FOOD SECURITY AND FOOD SAFETY CHALLENGES IN VENEZUELA

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FOOD SECURITY AND FOOD SAFETY CHALLENGES IN VENEZUELA

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EDITORIAL
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Editorial: Food Security and Food Safety Challenges in Venezuela

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Editorial on the Research Topic

Food Security and Food Safety Challenges in Venezuela

Venezuela has suffered a massive shift in status. Once considered an affluent nation with the largest proven fossil-fuel reserves in the world, and classified as an upper-middle income country, declines in oil production, fuel availability and flawed macroeconomic decisions, disrupted all sectors of the economy. A large proportion of the population had ready access to food, health services, clean drinking water, sanitation, domestic gas, electricity, fuel, and transport, but declines in food production, real income, and living conditions have generated malnutrition and food insecurity, forcing complex survival strategies. All this gave rise to a humanitarian space.

In 2019, this space was expanded through the installation of the international humanitarian coordination architecture of the UN. Under the Office for the Coordination of Humanitarian Affairs (OCHA), a country team and eight clusters were established: food security/livelihoods; water/sanitation/hygiene; education; nutrition; health; protection; shelter/energy/non-food items and logistics. OCHA indicates the humanitarian situation has not abated following six consecutive years of economic contraction, inflation/hyperinflation, political/social/institutional tensions, the COVID-19 pandemic and international sanctions[1].

According to The Office of the United Nations High Commissioner for Refugees (UNHCR) people continue to leave the country to escape violence, insecurity, and threats as well as a lack of food, medicine, and essential services, becoming one of the largest displacement crises in the world, with 5.9 million seeking better conditions elsewhere[2].

The prevalence of undernourishment (PoU) has increased almost 4-fold: from 6.4% in 2012–2014 to 21.2% in 2016–2018 (**Figure 1**). During the same recession period, reported inflation reached circa 10 million percent and growth in the real GDP worsened, going from negative 3.9 percent in 2014 to an estimated negative 25 percent in 2018 (FAO, IFAD, UNICEF, WFP and WHO, 2019). **Figure 1** shows a sustained increase in PoU since 2009. This would appear to repudiate, or at least not corroborate official claims attributing PoU to sanctions in place since 2017.

[1]OCHA-UN. Available online at: https://reliefweb.int/sites/reliefweb.int/files/resources/venezuela_humanitarian_response_plan_update_2021_june2021.pdf.

[2]UNHCR-UN. Available online at: https://www.unhcr.org/venezuela-emergency.html (accessed November 4, 2021).

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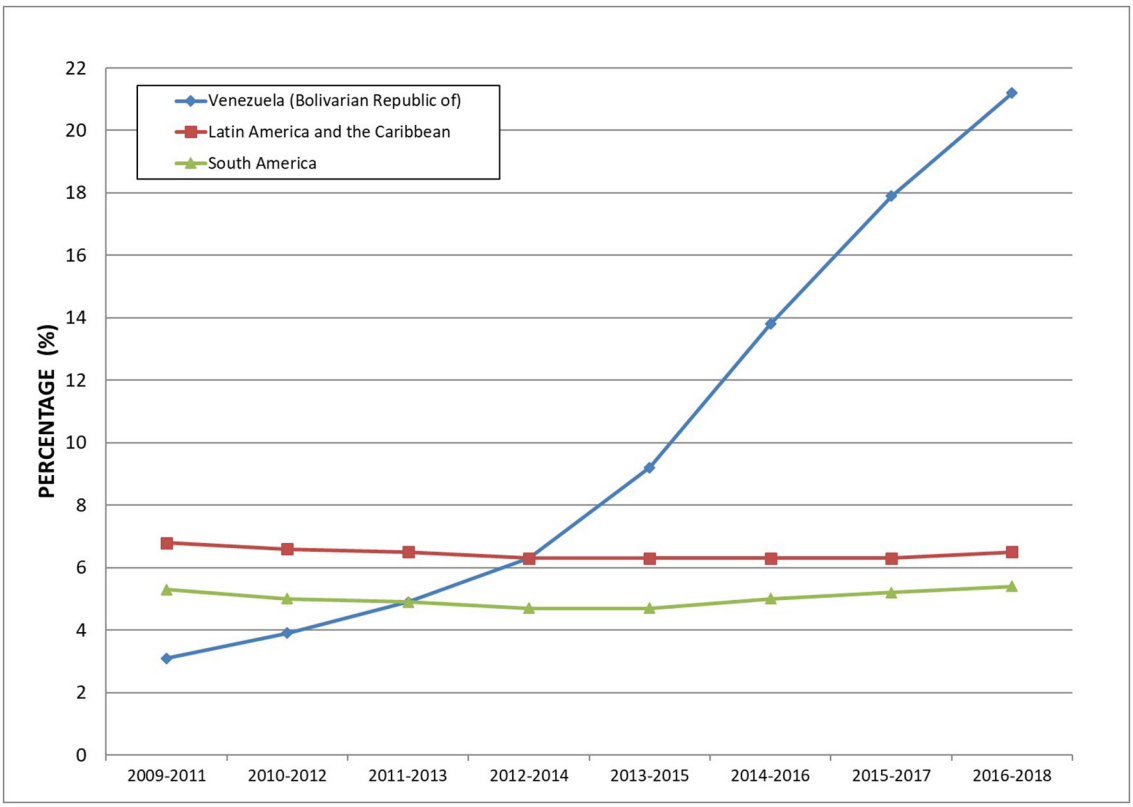

FIGURE 1 | Prevalence of undernutrition. Bolivarian Republic of Venezuela (2009–2018 in 3-year periods). Adapted from FAO, IFAD, UNICEF, WFP and WHO (2019). 2018 estimates in the 2016–2018 3-year averages are projected values.

In 2019, the World Food Program estimated that 7.9 percent of the population (2.3 million) was severely food insecure and 24.4 percent (7 million) moderately food insecure. One out of three Venezuelans (32.3%) was food insecure and in need of assistance[3].

Analyzing food and nutrition security (FNS) in Venezuela is an arduous task due to the lack of official information. The scientific and academic community, NGOs, and consultants, have therefore committed to collect information on FNS (Tapia et al., 2017). This is the case of this Research Topic.

Ten articles are published in the following order:

Rodríguez García article on "Food Security in Venezuela: From Policies to Facts" uses the Venezuelan experience to draw attention to the fact that decreeing many laws and regulations related to food and nutrition is not enough to guarantee the right to food.

Moreno-Pizani in "Water Management in Agricultural Production, the Economy, and Venezuelan Society" analyses the mismanagement of water as a fundamental resource for production, economy, and society. Despite abundant water resources, serious problems affect the Venezuelan food production system (irrigation infrastructure, low availability of water in production processes, and decreased electricity generation).

Hernández et al. in "Dismantling of Institutionalization and State Policies as Guarantors of Food Security in Venezuela: Food Safety Implications," use the Venezuelan case to illustrate how the food safety and security infrastructure of a country laboriously established over a century can be undermined and dismantled in a disproportionately short number of years.

"Assessment of Malnutrition and Intestinal Parasites in the Context of Crisis-Hit Venezuela: A Policy Case Study" by Mejias-Carpio et al. take a rational approach to international recommendations for countries in crisis, applying them to the alarming resurgence of intestinal parasites related to poverty and anemia which are aggravating the health and nutritional status of Venezuelan children.

Herrera-Cuenca et al. in "Challenges in Food Security, Nutritional, and Social Public Policies for Venezuela: Rethinking the Future," intend to conceptualize a public policy model that analyzes current food security, nutrition, and social indicators.

Raffalli and Villalobos in "Recent Patterns of Stunting and Wasting in Venezuelan Children: Programming Implications for a Protracted Crisis," show how the protracted humanitarian crisis has significantly impacted child growth, based on assessment of the patterns of wasting and stunting and their concurrence

[3]World Food Program-WFP-UN. Available online at: https://reliefweb.int/sites/reliefweb.int/files/resources/Main%20Findings%20WFP%20Food%20Security%20Assessment%20in%20Venezuela_January%202020-2.pdf.

among vulnerable children through anthropometric records captured by Caritas Venezuela.

In "Ethics and Democracy in Access to Food. The Venezuelan Case," Marrero Castro and Iciarte-García discuss the ethical dimension of the right to food under the premises of the Nobel laureate Amartya Sen that equate functional democracies and food security, demonstrating the relationship through the Venezuelan case.

Hernández and Camardiel in "Association Between Socioeconomic Status, Food Security, and Dietary Diversity Among Sociology Students at the Central University of Venezuela" found that sociology students who are food insecure are four times more likely to have a poor varied/monotonous diet.

Pico et al. address the migration crisis in "Food and Nutrition Insecurity in Venezuelan Migrant Families in Bogotá, Colombia" analyzing the changes in access, availability, and food consumption in Venezuelan migrants who arrive in Colombia as their first destination.

Finally, Marys and Rosales in "Plant Disease Diagnostic Capabilities in Venezuela: Implications for Food Security," discuss how the growing problems in diagnosing, monitoring, and managing plant diseases in the country affect national food security (i.e., huanglongbing devastating our citrus industry).

This Research Topic represents an extraordinary opportunity to expose Venezuela's situation, considered unique in a country outside of war. It uses science-based analysis to explore how food systems can be affected by multiple factors and help establish a framework to address the issues that Venezuela is currently facing, and which other countries may confront in the future. We express our gratitude to Frontiers for their support.

AUTHOR CONTRIBUTIONS

MT prepared this Editorial. All authors revised and approved the submitted version of the article.

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REVIEW
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Water Management in Agricultural Production, the Economy, and Venezuelan Society

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The availability of water resources has a direct impact on the economy of a country and the development of the main production processes, from agriculture, irrigation, and food production, to energy generation and water supply. The regional economic and social development is influenced by an adequate management of water resources because it stimulates the economy by expanding and ability to provide water for multiple uses, directly impacting on the generation of employment the improving the quality of life of the population. Venezuela has abundant surface water resources in the large basins. The northern part of Venezuela, where the highest percentage of the population and the main economic activities are based, face a severe water scarcity. Irrigation systems under public sector administration are characterized by large budgetary restrictions, with works for rehabilitation, operation, and maintenance generally carried out with inefficient results, due to lack of adequate technical supervision. There is a gap of official information that allows highlight the crisis that the agricultural sector has faced in the last decade. Another, very important aspect is Venezuela's severe energy crisis which began to present a deficit of electric power generation that has been alarmingly evident since 2009, which has worsened for more than a decade, causing the lack of electricity supply in large regions of the country for periods of time exceeding 100 h, contributing to aggravate the country's economic crisis. Due to the situation described, Venezuelan food systems have been seriously affected mainly by the advanced deterioration of irrigation infrastructure and the water availability on production processes. This paper explores and analyses the influence of water management on production Venezuelan economics and society, focus in three pillars representing the qualitative and quantitative relationships of water management and its impact on the system considering the aspects related to the sustainability of Venezuelan agri-food systems, analyzing the fundamental aspects for food production, main indicators related to the national economy, addressing the challenges to ensure food security.

Keywords: food security, irrigation, development, sustainability, economy

INTRODUCTION

To ensure the food of the world's population, agricultural production has accelerated, leading to water resource shortages in some regions, with environmental deterioration (FAO, 2020; Ibrahiem and Hanafy, 2020; Yang et al., 2020). In order to meet the increase in demand for food and bioenergy it is necessary to intensify existing farmland, increasing crop yields and, without a doubt, the most viable solution is through investments in irrigation technology (Beringer et al., 2011; Taheripour et al., 2016; Ledvina et al., 2018; Vågsholm et al., 2020).

