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# Is per capita fish consumption in Latin America aligned with international recommendations for a healthy diet?

Carla GUZMÁN-PINCHEIRA[1], María José ANDRADE-CUVI[2,3], Juan Carlos Bórquez PEREZ[4], Gabriel ARAUJO-SILVA[5], Angélica QUINTERO-FLÓREZ[6*]

**Abstract**

The World Health Organization (WHO) is urging Latin American countries to prioritize the prevention of chronic noncommunicable diseases. Diet is a crucial factor in determining one's health, and healthy eating recommendations emphasize the consumption of fish at least twice a week due to its protein, vitamin, mineral, and essential fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). This review was designed to compare the status of fish consumption as a source of EPA and DHA fatty acids in some Latin American countries (namely Brazil, Chile, Colombia, and Ecuador), and comparisons with international recommendations within a healthy diet could contribute to the WHO's call for a focus on preventing the aforementioned diseases in the region. A comprehensive literature search was conducted from January to October 2022 using PubMed, Scopus, EBSCO, and government compendia. Keywords included "fish," "consumption," "fatty acids," "nutrients," and "Latin America;" and "fish," "chronic non-communicable diseases," "all-cause mortality," "obesity," "cancer," "neurodegenerative diseases," "metabolic diseases," "diabetes," "polycystic ovary syndrome," and "metabolic syndrome." In countries such as Chile, Brazil, and Colombia, per capita fish consumption falls below WHO's recommended levels, and the most commonly eaten species do not contain sufficient polyunsaturated fatty acids to provide an optimal intake of EPA and DHA. It is therefore recommended that each country review its dietary guidelines and fish recommendations based on the most commonly consumed species to ensure that their populations obtain the recommended intake of EPA and DHA fatty acids and thus the benefits related to the prevention of chronic noncommunicable diseases.

**Keywords:** fish consumption; polyunsaturated fatty acids; eicosapentaenoic acid; docosahexaenoic acid; chronic noncommunicable diseases; public health.

**Practical application:** This research demonstrates the low average per capita fish consumption in the region, highlighting the importance for countries to take action to promote fish consumption within the context of a healthy diet, taking into account the species of fish consumed and their fatty acid profile, in order to adjust consumption recommendations so that the population can reach the daily recommended intake of EPA and DHA essential fatty acids for the prevention of chronic diseases.

## 1 INTRODUCTION

Latin America currently has a complex public health situation due to the increasing incidence of noncommunicable diseases. For this reason, the World Health Organization (WHO) and the Pan American Health Organization (PAHO) have focused their efforts on strategies to mitigate preventable risk factors (Kelly et al., 2008). Within this scenario, some of the scientific community's main concerns are the role of diet and specific dietary determinants of health and disease (Kovalskys et al., 2019). Food quality defines people's health status, which in turn depends on aspects such as the availability, production, and distribution of food. Within this context, the consumption of fish has been of interest for its contribution of vitamins (A, B, and D), minerals (zinc, selenium, calcium, and iron), polyunsaturated fatty acids (PUFAs), and proteins of high biological value (FAO et al., 2022), with beneficial effects on human health, since its consumption has been positively associated with cognitive development, immune system, and the prevention of cardiovascular diseases (CVDs) (Jayedi & Shab-Bidar, 2020). As part of a healthy diet, the evidence recommends consuming at least two servings per week (12.5 kg/year) of different types of fish, which translates into an average daily intake of 250 mg of eicosapentaenoic acid (EPA) + docosahexaenoic acid (DHA) (Piepoli et al., 2016). In the seafood market, fish consumption in

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[1]*Universidad San Sebastián, Facultad de Ciencias para el Cuidado de la Salud, Concepción, Chile.*
[2]*Universidad de San Francisco de Quinto, Escuela de Ciencias e Ingeniería, Quito, Ecuador.*
[3]*Instituto Universitario Vive Sano, Scientific Research Department, São Paulo, SP, Brazil.*
[4]*Universidad de Chile, Instituto de Nutrición y Tecnología de los Alimentos, Laboratorio de Investigación en Nutrición y Actividad Física, Santiago, Chile.*
[5]*Universidade Estadual do Amapá, Organic Chemistry and Biochemistry Laboratory, Macapá, Amapá, Brazil.*
[6]*Universidad de Sevilla, Facultad de Medicina, Departamento de Medicina Preventiva y Salud Pública, Seville, Spain.*
*Corresponding author: aquintero@us.es
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2019 accounted for 20% of animal protein intake in 3.2 billion people, with a projection for aquaculture supply exceeding 60% of global seafood consumption by 2030 (Research and Markets, 2022). Comparing the behavior worldwide, only 13 of the 31 European dietary recommendations for fish consumption were met by national seafood supplies (Lofstedt et al., 2021), with an average consumption of 24.35 kg per capita in 2017 (EUMOFA, 2021). Likewise, in the years 2013–2016, 20% of US adults consumed fish and seafood at least twice a week, which contrasts with 40% of non-Hispanic Asian adults, while only 14.5% of Hispanic adults met the established recommendation (Terry et al., 2018). However, despite the importance of having dietary intake data, there is a lack of information in Latin American countries. This study aimed to collect and integrate data to establish the per capita fish consumption situation in Brazil, Chile, Colombia, and Ecuador and to provide an overview of the fatty acid profile of the most commonly consumed fish species and compare it with the consumption recommendation of international organizations, as well as to find updated evidence regarding the health benefits associated with fish consumption.

