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Empowering fisherwomen leaders helped reduce the effects of the COVID-19 pandemic on fishing communities: Insights from Brazil

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ABSTRACT

Small-scale fishers in the developing world have been particularly affected by the COVID-19 pandemic given that they belong to one of the most socioeconomically vulnerable groups. In Brazil, one of the countries most affected by the pandemic, it was expected early on that the economy and wellbeing of fishers would be negatively impacted, yet fishers were expected to show some adaptive and coping mechanisms. To assess whether this was the case, 40 fishers, who are also leaders of fishing associations representing over 80 thousand fishers throughout the country, were interviewed. Results revealed that female leaders appraised the economic and health/well-being impacts to be harsher on fishers than men did. Moreover, fishers on the coast were found to be better able to adapt than those inland, although both had low levels of adaptive capacity. The nature of coping and adaptive mechanisms was also found to be different between locations. Whereas leaders from coastal associations stated that most of the adaptive responses occurred in the post-harvest sector (e.g., changes to the types of sales and changes to supply chain actors), leaders from inland communities stated that the changes that occurred related specifically to fishing (e.g., decrease in effort and changes in fishing grounds). These findings suggest that: 1) women may be better prepared to respond to COVID-19 because their appraisal may be more realistic than men, 2) the historic vulnerability of fishing communities may limit their adaptative capacity, and 3) coastal fishers have likely found ways to maintain part of their trade, contrary to inland fishers. Thus, to better help small-scale fisheries to cope with this particular pandemic or other large disruptive impacts, it would be recommended to invest in women in leadership roles while also guaranteeing that fishers have the minimal conditions to cope with and adapt to impacts. The latter can be done by assuring emergency cash transfers for the duration of the impact, as with the still ongoing pandemic, and investing in building fisher resilience for future shocks.

1. Introduction

In early 2020, the entire world was taken aback by a new pandemic, which had not occurred in over a hundred years. The new CoronaVirus (SARS-CoV-2), which is responsible for the COVID-19 CoronaVirus Disease in humans (WHO 2020), spread democratically throughout the world, without sparing rich northern countries for a change. However, after a few months, it was clear that COVID-19 found much more fertile grounds in places where inequality thrives [1]. In places with more inequality, the poor are less likely to be able to afford basic hygiene supplies, to live in houses with proper ventilation or enough room to isolate the sick, and to have access to quality health systems [2,3]. Additionally, the poor are more likely to suffer from comorbidities and poor nutrition, which make them more prone to developing more serious cases of the disease [4]. They are also less likely to work from home, as many depend on informal economies or precarious jobs that limit their options to stay home even when it is highly advisable to do so [2]. Meanwhile, COVID-19 has also brought gender inequality to the forefront. Globally, women are still responsible for a heavier burden of household chores and care (child and other adults) than men, and the pandemic seems to have further accentuated this gender gap, especially in unequal countries [1]. Given that women tend to work in even more precarious jobs than men and are more likely to take on the responsibility of caring for the sick and homeschooling their children.

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while schools remain closed [5], they may not only be more socially and psychologically vulnerable, but also have a different appraisal of the pandemic as a whole.

Brazil is a case study for all matters COVID-19 related. The country has become a large-scale experiment on what can happen to the virus and to people when the former is allowed to roam freely, and people are forced to face it out of fear of not being able to make ends meet otherwise. For example, this contentious experiment with human lives has shown that herd immunity has not been achieved: infection rates in parts of the Brazilian Amazon surpassed the theoretical limits of herd immunity and, instead of the virus being kept under control, it evolved into a more deadly and transmissible strain [6]. Unsurprisingly, the poor have been paying the highest economic and health prices of the pandemic, and some socioeconomically vulnerable groups, such as fishing communities, have been hit especially hard. Fishing communities on the northeastern coast of Brazil, for example, where most coastal artisanal fishing communities are located, were caught off guard by the pandemic right after they had been hit by the worst oil disaster to ever take place in the southwestern Atlantic Ocean [7]. Although the impacts of this oil spill are yet to be fully evaluated, initial accounts have estimated extensive economic losses for fishers from both a halt in tourism and a temporary fear among the public of consuming contaminated seafood [8].