Venezuela has a continental territory of 916,445 km^2, divided into 23 states, a Capital District, 235 islands and 71 islands and cays located in the Caribbean Sea that together are part of the called Federal Units of which, according to the Ministry of the Environment and Renewable Natural Resources MARNR, the total area of forests at that time was 529.060 km^2, of which 70.7% is located in the Guiana region. The rest of the area is covered by a wide range of plant formations of which the most abundant is the open savannah with 118.852 km^2 (Ministerio del Ambiente y de los Recursos Naturales Renovables (MARNR), 1982). The potentially arable lands are located north of the Orinoco river plus the Delta Amacuro state and total 10,986,195 hectares, of which only 2,031,836 hectares are of high quality (classes I and II), which represents 18.8% of the potentially arable lands Medium quality land (class III) constitutes 33.7% and low-quality land (class IV) 47.5%, both percentages refer to potentially arable land (Ministerio del Ambiente y de los Recursos Naturales Renovables (MARNR), 1995). Under tropical climate the temperature spectrum ranges from 0 to 40°C, with the coldest months being January and February with stable temperatures between 15 and 35°C, and maximum temperatures occur in March and September. The dry period (January to April) is characterized by drought and the wet period (May to November) with annual rainfall ranging from 1000 to 1500 mm in the central region of the country.

Since 2000, droughts have severely affected Venezuela's water, agricultural and hydroelectric sectors. During the period 1960–2005, the basins provided to the large Venezuelan reservoirs were exposed to recurrent droughts with varying degrees of intensity and persistence. This situation suggests that the sectors most vulnerable to these events (especially agriculture and hydroelectric), probably did not develop adequate policies to adapt to the climate variability of the environment where they carry out their activities. In any case, this hypothesis should be evaluated to the extent that new rainfall information is available in the watersheds (Paredes Trejo et al., 2016; Paredes-Trejo et al., 2020; Quiroz-Ruiz et al., 2016).

The behavior of a country's hydraulic infrastructure depends fundamentally on the quantity and quality of hydro-climate data available for the planning, project, and operation of each work, especially reservoir data. If hydrological data does not exist, or it is incomplete or deficient, the processes of maintenance and development of new reservoir works are postponed until the minimum essential database is available which results in a delay in the development of the country (Suárez Villar and Suárez Barrera, 2016).

In the case of Venezuela, on one hand, the progressive deterioration and dismantling of the national hydrological network, and on the other, to the climate changes that are taking place on a global scale, which manifest themselves in rivers by variations of the two hydrological extremes in opposite ways: higher flows of the rising during rainy periods and lower flows during the drought, maintaining the average annual flows without significant changes (Suárez Villar and Suárez Barrera, 2016).

In Venezuela, there are plenty not used irrigated and that could be used to meet the current and future agricultural production needs (Nuñez et al., 2009). Access to production data has been limited by government agencies, where the Confederation of Agricultural Producers Associations of Venezuela (FEDEAGRO) has records supplied by the Ministry of Agriculture and Land (MAT) in the period 1997–2017. By 2015 at least 12 items: maize, rice, sorghum, cane, sunflower, orange, coffee, potato, onion, paprika tomato, and sesame showed significant declines reaching in many cases historical minimums in the period evaluated (2015–2018) (Tapia et al., 2017). While FAO's Aquastat platform presents production data for only 2008 (FAO, 2015b), a situation that complicates any process of analysis and strategic planning at normal times and especially in crisis situations such as the current coronavirus pandemic (COVID-19).

One of the most human consumed foods is cereals, being the source of foods that account for more than half of the calories that humanity uses (Team, 2020; Yang et al., 2020). It is cereal production that poses the greatest challenge of sustainability of production in a responsible way that guarantees the protection of water resources (Upadhyay et al., 2020; Yang et al., 2020). In Venezuela, the most historically produced item has been cereals for both human consumption and balanced animal food processing, with this item having been drastically plummeting its production in recent years.

This paper explores and analyses the influence of water management on production (energy and agriculture), Venezuelan economics and society. The discussion of this paper will follow three pillars representing the qualitative and quantitative relationships of water management and its impact on the system.

The following diagram focuses on water management in production, economics, and social aspects, considering its interrelationship between the quantity and quality of this vital resource (**Figure 1**).

WATER MANAGEMENT IN ENERGY PRODUCTION AND AGRICULTURE

Hydropower–the Third-Largest Hydroelectric Plant in the World–Nationwide Blackout

Water management is based on the activities of planning, development, distribution, and management of the optimal and appropriate use of water resources (Su et al., 2020). The extent of irrigation land expansion is quantified based on water availability

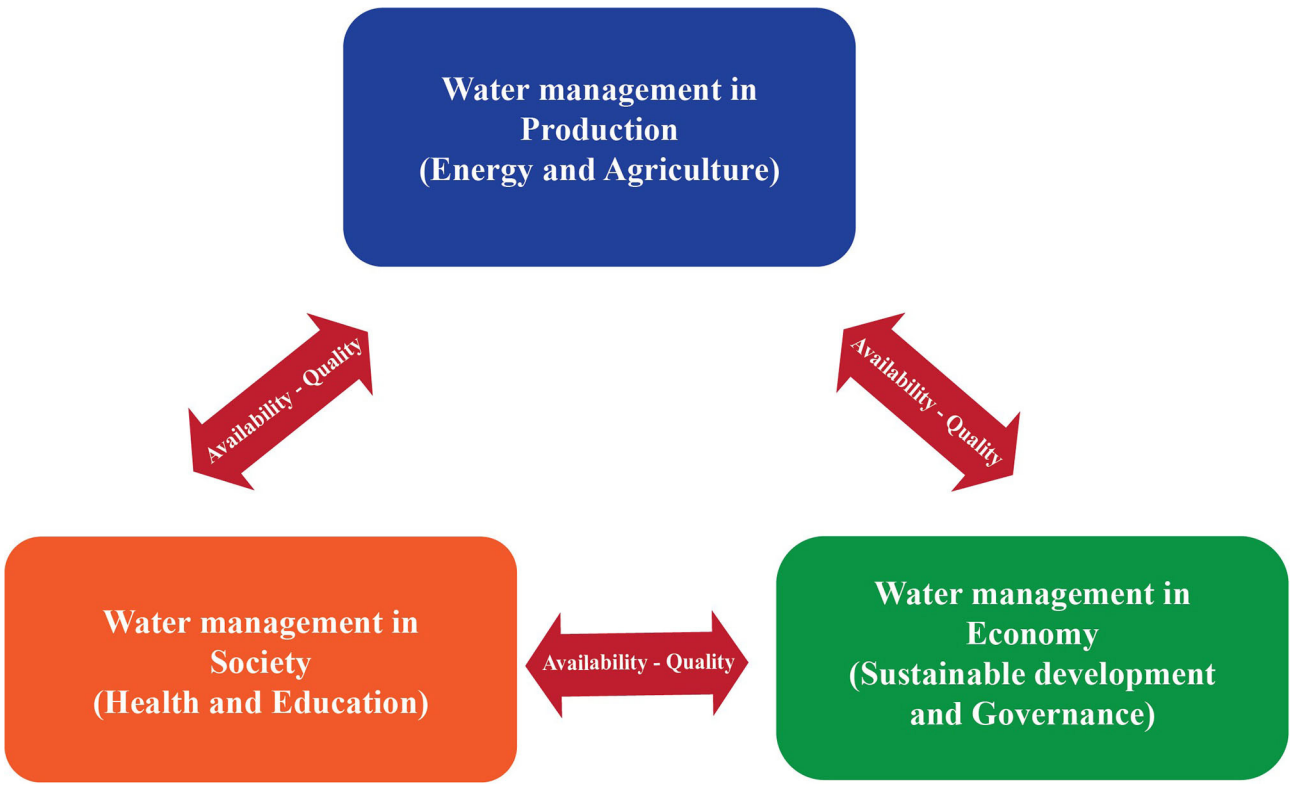

FIGURE 1 | The link of the three water management pillars.

and annual costs of irrigation infrastructure, considering that improvements in irrigation infrastructure include increased water storage, improved transport efficiency and improved irrigation efficiency. To know the conditions of irrigation infrastructure allows an exploration of water availability in land use, energy production, and economic activity (Ledvina et al., 2018). In Venezuela there is only one multi-purpose hydroelectric generation and irrigation system.

It should be noted that despite Venezuela's largely located and developed hydroelectric potential in Lower Caroní, it is a source subject to natural threats such as droughts and that this has consequences, Venezuela also exhibits great potential from hidropower, however today its development is minimal (Posso and Zambrano, 2014), with the exception includes the set of dams in the Lower Caroni: Macagua I, Macagua II, Caruachi, Tocoma (under construction), and El Guri a large-scale hydroelectric plant, whose operational problems and lack of maintenance has recently affected the country's energy balance.

The national electricity system (SEN) had a total installed generation capacity of ∼34,383 MW, for the year 2019, broken down as follows: Thermoelectric infrastructure: 17,985 MW (52.4%); Hydroelectric infrastructure: 16,228 MW (47.3%); 125 MW Eolic infrastructures (0.4%). The current operating capacity of the SEN is estimated at 14,933 MW (44%), broken down as follows: Thermoelectric 3,229 MW (9.4%); Hydroelectric 11,704 MW (34.2%). The discrimination of the available generation power capacity shows out of service: 82% of the thermoelectric, 28% of the hydroelectric plant, 100% of the Eolic infrastructure. The great difference between installed generation capacity and available capacity because of obsolescence, inadequate and inefficient technology, lack of maintenance, unfinished projects, and inadequate management has been worsening in recent years. The thermoelectric plants are practically inoperative, since the most important that Venezuela had was Tacoa and it is completely paralyzed, followed by the Planta Centro, which has been in ruins for years, without a gas supply that allows the precarious existing thermoelectric park to operate. The abandonment of thermoelectric infrastructure promoted the installation of thermoelectric plants of different technologies, including distributed generation units powered by internal combustion engines without adequate infrastructure or fuel supply or alternative supply mechanisms (AVIEM, 2019).

The current crisis in hydroelectric generation is caused by disinvestment caused by non-compliance with maintenance programs and projects aimed at modernizing and updating the generating units and the infrastructure associated with the lower Caroní plants, as well as in the plants located in the South-Western region of the country. The situation of unavailability of 38% of the installed capacity at the Simón Bolívar Power Plant in El Guri is of special attention, which has units 2, 9, and 10 of Power House 1 and units 14, 16, 18 out of service and 20 from Power House 2, for a total of 3,769 MW. The Antonio José de Sucre plant (Macagua) shows an unavailability of 25% of the installed capacity, standing out units out of service since

2012 for maintenance reasons. In the southwestern region of the country, 759 MW (65%) of the installed capacity in the region is unavailable. The total work stoppage of the José Antonio Páez Power Plant (240 MW) and the 52% out of service (269 MW) of the Fabricio Ojeda Power Plant (La Vueltosa) stand out. That 65% of capacity out of service places the electricity supply in the Southwestern region of the country in a very critical condition, because there is not enough thermoelectric generation capacity and capacity limitations to import energy from the national interconnected system (AVIEM, 2019).

The Guri Dam is located in South America and ranks third within the world's largest hydroelectric plants. It is responsible for supplying about 73% of Venezuela's electricity. In the last 40 years, there have been two major drought events recorded in Venezuela: the first from 2001 to 2004 and the second from 2009 to 2010, which caused a drastic decrease of 28% of its reservoir storage capacity in 2003. During the 2010 event, energy rationing policies were implemented to close the electricity gap, where reservoir storage experienced rapid recovery since the last drought in late 2010 (Adamo et al., 2020).

The construction and distribution of dams in Venezuela were carried out to ensure the demand for multiple uses such as: human and industrial supply, irrigation, fish farming, power generation, recreation, and sport. Stored water directly impacts economic and social development through the generation of opportunities and alternatives, providing facilities for new projects.