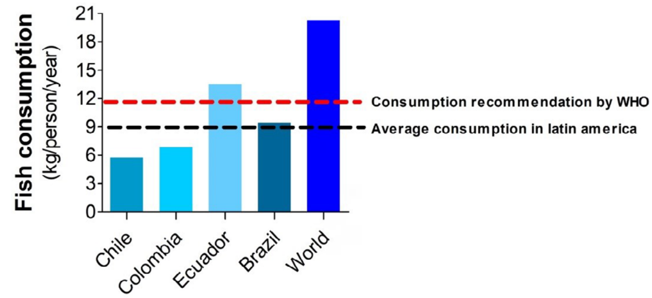
## 2 METHODS

This article was prepared through a narrative review based on exploratory bibliographic searches from January to October 2022 in PubMed, Scopus, EBSCO, and governmental compendia. Two types of literature searches were carried out: the first to obtain information on fish consumption in Latin America and the fatty acid composition of the most consumed species, using the terms "fish," "consumption," "fatty acids," "nutrients," and "Latin America;" and the second to locate information on the health benefits of fish consumption with the terms "fish," "chronic noncommunicable diseases," "all-cause mortality," "obesity," "cancer," "neurodegenerative diseases," "metabolic diseases," "diabetes," "polycystic ovary syndrome," and "metabolic syndrome." We searched using the Boolean operators "OR" and "AND." The eligibility criteria were limited to studies published in English and Spanish between 2012 and 2022. In order to ensure the quality of our review, we sought the expertise of international professionals from Chile, Colombia, Spain, Ecuador, and Brazil, who were tasked with evaluating the title and abstract of each publication.

## 3 RESULTS

### *3.1 Fish consumption in Latin American countries*

About one-fifth of global protein intake is represented by fish consumption, considered a nutritious food source and particularly relevant in counteracting micronutrient deficiencies. According to data provided by The State of World Fisheries and Aquaculture 2016 and 2018, the world's population had a per capita consumption of 20.3 kg, which is expected to increase to 21.5 kg by 2030 (OECD/FAO, 2021); however, the forecast indicates that 71% of available fish will be consumed in Asian countries, while the lowest amounts will be consumed in Latin America (FAO, 2022). Figure 1 shows the average fish consumption in four Latin American countries and the average worldwide. Research shows that Latin America's average fish consumption is only half of the global consumption, and it falls 20% below the recommended amount by the WHO. Only Ecuador surpasses the recommended consumption when analyzing individual countries, while Chile, Colombia, and Brazil only meet 48%, 57%, and 78% of the recommended annual per capita consumption, respectively.




WHO: World Health Organization.

**Figure 1**. Average fish consumption (kg/person/year) in Latin American countries.

#### *3.1.1 Brazil*

Brazil has a very diversified fish consumption across its regions; since it is a continental country, some areas lie far from rivers and seas (FAO, 2022). The average consumption evaluated in 2012 was 9.45 kg/inhabitant/year (Sartori & Amancio, 2012), below the WHO recommendation; however, when evaluating the Amazon region, which represents 60% of the national territory, the average fish consumption rises to approximately 35 kg/inhabitant/year (Isaac & Almeida, 2011). The lipid composition in fish tissues and the fatty acid profile are influenced by their diet and other environmental factors, such as salinity and geographic location, so we chose to study the Brazilian region with the highest fish consumption (Begossi et al., 2019). There needs to be more knowledge about most of the fish species caught in small-scale fisheries in the Amazon. Among the 90 most important Amazonian fish species for the diet of coastal fishing villagers, 78% still need to be evaluated or their biological information is unknown according to the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species (Gallão & Bichuette, 2012). Likewise, Amazonian communities consume large quantities of freshwater fish, yet few studies have considered the relationship between the high consumption of freshwater fish and the intake of DHA and EPA (Begossi et al., 2019). The most consumed fish species of continental origin include "aracu/piau" (*Schizodon* sp.), "curimatã" or black prochilodus (*Prochilodus nigricans*), "dourada" or gilded catfish (*Brachyplatystoma rousseauxii*), "filhote/piraíba" (*Brachyplatystoma filamentosum*), "pacu" (*Myleus* sp., *Methynis* sp., and *Mylossoma* sp.), "pescada/corvina" (*Plagioscion squamosissimus*), and "tucunaré" (*Cichla* sp.) (Ministério da Agricultura e Pecuária, 2021).