Whereas this sequence of high magnitude impacts, i.e., an oil disaster and a pandemic, may have further compromised the vulnerability of fishing communities [9], it may also reveal how these communities are able to react differently to such impacts. While some may become totally disrupted, others may cope or use adaptive strategies to accommodate temporary changes [10,11], or even transform the way they interact both socially and with the natural resources on which they depend [12]. Additionally, individual characteristics or fishing aspects, such as gender and type of fishing environment (e.g., inland vs. coastal), may explain different coping strategies between groups of fishers. Despite being poorly acknowledged, women may particularly contribute toward recovery after disasters by showing critical agency when formal help fails [13]. Women’s ability to make strategic decisions and meaningful choices contribute to adaption responses in risk situations [14] For instance, women have been shown to adapt to post-disaster conditions through their rapid proactive and often collective behavior and political mobilization at the household and community levels [13,15]. The type of environment where fishing takes place may also influence how people respond and adapt to impacts for multiple social and ecological reasons. Ecologically, different environments may have differences in species richness, diversity, and productivity, and this can reflect on fish and invertebrate demand and prices [16,17]. Socially, and specifically for Brazil, there is a large degree of variability between coastal and inland regions in their degree of social organization and access to markets. The Amazon, for example, has a deep history of grassroots movements to promote organizations that collectively manage natural resources, especially fish. This same type of social organization is not observed on the coast [18]. However, coastal communities are closer to cities and urban markets, which facilitate commercialization [19].

It is within this context that this study assessed how the COVID-19 pandemic has affected small-scale fisheries (SSF) in Brazil. Specifically, this study considered some of the socioeconomic and wellbeing impacts, and examined how fishers have responded to them. This assessment was carried out exclusively with the heads of fisher associations, who were considered to adequately represent the interests of their communities, but this was deemed to be the best strategy to cover a large portion of the country given that direct contact with interviewees was not advisable due to the pandemic.

Two hypotheses were tested. The first was (i) whether women leading associations would better perceive the health, wellbeing, and socioeconomic impacts of the pandemic. Although, supposedly, the impacts of the pandemic have been roughly the same on all associations independent of whether it is led by a woman or not, women were expected to present more acute perceptions given their roles in society, which would likely make them more sensitive to crises. For example, women tend to play the primary role of caregiver [20] and are impacted harder by economic crises given that they tend to be subjected to lower pay and often occupy less skilled jobs, commonly in the informal sector [21,22]. In the fishing sector, women are often either in charge of trading fish or work as middlemen, either position of which also provides them with a different perspective on economic crises [23,24]. There is also evidence that by acting both as caregivers and providers in post disaster scenarios, women increase their participation in economic activities and resource access to secure their families food security and wellbeing [15].

The second hypothesis was (ii) that coastal communities would be more prepared to respond to the pandemic-generated economic shock by adopting specific economic or fishing-related actions, especially given their supposedly easier access to both wealthier and tourist markets, such as those found in larger urban centers, state capitals, and along the coast itself. In a country with continental dimensions and which has responded extremely inefficiently to COVID-19, understanding how vulnerable communities, such as fishing communities, have appraised and responded to the impacts caused by this disease can provide insights to support urgently needed mitigation initiatives or to better respond to future shocks.

2. Methods

2.1. Study area

There are about 3.5 million people directly or indirectly involved in fishing and aquaculture in Brazil. In 2017, the total fisheries production was estimated at 704.1 thousand tonnes, with more than 30% of this production from inland fisheries. Overall, artisanal fishing represents 60% of total landings in the country and generates about 90% of all jobs in the sector. These figures are most likely higher for inland fisheries, where there is little representation of the industrial sector [25].