In Venezuela, the first dam built was Caujarao Dam, located in Falcón state (construction period: 1863–1866), located in the Coro River, which flows over the sedimentary plain of what was the ancient reservoir. By the time, the commission of engineers of the Ministry of Development that received the work, the report highlights that its dimensions are greater than the Croton Dam, the first aqueduct of New York City, built in 1842 (Suárez Villar and Suárez Barrera, 2016).

The construction of hydraulic works, which had so successfully begun in Venezuela in 1863 with the Caujarao Reservoir, is interrupted because of the political turbulence experienced by the country between the last years of the 19th century and the early 20th century. However, as an exception, during this period Ricardo Zuloaga built and put into service in 1897 the El Encantado Hydroelectric Plant, located on the Guaire River downstream of Petare, for the supply of energy to the capital of the country, thus starting hydroelectric generation in Venezuela, which at that time was a global technological innovation (Suárez Villar and Suárez Barrera, 2016).

They are 105 reservoirs in Venezuela that store about 157 km^3 of water. Its hydroelectric potential is one of the most important in Latin America, with 92% of its potential located on the right bank of Orinoco River (Guayana Region). 60% of its electricity is generated from hydroelectric plants (Nuñez et al., 2009; Suárez Villar and Suárez Barrera, 2016). Of these large dams, about half are directly or indirectly associated with an irrigation system, regardless of those that are being carried out to construction. Dams and their reservoirs have contributed significantly to human development in different ways, ranging from storage and deviating for energy generation, agricultural activities such as irrigation, flood control, and other human activities such as transporting fishing, tourism, and recreation (Hogeboom et al., 2018).

Comparing the highest hydro energy production records in history found in **Table 1**, The Guri Dam, the highest in Venezuela with 162 m height, with a capacity of 135,000,000 m^3 (ICOLD, 2020) is located in third place, surpassed only by Itaipu (Brazil–Paraguay) and Three Gorges Dam (China) (ITAIPU, 2020).

The relationship between production vs. flood zone: GWH ratios produced by the reservoir area worldwide are presented in **Table 2**, where the Guri Dam ranks sixth with an estimated 13 GWH per Km^2.

Installed capacity and a comparison between the world's leading hydro energy generating plants are presented in **Table 3**, where the Guri Dam is placed in the third position of this ranking.

On the global stage, water demand is steadily increasing and reaching 2–3% annually in the coming decades. Large climatic fluctuations influence the uneven distribution of finite water resources. With their current storage, dams clearly make a significant contribution to the efficient management of finite water resources. Therefore, know the current state of the reservations and evaluate the need to build many other dams to ensure the proper use of this resource. The lack of electricity, as well as other reliable energy sources, is a key factor in guaranteeing the availability and supply of water for cities throughout the country (Rendon et al., 2020).

Venezuelan dams are embankment, followed by the type of rockfill dams, and gravity, distributed according to **Figure 2**. There are five concrete dams in Venezuela, gravity type: Caujarao (masonry), San Juan, Macagua I, Guri, and Taguacita; two arch dams: Santo Domingo and Ocumarito; five rockfill dams: La Pereza, Turimiquire, Canoabo, Macagua II, and Caruachi; one hydraulic filling dam: Petaquire. All other dams are earth dams (Suárez Villar and Suárez Barrera, 2016).

The evolution of dam construction in Venezuela had a maximum of 31 in the 1970s, from which it began to decline, the most recent being under construction, without being completed three large dams: Yacambú (to provide water one of the most productive regions called the Quibor Valley in Lara state with potential 26,000 ha for vegetable cultivation); Tocoma (intended hydroelectricity) and Cuira (to alleviate drinking water deficiency in the Capital District), which have not been completed.

The northern region of Venezuela, where the highest percentage of the population and major economic activities are based, is the lowest in water resources (FAO, 2015b). The highest concentration of dams built is in the central west of Venezuela, the relative location of the main dams is shown in **Figure 3**.

Impact of Incidents on Venezuelan Dams

An "incident" can be defined as an unwanted or unscheduled event that will deteriorate or decrease the operational efficiency of the company, from understanding the meaning of these concepts, control processes can be initiated for all causes and origins of accident incidents (de Carvalho, 2011). An incident does not necessarily mean the failure of the work, although in some extreme cases this happened (Suárez Villar and Suárez Barrera, 2016).

TABLE 1 | Hydropower production: comparison among the highest operating records in history.

Power plant	Country	Production record (mi de MWh)	Record year	Average of the best 4 years (mi de MWh)
Itaipu	Brasil-Paraguay	98,63	2013	94,27
Three Gorges Dam	China	98,11	2012	84,21
Guri Dam	Venezuela	53,41	2008	51,10
Tucurui	Brasil	41,43	2009	39,52

Source: ICOLD (2020); ITAIPU (2020).

TABLE 2 | Production vs. flooded area–generation capacity relations produced by reservoir area in the world.

Power plant	Country	Generation capacity/Area reservoir (GWh/Km^2)
Grand Coulee Dam	EUA	83
Three Gorges Dam	China	78
Itaipu	Brasil-Paraguay	73
Sayano-Shushenskaya Dam	Russia	41
Tucurui Dam	Brazil	14
Guri Dam	Venezuela	13

Source: ICOLD (2020); ITAIPU (2020).

TABLE 3 | Installed capacity: comparison between the set of generating units of the main plants of the world.

Location	Installed capacity	
Three Gorges Dam (China)	22.400 MW	160%
Itaipu (Brazil–Paraguay)	14.000 MW	100%
Guri Dam (Venezuela)	10.000 MW	74%
Tucuruí (Brasil)	8.370 MW	60%
Grand Coulee (Estados Unidos)	6.809 MW	49%
Sayano Shushenskaya (Russia)	6.400 MW	46%
Krasnoyarsk (Russia)	6.000 MW	43%
Robert-Bourassa (Canada)	5.616 MW	40%

Source: ICOLD (2020); ITAIPU (2020).

Of the existing dams in the country, 32 have suffered failures or incidents, in multiple cases, most of which were successfully re-addressed (Suárez Villar and Suárez Barrera, 2016). In the last six decades in the country, a total of seven dam faults have occurred. A list of these failures and incidents, classified by category is presented in **Table 4**. The failure of the Guapo dam, has been the most destructive, among the damage and losses caused by the collapse of the dam in the sub-region of Barlovento affecting 7,375 people, 5,236 affected and 300 casualties, with 790 homes destroyed, 1,500 affected, one hospital and 100 flooded outpatients, 30 schools with minor damage to serious damage, destruction of 2.5 km of the national road to the east and three bridges, affectation of 9 km of drinking water conduction, the dam supplied 70% of drinking water for the Barlovento sub-region, collapse of nine towers of the 230 kw line and 60% of the Barlovento plantings were left under the waters, losses of 11 billion in crops (Suárez Villar and Suárez Barrera, 2016; Méndez et al., 2018). This is the only case in the country where the loss of human life has been recorded because of the failure of a dam.

Globally, the most common cause associated with the failure of large land dams is their overflow, due to insufficient capacity of relievers, caused by a deficient project that is specifically due to the underestimation of the river flood, which in turn responds, in the case of Venezuela, to the progressive deterioration and dismantling of the national hydrological network (Suárez Villar and Suárez Barrera, 2016; Méndez et al., 2018).

In a park of about 100 dams in Venezuela, the failure of three of them represents a percentage of 3% of the total of these structures in operation. According to statistics from the International Commission of Large Dams (ICOLD), the global average of failures in large dams is about 1%, as the percentage of dam failures far exceeds the global average.

Incidents in Venezuelan dams have generally been treated correctly and rarely have preventive interventions and safety assessments of a dam to anticipate the occurrence of disruption events. From the point of view of dam safety management, the detailed collection and study of each of these incidents justifies the need for a national safety assessment program in order to alert in advance of the possible occurrence of a similar event (Suárez Barrera and Vethencourt, 1997; Suárez Villar and Suárez Barrera, 2016). Venezuelan reservoirs requiring priority actions are: Clavellinos Reservoir (Sucre State), by abandoning the construction of the new take-off work; Turimiquire Reservoir (Sucre State), due to the basset of leaks in the downstream slope; Manuelote Reservoir (Zulia State), due to the subdimension of the spillway; Agua Viva Reservoir (Trujillo State), due to problems of sedimentation and obstruction of the tunnel; Caparo Reservoir (Táchira State), due to damage to gates and control systems; Pao La Balsa Reservoir (Cojedes State), for significant damage to the spillway; Macarao Reservoir (D.F Caracas), because of the high levels of sediment that interfere with the

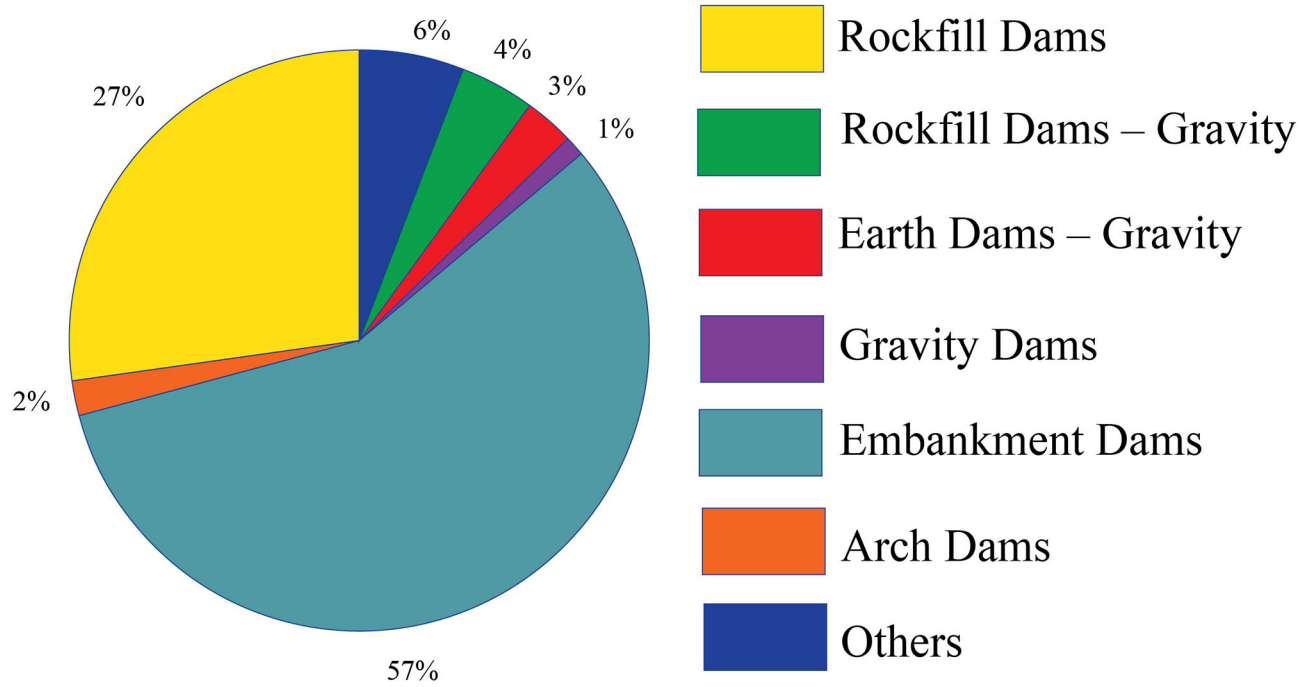

FIGURE 2 | Distribution of the main type of dams in Venezuela. Source: Adapted of FAO (2015a).

management of the gates of the intake tower (Suárez Villar and Suárez Barrera, 2016).