#### *3.1.2 Chile*

In Chile, according to data provided by the National Food Consumption Survey, low fish consumption has been reported in both men and women, with no significant differences in the proportions of consumption by age group, remaining homogeneous throughout all age subgroups. However, intake decreases as the socioeconomic level decreases (Ministerio de Salud de Chile, 2010), which is explained by the fact that the average monthly expenditure for the purchase of this product reaches only 3% of total food expenditure, being higher in higher quintiles (Araneda F. et al., 2016). On the contrary, there is a trend of higher consumption, albeit not significant, in urban sectors compared to the rural sector, which may be due to availability since the highest demand is concentrated in ports and localities with higher transportation facilities (Couyoumdjian, 2009). The mean reported for fresh or canned fish and seafood is 15.8 g/day (5.7 kg/person/year), which, when disaggregated, represents 17.0 g/day in men and 13.7 g/day in women (Ministerio de Salud de Chile, 2010). At the same time, an average consumption in children of no more than 9 g/day has been reported (Olivares et al., 2005), registering as the product with the lowest consumption as compared to red meat, poultry, and dried legumes. The low consumption of fish can be explained by its high price, even though Chile is the world's leading producer of salmonids, representing 94% of the exports in the aquaculture sector, concentrated in three species: Atlantic salmon (*Salmo salar)* (67.1%), Pacific salmon or, more specifically, coho salmon (*Oncorhynchus kisutch)* (15.6%), and rainbow trout *(Psalm gairdneri)* (9.2%) (Rodrigo Astorga et al., 2019).

### *3.1.3 Ecuador*

Ecuador has a rich marine shelf due to its privileged position in oceanographic terms and important aquaculture production, being one of Latin America's leading exporters of fishery products (Carrión, 2019). The diversity of fish species in Ecuador's inland waters is remarkable; there are approximately 1,400 species of fish, including marine and inland water (rivers, lagoons, and estuaries) species, of which more than 730 are from rivers. This figure represents 4% of the world's freshwater species (Instituto Nacional de Pesca, 2018). The most consumed species are skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*), six types of "corvina" (*Sciaenidae spp*), swordfish (*Xiphias gladius*), "dorado" or common dolphinfish (*Coryphaena hippurus*), and four types of catfish (including *Bagre panamensis*) (Prado & Báez, 2004). There are also introduced species with high consumption, for instance, trout (*Oncorhynchus mykiss*) and Nile tilapia (*Oreochromis niloticus*), especially in the Andean region, which have had a great impact on native fish populations (Instituto Nacional de Pesca, 2018). Ecuador is one of the world's largest tuna exporters. The country has the second most powerful tuna fleet in the Eastern Pacific. Fishery exports include tuna loins and canned tuna, frozen fish, fish fillets, fresh fish, and by-products such as fishmeal and fish oil (Ormaza et al., 2021). Even though fisheries and aquaculture are a pillar of Ecuador's economy, domestic consumption is among the lowest in Latin America. In 2011, the average per capita consumption of fish and other fishery products was 7 kg/year, below the world average (Jácome et al., 2011). In 2020, an exploratory study by Ormaza et al. (2021) showed an increase in per capita consumption of 13.5 kg/year. These figures vary according to the population's habits, prices, and product availability. Fish consumption is conditioned by several factors, such as distribution, especially in the Andean and Amazonian areas, where distribution problems make the product more expensive in addition to the purchasing power of a large part of the population.