Brazil has marked regional differences when it comes to the distribution of the different types of fisheries. This is expected in a country with different levels of socioeconomic development and biogeographic peculiarities [26]. For example, artisanal fisheries are the dominant type of fishery in the north (especially in the Amazon) and the northeast (especially coastal regions), whereas industrial fisheries predominate in the south and southeast [25]. Given the prevalence of artisanal fisheries, three out of four fishers (hereafter used to refer to both fishermen and fisherwomen) are registered in the north and northeast regions, whereas the remaining are distributed throughout the south, southeast, and center-west regions. Fisherwomen, specifically, represent a third of all workers in the sector and are more commonly found in the north and northeast regions as a result of the type of fishing they practice (e.g., shellfish gleaning) [27]. Fishers are typically organized into some sort of association, which have diverse origins and are sometimes controversial. The so-called colonies, for example, were originally created by the government at the beginning of the XX century to serve as marine corps backup forces in the event of war. During the dictatorship, which ended in 1985, these colonies were led by low-ranking military personnel, which is why they did not have social representativity for a long period (their representativity has slowly improved in the last four decades) [28]. To provide an alternative to colonies, different organizations emerged, such as fisher syndicates and cooperatives. According to the latest available information, there are 760 colonies, 137 syndicates, and 47 cooperatives in Brazil (hereafter, all of these bodies will be referred to as associations) [29].

2.2. Sampling

Participants in this study were heads of fisher associations. Inclusion was initially based on opportunistic sampling, whereby the first
associations to be contacted were those either already known to the authors or with contact information available online. Next, a snowball sampling approach was adopted whereby each association named successive ones in their respective states and at the national level. Many of the associations did not have a valid telephone number and/or e-mail address, which suggests a very low level of organization and has likely restricted representativity. There was an effort to interview as many organizations as possible in the five geopolitical regions of Brazil (north, northeast, center-west, southeast, and south) from both coastal and inland areas (Fig. 1). However, it was much easier to access organizations in the northeast (n = 24) and north (n = 11), followed by those in the southeast (n = 3) and south (n = 2). No association in the center-west could be contacted for an interview. Although the reasons why it was harder to access organizations in certain regions are not clear, the distribution of the interviews roughly corresponds to the relevance of small-scale fisheries in each region, whereby productivity (in relation to the industrial fisheries) is mostly concentrated in the north and northeast regions [26].

The questionnaire adopted here was provided by Pita et al. (this volume), as part of a larger effort to understand the impacts of COVID-19 on small-scale fisheries. The questionnaire was answered between April and September, 2020, which corresponded to the first wave of the pandemic in Brazil. However, given the size and socio-geographical peculiarities of the country, this first wave did not occur evenly across the country. It started stronger in the north, which registered the first health system collapse (in Amazonas state), and the northeast, and coincided with the rainy season in these regions. Shortly after, the pandemic hit the south and southeast, coinciding with the winter season in these regions. Thus, the different associations were interviewed in different periods of the pandemic and of the restrictive measures that were being adopted. This is not considered to be a strong caveat because associations in different regions were assessed throughout the entire period of the research. Moreover, despite the undeniable need and calls by scientists, Brazil never adopted a real lockdown, but rather states were free to establish all sorts of measures to restrict the circulation of people. These measures could not be taken into account here because they varied from municipality to municipality, state to state, and over time.

Of the 40 heads of associations interviewed here, 42.5% were female and 57.5% were male. The number of female association leaders, including colonies, which have traditionally been male-dominated spaces, has been growing over the last years [24]. The associations included here represent a total of 81,196 fishers who mostly use cast nets (70%) and gillnets (55%) to fish.

Interviews were carried out remotely either through a range of online tools (e.g., WhatsApp and email) or by telephone and followed a semi-structured questionnaire. The questionnaire consisted of two sets of questions. The first set of questions, presented on a 5-point Likert scale (1 = very low; 2 = low; 3 = neutral; 4 = high; 5 = very high), regarded the impacts of the pandemic on the fishing-based economy and on the health and wellbeing of fishers. With respect to the socio-economic impacts of the pandemic, interviewees were asked about general direct and indirect economic losses (hereafter “economic loss”), job losses, loss of regular and tourist customers, supplier difficulties, price reductions, catch decrease, and changes to the degree of dependency on fishing (“fishing dependency”). With respect to the health and wellbeing impacts, fisher association leaders were asked about their perception of fear of the virus among fishers (“fear of virus”), whether fishers felt more vulnerable when fishing (“vulnerability”), whether they felt like they needed to take more care of their families (“family needs”), and whether they felt impacted by a lack of personal protective equipment (“PPEs lack”). The second set of questions regarded the adaptive measures that