In addition, flow and water supply rates for the population have been reduced by ∼60%, compared to water supplied in 1999, resulting in constant blackouts across the country, highlighting those that occurred in March lasting more than 90 h, causing electricity rationing in Venezuela, a situation that directly impacts the production and development of the economy in the country (Rendon et al., 2020). By March 16, 2019, 9 days after the first mega blackout, the electricity generation capacity had not been recovered from the Bajo Caroní, for that date there was a deficit of 67%. On March 25, 2019, one of Guri's transformers caught fire and a mega blackout occurred again in almost the entire country. In one fell swoop, a quarter of the average effective generation of Bajo Caroní was lost, due to a lack of backup equipment, and lack of maintenance and recycling of other equipment from the San Gerónimo and Yaracuy substations, which were only enough to apply palliative. This situation justifies a national inventory of dams and irrigation systems to determine the current conditions of all this infrastructure and potentials by sustainably supporting an energy and agricultural sector boost, by creating a Water Resource Management system linked to a georeferenced dynamic access database.

WATER MANAGEMENT IN THE AGRICULTURAL PRODUCTION

Venezuela is a resource-rich country, and despite this it suffers from the most severe food shortages historically recorded, (Tapia et al., 2017) due to inefficient public policies, evidenced through public policies based on subsidies and other public policies that have been distorted over time. Hugo Chávez's government created the Mercal Mission, in 2003 to distribute food wholesale and retail to provide and build fixed sales centers (warehouses, small supply and supermarkets) and mobiles, with food with large discounts, subsidized, and another public polices without intermediaries. The Ministry of The People's Power for Food (MPPAL) was established in 2004, with competence in food security with a complex system of administrative bodies. In 2008 the Decree-Law on Agri-food Security and Sovereignty was enacted, to support expropriations and declare the entire production chain as "public utility," allowing the occupation of farms, companies, and any private productive unit without the process or without any prior notification. The Fair Costs and Prices Act was enacted in 2011, with the aim of its reforms intensifying, in including another kind of food, applying to different associations in the agriculture chain and agribusiness (any producer, wholesalers, factory, retailer), making it difficult for marketplaces to operate appropriately (Purcell, 2017; Tapia et al., 2017). The Venezuelan Chamber of the Food Industry (CAVIDEA) has identified than 200 laws, decrees or resolutions that affect final prices. The legal frameworks that manage these price controls and the organizations that manage this work, however, do not implement these controls.

Venezuela has abundant surface water resources in the large basins that make up its hydrography: Orinoco and Cuyuní rivers (Atlantic slope), Negro river (Amazon slope), Maracaibo Lake and Caribbean Sea (Caribbean slope) and the endorheic basin of Lake Valencia. Mean annual precipitation for the

FIGURE 3 | Distribution the meaning Dams in Venezuela.

whole Venezuela is 2,044 mm, which represents 1,864 Km^3 $year^{-1}$. Renewable internal water resources are estimated at 722 $km^3.year^{-1}$, with 85% of the total generated on the right bank of the Orinoco River. The rest of the territory, while those basins that drain into the Caribbean Sea or Lake Maracaibo, contribute the remaining 15% (FAO, 2015b).

The regions that present the most relevant aquifer formations are located on the West Coast of Lake Maracaibo, Mesa de Guanipa and the western part of the Apure River. The recharge of aquifers comes mainly from direct infiltration and recharges from surface water channels, in a minor degree from the Cordillera leaks. Renewable underground water resources are estimated at 227 $km^3.year^{-1}$ (FAO, 2015b).

There are 105 reservoirs in Venezuela, which store about 157 km^3, with 15 of these being in the project or construction phase. Its hydroelectric potential is one of the most important in Latin America, with 92% of that potential located on the right bank of the Orinoco River (Guayana Region). Of these large dams, about half are directly or indirectly associated with an irrigation system, without considering those currently under construction (FAO, 2015b). In Venezuela there are 36 large and medium-sized irrigation systems with a net irrigable area of 302,062 ha of which only 137,002 ha are under irrigation. While there are 1,173 small irrigation systems with a net irrigable area of 147,443 ha of which 111,924 ha are under irrigation. Venezuela is considered to have great potential to increase the area under irrigation. In general, the availability of soils (2,676,000 ha) is vastly superior to the surface with availability of quality water resources. Some recent

TABLE 4 | Failure Dams in Venezuela.

Dam	Type of failure	Date of failure
Siburúa	Slope slippage	1964
Las Tinas	Dispersive clays	1965
Aracay	Dispersive clays	August 21, 1986
El Cristo	Underestimated crescents overflow	April 9, 1999
El Guapo	Underestimated crescents overflow	December 16, 1999
Tocuyo de la Costa (Játira)	Underestimated crescents–overflow	December 17, 1999
Manuelote	Seepage–Underestimated crescents–overflow	December 5, 2010

Source: Suárez Villar and Suárez Barrera (2016).

studies have revealed that Venezuela has1.7 million hectares of potential irrigation area, of which 35% would be irrigated from groundwater and 65% from surface water. There are agrological, edaphotechnical and groundwater studies carried out by the Ministry of Public Works (MOP) since 1970 with valuable information very useful for the strategic planning of irrigation systems and associated structures. The government's response to severe food shortages in 2016, was promoted as the way to "socialist food sovereignty" among many kinds of urban farms and different way of agro-industrial micro-ecology. While the Maduro government speaks of a so-called "economic war," the evolution of Venezuelan agriculture is stagnant, abandoned and trapped within a process of super inflation, scarcity, and with an accelerated increase in "malnutrition and hunger". This is a position and characteristics of a revolutionary government that works in a very well-structured way through the interest of peasantry and the working class, establishing itself as a farce at best and as a self-destructive process in the worst case (Purcell, 2017).

The country had high levels of commodity scarcity, at the beginning of 2017, shortage and fall in agricultural production, which averaged 27% between 1999 and 2014, official figures (other figures 50%). In January 2016, the name was changed to the scarcity index (which measures product shortages) for "appreciation of the existence of overstocking" (87%), which expresses of a real shortage of about 90%, and has not been published since 2014 (24%). The National Superintendency for the Defense of Socio-Economic Rights (SUNDDE) sought to genuine the situation by modifying the price of pasteurized milk (1,973%), chicken (1,000%), and pre-cooked maize flour (900%) (Purcell, 2017; Tapia et al., 2017).

Rising prices in this uncontrolled way leads to the highest inflation levels in the world, confirming that the government's price control policy has been inefficient in Venezuela. Food inflation of 315% in 2016 and more than 700% by 2017 is estimated and the production and marketing of agricultural products has been distorted in Venezuela due to the obstacles of foreign exchange control that prevents supply companies from accessing the market, as well as government-implemented subsidies (Tapia et al., 2017).

Venezuela, the planting of the main maize harvest began at the end of May after the timely start of seasonal rains. Production prospects are unfavorable, as the planting level is likely to continue to follow the downward trend since the 2014 economic crisis and yields are expected to be constrained by severe shortages of agricultural and fuel inputs (FAO, 2020).

Historically, the most produced crops have been the cereal group for both human consumption and balanced animal feed processing. In Venezuela, the production of current maize, is divided into three parts, the first is in the central states constituted by Aragua, Carabobo and some parts of Guárico, the second is in the eastern states such as Monagas and Bolívar, following the western states, where it is produced in Yaracuy, Portuguesa, Barinas and Cojedes. Maize production in Venezuela is of great importance as Venezuelan is a natural consumer of maize flour from a sociocultural point of view. So, if we go to the statistics of the Ministry of People's Power for Productive Agriculture and Land (MinPPAPT) we have to date (December 2016) there have been 1,273,663 metric tons of cereals harvested between white and yellow maize.

The decrease in the harvested area for annual crops is mainly due to reduced financing and increased costs of agricultural inputs, dismissing agricultural producers. It occurs equal in cane, with averages in the middle of the historical in kg per hectare. The reduction of the area planted with coffee has been reduced to 1/3 area and with low yield characteristics, vegetables with many complications by transport and inputs, let's not mention citrus trees destroyed by the yellow dragon disease. In recent agricultural history agriculture was eliminated as the main sector of disaggregation of GDP (Tapia et al., 2017).

In terms of numbers of people in crisis or worse, according to the WFP's Emergency Food Security Assessment for 2019 Venezuela ranked 4th after Yemen, the Democratic Republic of the Congo and Afghanistan with 9.3 million people (32 percent of the total population) in phase three of the Integrated Food Security Phase Classification (IPC) categorized as a crisis of severity of acute food insecurity (FSIN, 2020)

Availability and access to production data in Venezuela has been restricted in recent years, despite sufficient irrigable land that is not being used and that can meet current and future agricultural production needs (Nuñez et al., 2009), sustainable food production and reduced import dependence can only be guaranteed through knowledge and investment (Tapia et al., 2017). Between 2008 and 2014, the reduction in production of the main agricultural areas was accentuated. There were only positive tons per hectare per capita production of banana: 3.3%. The other products considered in the analysis had negative PCPs: beef (−3.2%); rice (−1.3%); maize (−8.4%); oil palm (−0.9%); cassava (−0.9%); sugar cane (−9.0%); cocoa (−2.3%); poultry (−0.9%); eggs (−0.6%) pigs (−1.6%), (Gutiérrez, 2015). Statistics indicate that agri-food imports per capita (MAAPC) increased during the oil bonanza. Lower oil prices and macroeconomic policies led to currency shortages and declining local food production could not be offset by imports. Imports are projected to have been reduced by 66.5% (from 2012 to 2016). MAAPC imports had a year-on-year reduction in 2016 compared to 2015 of −24.5%, and a decrease of 44.2% between 2012 and 2016 (Tapia et al., 2017).

The 12 main items to which FEDEAGRO tracks, whose contribution to the Value of Plant Agricultural Production exceeds 70%, 11 of them in 2015 showed significant declines in many cases historical minimums in the period evaluated (2015–2008): sorghum −80.5%, sunflower −80%, maize −58.5%, rice −37.3%, cane −31.3%, orange 31%, potato −74.3%, coffee −71.2%, onion −52.5%, tomato −18.7%, peppers −40.9%, and garlic 103.3%. In most cases the drop in production due to the lack of agricultural inputs (agrochemicals, fertilizers, and seeds), problems of gain access to currency to attend domestic demand (Tapia et al., 2017) and while FAO's Aquastat platform presents production data regarding the year 2008 (FAO, 2015b).

One of the biggest impacts recorded during this crisis has been the decrease in production volume are in sugar cane of 4 million tons, significant reduction of bovine herd and production of coffee, rice, maize, and potato, overproduction of vegetables, tubers, root, and fruits (Tapia et al., 2017; FAO, 2020).

WATER MANAGEMENT IN ENERGY PRODUCTION IMPACT ON QUALITY OF LIFE, ECONOMIC ACTIVITIES

Despite being one of the 15 territories with the highest renewable freshwater resources, nearly eight out of 10 Venezuelans do not have access to safe water and basic sanitation, about 82% of the population has no continuous water service (Bausson, 2018; Rendon et al., 2020). Drinking water in Venezuela has become a luxury, and just as with price controls set in order, a bottle of water is about $3, a significant portion of the minimum salary of about $8 per month. Water crisis in Venezuela also impacts sanitary wastewater, wastewater control and availability to water for irrigation. Partly as a result, production in agriculture, even for major crops such as rice, maize, and coffee, has fallen to about 60% in the last 20 years. This autumn in agriculture production is associated with the national average weight loss of 12 kg in 2017 (Rendon et al., 2020).