### *3.1.4 Colombia*

In Colombia, fishing and aquaculture production comes from inland and marine aquaculture (44%), marine fishing from the Caribbean Sea and the Pacific Ocean (43%), and, to a lesser extent, from inland freshwater fishing (13%) (Perucho Gómez, 2010). The main industrial saltwater fish are tuna *(Thunnus)*, shrimp, lobster (Nephropidae), northern red snapper *(Lutjanus campechanus)*, grouper (Epinephelinae), "sierra" or smalltooth swordfish (*Pristis pectinata*), and wreckfish (Polyprionidae). The main saltwater fish for artisanal fishing are shrimp, snapper, offshore hake (*Merluccius albidus*), "sierra," tuna, "piangua" *(Anadara tuberculosa)*, clam *(Argopecten ventricosus)*, and lobster (Perucho Gómez, 2010). The most important fish for artisanal fisheries in inland areas (rivers, lakes, marshes, and reservoirs) are "bocachico" (*Prochilodus reticulatus magdalenae)*, "valentón" or Laulao catfish (*Brachyplatystoma vaillantii)*, "catfish" (Siluriformes), "nicuro" or Bloch's catfish *(Pimelodus blochii)*, "baboso" or bignose shark (*Carcharhinus altimus*), "capaz" (*Pimelodus grosskopfii*), "bocón" (*Opistognathidae*), and "doncella" or Mediterranean rainbow wrasse (*Coris julis*) (Perucho Gómez, 2010). The main aquaculture species are tilapia (*Oreochromis* sp.), trout (*Salmo gairdneri*), "cachama" or red-bellied pacu (*Piaractus brachypomus*), and shrimp (AUNAP, 2013). Another source of consumption of fishery and aquaculture products is imported food items, which in 2008 were mainly in the form of preserves and preparations (65.89%), followed by crustaceans (fresh crabs and lobsters, and frozen shrimp) (12.35%), other fish (7.53%), mollusks (6.26%), tuna (4.73%), salmon (1.67%), and finally trout and hake (< 1%) (Perucho Gómez, 2010). Apparent consumption of fishery and aquaculture products, calculated as production plus the difference between imports and exports per number of inhabitants in Colombia between 2006 and 2018, showed an increase from 2.81 kg/person/year (AUNAP, 2013) to 6.86 kg/person/year (Ministerio de Agricultura de Colombia, 2018). These are both, however, well below the Latin American average, which is around 9 kg/person/year. The potential consumer population ranges between 5 and 70 years of age, representing 85.20% of all Colombians (Perucho Gómez, 2010). According to the 2015 National Survey of Nutritional Status (Jiménez Soto et al., 2020), the national prevalence of fish or seafood consumption by age group is 63.1% for 3–4-year-olds, 59.6% for 5–12-year-olds, 57.3% for 13–17-year-olds, and 65.3% for 18–64-year-olds. There is no data available for those over 65 years of age. The frequency of consumption per day in all age groups at the national level is 0.1, which is equivalent to less than once a week. Fish consumption varies according to ethnicity, region, and wealth index. The Afro-descendant population had a higher fish consumption prevalence than those not of African descent. The regions with the highest prevalence and frequency of fish consumption were the Atlantic, Pacific, and Orinoco-Amazon regions. As regards the wealth index, the populations in the very low and low quartiles have the lowest prevalence of fish consumption, although, in the 18–64 age range, the frequency was higher in the lowest quartile (0.2 times/day). The average amount of fish consumed by the age group was estimated in the 3–4-year-olds group as 116.5 g and in the 18–64-year-olds group as 168.5 g. In the other age groups, no average figure is found since only the 40 most consumed foods are reported, which indicates that fish is not a prominent food in Colombian people's diets.

### *3.2 Fish and fatty acid profile*

Unfortunately, there is no exact information on the most consumed species in each country or updated information on the fat composition and complete lipid profile of all the species produced and/or consumed. Table 1 shows the lipid profile of Brazil, Ecuador, Chile, and Colombia's most important produced and/or consumed fish. According to the data collected, it can be observed that in Chile, the species "corvina," mackerel, Chilean horse mackerel, and Chilean sandperch are rich in DHA and EPA. The consumption of one portion/week (125 g) of mackerel, two portions of Chilean horse mackerel, or three portions of Chilean sandperch covers the recommended daily consumption of DHA+EPA for an adult (250 mg/day). In Colombia, the species with the highest DHA content are rainbow trout and snapper. Four servings of these species should be consumed weekly to cover the recommended daily consumption of DHA and EPA. The other species are not a source of these two fatty acids. On the contrary, although Ecuador has the highest per capita fish consumption, the most important species are not rich in DHA and EPA. In the Brazilian Amazon, as in Ecuador, although per capita consumption is the highest in this region, the species consumed are low in EPA and DHA. Therefore, to reach the daily consumption recommendation, at least six portions per week of "tambaqui" or eight portions of "piracuco," "aracu," or "curimatã" should be consumed.

### *3.3 Fish consumption and health*

Unhealthy diets are the leading risk factor for noncommunicable diseases, causing 41 million deaths annually (Forouzanfar et al., 2016). CVDs, cancer, and type 2 diabetes mellitus (DM2) are the top causes. In Latin America, unhealthy diets are responsible for 18% of adult deaths (Afshin et al., 2019) and represent a significant economic burden, particularly in developing countries (Jayedi et al., 2018). Incorporating fish into one's diet at least twice a week can contribute to a healthy lifestyle by providing anti-oxidative, anti-inflammatory, neuroprotective, cardioprotective, and healing benefits. These properties can help prevent conditions such as diabetes, obesity, and polycystic ovary syndrome (PCOS). Studies show that consuming fish is linked to a lower risk of all-cause mortality (Zhao et al., 2016), possibly due to the high levels of EPA and DHA fatty acids found in fatty fish (Shao et al., 2022) (as shown in Figure 2).

#### *3.3.2 Fish consumption and cardiovascular disease*

The Mediterranean diet is recommended by the American College of Cardiology for preventing CVDs. Studies have shown that an intake of olive oil, wine, and fish/seafood, along with a lower intake of sugary drinks and sweets, decreases the risk of CVD (Li et al., 2020). Another study found that consuming at least 175 g/week of fish with higher amounts of omega-3 fatty acids can also lower the risk of CVD and total mortality (Mohan et al., 2021).