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**Fig. 1.** Map of Brazil showing the sampled regions and their respective states. The legends show the percentage of inland and coastal fisher associations and the percentage of those that are led by men and women. The south and southeast regions are considered together here due to their low sampling size.
association leaders believed had either been adopted or not (binary variables). The term “adaptive” here is used loosely, as it may include reactive responses akin to coping mechanisms as well as longer-term strategies [11]. These adaptive measures included changes in target species, fishing effort or fishing spots, changes to the types of sales (e.g., to the final consumer instead of through middlemen), changes to the supply chain actors (“supply chain actors”), and whether fishers were provided economic support by the local or national governments (“financial help”).

2.3. Data analysis

Two steps were adopted to test the two hypotheses proposed here. First, a Multiple Correspondence Analysis (MCA) explanatory approach was used to examine the original variables and identify any general patterns in the data and among associations. MCA is a multivariate exploratory data analysis tool that visually contributes to understanding the relationships among categorical variables [30]. MCA summarizes exploratory data analysis tool that visually contributes to understanding patterns in the data and among associations. MCA is a multivariate tool that visually contributes to understanding the relationships among categorical variables [30]. MCA summarizes the multivariate data table into a dimensional space where the more correlated variables can be observed. The MCA eigenvalues describe the degree of variation explained by each dimension and the first eigenvalues explain most of the variance in the data. MCA also provides a squared correlation ratio ($R^2$), which is a measure of the variance of the quantified variable computed for each dimension (ranging from 0 to 1). To carry out this analysis, variables from the three categories (socioeconomic impacts, health/wellbeing impacts, and adaptive measures) were analyzed together with the supposed driving variables (e.g., fisher gender, and type of fishing environment) using the “FactoMineR” package in R [31].

Second, Generalized Linear Models (GLMs) were fitted to predict the COVID-19 pandemic impacts on fishing and how communities have responded (adapted) to them. Instead of using each question as a response variable, summary indices of the impacts (socioeconomic and health/wellbeing) and adaptive measures from all responses were calculated. To that end, the scores for each of the three sets of questions (socioeconomic impacts, health and wellbeing impacts, and adaptive measures) were calculated by dividing the sum of responses by the maximum possible total score value. For example, every interviewee answered eight questions on a 5-point Likert scale regarding socioeconomic impacts. Thus, their score was calculated as a proportion of a maximum of 40 points (from 0 to 1). Adaptive responses were measured on a binary scale (yes or no) and corresponded to a maximum of seven points (if all answers were “yes”), corresponding to the seven questions. Each of these three total scores were treated as the response variable in each of the three models. Questions that were not applicable to the fishing association (e.g., impact on tourism where this activity does not occur) or not answered were not considered in the maximum possible total value.

The three GLMs were then run using the three indexes as response variables, which all varied from 0 to 1: perceptions of socioeconomic impact (model a) and health and wellbeing impact (model b) impacts, and adaptive measures (model c). Gender (female or male) and type of fishing environment (inland or coastal) were treated as factor predictors, in addition to geographic region (north, northeast, and south/southeast, the latter were joined due to low sampling numbers) and the number of associates (continuous). Multicollinearity of these predictors was checked with the “corvif” function [32]. The GLMs were fitted using the “quasi-binomial” error family and “logit” link functions, given that the ratio of the residual deviance to the residual degrees of freedom suggested underdispersion [33,34]. The “drop1” function was used to find the optimal model [34] by removing non-significant variables, and the “exp” function was used to transform the log odds ratio estimates back to odds ratios with a corresponding 95% confidence interval. The “hnp” package was used to check for residual adjustments and influential values by checking the Cook’s distance, Studentized residuals, and hat-values [35]. Plots representing the regression line were produced using the “effects” package [36] in R.