The operation of drinking water treatment systems has been negatively impacted due to the constant electrical failures, which has caused around 1 million Venezuelans to have had to resort to sources of water exposed to contamination, or without being treated, which puts people at risk of waterborne viruses, threatening the lives of children and the most vulnerable (Rendon et al., 2020). At the end of the last century, 96% of households have access to drinking water service at least basic in 1998, ∼87 percent of the population had a continuous and regular supply of clean drinking water. The scale of the water crisis indicates that this percentage of access to drinking water hastily declined in the years after Maduro took power, falling to 18% in 2018. (World Bank, 2015; Beyrer and Page, 2019; Page et al., 2019; World Health Organization, 2020).

Venezuela's water crisis has impacted the infant mortality rate. In 2017, the mortality rate for children under the age of five reached an alarming 31 deaths per 1,000 live births, well above the values recorded in 1990 and much higher than in countries such as Bangladesh and Cambodia. According to the UNICEF report, if the infant mortality rate remained where it was in 2010, 12,000 would have died in 2017. Implementation of projects and actions that promote the improvement and access of the population to sanitation and hygiene systems can contribute to the prevention of child mortality in Venezuela (World Bank, 2015; Tapia et al., 2017; Beyrer and Page, 2019; World Health Organization, 2020).

Influence of Water Management on the Economic Crisis

The last official census conducted in 2011 recorded 27,227,930 inhabitants (INE–Instituto Nacional de Estadística, 2011). In 2013, the total population amounted to 30,405,000 inhabitants, of which 6% were rural populations. The average population density is 33 inhabitants/km^2, ranging from 5 inhabitants/km^2 in rural or less populated areas to 1,381 inhabitants/km^2 in urban areas. In 2007, 94 per cent of the urban population had access to drinking water supply, while in the rural areas 75 percent (FAO, 2015b).

Some aspects of the national context concerning the severe crisis of inaccessibility to basic foods due to uncontrolled and high levels of inflation. The Central Bank of Venezuela reported high inflation rates of 180.9%, by the end of 2015. The International Monetary Fund projected figures of 720.5% in 2017 and 2068.5% in 2018 (Tapia et al., 2017). Venezuela's hyperinflation is severe, started in November of 2016 and has yet to end. It has lasted for 36 months and counting. At the peak of Venezuela's inflation, which occurred in January 2019, it took 14.8 days for prices to double. This puts its rate at the upper-end of the mid-range of hyperinflation severity (Forbes, 2019).

At present, the world's highest inflation rate is Venezuela's, where the annual inflation rate at the end of October of 2020, was 2,265 percent per year. Venezuela and Lebanon are members of the rogues' gallery of hyperinflation episodes, of which there have only been 62 in recorded history. The International Monetary Fund's (IMF) year-end forecasts for October 2020 for Venezuela was 6,500% (National Review, 2020).

The hyperinflation in Venezuela destroyed the prosperity of the middle and upper classes, where the government's supporters gained, and the opponents of the government lost (Pittaluga et al., 2020).

In addition, the fall in oil prices internationally has produced strict controls in the Venezuelan economy, a reduction in the inputs needed for agricultural production and the processing of industrialized food, taxing the import of food, resulting in greater shortages of basic food. In an attempt to combat shortages, the Venezuelan government implemented restrictive policies such as regulating commodity prices, biometric fingerprint registration for food purchases, a failed attempt to regulate and control prices. Food purchase authorization was also implemented through the submission of terminal digit identity documents (one day/week/person), and through the control of so-called local supply and production committees (CLAPs) composed of government organizations and members of the government party that sell regulated staple foods without periodicity, without proper health checks, lacking transparency in the processes and distribution criteria. As a result, the population has had to develop innovative strategies to find regulated scarce staple foods, and with this came the practice of informal food reselling called "bachaqueo" based speculation processes and with consequent price increases of up to 1,500% (Tapia et al., 2017). The so-called "Bachaqueo" has spread and consolidated in time through Venezuela's growing subsidized goods market and unfortunately these networks operate within the armed forces and other state institutions without any control (Van Roekel and De Theije, 2020).

Poverty increased from 48 to 82% in 2016, and was worse in women who, as heads of households, had to wait long lines to get insufficient amounts of food and medicine. According to the Latin American Study of Nutrition and Health, 93.9% of Venezuelans do not cover the recommendations of caloric requirements, with women's caloric intake being 1,749.1 Kcal/day and 2,059 Kcal/men's day. Caloric intake decreased significantly at the age of women (Tapia et al., 2017; Van Roekel and De Theije, 2020).

The crisis has created a situation in which food availability, access and consumption in Venezuela have a closer effect on girls and women, where 6.3% of children under the age of five

are severely malnourished, while ∼30% of children under the age of five and 23.9% of women under the age of 15–49 are anemic (FSIN, 2020). This has serious consequences not only for the country, but also on the health and prosperity of future generations of Venezuelans (Tapia et al., 2017).

There is a direct link between the difficulties that the Venezuelan population has in constantly accessing the service of drinking water and sanitation and the presence of diseases. Due to the absence of clean and treated water, the presence of diseases has raised cases of infant mortality from diarrhea (six times greater than a 15-year period). The increase in cases of Hepatitis A (with a rate of 150 times higher only in the city of Caracas), and the increase in cases of dengue and other diseases that had already been eradicated such as malaria (Claborn, 2020). It is likely that, because of this extraordinary increase in infant mortality figures, the government stopped publishing public health data, which had historically been unreliable anyway. In regions where the collapse of the water system is evident, preventable childhood diseases such as diphtheria have reappeared (Rendon et al., 2020).

For many decades, Venezuela was a leader in vector control and public health policy in Latin America, even more so after becoming the first WHO-certified country to eliminate malaria in most of its territory in 1961, over the past 10 years, leading for decades in the implementation of public health policies and vector control. Venezuela has faced a serious economic crisis, precipitated by politics and declining oil revenues. The severe economic crisis, the decline in oil revenues, coupled with political instability has affected public health services. The crisis of success in the quantity and quality of drinking water has negatively influenced a 359% increase in malaria cases in 2010–2015, followed by a 71% increase in 2017 (411,586 cases). Neighboring countries, such as Brazil, have kindly reported malaria cases imported from Venezuela, from 1,538 in 2014 with a growing trend to 3,129 by 2017. In Venezuela, the increase in active transmission of Chagas disease in children (<10 years) has been highlighted. In the period 1990–2016, more than four times the incidence of dengue was shown to increase, and an epidemic peak of chikungunya of 6,975 cases per 100,000 people and the incidence of Zika virus is 2,057 cases per 100,000 people. In 2017 there were 406 malaria deaths, Venezuela's malaria epidemic has crossed international borders, with refugees and migrants often arriving in Brazil and other parts of Latin America, which has led to an increase in Malaria cases in other countries in the region (Page et al., 2019).

Venezuela had the highest rate of malaria growth in the world, and in 2015, TB rates were the highest in the country in 40 years. Between 2017 and 2018, most patients who were infected with HIV discontinued therapy due to a lack of medication. Venezuela's economic crisis has shattered the health system and led to an increase in morbidity and mortality. Accelerated expansion in the country and region of infectious diseases associated with declining basic public health services are at risk of health (Page et al., 2019).

HIV testing among neonatal exposures has decreased by 50% since 2014, and with the scarcity of antiretrovirals (ART) treatments have been discontinued. Drug resistance tests have not been available since 2016, and of the 79,467 HIV patients registered for antiretroviral processing, the Pan American Health Organization (PAHO) estimates that 69,308 (87%) they are not receiving it, and the likelihood that some patients have emigrated to other countries looking for treatment. Between 2014 and 2017, TB cases increased by almost 68% (6,063 cases compared to 10,185); the 2017 TB incidence rate (32.4 per 100,000) was the highest registered in Venezuela in 40 years (Page et al., 2019).

With decaying health infrastructure, a massive departure of trained medical personnel (a full medical professor earns US$10 per month) and the decline of all public health programs, the country is experiencing an increase and expansion of vector-borne diseases. In March 2018, it is estimated that around 40,000 Venezuelans lived in Brazil, and at least 600,000 people have sought refuge in Colombia. Official data are likely to be underestimated given the existence of informal border crossings (Grillet et al., 2019).

Since 2007, reports had a 20-week interruption in publication, regaining periodicity until November 2014, when publication was stopped by the government; the reports have not been published since 8 June 2018, the Venezuelan Centre for Disease Classification–a part of the Division of Epidemiology and Vital Statistics of the Ministry of Health that was in charge of providing PAHO and WHO with updated indicators of morbidity and mortality–was eliminated by the government after 63 years of uninterrupted activity (Grillet et al., 2019).

Considering that the 2019–20 coronavirus pandemic (COVID-19) began in December 2019, in Wuhan, and spread around the world in the first months of 2020, cases began to appear in Colombia in early March, while Venezuela reported its first two cases in mid-March (Chang, 2020). As of 28 April 2020, only 329 confirmed cases had been reported through government sources; however, this number could be underestimated due to lack of tests and tests for the despising of COVID-19 (Paniz-Mondolfi et al., 2020). All this coupled with the precarious availability of water, as hospitals have closed due to shortages of different types: 80 percent do not have access to water, 53 percent do not have adequately equipped rooms, and 60 percent do not have beds (Rendon et al., 2020).

Access to water must be facilitated to ensure proper use for health and hygiene, in small houses there are storage restrictions where family members prioritize the use of water for drinking and cooking to the detriment of hygiene (Ray, 2020). The pandemic situation itself requires a water availability in quantity and quality sufficient to carry out all hygienization activities, spaces, food, rumbles, equipment. Oonly with hand washing for 20 s up to 8–10 times per day (uses per person per day we are talking about at least 8–10 liters of water per person per day more than in normal conditions (Staddon et al., 2020). Members of these households cannot make soap under running water every time they eat, come home with groceries, clean their children's feces, or feed their animals. They must store water in plastic or metal containers and most of the time make large journeys to a water source that is sometimes not drinkable. This situation technically makes it difficult to meet the Sustainable Development Goals for access to basic soap and water supplies (Ray, 2020).

Water Management and Impact on Education

The complexity of the studies, as well as the construction, use and monitoring of irrigation works, requires the participation of specialized personnel in a wide range of disciplines of both engineering and basic, natural, and social sciences. And since the 1930s Venezuela had few specialist professionals in the area, this figure was well below the requirements of a country that was beginning to live a modernization process (Arnal, 2017).

Venezuela's highly skilled brain loss and human capital have been motivated by increased violence and insecurity and policies by the socialist regime, the main reason for academically prepared professionals and skills in high-demand occupations to leave the country in search of better living and working conditions (Garcia Zea, 2020).

Official policies have tended to discourage technological innovation and the training and maintenance of human resources. The largest mass outing of highly qualified researchers, oil industry experts, teachers, and technical staff has been evident in all areas and especially in the water resource management area. The added government policies, the increase in criminality and vandalism that Venezuelan educational institutions and universities have whipped, if as the gradual loss of freedoms and personal deactivations of potential freedoms for and developed, has called for the mass exodus of the country in search of better working conditions and that allows the potential and medium-life development (Garcia Zea, 2020). Official figures from the National Observatory on Science, Technology and Innovation indicate that the percentage of researchers accredited in the PEII Innovation and Research Stimulus Program engaged in agricultural research has fallen from 23% in 2012 to 11% in 2015, with 520 agricultural researchers being lost in 4 years. According to the PEII, in 2015, 61% of the accredited were women and the number of projects fell from 286 in 2014 to just 62 in 2015 (Tapia et al., 2017).

On the other hand, considering that agricultural communities have a single educational infrastructure that has developed over more than a century. This network allowed new technologies and practices to quickly reach the hands of farmers and ranchers to make immediate practical use of them (Rendon et al., 2020).