#### *3.3.3 Fish consumption and cancer*

Eating high omega-3 fish may reduce cancer risk by controlling inflammatory molecules, but more research is needed (Larsson et al., 2004; Molina-Montes et al., 2021; Ubago-Guisado et al., 2021). Eating more marine omega-3 may lower the risk of breast cancer according to multiple studies. Observational and cohort studies have shown a reduction in breast cancer risk (Zheng et al., 2013), but case-control analyses did not yield significant results (Lee et al., 2020). Consuming fish may also lower colorectal cancer risk (Sofi et al., 2019). Adding fish and marine omega-3 to one's diet may protect against cancer survival (Wang et al., 2023). However, omega-3 has a negative correlation with overall survival for lung cancer patients (Wang et al., 2023).

#### *3.3.4 Fish consumption and metabolic syndrome*

Studies show that consuming fish may improve metabolic health and protect against metabolic syndrome (MetS) (Karimi et al., 2020; Torris et al., 2014). Men may benefit more than women (Torris et al., 2014), and consuming between 30 and 150 g/week of fish is effective in reducing the risk of MetS. However, consuming over 400 g/week may increase the risk beyond a certain threshold (Karimi et al., 2020).

#### *3.3.5 Fish consumption and diabetes mellitus*

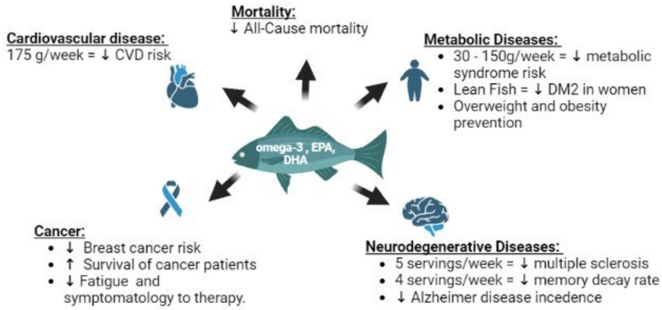
The American Diabetes Association recommends eating high-quality foods such as whole grains, legumes, nuts, fruit, and vegetables and reducing one's intake of refined and processed foods to lower the risk of DM2. Various diets, e.g., a Mediterranean, Dietary Approaches to Stop Hypertension (DASH), and vegetarian diet, also help (ElSayed et al., 2023). Changing our dietary habits is better than focusing on caloric restriction (Díaz-Rizzolo et al., 2021).

Eating fish high in omega-3 has positive effects on CVDs, but its impact on type 2 diabetes is uncertain (Djoussé et al., 2011). Norwegian women who consume lean fish have a lower risk of type 2 diabetes due to its protein and amino acid content (Imae et al., 2014; Øyen et al., 2021). However, studies show that the association between fish consumption and type 2 diabetes varies based on gender, geographic location, and the amount consumed (Djoussé et al., 2011; Pastorino et al., 2021; Schwingshackl et al., 2017). Generally, women who consume large amounts of fish have a higher risk of type 2 diabetes, while men do not (Pastorino et al., 2021). Consuming more than two servings of fish per day can increase the risk of DM2 (Djoussé et al., 2011), which is believed to be due to environmental contaminants in fish (Díaz-Rizzolo et al., 2021; Marushka et al., 2017; Namazi et al., 2019; Øyen et al., 2021; Pastorino et al., 2021; Wylie-Rosett et al., 2012). More studies are needed

