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Characteristics related to fish consumption and the risk of ichthyozoonosis in a Colombian population

Características relacionas con el consumo de pescado y el riesgo de ictiozoonosis en una población de Colombia

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ABSTRACT

Objective This study aimed to determine the dietary habits related to fish consumption and the risk factors associated with acquiring an ichthyo-zoonotic disease.
Materials and Methods A descriptive, cross-sectional study was carried out by means of a structured survey administered to 150 individuals in the city of Cali, Colombia.
Results Epidemiological variables regarding fish consumption and preparation were contrasted with the medical records of the respondents. The median fish consumption in the surveyed population was three times a month, with raw or salted/marinated fish once a month. A positive correlation between fish consumption and allergic conditions was confirmed. There was no infectious or parasitic history associated with the data on fish consumption.
Conclusions A relationship between fish consumption and allergies was confirmed. Further research is necessary to establish the possible pathogens associated with hypersensitivity, such as parasites of the *Anisakidae* family.

Key Words: Foodborne diseases; zoonoses; public health; Colombia; hypersensitivity *(source: MeSH, NLM).*

RESUMEN

Objetivo Este estudio tuvo como fin determinar los hábitos alimenticios relacionados con el consumo de pescado y los factores de riesgo asociados con la adquisición de una enfermedad ictio-zoonótica.
Materiales y Métodos Se realizó un estudio descriptivo de corte transversal mediante una encuesta estructurada a 150 individuos de la ciudad de Cali, Colombia.
Resultados Las variables epidemiológicas del consumo y preparación de pescado se relacionaron con la historia clínica de los encuestados. El consumo medio de pescado en los encuestados fue de tres veces al mes, con pescado crudo o salado/marinado una vez al mes. Se confirmó una correlación positiva entre el consumo de pescado y las condiciones alérgicas. No se asociaron antecedentes infecciosos o parasitarios con los datos sobre el consumo de pescado.
Conclusión Fue posible confirmar una relación entre el consumo de pescado y las condiciones alérgicas. Se necesita investigación para establecer los posibles patógenos asociados con la hipersensibilidad, como los parásitos de la familia *Anisakidae*.

Palabras Clave: Enfermedades transmitidas por los alimentos; zoonosis; salud pública; Colombia; hipersensibilidad *(fuente: DeCS, BIREME).*

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Ichthyozoonosis refers to diseases transmitted to humans via bacteria, viruses and parasites through fish consumption. They are associated with sociocultural factors that favor the onset of the disease, particularly the consumption of raw fish in dishes such as ceviche and sushi, or undercooked, smoked, marinated or salted fish (1–3).

In Latin America, helminth parasites are responsible for the highest number of ichthyozoonoses —causing diseases such as paragonimiasis, gnathostomiasis, anisakiasis and diphyllobothriasis—, as well as protozoans such as myxosporidia. All are considered to be emerging diseases (1,2,4–7), and the majority of clinical cases are associated with Japanese cuisine in the context of increased fish consumption (1,3,8). In the particular case of *anisakis* nematodes, *Anisakis simplex* is the species that has been most commonly linked to the occurrence of allergic reactions (type I hypersensitivity).

Public health interest in these diseases is increasing as the general population has also increased the consumption of raw or minimally processed fish products. In particular, Colombia is a country abundant in fish with coastlines along both the Pacific Ocean and the Caribbean Sea. However, it still has a low per-capita consumption of fish and shellfish compared to other countries in the world and the region. Thus, according to the Food and Agriculture Organization of the United Nations (FAO, 2014) and the Ministry of Agriculture for Rural Development in Colombia, the Colombian population consumes an average of 4.73 kg/year of fish and shellfish per person, whereas countries such as Spain and Japan consume 38 kg/year and 54 kg/year, respectively. For Latin America, the average per capita consumption of fish products is 18 kg/year (9).