However, in Venezuela, educational facilities of all levels in both rural and urban regions (from primary institutions to universities) have closed in part because there is no access to water service for drinking or sanitation. The decay of the educational infrastructure, with strong rations of electricity and drinking water supply has negatively impacted the quality of life of Venezuelan professionals dedicated to education (Garcia Zea, 2020). By 2018, 28 percent of students did not attend school due to water shortages, 22 percent due to lack of food at home, and 13 percent due to food shortages at school (Rendon et al., 2020).

INSIGHTS AND CONCLUSIONS

Venezuela has abundant water resources distributed in seven hydrographic systems and 16 hydrographic regions. The problems of water availability are found in the northern region of the Orinoco where the highest concentration of economic activities has been developed and where the highest concentration of the population is located. The country there is only one multipurpose hydroelectric generation and irrigation system, with more than 100 reservoirs built and associated for different purposes: hydroelectric power generation, irrigation, drinking water supply, industrial use, flood control, and recreation.

Challenges in the use of water resources include: Development of plans and projects that can generate reliable information and each on Venezuelan reservoir systems and associated irrigation works; submit projects to international funding agencies as a reinvestment of the required studies; Development and implementation of an integrated water resource management plan; implementation of measures to solve eutrophication problems, loaded–colmatation (sedimentation of reservoirs by sediments derived from erosion and contamination); decrease in water flow and conflicts of use, as well as raising awareness of users for sustainable water management; improve the efficiency of water use in the agricultural, urban and industrial sectors.

It is necessary to promote the development of extension programs that make it possible to disseminate the importance of the value of water and its relationship with food security in the different scenarios of climate change and crisis situations. In addition to promoting the transfer of technologies from manual systems to digital systems to integrate related networks by rethinking the organizational, planning and maintenance processes and the control of irrigation systems and planning the integrated management of water resources. As a result of the proposed studies determine the progress of the rehabilitation of irrigation systems and construction of new ones. And in this way carry out the training of farmers for the administration of irrigation systems, the management of efficient water and the selection of drought-resistant varieties. The planning of the Venezuelan State for Phase I (2015–2019), to increase the irrigation area by 279,404 ha waiting to hit 37 crops, with the expectation that it will make the sanitation of an area of 409,000 ha cured impact at least the main eight crops in the country produced (Tapia et al., 2017).

Considering the above, it is necessary to carry out the monitoring and control evaluation through a system that allows the monitoring, monitoring and control of reservoir and dam works in Venezuela, as well as the irrigation systems associated with them, which will allow the sustainable agricultural and economic development of the country.

In the past, projects were developed under the Organic Law of Science and Technological Innovation (LOCTI), irrigation technologies for farmers of different productive plants in Venezuela, the need for technical support to farmers was detected, both in the installation, management, and maintenance of irrigation systems (Moreno and Farías, 2013). Subsequently, it was proposed to develop a geographic information system for irrigation management (SIGMAR), to carry out the evaluation and monitoring of irrigation systems in Venezuela, adapt to the particularities of each system or set of these, to interpret the results obtained in relation to irrigation statistics at the national level. And establish a procedure to determine the irrigation

needs of crops and schedule the distribution of irrigation water. However, the difficulties in the implementation of the Organic Law of Science and Technological Innovation (LOCTI) of the Central University of Venezuela (León, 2014), make the implementation of this last project unfeasible.

There is interest of agricultural workers in innovating for higher yields and profitability, and confidence in research, demonstrated by the active participation of producer associations in discussions of laws such as LOCTI, and by the linkage of the scientific sector with agriculture. One obstacle is the low triangulation between the public, private and science and technology sectors. Considering that 64% of the electricity is generated hydro energy and the hydroelectric potential for 1998 was 83,433 MW (Tapia et al., 2017). Among the challenges: solving power failure problems and developing infrastructure needed to leverage energy resources.

At the educational level, technical assistance and education are required to reduce post-waste losses and at all points in the production chain, and this is only achieved by attracting to the country professionals trained in the different areas of knowledge who migrated in search of a better quality of life based on fundamental rights of food, health, safety, education, and quality of life.

The crisis in public health in Venezuela can have an aggravating by the return of several diseases that were previously controlled by regional efforts. This could represent a threat that could impact in national and global scale, which is why the authorities need to take action to prevent the worsening of these epidemic situation and anticipate an outcoming overflow of them from Venezuelan borders.

Only by ensuring the implementation of public policies that promote the development of agriculture under irrigation and the strengthening of agri-food systems, which promotes and rescues the healthy living and consumption patterns that Venezuelans deserve. It is necessary to promote food autonomy by promoting a positive trade balance against major international trading.

In this way it is necessary to adopt conservation measures as well as research and inventory of natural resources (availability and quality), among others, which together had to take Venezuelan agriculture to new levels both scientifically and technologically (Arnal, 2017).

The Venezuelan crisis is a call for attention for all and contains important lessons for both developed and developing countries. This crisis stems from a perverse combination of corruption, authoritarianism and political misrepresentation that beats the country for the past 20 years. In this way it is necessary to restore the fundamentals of an open society and a prosperous economy based on the rule of law, with public policies technically led by qualified professionals, with transparency, based on prudent fiscal and monetary policy, focused on the development of essential public goods such as education, health, housing, transport and infrastructure promoting the development of the three pillars of water management in production, economy and society in a sustainable way.

It is necessary to incorporate and attract the national and international private sector to make investments to boost Venezuela's production apparatus, to build confidence to stimulate national food production that guarantees the food security of Venezuelans.

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AUTHOR CONTRIBUTIONS

MM-P conceptualization, data curation, investigation, design, search, and collated references, and wrote the paper.

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Dismantling of Institutionalization and State Policies as Guarantors of Food Security in Venezuela: Food Safety Implications

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Historically, Venezuela was recognized as a country with solid government food safety policies, science-based legislation, clear national food security goals, strict standards for domestic food production and imports, and a system of institutions committed to ensuring safety and quality along each step of the food chain. Major institutions that aimed to insure people's welfare, nutrition and food availability, and safety were created between 1936 and 1949. Remarkable progress was achieved in terms of control of tropical maladies and fight against hunger and malnutrition. The National Institute of Hygiene set the standards for food safety and the continuous surveillance of available foods. The National Codex Alimentarius Committee was officially created in 2001. Nowadays, the situation has dramatically deteriorated as indicated by a severe decline of national food production and a strong dependence on food imports, whose prices make them inaccessible to the majority of Venezuelans. In response to the humanitarian crisis, the government created a food program, the so-called Local Supply and Production Committee (CLAP), to distribute basic foods at reduced prices but with clear intentions of social and political control of the population. Currently, CLAP products come from government imports at a preferential exchange rate. Under the umbrella of an economic emergency decree, many food safety regulations and surveillance protocols have been relaxed or eliminated, often resulting in the acquisition of low-quality items that do not meet Venezuelan food preferences or quality standards. The objective of this work is to describe, through the Venezuelan case, how the food security infrastructure of a country can be dismantled. We address (1) the development of institutions dedicated to promoting food security and nutrition and the recent dismantling of the sector; (2) the creation, characteristics, and weakness of the CLAP program; and (3) the current food insecurity crisis and the attempts to provide humanitarian help to the Venezuelan population.

Keywords: food security, food safety, state policies, science-based legislation, Venezuela

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"-How long are you going to treat these children, Dr. Bengoa?
-Until they smile, Father Quintana" (Bengoa, 2002)

INTRODUCTION

Once a rich country, with its economy based mainly on oil production and export, Venezuela managed to guarantee food security by complementing its food availability with the import of some items such as wheat, powdered milk, and edible fats. Venezuela's modern history as a major oil producer started in 1922; shortly thereafter, the country began to build an important institutionalization since 1936, including the creation of the Ministry of Health and Social Welfare and the National Institutes of Hygiene and Nutrition. Public policies implemented helped the acquisition of capital goods and the import of processed foods and raw materials. The demand for processed foods, purchasing power, and urbanization grew from 1936 through 1945 (Machado-Allison, 2007).

Child malnutrition was a big concern; it became evident from a food survey conducted in a poor neighborhood in Caracas in 1943, leading to the implementation of a net of school and popular diners. The National Institute of Nutrition (INN) developed programs to improve the alimentary and nutritional status of the Venezuelan population, as well as those aimed to treat and recover children suffering from severe malnutrition. In the 1960s, the success of the campaign to control malaria (1936–1964) and other diseases was resounding, and progress was also unquestionable in fighting hunger and malnutrition and in promoting food security and safety (López de Blanco and Carmona, 2005). The National Institute of Hygiene (INH) set the standards for food and drug surveillance.

From 1945 to 1978, there was a 4% annual growth in agricultural production (Pinto-Cohen, 1984). From 1945 to 1958, both food imports and agro-industrial development grew rapidly. In the 1960s, agriculture, livestock, and national production grew at an accelerated rate; unemployment also decreased, and the purchasing power increased; all these factors contributed to improving the population's food security (Machado-Allison, 2007). Despite the economic crisis of the 1980s, agriculture continued to grow. Available calories per inhabitant reached their maximum between 1978 and 1980 (2,800 kcal/day) (Machado-Allison, 2007; FAOSTAT, 2016). Between 1990 and 1996, a more equilibrated agricultural trade balance was achieved thanks to increased exports (Gutiérrez, 2002). Imports remained around US$75 per inhabitant per year for many years, dominated by feed grains, wheat, oils, sugar, and powdered milk.

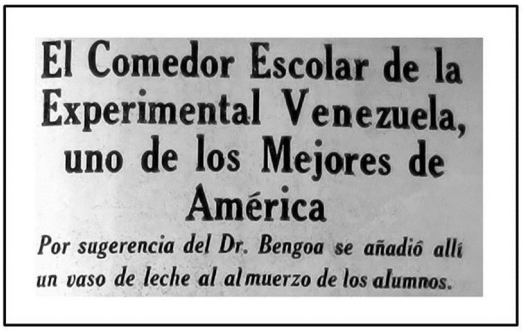
In 1998, the incoming administration of Hugo Chávez promised to share the country's oil wealth with the poor to guarantee food security, relying on oil revenues, which accounted for 93% of exports in 2008. Although agricultural and food security and sovereignty were state objectives, there was a drop in domestic food production, and the imports were increased to guarantee availability. Unfortunately, the decline in oil prices and erratic macroeconomic policies caused, particularly between 2008 and 2014, a shortage of foreign exchange and the falling domestic food production that could not be compensated by imports (Gutiérrez, 2016). The fall in oil prices in 2014, together with the reduction in oil extraction capacity, profoundly impacted the import of crop seeds and agricultural supplies. This negatively affected national food production. The crisis in food production deepened, not only as a result of currency restrictions but also due to government regulations, lack of confidence of private investors, and large property seizures, particularly of crop and cattle farms and industrial facilities (Doocy et al., 2019). For example, national food production, which covered 75% of food demand in 2013, fell to only 25% coverage by the end of 2017. From 2012 to 2016, total per capita imports fell by 66.5%. This caused a severe shortage of essential foods, and total food availability fell to critical levels never seen in the country.

Food safety was closely monitored by three organizations: the INH; the Venezuelan Industrial Norms Committee (COVENIN Standards), which established a series of strict regulations on manufactured foods; and the National Codex Alimentarius Committee, which was officially created in 2001. Therefore, until 1999, Venezuela had science-based legislation, clear national food security goals, strict standards for domestic food production and imports, and a system of institutions committed to ensuring safety and quality along each step of the food chain, all of them coordinated by the National Food Council, created by a presidential decree but whose activities were ended around 2003 when the food program Mercal came into play. Despite the fact that food security and safety were recognized as a fundamental right of the Venezuelan people in Article 305 inscribed in the Constitution of the Bolivarian Republic of Venezuela, nowadays, the alimentary situation has dramatically deteriorated. This work describes, through the Venezuelan case, how the food safety and security infrastructure of a country has been dismantled.