**Table 1**. Total lipids and fatty acid profile of Latin American fish per 100 g of fish.

| Species | Scientific name | Total lipids (g) | SFA(mg) | MUFA(mg) | PUFA(mg) | DHA(mg) | EPA(mg) | Ref. |
|---|---|---|---|---|---|---|---|---|
| **Chile** | | | | | | | | |
| Corvina | *Cilus gilberti* | 1.4 | 326.0 | 208.8 | 376.2 | 187.8 | 106.8 | (Rincón-Cervera et al., 2020) |
| Mackerel | *Scomber japonicus* | 6.4 | 2,065.5 | 1,897.5 | 1,906.5 | 956.0 | 414.7 | (Rincón-Cervera et al., 2020) |
| Common hake | *Merluccius gayi gayi* | 1.3 | 243.9 | 151.8 | 369.8 | 188.0 | 121.4 | (Rincón-Cervera et al., 2020) |
| Chilean horse mackerel | *Trachurus murphyi* | 3.8 | 1,126.1 | 899.7 | 1,068.0 | 504.9 | 282.0 | (Rincón-Cervera et al., 2020) |
| Chilean sandperch | *Pinguipes chilensis* | 2.7 | 859.6 | 863.5 | 690.3 | 221.7 | 285.9 | (Rincón-Cervera et al., 2020) |
| Fine sole | *Paralycthis adpersus* | 0.8 | 139.1 | 59.4 | 239.9 | 169.7 | 32.2 | (Rincón-Cervera et al., 2020) |
| Southern hake | *Merluccius australis wild* | 4.4 | 11.3 | 18.1 | 14.3 | 5.6 | 5.6 | (Serrano et al., 2020) |
| Southern hake | *Merluccius australis captive* | 7.7 | 20.4 | 28.7 | 28.7 | 10.5 | 10.8 | (Serrano et al., 2020) |
| **Colombia** | | | | | | | | |
| Rainbow trout | *Salmo Gairdneri* | 4.1–8.1 | n.d. | 1,000–2200 | 610–1,320 | 240–480 | 10–20 | (Perea et al., 2008) |
| Red tilapia | *Oreochromis* sp. | 2.2–4.5 | n.d. | 0–100 | 410–720 | 50–120 | 0–10 | (Perea et al., 2008) |
| Catfish | *Pseudoplatystoma fasciatum* | 0.0–1.9 | n.d. | 0–100 | 0–100 | 10–40 | 0–10 | (Perea et al., 2008) |
| Bocachico | *Prochilodus reticulatus magdalenae* | 1.3–5.2 | n.d. | 0–100 | 10–140 | 20–60 | 0–10 | (Perea et al., 2008) |
| White cachama | *Piaractus brachypomus* | 1.6–6.3 | n.d. | 500–1,900 | 200–802 | 10–50 | 0–10 | (Perea et al., 2008) |
| Snapper | *Lutjanus campechanus* | 1.12 | n.d. | 189 | n.d. | 260,9 | 67,7 | (Izquierdo et al., 1999) |
| **Ecuador** | | | | | | | | |
| Yellowfin tuna | *Thunnus albacares* | 12 | 12.1 | 38.1 | 48.8 | 48.8 | 7.1 | (Renuka et al., 2016) |
| Skipjack tuna | *Katsuwonus pelamis* | 11.7 | 32.9–34.7 | 15.5–21.3 | 35.4–42.6 | 24.7 | 4.6 | (Srichan et al., 2018) |
| Swordfish | *Xiphias gladius* | n.d. | 42.4 | 43.0 | 13.9 | 7.1 | 2.2 | (Lazo-Andrade et al., 2021) |
| Dorado | *Coryphaean hippurus* | 2.15 | 30.8 | 14.1 | 52.8 | 43.3 | n.d. | (Messina et al., 2019) |
| Trout | *Oncorhynchus mykiss* | 5.11 | 26.5 | 34.3 | 32.5 | 13.4 | 5.5 | (Fallah et al., 2011) |
| Nile tilapia | *Oreochromis niloticus* | 1.09 | 26.3 | 28.9 | 44.7 | 0.1 | 1.4 | (Justi et al., 2003) |
| **Brazil (Amazon)** | | | | | | | | |
| Tambaqui | *Colossoma macropomum* | 7.6 | 241.4 | 259.3 | 163–490 | 45–223 | 43.2 | (Oliveira et al., 2020; Petenuci et al., 2016) |
| Pirarucu | *Arapaima gigas* | 6.38–8.26 | 1,884.1–2,549.6 | 1,545.5–2,055.7 | 1,009.4–1,513.1 | 54.2–87.8 | 59–83.8 | (Cortegano et al., 2017; Coutinho et al., 2019) |
| Aracu | *Leporinus friderici* | 3.9–7.3 | 241.3 | 248.8 | 180.9 | 141.9 | 38.9 | (Petenuci et al., 2016) |
| Curimatã | *Prochilodus nigricans* | 4.3–5.7 | 267.5 | 273.5 | 171.2 | 113.9 | 57.3 | (Petenuci et al., 2016) |
| Piraíba or filhote | *Brachyplatystoma filamentosum* | 6.7–9.5 | 274.9 | 248.5 | 172.9 | 140.0 | 32.3 | (Petenuci et al., 2016) |
| Piraíba or filhote | *Brachyplatystoma flavicans* | 6.8–15.4 | 297.5 | 274.1 | 172.4 | 147.7 | 32.7 | (Petenuci et al., 2016) |
| Tucunaré | *Cichla sp.* | 0.8–2.5 | 38.8–44.5 | 22.8–30.0 | 24.2–35.8 | 14.3–17.7 | 9.5–17.3 | (Inhamuns et al., 2009) |
| Piranambú/Barbado | *Pinirampus pirinampu* | 3.8–14.4 | 296.1 | 335.2 | 162.6 | 64.4–71.8 | 19.7–25.7 | (de Souza et al., 2020; Ramos Filho et al., 2010) |
| Piracatinga | *Calophysus macropterus* | 1.8–4.9 | n.d. | n.d. | n.d. | n.d. | n.d. | (de Souza et al., 2020) |
| Mapará | *Hypophthalmus edentatus* | 1.2–2.5 | n.d. | n.d. | n.d. | n.d. | n.d. | (de Souza et al., 2020) |
| Jaú/Pacamon | *Zungaro zungaro* | 9.98–10.9 | n.d. | n.d. | n.d. | 71.8–76.6 | 42.14–44.3 | (de Souza et al., 2020; Ramos Filho et al., 2010) |
| Tambaqui | *Colossoma macropomum* | 7.5–10.1 | n.d. | n.d. | n.d. | n.d. | n.d. | (de Souza et al., 2020) |
| Caparari | *Pseudoplatystoma tigrinum* | 0.9–1.1 | n.d. | n.d. | n.d. | n.d. | n.d. | (de Souza et al., 2020) |
| Jandiá | *Leiarius marmoratus* | 1.6–2.6 | n.d. | n.d. | n.d. | n.d. | n.d. | (de Souza et al., 2020) |
| Pirarara | *Phractocephalus hemioliopterus* | 9.3–26.3 | n.d. | n.d. | n.d. | n.d. | n.d. | (de Souza et al., 2020) |
| Surubim | *Pseudoplatystoma fasciatum* | 4.2–10.8 | n.d. | n.d. | n.d. | n.d. | n.d. | (de Souza et al., 2020) |