Once the significant variables that explained the GLMs, which were in agreement with the visual inspection provided by the MCA, were identified (i.e., gender) they were used to compare the mean responses of each original question. The mean responses were assessed by gender (male vs. female leadership), for the socioeconomic, and health and wellbeing impacts, and by fishing environment (coastal vs. inland), in the case of adaptive measures, using a Welch t-test and variables were plotted using the “likert” package in R [37]. All the analyses were performed in Rstudio Version 3.1.1093 [38] at a statistical threshold level of $p < 0.05$.

3. Results

Overall, the most discriminating variables in the MCA were those that best identified patterns of fisher responses to the impacts of COVID-19, in addition to some variables that measured impacts, namely: loss of regular and tourism customers, job losses, supplier difficulties, catch decreases, price reductions, fishing dependency, economic losses, vulnerability, fear of the virus, lack of PPEs, and changes in target species (Table 1). These variables tended to be more closely associated with fisher gender (Fig. 2). This was a first indication that fishermen and fisherwomen leaders may perceive the socioeconomic and health/wellbeing impacts of COVID-19 differently (Fig. 3a). Specifically, fisherwomen leaders tended to assess both the economic and wellbeing/heath impacts as high and very high, whereas fishermen leaders tended to cluster closer to the low and very low categories (Fig. 3c).

The first and second dimensions of the MCA explained 43% of the total variance in the data (Fig. 2). Variables clustered further away from the origin are the most discriminating, whereas those closer the origin are less important. For example, the variables associated with adaptive measures explained less of the data variability and were more closely associated with the fishing environment than with other driving forces (Fig. 2). Although there is greater overlap of adaptive strategies between coastal and inland fishers (Fig. 3b), these measures were revealed to be more related to coastal fishers than inland fishers. Additionally, coastal areas were more closely related to high and very high responses in both impact categories, and to the adoption of adaptive measures (category “yes”) (Fig. 3c).

The tendency for women to perceive the socioeconomic and health and wellbeing impacts to be harsher than men do was also observed in the GLMs (Fig. 4a and b; geographic region, number of members, and type of fishing environment were not significant). Men were shown to have a 66.25% lower likelihood of perceiving the economic impacts and a 45.94% lower likelihood of perceiving the health/wellbeing related impacts than women (Table 2). These tendencies were also visually confirmed upon inspection of the Likert-scale responses (economic impacts: t-test $= 3.377$; and health/wellbeing impacts: $t$-test $= 1.9626$) (Fig. 5a and b). Among the socioeconomic impacts, overall economic

| Table 1 | Significance of key variables on dimensions 1 and 2. All square correlation ratios ($R^2$) were statistically significant ($p$-value $< 0.05$). PPEs = personal protective equipment. |
|---------|-----------------|-----------------|
| **Variables** | **Dimension 1** | **Dimension 2** |
| Loss of regular customers | 0.77 | Supplier difficulties | 0.75 |
| Job losses | 0.74 | Loss of tourism customers | 0.69 |
| Supplier difficulties | 0.74 | Family needs | 0.56 |
| Loss of tourism customers | 0.68 | Economic losses | 0.51 |
| Catch decreases | 0.66 | Price reductions | 0.50 |
| Price reductions | 0.64 | Loss of regular customers | 0.49 |
| Lack of PPEs | 0.47 | Lack of PPEs | 0.42 |
| Fear of virus | 0.40 | Fear of virus | 0.22 |
| Economic losses | 0.31 | Job losses | 0.32 |
| Changes in target species | 0.25 | Catch decreases | 0.15 |
losses, supplier difficulties, fishing dependency, catch decreases, and price reductions were the most negatively perceived among fishers. Fisherwomen leaders in particular tended to point out the loss of regular (88%) and tourist customers (93%) more often than fisherman leaders (39% and 3%, respectively) (Fig. 5a). Regarding the health and wellbeing impacts, all fisherwomen leaders agreed that the needs of fisher families were highly impacted during the pandemic and that people were very afraid of the virus, but only 26% of fishermen leaders felt that the pandemic had significantly impacted the health and wellbeing of fisher families (Fig. 5b).