Nevertheless, the increasingly globalized world has also witnessed an increase in the consumption of exotic dishes, the spread of the Mediterranean diet (rich in fish) for the prevention of cardiovascular diseases, and the permanent use of microwave ovens, which may result in undercooked foods. All these factors favor the survival of pathogens (10) and encourage the onset of ichthyozoonoses (3).

In Latin America, there is a higher number of zoonotic diseases as more people are consuming foods made of undercooked or raw fish, such as sushi (2). In Chile, cases of foodborne diseases caused by sushi skyrocketed by 100% in 2013 compared to previous years, and food poisoning cases were associated with the consumption of raw or semi-processed fish or shellfish containing nematodes, trematodes, cestodes or protozoa (11), a clinical picture related particularly to *Diphyllobothrium* spp., *Pseudoterranova decipiens* and *Anisakis* spp. (3,4,12,13). Furthermore, anisakidosis is considered an emerging disease in Peru (14); *Diphyllobothrium* and *Ascocotyle* characterize cases in Brazil; and fish-borne diseases are almost entirely related to *Diphyllobothrium* in Argentina, mainly in the region of Patagonia (15).

Chile, Peru, and Cuba have described cases of diphyllobothriasis (4), while paragonimiasis has been reported in Ecuador and Peru, where it is an endemic disease, and in other countries of the region such as Mexico, Costa Rica, Colombia and Venezuela, where it is found in a smaller number. Gnathostomiasis, on the other hand, is an emerging ichthyozoonotic disease in Latin America that affects an increasing number of people; although it was initially considered a disease exclusively found in Asia, Ecuador and Mexico have reported cases that demonstrate the existence of the disease in this region (4). Finally, Venezuela, Ecuador and Colombia have not reported cases associated with any ichthyozoonosis, but there are records of fish for consumption parasitized mainly by nematodes of the *Anisakidae* family (6,16,17).

Therefore, the present study aimed to determine dietary habits related to fish consumption in a population from Cali, Colombia, in order to identify the possible risk factors associated with the acquisition of an ichthyozoonotic disease.

MATERIALS AND METHODS

A descriptive, cross-sectional study was carried out on a sample of 150 healthy individuals selected by non-probabilistic sampling for convenience (accessibility and proximity of subjects). The individuals studied were students and professors of the Universidad del Valle, San Fernando Campus, in Cali, Colombia.

A questionnaire of 28 items on fish preparation and consumption habits was administered: 6 items were general information questions, 14 were multiple-choice questions about fish/seafood consumption, and 8 were open-ended questions about the clinical history of the participants.

The questions were designed to establish the frequency of fish and seafood consumption per month, the places of consumption (restaurants/home), preparation and/or consumption (canned, raw, salted), the species of fish consumed, and the individuals' clinical history. The survey was previously validated by means of a pilot administered to 44 participants from the same study population (Table 1).

Each participant was duly informed about the characteristics of the study and received training to complete the survey after signing an informed consent.

The SPSS version 15.0 was used for the statistical analysis, and a descriptive analysis was performed to establish the frequency and averages of variables with normal dis-

