairs and maintenance contribute to the efficiency of the boat (carrying capacity, travelling distance and speed of the boat).

Additionally, insurance cover was found to be negative and significant at 1 percent. Implying that fishers who have insurance cover were less likely to land high volumes of fish catch. This contradicts prior expectations because fishers who have insurances cover would have extra financial burden in addition to the usual operational cost of fishing, thus, would be compelled to put more efforts to increase catch to meet these obligations. But the negative relationship also makes sense because the terms and conditions (time of fishing, number of people, speed etc.) attached to insurances may not allow fishers to operate like the regular fisher will do and this could have implications on the quantity of fish catch.

Finally, the position of the respondent on the boat also determines the quantity of fish catch. The positive coefficient for position on boat implies that being a captain increases the likelihood of the fishers catching high volume of fish. This conforms to prior postulations because captains are more likely to have good fishing experience, knowledge and skills of the weather patterns, better knowledge about the locations of fish, current and tides, bottom conditions and how to best catch fish. Thus, would be more likely to land high volumes of catch.

3.8. Determinants of the value of fish catch among Fishers at James Town, Ghana

The analysis of the effect of volumes of fish catches on the value of catch in Ghana Cedis is presented in column 2 and 3 of Table 3 above. The results of the likelihood ratio test for the independence of the three equations were significant at 1 percent level of significances, thus rejecting the null hypothesis that the three equations were jointly independent. Also, the correlation between volumes of fish catch and the value of fish catch “rho1 and rho2” was positive and negative respectively with only the correlation of high volume of catch been significant at 1 percent. The parameter for both high and low volume was positive and significant at 1 percent. Overall, the results imply both observed and unobserved factors determine the fish catch and the value of fish catch.

From the results, household size, boat size, boat age, repairs and maintenance and position on a boat were the key factors influencing the value of fish catch among fishers in the study area. Except for boat size, which was negative to the value of fish catch, the remaining four were positive to the value of fish catch for fishers who landed high volume of catch. It is worth noting that none of the factors were significant in influencing the value of catch for fishers who landed low catch. The positive coefficient of household size to the value of fish catch implies that an increase in household size will increase the value of fish catch. Fishers do not only fish for market but also for their household consumption. Thus, bigger household size will mean reduction in the number of fish available for market and by implication good/higher value for fish catch. Also, the negative coefficient for boat size implies that an increase in boat size contributes to reduction in the value of fish catch all else equal. This is understandable because boats are likely to have strong engine which will allow it to travel far and thereby increasing the chance of good catch. Again, bigger boats could also result in higher crew size which will help meet the labour needs as fishing is labour demanding and increase catch. Thus, the increase or good catch may result in excesses in the market and by extension justifying the negative sign for the coefficient of boat size.

Additionally, repairs and maintenance were positively and significantly related to the value of catch. This is contrary to expectations because fishers who repair and maintain their boats are likely to be highly efficient in operation without encountering faults during catch and therefore would be more likely to land high volume of catch which will translate to reduced value of catch. But the results is understandable

because fishers who do regular repairs and maintenance of their boats are likely to be big time fishers who have many market outlets and establishment as they could easily cart their fish to areas where they are most needed which will also give them good value. Again, high catch could also allow fishers to move their fish far markets where they can make good returns.

Finally, the position of the fisher on the boat was found to have positive impact on the value of fish catch. The results imply that being a captain on the boat increases the value of catch. Being a captain may afford a fisher the privilege to select bigger fish or those in high demand with good prices. Thus, could increase the fishers market value of catch.

3.9. Effect of volume of fish catch on the value of fish catch by Fishers at James Town, Ghana

As presented in Table 4 below, fishers who land high volume of catch cell “a” has a value of catch of 51.497 units. Similarly, fishers who land low volume of fish catch cell “b” has a value of catch of 61.89 units. Again, cell “c” presents the counterfactual for fishers who had high volume of catch given they had low volume in fishing, their value of catch would have been 63.035 units. Also, cell “d” illustrates the counterfactual for fishers who had low volume of catch if they had high volume of catch, they would have had a value of catch of 50.862 units. The results of the treatment effect estimated showed that the expected value of catch of fishers who had high volume of catch is lower as compared to those who had low volume of catch by -10.393 units (a-b). The treatment effect is that if those who had high volume of catch, had low volume of catch, the counterfactual situation of those who had high volume of catch would have gained a value of catch of 11.538 units (a-c) which is statistically significant at 1 percent. This implies that had the fisher who had high volume, had low volume he/she would have gained a value of catch of 18.30 percent. Similarly, if the fishers who had low volume of catch, had high volume of catch, thus the counterfactual situation, the fisher who had low volume of catch, they would have lost a value of fish catch equivalent to 11.028 units which was significant at 1 percent level. This suggest that had the fisher who had low volume of fish catch, had high volume of catch, he/she would have lost a value of catch of 17.82 percent.