The second hypothesis was also confirmed, i.e., that coastal communities are more prepared to adapt to economic impacts than inland ones (Fig. 4c). The likelihood that adaptive measures are in place is 46.64% lower if the fishing environment is inland (Table 2). Gender was not relevant in identifying the adoption of adaptive measures to COVID-19, neither were geographic region or number of members. In general, fishers answered that receiving financial help (local and national), changing fishing effort, and types of sales were the adaptive strategies most commonly adopted during the pandemic (Fig. 5c).

4. Discussion

4.1. Socioeconomic and health and wellbeing impacts of the COVID-19 pandemic

There is already significant anecdotal evidence and some scientific literature that suggests that the COVID-19 pandemic has been particularly harsh on the livelihoods of small-scale fishers in developing countries [39,40]. Given how the impacts of the pandemic have quickly spread around the world, there is an urgent need to understand them and the potential adaptive mechanisms that could contribute toward solving immediate problems and building resilience [41], which would be key to address future impacts as well. Here, for example, it was shown that gender plays a key role in how the impacts of the pandemic are perceived, specifically that female leaders assess both the socioeconomic and health/wellbeing impacts harsher than their male counterparts.

Although the link between perception and action remains controversial in the psychological literature [42], the way facts are perceived can either facilitate or inhibit action [43]. With respect to male leaders, their less severe appraisal of the pandemic’s impacts could translate into delayed actions and further compromise the negative consequences of the disease on the livelihoods of fisher families. Although decisions to follow control measures, such as social distancing and the use of face masks, occur at the individual level, leadership plays an important role in how widespread and how efficiently these measures are adopted. This is because leaders are both considered role models by some, if not all, members of the groups they lead [44] and often the ones making decisions to reduce negative impacts. An example of the latter are effective and proactive governments, i.e., those who quickly implemented quarantines, lockdowns, and screenings, which proved to be critical to decreasing the COVID-19 mortality worldwide [45]. However, people may view the legitimacy of leaders and the success of leadership outcomes differently [46]. This is particularly important in the case of fishing colonies due to their authoritarian past, with some still led by people with vested political interests [47,48].

Brazil, specifically, has an authoritarian history of fisheries management [49], widely based on top-down systems, which have contributed to erode the legitimacy of some measures, even when they find scientific support [50]. Fortunately, this pattern has been slowly reversing. With the redemocratization of the country, the development of participatory approaches (e.g.: fishing agreements in the Amazon basin and marine extractive reserves in coastal areas) has been restoring at least the legitimacy of fishers’ unions (“Colônias”) in fishing communities [51]. Yet, fisherwomen still struggle to gain recognition for their activities [23,52], including their role as leaders, although here too progress has been made. For instance, the number of fisherwomen heading fishing colonies has increased [24]. These positive achievements were mainly due to development in fisheries legislation (e.g.: Fishing Law 11.959/2009) and, especially, an increase in fisherwomen mobilization since the last decade [24]. After the long failure of the top-down system and the lack of empowerment of fisherwomen, female leadership begins to be recognized in Brazilian fisheries, challenging power relations and increasing the representativeness of fishing communities and the success of fisheries management [53].

By understanding the role of effective leadership, it may be possible to understand why women appraise the impacts of the same disease differently than men. From a health and wellbeing perspective, for example, fisherwomen leaders revealed that they were more worried about family needs and more afraid of the virus than fisherman. One way to begin to understand these differences is by assessing how their involvement in fisheries is recognized. In general, there is a cultural and economic difference between how the work of fisherwomen and fishermen is recognized in fisheries [53], partially as a consequence of how their social roles are unequally established. For instance, fisherwomen regularly bear a heavier share of household chores and childcare [54], which often limits their fishing-related activities to areas closer to home and/or in the post-harvest sector [24,55]. At the same time, these care-related attributions likely provide women with specific health, family income, and food security learning experiences [20].