DEVELOPMENT OF INSTITUTIONALIZATION IN NUTRITION AND FOOD SECURITY IN VENEZUELA

Up to the Second World War, Venezuela was a rural country with minimal development of public institutions. The Ministry of Health and Social Welfare and the INH were created in 1936 and 1938, respectively. In the early 1940s, child undernutrition was a widespread problem, and the general population did not receive an adequate and balanced food supply. The first nutrition survey ever performed in Venezuela evaluated the nutritional situation of the inhabitants of "El Guarataro," a low-income Caracas neighborhood. Results of this study prompted the development of a nationwide net of popular diners where the working class could eat a complete lunch at a much reduced price; in addition, school children started to receive a daily glass of milk and/or a free lunch in their schools (Carmona, 2014).

Figure 1 shows a newspaper headline celebrating the 1943 opening of a school canteen; meals served included a glass of milk for every child. These early intervention programs led to the creation in 1949 of the INN. From this organism, solid and long-lasting policies were conducted, resulting in substantial amelioration of malnutrition among children up to 14 years of age. In regard to the food supply and safety, two food surveys at the national level were conducted, along with the periodic assessment of life conditions, evaluated through yearly surveys performed by the National Institute of Statistics and


El Comedor Escolar de la Experimental Venezuela, uno de los Mejores de América

Por sugerencia del Dr. Bengoa se añadió allí un vaso de leche al almuerzo de los alumnos.

FIGURE 1 | A 1943 newspaper account of the opening of the first Venezuelan school diner. "The diner of the Experimental Venezuela School, one of the best in America. By suggestion of Dr. Bengoa a glass of milk was added to the students' lunch." Source: José María Bengoa personal archive.

the Central Bank of Venezuela. Numerous campaigns were conducted based on food nutrition guidelines, the assessment of the nutritional status of adults and children, and the promotion of breastfeeding. The INN also published the National Food Balance Sheets, the Food Composition Tables, the Energy and Nutrient Requirements Tables for the Venezuelan Population, food guidelines for various population groups, reports of undernutrition prevalence, and the Venezuelan Archives of Nutrition that were later converted to the Latin-American Archives of Nutrition.

INN commanded the war against severe child malnutrition. Jose Maria Bengoa in 1939 pioneered the creation of recovering centers for malnourished school children. In a small Venezuelan rural town, he cared for emaciated and gloomy school children. Years later, the installation of a few nutritional recovery centers, financed by either public or private funds, almost eliminated the severe malnutrition prevalence. In 1991, a resolution from the Ministry of health (G-845) decreed that the report of malnutrition cases, evaluated by either clinical examination or anthropometric evaluation, should be mandatory. Nonetheless, since 2007, there have been no official bulletins published by INN.

Since 1975, United Nations (UN) agencies have proposed a strategy for the planning of a food and nutrition policy composed of three elements: (a) promote integrated rural development to improve food production and family income; (b) improve the combination of food produced, its processing, and its distribution; and (c) emphasize intervention programs toward specific target groups (Permanent Advisory Commission on Food Nutrition in the Andean Area, 1975).

Although in national planning, the nutritional issue was treated implicitly, it was only in the 5th National Plan (1976–1980) when "nutrition" was explicitly mentioned for the first time, emphasizing its importance for the country's social and economic development. It was in the 11th Plan of the Nation (1995), when the issue of food security was first addressed.

Besides, the prevention of micronutrient deficiencies, especially iron, was also considered. A program to enrich both corn and wheat flours, with various vitamins and minerals, was launched in 1993, resulting in a significant decrease in anemia (Comisión Venezolana de Normas Industriales, 1996; Chávez-Pérez, 2005). The National Food Council was created in 1995 with the mission to advise the government on the policies required to guarantee an adequate food supply, its physical and economic access, and its optimal biological use by the entire population (Carmona, 2000).

As shown in **Figure 2**, the availability of energy from 1980 to 2008 was only slightly adequate since most values were only 10–15% higher than the country's requirement (Instituto Nacional de Nutrición, 2008), which was increased to 2,300 kcal/day in late 2000 (Instituto Nacional de Nutrición, 2000); nonetheless, the population's access to available foods was unequal. By the end of the 1990s, around 50% of the population lived in poverty, and almost 30% was extremely poor (Consejo Nacional de la Alimentación, 1998, 2001). Bolivarian Republic of Venezuela (1999) considered food security as a fundamental right of the population (Article 305). Despite this fundamental advance, the obligation to fulfill this mandate is far below any expectancy.

The planning of food security policies requires timely, reliable, and trustworthy information. INN collected data on the population's nutritional status and published them in quarterly and annual bulletins easily accessible to the general public. This access was limited since 2008 (see **Figure 2**), although the collection of relevant information has continued. Therefore, there is a manifest void of information regarding the nutritional and alimentary status of the population, which is so necessary in the critical moments that the country is experiencing.

South America hosts the majority of the undernourished in the region (FAO et al., 2019); the increase observed in recent years is due mainly to the deterioration of food security in Venezuela, where the prevalence of undernourishment increased almost four-fold, from 2012–2014 to 2016–2018.

The strategies to survive in the face of lack of food are the following: 27% of households have had to resort to begging, 35% have eaten foods that they would rather not have eaten, 42% had to rummage for food on the streets in order to eat, and 57% have incurred some form of food deprivation (Caritas de Venezuela, 2020).

Regarding food safety, there was great concern from different government administrations until the 1990s. In 1940, the INH created the Food Control Laboratory; a year later, the first regulation on food and beverages was dictated, and the food registry was created (Belisario, 2008). Traditionally, the ministries of the health sector operated the food and nutrition programs and policies. Currently, the INN is allocated to the Ministry of Food. Food security policies put emphasis almost exclusively on food supply, disregarding nutritional and safety issues.

At present, food availability is not sufficient and does not meet the nutritional requirements of the Venezuelan population; food quality and safety are not usually addressed. For instance, every so often, there are newspaper reports of cyanide poisoning and deaths resulting from bitter cassava consumption; no enforcement is in place to avoid retail sales of this root variety used to produce a traditional starchy cake after cyanide glycosides are eliminated. A few years ago, the country was shaken by

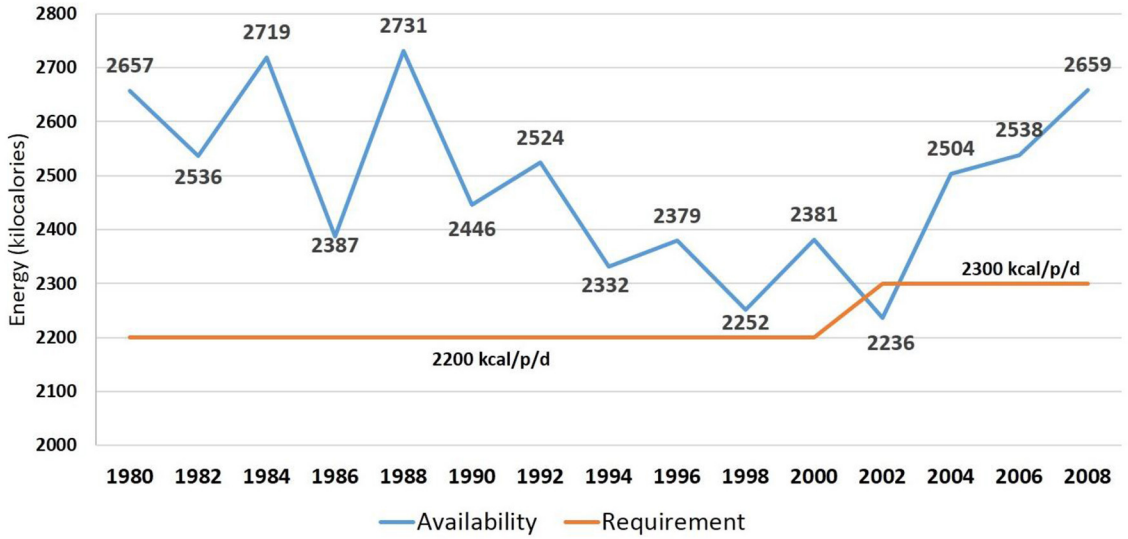


FIGURE 2 | National energy availability. Venezuela 1980–2008 (includes alcoholic beverages). Source: Food Balance Sheet. Instituto Nacional de Nutrición (2008).

the discovery of full loads of rotten foods resulting from uncontrolled imports. Complaints are also frequent in relation to poorly refrigerated meat and poultry food distributed through government programs. All of these must be considered in broader terms, like ingredients of a disaster cocktail; the provision of important public services (tap water, electricity, and household gas) limits household hygiene and regular cooking practices and jeopardizes food safety and consumer health. The use of firewood for cooking is growing even in the provincial capitals. In many respects, life in Venezuela resembles that of a war zone with surmounting limitations. Oletta-Lopez et al. (2016) reported an increase in outbreaks and cases associated with foodborne diseases (FBDs), concluding that the official silence on epidemiological information does not contribute to reducing the threat of infectious diseases, exacerbated by the precarious situation of public services and environmental conditions. The main problems include the shortage of potable water, inappropriate solid waste collection and wastewater treatment, the proliferation of vectors, the contamination of reservoirs and water sources, the spread of informal food and beverage consumption, the shortage of staples, and the impoverishment of the population, which has led to the consumption of discarded food.

This affects the biological use and hygiene of cooked foods, increasing the risk of tropical maladies such as diarrhea and dysentery in malnourished children (World Food Program, 2019; Observatorio Venezolano de Servicios Públicos, 2020).

In 2001, the Venezuelan Codex Committee was created and began its operations within the Ministry of Commerce's regulatory and quality control office. With this, Venezuela took a significant step to harmonize national regulations with Codex standards. It was a short-lived commission, since its activities ceased in 2006. This left Venezuela without adequate connection with international norms and regulations in the commercialization of food, particularly in times when national food imports have dramatically increased, most often without proper quality and safety control. **Figure 3** presents the timeline course of the creation and dismantling of agencies and programs within the food and nutrition sectors. For more than six decades, food security and safety institutions were created, showing a positive synergy between the country's scientific and political establishments.

In contrast, after 1999, erratic policies, rooted in the growing political conflict, have led to the dismantling of, otherwise, successful agencies. For instance, the National Food Council ceased its activities in 2003 and was finally replaced in 2015 by the National Center for Food Balance (CENBAL). This administrative body is in charge of supervising national food production and imports. The 1996 Strategic Food Program (PROAL) was abandoned. Through this component, six strategic foods (corn flour, rice, oil, sardines, grains, and powdered milk) were subsidized and distributed at local levels (Consejo Nacional de la Alimentación, 2001). PROAL was substituted by a series of unsuccessful food programs, Mercal, PDVAL, and lately by the so-called Local Supply and Production Committee (CLAP), whose characteristics and functions are described below.