Table 1. Questionnaire about fish consumption habits and medical history

	Survey
	Dietary habits
1	How many times a month do you eat fish?
2	Do you eat canned fish? Yes/No. If yes, how many times per month?
3	Do you eat fish in restaurants? Yes/No If yes, how many times per month?
4	When eating in restaurants, how do you like your fish to be prepared? (Various options) 1) Fried, 2) Stewed, 3) Steamed, 4) Oven-baked, 5) Breaded or battered, 6) Raw, 7) Other
5	Do you eat raw fish? For example, sushi or ceviche? Yes/No. If yes, how many times per month?
6	Do you eat smoked or marinated fish? Yes/No. If yes, how many times per month?
7	Which species of fish to you eat most frequently? (Name three).
8	Do you eat any type of shellfish? Yes/No If yes, how many times per month)?
9	Which species of shellfish do you eat most frequently? (Name three).
10	How do you or your relatives prepare fish at home? (Various options) 1) Fried, 2) Stewed, 3) Steamed, 4) Oven-baked, 5) Breaded or battered, 6) Raw, 7) Other
11	Which of your relatives enjoy eating fish? 1) Children, 2) Teenagers, 3) Men, 4) Women, 5) Adults, 6) Everyone
12	Where do you buy fish or shellfish? 1) Supermarket, 2) Markets, 3) Both, 4) I don't buy it.
13	When you buy fish, where do you store it? (Various options) 1) Freezer, 2) Refrigerator, 3) Food storage containers, 4) I don't store it, 5) Other.
14	On average, how long does it take from the moment you buy the fish to the time you get home? (One option only) 1) Less than an hour, 2) Between one and two hours, 3) Half a day to a day, 4) More than a day, 5) I'm not sure/No response.
	Medical history
15	Have you ever had a reaction or illness after eating fish or shellfish? Yes/No. Which? 1) Digestive problems, 2) Skin rash, 3) Other allergy, 4) Other (Please specify).
16	Do you have any food allergies? Yes/No. If yes, to which food(s)?
17	Do you suffer from any respiratory difficulties from an allergy? Yes/No. Which?
18	Are you allergic to dust mites? Yes/No.
19	Do you suffer from any other medical conditions? Yes/No. If yes, which condition(s)?
20	Have you ever been diagnosed with parasites (in particular, nematodes or roundworm). Yes/No. If yes, which type? How long ago were you diagnosed?
21	Have you suffered from a chronic infectious disease? Yes/No. If yes, which one? I don't know/ No response
22	Have you been diagnosed with acute or chronic urticaria (hives)? Yes/No. If yes, which type? Acute/Chronic/Not sure/No response

tribution such as age. Other numerical variables studied were frequency of fish intake; consumption of canned, raw, and salted fish; consumption of seafood; and consumption of fish in restaurants. It was observed that these numerical variables did not follow a normal distribution after applying the Kolmogorov–Smirnov test, so the median and interquartile ranges were estimated and the comparisons were performed using the Mann-Whitney test. Variables with p value <0.05 were considered significant.

Ethical considerations: This study was carried out in full compliance with the guidelines and the current revision of the Helsinki Declaration (18), which provides greater protection to study participants. It also complies with Resolution 008430 of 1993 from the Colombian Ministry of Health (19). The Institutional Committee for the Review of Human Ethics of the Faculty of Health, Universidad del Valle, Cali, Colombia, approved this study (code: 015-015).

RESULTS

Of the 150 participants, 84 were women (56%) and 66 men (44%), aged between 18 and 67 years, and 18 and 61 years, respectively. The dietary habits associated with fish consumption are presented in Table 2.

Fish consumption

The median of consumption was three times per month (interquartile range – IQR: 2-5). The median consumption of canned fish (tuna and sardines) was twice per month (IQR: 1-3). The median seafood consumption was once per month (IQR: 0-1.25). The median of eating fish or seafood in restaurants was once per month (IQR: 0 - 1.25).

Consumption of raw fish

The median consumption of raw or salted/marinated fish was once per month (IQR: 0-1.25). 19% of the respondents preferred to eat raw fish in restaurants, while the preferred form of preparation at home was fried fish (70%).

Most commonly consumed species

The 5 fish species most commonly named for consumption were tilapia (*Oreochromis* sp.) (31%), tuna (*Thunnus* sp.) (26%), salmon (*Salmo* sp.) (17%), trout (*Oncorhynchus mykiss*) (10%), and snapper (*Lutjanus* sp.) (3%).