n.d.: no data.




CVD: cardiovascular disease; DM2: Diabetes Mellitus type 2.
**Figure 2**. Fish consumption and health.

to determine the link between fish consumption and DM2. Factors such as fish farming type, mercury and fat content, cooking methods, accurate measurements of intake, and demographic and health characteristics must be considered.

*3.3.6 Fish consumption and obesity*

The nutritional profile of different fish species has shown the benefit of fish consumption to combat malnutrition and obesity due to their high contents of omega-3 PUFA, minerals, and vitamins D and B12, their high biological value protein, and their lower caloric content, being considered leaner than red meat (Balami et al., 2019; Tacon et al., 2020). Therefore, to prevent obesity, it is advisable to encourage a dietary pattern that is moderately high in high-quality fats rather than restricting the intake of fats altogether (Pastorino et al., 2021). A dietary pattern study of normal-weight and obese reproductive-age women in Indonesia indicated that the obese group was characterized by the consumption of oils and fats through fried foods and snacks, while the normal-weight group included fish and seafood in their diets (Yulia et al., 2016). In contrast, compelling evidence shows that fish consumption is not directly related to body weight control, obesity, abdominal obesity, or being overweight (Jakobsen et al., 2013; Schlesinger et al., 2019). It would be interesting to relate fish consumption in Latin America with the prevalence of overweight and obese people, considering factors such as sex, age, economic group, and physical activity.

*3.3.7 Fish consumption and polycystic ovary syndrome*

PCOS affects 4–20% of reproductive-age women (Deswal et al., 2020). Fish contains nutrients associated with proper metabolic and endocrine function, such as iodine, selenium, vitamin D, taurine, and omega-3 fatty acids (Mendivil, 2021). Fish oil has been widely used as a supplement for PCOS. This oil contains omega-3 fatty acids, EPA, and DHA (Zhang et al., 2018) and produces benefits in terms of mental health parameters, insulin metabolism, and inflammatory and oxidative stress markers, such as malondialdehyde and C-reactive protein (CRP) (Hajivandi et al., 2020). It also improves the expression of genes associated with low-density lipoprotein receptors and glucose transporters and reduces testosterone and insulin levels (Hajivandi et al., 2020) compared to the dietary and physical activity behavior of 39,471 women with and without PCOS. A poor intake of the main food groups (grains, fruit, vegetables, proteins, seeds, nuts, and dairy) was found in women with PCOS. Likewise, low consumption of whole grains, fish, and yogurt was found in women with PCOS in Latin America. Similar metabolic profiles are found across Latin American countries and other countries with high consumption of processed foods (Kovalskys et al., 2019; Marchesan et al., 2021).

*3.3.8 Fish consumption and neurodegenerative diseases*

Neurodegenerative diseases [such as multiple sclerosis (MS), Huntington's disease, Parkinson's disease (PD), and Alzheimer's disease (AD)] cause significant levels of morbidity and disability, impacting worldwide social, economic, and health systems (Marques-Aleixo et al., 2021). Numerous investigations have focused on studying neurodegenerative diseases and diet. No consistent association between (fatty) fish consumption and cognitive impairment has been observed in Huntington's disease patients (Zahra et al., 2020). In contrast, in MS patients, the benefits of fish oil and omega-3 supplementation have been reported in terms of reducing recurrence rate and markers of inflammation and improving quality of life (AlAmmar et al., 2021). In addition, a protective effect between fish consumption and a lower risk of developing MS has been associated with consuming five servings per week (Rezaeizadeh et al., 2022). Likewise, a diet rich in nuts and fish (with omega-3 and omega-6) can reduce the risk of MS; however, controversy is found about the essential role of the relationship between omega-3 and omega-6 (Esposito et al., 2018; Mische & Mowry, 2018).