In totality, the negative transitional heterogeneity of -0.51 denotes that the impact of the volume of fish catch on the value of fish catch is significantly lower for fishers who land high volume of fish catch than those who land low volume of fish catch. This is in line with prior expectations because when high volumes of fish are landed, supply outweigh demand, thus, reducing the value of catch.

4. Conclusion

The findings revealed that 50.50% of the fishers have formal education. Also, it can be concluded that majority of the respondents (79) representing 78.22% do not belong to fishing associations. Again, it could be concluded that household size, boat size, boat age, repairs and maintenance of boats, as well as position of respondents on boat (captain or otherwise), to a large extent, affects or determines the volume of fish catch among fishers. The study also revealed that high cost of premix,

Table 4
Effect of volume of fish catch on the value of fish catch by fishermen at James Town, Ghana.

Variable	High volume	Low volume	Treatment	% Change	Heterogeneity effect
High volume (a)	51.497	63.035 (c)	-11.538***	18.30	
Low volume (d)	50.862	61.89(b)	-11.028***	17.82	-0.51***
Ha	0.635	1.145	-0.51		

***p < 0.01, **p < 0.05, *p < 0.1.

high cost of equipment, no transparency in distribution of pre-mix as well as dumping of waste in the sea by foreign vessels are the major problems faced by fishermen.

CRedit authorship contribution statement

Christian Larbi Ayisi: Conceptualization, Data Collection, Writing – original draft, Review of Manuscript. **Gifty Sienso:** Data analysis, Writing – original draft, Review of Manuscript. **Gertrude Dzifa**

Mensah: Data Collection, Review of Manuscript. **Kodjo N’souvi:** Design of Questionnaire, Review of Manuscript. **Kezia Baidoo:** Review of Manuscript. **Elliot Haruna Alhassan:** Resources, Review of Manuscript. **Samuel Ayeh Osei:** Data Collection, Review of Manuscript.

Declaration of competing interest

The Authors Declare no Conflict of interest.

Appendix 1. Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Household size	1.000												
(2) Boat length	0.127	1.000											
(3) Age	0.110	0.012	1.000										
(4) How long has vessel been used	-0.129	-0.289	-0.147	1.000									
(5) Number of days spent at sea	0.140	0.213	0.183	-0.035	1.000								
(6) Number of people in household fishing regularly	0.118	0.058	0.113	-0.097	0.486	1.000							
(7) Working hours onshore	0.036	0.188	0.126	-0.100	0.480	0.091	1.000						
(8) Repairs and maintenance	-0.095	0.024	0.085	0.058	-0.302	-0.079	-0.137	1.000					
(9) Insurance	0.257	0.156	0.013	-0.084	0.141	0.022	0.206	-0.008	1.000				
(10) Position on boat	0.106	0.251	0.102	-0.152	0.597	0.213	0.461	-0.429	0.174	1.000			
(11) Married	0.247	0.038	0.480	-0.210	0.047	0.242	0.072	0.229	0.003	-0.091	1.000		
(12) number of people engaged in fishing trip	0.047	0.081	-0.011	-0.100	0.424	0.803	0.234	0.088	0.042	0.115	0.225	1.000	
(13) Fishing experience	0.213	0.044	0.663	-0.133	0.179	0.104	0.204	0.031	0.017	0.276	0.243	-0.008	1.000

Appendix 2. Probit regression

Volume of Catch	Coef.	St.Err.	dy/dx	std.	[95% Conf Interval]	Sig	
Household size	1.39	.457	0.422	0.124	.494	2.286	***
Fishing experience	.127	.387	0.039	0.118	-.632	.886	
Married	.092	.353	0.028	0.107	-.6	.785	
Boat length	.149	.084	0.045	0.024	-.016	.314	*
Age	-.01	.018	-0.003	0.006	-.046	.026	
How long has vessel been used	.011	.045	0.003	0.014	-.076	.099	
Number of days spent at sea	-.028	.141	-0.009	0.043	-.304	.248	
Number of people working onshore	-.93	.462	-0.283	0.133	-1.835	-.025	**
Number of people engaged in fishing trip	.829	.427	0.252	0.123	-.007	1.665	*
Working hours onshore	.075	.08	0.023	0.024	-.083	.232	
Repairs and maintenance	.002	.001	0.001	0.000	0	.004	**
Insurance	-.712	.431	-0.216	0.127	-1.557	.133	*
Constant	-4.909	2.139	-2.29	.022	-9.102	-.716	**
Mean dependent variable		0.644	SD dependent var			0.481	
Pseudo r-squared		0.175	Number of obs			101	
Chi-square		18.968	Prob > chi2			0.089	
Akaike crit. (AIC)		134.543	Bayesian crit. (BIC)			168.539	

***p < 0.01, **p < 0.05, *p < 0.1.

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