Table 2. Dietary habits associated with the consumption of fish and shellfish in a population surveyed in the city of Cali, Colombia

Dietary habits	%	Frequency per month
Fish consumption in restaurants		
Fish and shellfish	73	2
Preferred preparation methods when cooking fish at home (respondents could select more than one)		
Fried	70	-
Stewed	57	-
Breaded/Battered	29	-
Oven-baked	17	-
Steamed	15	-
Raw	7	-
Family member that consumes fish		
Everyone	47	-
Adults	32	-
Adolescents	3	-
Children	2	-
Not sure/ No response	16	-
Place of purchase (fish/shellfish)		
Supermarket	53	-
Food market	11	-
Both (supermarkets and markets)	29	-
Doesn't buy fish/shellfish	5	-
Other (brought from artisan fishing)	2	-
Time elapsed between buying fish/shellfish and getting it home		
Less than one hour	67	-
Between one and two hours	21	-
Half a day to a day	1	-
More than a day	2	-
Not sure / No response	9	-
Fish/Shellfish storage		
Frozen	87	-
Refrigerated	13	-
Fish species consumed		
Nile tilapia (*Oreochromis niloticus*)	31	-
Tuna (*Thunnus* sp.)	26	-
Salmon (*Salmo* sp.)	17	-
Rainbow trout (*Oncorhynchus* mykiss)	10	-
Snapper (*Lutjanus* sp.)	3	-
Bocachico (*Prochilodus magdalenae*)	2	-
Catfish (*Ariopsis* spp.)	1	-
Corvina (*Cynoscion* spp.)	1	-
Snook fish (*Centropomus* sp.)	1	-
Striped catfish (*Pangasius hypophthalmus*)	1	-
Cachama (*Colossama* sp.)	1	-
Blue marlin (*Makaira* sp.)	1	-
Hake (*Merluccius* sp.)	1	-
Weakfish (*Macrodon* sp.)	1	-
Not sure / No response	3	-
Shellfish species consumed		
Shrimp	55	-
Prawn	4	-
Squid	1	-
Octopus	1	-
Crab	1	-
Lobster	1	-
Piangua clams	1	-
Not sure / No response	1	-
Doesn't eat shellfish	35	-

Regarding seafood, participants preferred to consume shrimp (55%) and prawn (4%).

Place of purchase

53% of the respondents bought their fish in retail supermarkets and 11% in food markets.

Medical history

Of the 150 respondents, 11% reported experiencing digestive symptoms associated with the consumption of fish or shellfish, and 12% some type of allergic reaction. 3 respondents (2%) reported having had both allergic and digestive symptoms.

With regard to food-related allergies, 11% reported being allergic to some type of food. 4% of all respondents reported being allergic to shellfish. 1 respondent reported being allergic to shellfish and canned fish, and another reported being allergic to seafood, passion fruit and pork. 27% of respondents reported having a respiratory allergy, while another 47% reported being allergic to dust mites. Table 3 summarizes the clinical history of the respondents.

Table 3. Summary of the main findings of the clinical history of the population under study

Clinical history	%
Symptoms associated with the consumption of fish	
Digestive	11
Allergic	12
Digestive and allergic	2
None	77
Known food allergies	
Shellfish	4
Dairy products	1.3
Gluten	1
Canned foods	1
Tuna	1
Olives	1
Passion fruit	1
Pork	1
Cinnamon	1
Canned corn	1
No specific food allergies	1
Respiratory allergies	
Respiratory allergies	27
Allergy to dust mites	47

When asked about other diseases, 2% said they had been diagnosed with a chronic infectious disease (Epstein-Barr virus and tuberculosis). The respondent with Epstein-Barr virus reported having had digestive symptoms associated with fish consumption, while the individual with a history of tuberculosis reported being allergic to dust mites. 4% of respondents stated that they had been diagnosed with urticaria and that they were allergic to dust mites; 1 had allergic symptoms caused by fish consumption, 1 reported being allergic to tuna, and 1 was allergic to dairy products.

The comparative study of the variables showed that participants consuming salted fish were more likely to suffer from urticaria ($p < 0.03$), be allergic to mites ($p < 0.02$) and to some foods ($p < 0.04$). On the other hand, seafood consumption had a positive association with the probability of presenting urticaria ($p < 0.04$). In addition, regarding the frequency of fish consumption per month, the analysis determined that the higher the intake of fish, the greater the probability of developing urticaria ($p < 0.001$); it also identified a tendency towards significance with respect to having an allergy to dust mites ($p = 0.063$).