A meta-analysis of observational studies with moderate quality of evidence concluded that compared with low (once a week) or no fish consumption, higher fish consumption was related to a lower incidence of AD (Barbaresko et al., 2020) and that an increase of one serving/week of fish in one's diet is associated with lower risks of dementia (Zhang et al., 2016). In contrast, Fischer et al. (2018) found no significant association between fresh fish intake and AD or memory decline; their contrasting results may be because approximately one-third of their study population consumes freshwater fish, which does not provide significant amounts of omega-3 fatty acids, as opposed to saltwater fish. The long-term benefit of fish consumption is likely related to the positive impact of EPA and DHA on an individual's cognitive functions (Kosti et al., 2022); however, a 0.1 g/day increase in marine-derived DHA intake has been associated with a lower risk of dementia and AD; the dose–response relationship is not linear (Zhang et al., 2016). Thus, many unanswered questions remain about the mechanisms linking fish consumption's short- and long-term effects and EPA and DHA intake (Kosti et al., 2022).

## 4 DISCUSSION

Fish is a product that can be prepared and consumed in various ways. It is a food source of vitamins (A, B, and D) and minerals (Zn, Se, Ca, and Fe). It has been mainly promoted as a source of PUFAs (omega-3, omega-6, and omega-9), which gives it an important antioxidant activity associated with preventing CVDs, cancer, MetS, diabetes, obesity, PCOS, and neurodegenerative diseases, among others. Numerous cross-sectional, observational, and prospective cohort studies show that weekly fish consumption significantly reduces the risk of developing these diseases. However, data collected in various countries show that fish consumption generally does not cover the FAO/WHO recommendation of 3–4 servings per week (125–150 g), except when fresh fish and slightly or nonindustrialized fish are consumed.

It is essential to highlight the importance of studying in depth both the consumption and the species of fish consumed since, as we have seen, recently published research demonstrates that people in the countries in the region with the highest per capita fish consumption (Ecuador and Brazil) tend not to consume species with important sources of DHA+EPA. Therefore, the recommendation of local fish consumption should be increased to approximately seven portions per week, double the consumption recommendation of the WHO. In the case of Chile, it is essential to encourage the consumption of the three species rich in DHA+EPA to achieve the recommended consumption of these omega-3 fatty acids with just a few servings per week.

Despite our study successfully gathered the necessary information to answer our research question on fish consumption patterns in Latin American countries. However, we face certain limitations in reaching an accurate conclusion. First, food and nutrition surveys and/or food registers in the countries studied do not provide sufficient information on fish consumption by species. Fish is often treated as a homogeneous food group when analyzing diets. Therefore, we could only estimate total fish consumption and not species-specific consumption.

It is still uncertain which nutrients and essential fatty acids are present in all fish species indigenous to the countries in the region. This limitation is also found at the global level, with the nutritional composition of only a quarter of the fish species consumed worldwide reported to be available, and the most food insecure and nutritionally vulnerable countries are the worst at accounting for the nutritional composition of the Indigenous species consumed (Byrd et al., 2021). Second, there are difficulties in harmonizing and comparing available data on fatty acid composition due to differences in units of measurement and parts of fish measured.

In addition, it was difficult to accurately determine fish consumption in Latin American countries due to inconsistencies in how composition is measured and reported in the literature. These limitations include variations in the parts of fish analyzed (e.g., whole fish, dry weight, muscle, and raw edible parts) and differences in the measurement metrics used to report fatty acid content (e.g., percent chromatographic peak area versus mg content per 100 g of product).

However, our review also provides a starting point for future research, which should consider the challenges to the limitations outlined here. Future research should address these challenges by examining fish consumption patterns by species and origin, harmonizing measurement techniques and metrics, and thus expanding nutrient and fatty acid composition data for locally consumed fish. Creating a comprehensive database on the fatty acid composition of local fish will allow us to understand better the relationship between fish production, consumption, and nutrient availability and provide better nutritional recommendations.

## 5 CONCLUSIONS

Latin American countries face a concerning decline in fish consumption that is below WHO recommendations and the global average. Fish offers numerous health benefits, including preventing heart and brain issues, obesity, diabetes, and PCOS due to its antioxidants and anti-inflammatory properties. Encouraging fish consumption in the region is vital by tailoring recommendations to the most consumed species and their fatty acid composition. Challenges lie in identifying species accurately due to the variety and regional differences. It is important to continue with research in Latin American countries on fish consumption, species, and fatty acid intake to arrive at more specific nutritional recommendations and thus obtain the benefits of its consumption in the population. Assessing contaminating compounds, e.g., mercury, and studying health benefits and chronic noncommunicable diseases of popular fish species are essential areas for exploration.

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