On the other hand, socioeconomically, the differences in perceptions between male and female leaders were particularly evident regarding aspects such as economic and job losses, supplier difficulties, price reductions, and fishing dependency, all of which are harder to explain solely based on a care-related approach. One possible explanation may regard how genders still play different roles in the household and family contexts. Women’s mothering and family oriented identities and performances appear to enhance women’s desires for greater security, which would contribute to changes in fisheries practices and organizations [56]. Furthermore, diversification, innovation, and
Fig. 3. MCA factor maps of the driving variables and variable categories on a 2-dimensional scale: a) distribution of fishers by gender (female = red, male = blue); b) distribution of fishers by type of environment (coastal = red, inland = blue); c) distribution of variable categories of the three aspects (S = socioeconomic; W = health and wellbeing; A = adaptive). Very high (VH), high (H), and yes (Y) are in blue; Neutral (N), low (L), very low (VL), and no (N) are in red; and, female (F), male (M), inland, and coastal are in green. Ellipses are the confidence interval of 95%. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Fig. 4. Patterns in the perception of socioeconomic impacts (a) health/wellbeing impacts, (b) adaptive measures, and (c) type of fishing environment as identified in the Generalized Linear Models (only the significant variables are shown for each model). See Table 2 for parameter estimates. All slopes were significant (p-value < 0.05). The confidence interval is represented by range.
4.2 Fisher adaptive measures

Better at responding to its impacts. One alternative is that the aspects of being benefited by some money transfer programs, fisher leaders seldomly stated that adaptive measures had been adopted. With the exception of being benefited by some money transfer programs, especially on the coast, where other state or city level money transfer programs were also mentioned by 61% of the interviewees. More revealing though are the differences in adaptive measures between fishing environments. On the coast, the measures were specifically related to the post-harvest sector, whereby fishers seem to have changed their type of sale (likely by increasing their sale share to local consumers) and suppliers (likely by replacing middlemen) more often. The replacement of middlemen may have happened for various reasons, from finding people willing to pay a little more in difficult times, when fishers can be more vulnerable to economic abuses, to the simple exclusion of this link in the supply chain. Despite the serious consequences of the pandemic on tourism as well [67], tourism never came to a full halt, which may have provided an outlet for some coastal fishing production.

These post-harvest options may be less available inland, where final local consumers may be more scarce. For example, in the Amazon, fishing is practiced to some degree by most riverine people. In adverse economic times, Amazonians may turn even more to fishing, as it represents a healthy and money free protein [68]. Inland tourism in the Amazon and in the countryside overall in Brazil is poorly developed and not properly integrated with communities living by rivers or reservoirs [68], thus it does not offer an alternative outlet. Finally, infrastructure tends to be worse inland, further away from capitals, thereby binding fishers to the same middlemen [69]. On the other hand, the adaptive measures adopted inland relate mostly to fishing itself, such as decreasing fishing efforts and changing fishing spots. The reasons why these specific measures have been adopted can only be conjectured. For example, with economic activities and market options limited, it is possible that fishers either did not feel the need to work as much as before or to visit more distant grounds as their fishing activity was mostly restricted to subsistence. Worldwide, coping mechanisms and adaptive responses to the COVID-19 pandemic have also varied. For example, some fishers in the United States have switched species and begun to engage in direct seafood sales [70], and fishers in Ghana have created home delivery systems and online platforms to sell fish [39].

Finally, whereas further studies will be necessary to clarify what motivates coastal and inland fishing communities to adopt different adaptive measures and behavior, money transfer programs appear to have been a key and an urgent remedy for both. However, in Brazil, these programs were planned to be short-term compensations and likely did not reach all fishers in need given the high degree of informality in the sector [39], and the isolation of many fishing communities, especially those in the Amazon. Worse yet, since the second and harsher pandemic wave, a much smaller cash transfer program (for fewer people and at a lower value) was implemented, which has accentuated the vulnerabilities of fishing communities. In addition to restoring fair and widespread cash transfer programs, there is an urgent need to invest in building resilience to decrease the effects of future shocks [41].