DISCUSSION

This research was carried out in the city of Cali, located 122 km from Buenaventura, the main fishing port of Colombia in the Pacific Ocean and the point from where seafood is distributed to the interior of the country (20–22). Between 1998 and 2013, 1 099 568 tons of fish were caught in the Colombian Pacific region, by both industrial and artisanal fisheries (23). However, it is well known that the management of fishery products is inadequate during the extraction, processing and commercialization stages, and that it has a minimal level of processing in closed and controlled conditions. One of the main challenges for the development of the sector is the lack of dock services, in terms of processing and chilling, and this is evident in the inadequate handling of both fresh and frozen fish (22).

In the present study, the reported levels of fish consumption were generally low, although 87% of the subjects stated that they had no difficulty consuming raw or half cooked fish (sushi, marinated or salted fish), thus increasing the risk of acquiring an ichthyozoonotic disease. Moreover, the percentage of fish consumption is higher than the 74.2% reported by university students in the city of Bucaramanga (24), possibly due to the fact that only 13% of the participants in that study were from the Caribbean or Pacific coasts where fish consumption is more common based on cultural traditions.

Some of the agents that cause ichthyozoonoses are bacteria, viruses and parasites (3). In Latin America, helminth parasites cause the greatest number of these fish borne zoonoses. These parasites require aquatic organisms to complete their life cycle, and humans can act as accidental hosts by consuming infected fish carrying trematode, cestode and nematode parasites. In humans, they can cause diseases such as paragonimiasis, gnathostomia-

sis, diphyllobothriasis and anisakidosis, all emerging diseases in the region (3,14,25,26).

In Colombia, reports have only described some cases of paragonimiasis (25–28) and a single case of gnathostomiasis (26) of a patient diagnosed in Argentina who had been in Colombia for a few days in 2013 (29). In addition, cases of fish for consumption parasitized with *Anisakis* nematodes have been described in different areas along the Caribbean coast (17,29)(28-31); even though there are no reports of cases in humans in Colombia, these parasites have a global distribution and are found in several ecologically important species. Therefore, they are an emerging and permanent concern for food safety entities as they not only produce digestive or extraintestinal symptoms associated with raw fish consumption, but also cause allergic conditions (32). Consequently, several disciplines have become interested in this parasite, not only in the field of fisheries, parasitology and food safety, but also in several medical specialties, particularly allergy and immunology (32).

This study found that respondents between 26 and 45 years of age reported eating raw fish more frequently in dishes such as sushi —up to 5 times per month—, making evident the increasing popularity of Japanese food and a more Mediterranean-style diet among the younger population. These dietary trends increase the potential risk of developing ichthyozoonotic diseases in Colombia, requiring further research to have a clearer picture of the situation. Another area for further study is the development and availability of specific diagnostic tests for diseases that can be of importance for public health and medicine.

Control and prevention measures for these diseases are relatively simple. In Europe, where they are fully identified, legislation states that any fish to be consumed raw or undercooked should be frozen at -20°C for at least 24 hours, and that the finished product should be frozen in its entirety (Regulation EC No.854/2004 of the European Parliament and of the Council of April 29 2004) (33). In Colombia, these pathogens are not identified and, therefore, are not diagnosed, so there is no clear legislation in this regard. However, the Ministry of Health established — through Decree No.561 of March 8, 1984 (34), article 21, regarding the capture, processing, transport and sale of fishery products, that the evisceration can be carried out as soon as the catch arrives onboard; however, if the process is not carried out immediately, the product must be washed once it reaches the deck using drinking water or clean sea water. Not performing the evisceration immediately facilitates the movement of parasites, such as *Anisakis*, from the viscera to the musculature of the fish, thus increasing the risks for the end consumer. Nevertheless, the microbiological requirements for fishery products set out in Resolution 776 of 2008 from the Ministry of Social Protection (35) only establish the analysis for the identification of *E. coli*, *Staphylococcus* spp., *Salmonella* spp. and *Vibrio cholerae*.

Further risk comes from the increase of imported seafood. In 2017, to meet growing domestic demand, the Colombian Aquaculture and Fisheries Unit imported 180 million tons of fish from Asia, where, as mentioned above, parasitic diseases are endemic and constitute a public health issue. Increasing fish imports to Colombia may elevate cases of emerging fish borne zoonotic diseases. It is worth noting that 53% of the participants of this study purchased fish in supermarkets and only 11% purchased it from local food markets. Supermarket purchases favor the consumption of imported fish, mainly of Asian origin, as they are often cheaper than local fish species.

The most commonly consumed fish species reported by the survey respondents were tilapia (*Oreochromis niloticus*), tuna (*Thunnus* sp.), salmon (*Salmo* sp.), trout (*Oncorhynchus mykiss*) and snapper (*Lutjanus* sp.). Regarding shellfish, respondents preferred to consume shrimp and prawn. These results coincide with the research conducted in 2015 by Restrepo-Betancourt *et al.* (36), who found that the preferred species of university students in the city of Medellín were tuna, tilapia, trout and shrimp; in turn, Gamboa-Delgado *et al.* administered another survey to university students in Bucaramanga, and also found that they preferred trout, snapper and tuna (24). In 2005, Hererra-Arias *et al.* (37) found a high prevalence of *Salmonella* spp. in commercialized fresh trout in Pamplona, (department of Norte de Santander, Colombia), with similar prevalence levels of the pathogen in fish products sold in formal establishments and those sold more informally, demonstrating the presence of pathogens in the species preferred for consumption.

In the literature review, there were no reports of an association between fish for human consumption and ichthyozoonotic diseases in Colombia, possibly because they are emerging diseases that are largely unrecognized by the local health staff, making underreporting likely. However, there are reports of fish consumption with presence of *anisakis* geographically related to the Caribbean Sea, both in the sea and in continental waters, where several authors have found *Contracaecum* sp. (31). Moreover, *anisakis* parasites have been identified in species in other Latin American countries: in Chilean jack mackerel (*Trachurus murphyi*) and Argentine hake (*Merluccius hubbsi*) in Argentina; in Peruvian hake (*Merluccius gayi*) and Lorna drum (*Sciaena deliciosa*) in Chile and Peru; in anchovy (*Pomatomus saltatrix*), largehead hairtail (*Trichiurus lepturus*) and red porgy (*Pagrus pagrus*) in Brazil; and in species of the *Mugilidae* and *Gerreidae* families in Venezuela (16,38,39).

In the final section of the survey, respondents were asked about their medical history: 11% reported having digestive symptoms associated with fish consumption, 12% reported allergic symptoms for the same cause, and 2% reported both digestive and allergic symptoms. These percentages are higher than those reported by Gamboa-Delgado *et al*. in 2010, who found that 9.6% of the student population surveyed at the Universidad de Bucaramanga were allergic to fish (24) and 4% were allergic to shellfish. These data, along with the high frequency of dust mite allergy, are not unexpected in a population living in a humid climate. The association between sensitivity to dust mites and suffering from allergies to shellfish, especially from the group of crustaceans and frequently caused by cross-reactivity of allergens (40), has been well documented. The percentage of respondents who were allergic to dust mites far exceeds the percentage of patients who claim to have a respiratory allergy. Since it is a questionnaire, it was not possible to rule out an understanding bias on the part of the patient. However, it is possible that the allergy study performed on patients allergic to mites was performed for other reasons, e.g. episodes of urticaria, food allergies, etc., given the frequent sensitivity to dust mites in tropical zones.

A relationship between fish consumption and allergies was confirmed. Further research is necessary to establish the possible pathogens associated with hypersensitivity, such as parasites of the *Anisakidae* family ♦

Conflict of interest: None.

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