Table 2

Coefficient estimates for each of the three final quasi-binomial Generalized Linear Models (a. socioeconomic impacts, b. health/wellbeing impacts, and c. adaptive measures). The values are presented on a logit scale as log odds ratios. Legends: standard error (SE); degrees of freedom (df); confidence interval (CI); and significance codes (p): 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05. Only the final models are shown, as non-significant variables were dropped during the analyses.

| Variable                  | Coefficient estimate | SE     | df  | t value | Odds ratio | Lower CI | Upper CI |
|---------------------------|----------------------|--------|-----|---------|------------|----------|----------|
| (a) proportion of socioeconomic impacts | Intercept            | 1.6865 | 0.2969 | 39 | 5.680*** | 5.4007172 | 3.017945 | 9.664158  |
|                           | Gender (male)        | -1.0863 | 0.3545 | 38 | -3.064** | 0.3374548 | 0.1684494 | 0.6760556 |
| (b) proportion of health and wellbeing impacts | Intercept            | 1.7945 | 0.2355 | 38 | 7.578*** | 5.9565217 | 3.754368 | 9.450617  |
|                           | Gender (male)        | -0.6150 | 0.2858 | 37 | -2.152*  | 0.5406147 | 0.3087671 | 0.946442  |
| (c) proportion of adaptive measures | Intercept            | -0.2534 | 0.1864 | 36 | 1.360    | 0.7761194 | 0.5386205 | 1.1184502 |
|                           | Fishing (inland)     | -0.6281 | 0.2643 | 35 | -2.377*  | 0.5336053 | 0.3178652 | 0.8957696 |

Entrepreneurial roles of women in fishing families are cited as ways to improve the economic situation of fishing families [57]. Here, fisherwomen leaders were more aware of the economic impacts of COVID-19 on their livelihood, which is probably related to their role and responsibilities in household and fisheries management, including fish processing and sales [24,53]. In addition to gender roles, it is possible that former public policies, e.g., the right to join a fishing association on their livelihood, which is probably related to their role and responsibilities in household and fisheries management, including fish processing and sales [24,53]. In addition to gender roles, it is possible that former public policies, e.g., the right to join a fishing association on their livelihood, which is probably related to their role and responsibilities in household and fisheries management, including fish processing and sales [24,53]. In addition to gender roles, it is possible that former public policies, e.g., the right to join a fishing association on their livelihood, which is probably related to their role and responsibilities in household and fisheries management, including fish processing and sales [24,53].
Fig. 5. Percentage of fisher answers by gender for all variables in the three aspects: a) socioeconomic and health/wellbeing impacts, and b) adaptive measures. Very low (dark blue), low (dark gray), neutral (light gray), high (light brown), and very high (yellow) are the Likert scale categories, and the percentage values present the neutral (in the middle) and sums of negative (before neutral) and positive (after neutral) categories. For the adaptive aspect, yes (dark blue) and no (yellow) represent whether the leaders believed that fishers had adopted adaptive strategies or not. The left and right panels in a) and b) report the percentage of female (F) and male (M) fishers, and in c) coastal and inland environments. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)
5. Conclusions

This is a first assessment of how small-scale fishing communities in Brazil have both been impacted and reacted to the effects of COVID-19, particularly during the first wave. Although the findings here warrant further studies to cover a larger number of associations across all Brazilian regions, together with follow-up impact and response assessments as the pandemic developed (in a worse form in the second wave), they are already telling. The findings show that leaders everywhere in the fishing sector have perceived economic and health/wellbeing impacts, but that, at the time of the survey, fishers did not show strong adaptive and coping responses, and were primarily reliant on government cash transfer programs. Despite some differences between coastal and inland fishing communities, the former of which adopted more post-harvest adaptive mechanisms whereas the latter more fishing-related changes, no communities showed any particularly marked form of response. The reasons why fishers did not change much of their strategies are unclear, but it is a reason for concern and suggests a high level of vulnerability to external shocks.

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Conflict of interest

The authors report no conflict of interest.

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