LOCAL SUPPLY AND PRODUCTION COMMITTEE: IRREGULARITIES FROM VARIOUS INSTITUTIONAL EDGES

In an attempt to ameliorate food access and consumption problems, in 2016, the government made significant efforts and allocated enormous resources to implement a new food distribution program. CLAP was part of a presidential state of emergency decree. This is an indirect food subsidy program that distributes food bags to various population segments that should

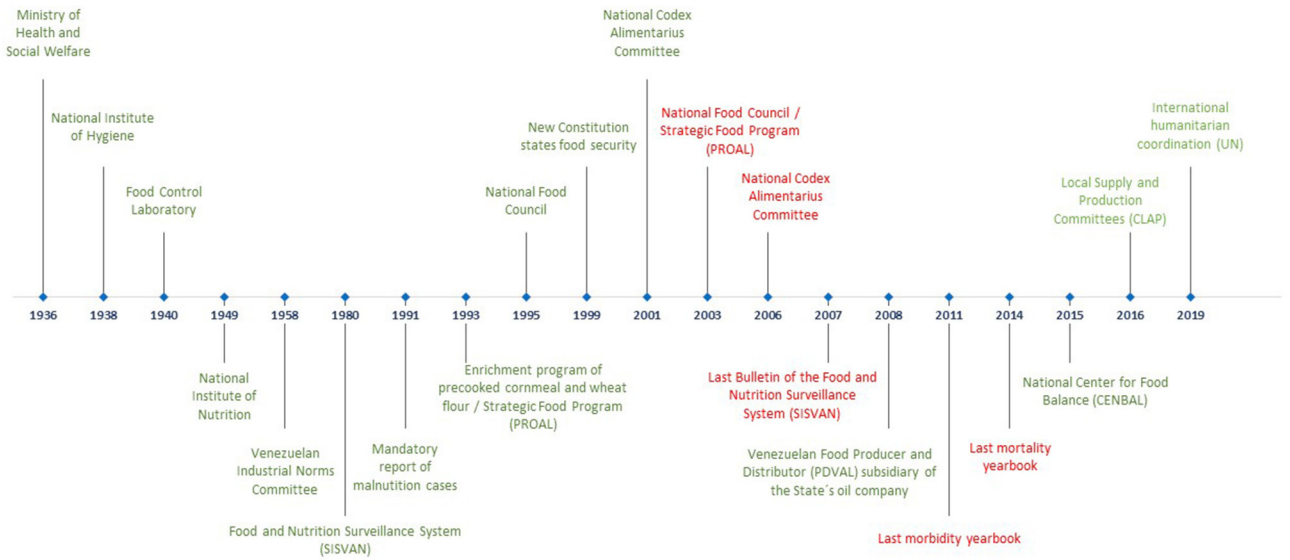


FIGURE 3 | Timeline of construction (in green) and dismantling (in red) of agencies and programs of the food and nutrition sector.

register in the program in order to be eligible. CLAP allocates basic foods (precooked cornmeal, rice, pasta, oil, sugar, powdered milk, etc.) through communal boards and other organizations controlled by the government. Because of its character, this program has been considered an instrument of social control of the population motivated by political reasons. For instance, admission or rejection is discretional and closely monitored by the government and/or the ruling party.

According to data from 2017 (Aponte-Blank, 2019), CLAP attended to around 12.6 million Venezuelans; it is clearly an insufficient coverage considering that 87% of the 28 million inhabitants are suffering poverty. In addition, despite the fact that the program was designed for a monthly distribution, actual delivery is erratic; for instance, 53% of beneficiaries reported unpredictable distribution frequencies, without a sustained periodicity. Furthermore, as compared to the initial food basket supplied, many products have disappeared from the bags, particularly the animal protein sources, to include mostly cereals.

In October 2016, Venezuelan food industries were forced to sell up to 50% of their production for CLAP distribution, affecting the regular commercial channels and excluding the vast majority of the population from the system. Since the volume of foods required could not be guaranteed only through domestic production, a niche was opened for food imports to favor a monopoly of private Venezuelan importing companies, which benefited from a highly advantageous differential exchange rate (Tapia et al., 2017). This avalanche of food imports was shielded by the economic emergency decree which allowed transitory regulations and laxity in procedures to bypass nutritional and/or safety requirements and favored different forms of corruption, as has been denounced.

Precooked cornmeal is one of the most indispensable products of the Venezuelan food pattern, always present in the CLAP inventory. Some cornmeal, imported, for instance, from Brazil or Mexico, is not tested to check if they meet Venezuelan regulations for protein content and vitamin and mineral fortification. Nutrient fortification was required and promoted by the official sector (Comisión Venezolana de Normas Industriales, 1996; Chávez-Pérez, 2005), and its monitoring and control was the responsibility of the INH and INN. Nonetheless, in recent years, this requisite seems to have been bypassed. Another example relates to genetically modified organisms (GMOs) whose planting, use, and marketing are prohibited in Venezuela (República Bolivariana de Venezuela, 2002, 2008). However, the cornmeal imported from Brazil is labeled as made with transgenic maize, which contradicts Venezuelan food regulations.

Another critical example is powdered milk. Consumers benefiting from CLAP started to perceive conspicuous sensory problems after consuming the powdered milk distributed; many consumers denounced, through social networks, that some kinds of milk imported from Mexico were salted, did not make foam, and tended to precipitate and to cause diarrhea in children and adults.

Hernández et al. (2019) evaluated the nutritional composition of 14 Mexican dairy product brands distributed by CLAP in Venezuela. A descriptive and cross-sectional study was conducted; samples were obtained from households in the Caracas metropolitan area. The information presented in the product labeling was compared with both the Venezuelan standard (Comisión Venezolana de Normas Industriales, 1982a,b, 2001) and the results of the chemical and nutritional composition analysis conducted. Regarding labeling, it was found that, for 43% of the brands, there was an agreement between declared values and the chemical analysis results; only two brands were labeled as dairy products. The chemical analysis showed inaccuracies in the information presented in the labels. The principal components analysis, followed by a hierarchical conglomerate, allowed differentiation of four clusters: two real

and two ideals. Most of the products analyzed were significantly higher in carbohydrates and sodium ($p < 0.05$) and low in protein and calcium ($p < 0.05$). All evaluated samples did not comply with not only the 1,481 Venezuelan standard (Comisión Venezolana de Normas Industriales, 2001) but also the criteria of the Official 155-SCFI-2012 Mexican standard. Therefore, for most brands, the declared product name and composition did not correspond to the nutritional content resulting from chemical analysis.

Interestingly enough, there were relevant differences in protein content; in one of the brands, protein tenor was 3.82 g/100 g instead of 25.53 g/100 g as declared in the label; this low protein level may explain the lack of foam formation upon dilution. Most of the brands traded had carbohydrate contents accounting for up to 80% of total solids. Considering that the principal milk's sugar is lactose, the excess of this disaccharide can cause osmotic diarrhea. There were also significant differences in micronutrients; sodium content was above 1,100 mg/100 g in three milk brands. Therefore, this high sodium level may produce the salty taste reported by consumers. In only one brand, the actual calcium content corresponded to that indicated in the label. The minimum calcium value found was 40.36 mg/100 g. This value is similar to the calcium content in rice flour (Hernández et al., 2019). Many parents offer milk to their children as a nutritional source of calcium and protein. Regular consumption of these products could affect children's growth. Additionally, sodium excess may affect young children's renal function and increase the risk of cardiovascular diseases in adults. These irregularities were reported to the Venezuelan Ministry of Food and the INH without any official answer. Nevertheless, because the milk's adulteration had occurred in Mexico, the Mexican prosecutor opened an investigation in 2019 for food fraud and a corruption case.

Finally, there are examples of food mislabeling, such as yellow cornmeal labeled as white cornmeal. This basic mistake is widespread in CLAP products. Although this does not compromise food safety, it violates food laws and regulations; this shows the relaxed quality control of CLAP foodstuffs while strict surveillance is imposed on processed foods made by Venezuelan private industries.

IMPACT ON VENEZUELAN CONSUMERS IN A SITUATION OF VULNERABILITY AND LACK OF PROTECTION IN TERMS OF FOOD SAFETY AND SECURITY

The absence of reliable information from official sources makes it very difficult to assess the population's current state regarding food safety and food security. Under this scenario, the three highest-ranked universities of Venezuela have coordinated their actions and developed the National Survey of Living Conditions (ENCOVI, by its Spanish acronym) in an effort to provide an independent set of national indicators, especially on food security. The 2014 survey included only questions limited to assess income information; around 80% of the respondents declared that salaries and other money incomes were not enough to buy food (Landaeta-Jiménez et al., 2015). Three years later, using a six-item food security scale (Landaeta-Jiménez et al., 2017), it was found that 70.8% of those answering the survey did not have enough food at home to meet their needs. Strikingly, in 6 out of 10 households, at least one adult went hungry to bed because they did not have food or money to access it. The absolute value of food insecurity was 80%, but its severity was not determined. In 2018, the ENCOVI group changed the measurement methodology to the Latin American and Caribbean Food Security Scale (ELCSA) (Universidad Católica Andrés Bello, 2020). Results show an increasing trend of food-insecure households: 88% in 2018, 94% in 2019, and 97% in the current COVID-19 period. It should be noted that families with moderate food insecurity were the ones that statistically contributed the most to this increase (2018: 31%, 2019: 36%, and 2020 COVID-19: 41%) (Universidad Católica Andrés Bello, 2020).

The Venezuelan government invited the WFP to conduct a food security assessment in the country (World Food Program, 2019). A total of 8,300 questionnaires were applied. Results showed that a third of Venezuelans (32.3%) did not get enough to eat, while only 8% were food secure. Therefore, it was deduced that 92% of the Venezuelan population suffers food insecurity in any of its degrees (mild, moderate, or high).

The food insecurity state is related to a poor nutritional status. According to FAO et al. (2019), for the 2014–2016 interval, Venezuela had a 6.4% prevalence of undernourishment. This value increased to 21.2% between 2016 and 2018. These data represent a three-fold increase in undernourishment during the indicated period. A previous report from ENCOVI reported an average weight loss in responders, close to 11 kg between 2016 and 2017 (Landaeta-Jiménez et al., 2018). The average caloric intake registered was 1,749 and 2,059 kcal for women and men, respectively (Ramirez et al., 2017).

Another consequence of the food insecurity state is the unstoppable migration. According to the United Nations High Commissioner for Refugees (UNHCR), worldwide, there are, currently, around 4.5 million Venezuelan refugees and migrants; one of the major driving forces of this migration is hunger, along with the pitiable living conditions (https://www.unhcr.org/venezuela-emergency.html).

ACCOUNT OF RECENT HUMANITARIAN INITIATIVES

Based on the absence of official data on the socioeconomic and health status of the Venezuelan population and the humanitarian situation, a joint effort of Johns Hopkins School of Public Health and Human Rights Watch, using 2018 information shared through key informant networks and a literature review, evaluated the food and nutrition situation in Venezuela. They also assessed if the crisis met thresholds for a food emergency declaration (Doocy et al., 2019). They concluded that an extensive intervention program in Venezuela was urgently needed, suggesting a tripartite group composed by representatives of the Venezuelan government, UN agencies,

and civil society organizations to coordinate the provision of humanitarian assistance.

In 2019, the humanitarian space in Venezuela expanded through the proper installation of the international humanitarian coordination architecture of the UN, composed by OCHA, a humanitarian country team, and a group to coordinate eight clusters that have been formally activated, namely, food security and livelihoods; health; nutrition; water, sanitation, and hygiene; protection (including the areas of responsibility of child protection and gender-based violence); shelter, energy, and non-food items (NFIs); education; and logistics. Together, these mechanisms are leading the coordination of principled humanitarian action across Venezuela (https://reliefweb.int/report/venezuela-bolivarian-republic/venezuela-humanitarian-response-situation-report-no-02-july).

The UN's humanitarian architecture and its partners scaled up actions with a Humanitarian Response Plan providing caring and protection assistance to 2.4 million people in 2019. In 2020, the humanitarian situation in Venezuela continues to have an impact on the physical and mental well-being, living conditions, and protection of the seven million people estimated to have humanitarian needs in 2019. The Humanitarian Response Plan for 2020 has been expanded to include a component to ameliorate the health and socioeconomic impact of the global COVID-19 pandemic (https://www.unocha.org/venezuela/about-venezuela).

CONCLUSION

An intense effort to develop solid institutions aimed to address chronic health and nutrition problems can be documented in Venezuela since the onset of the Second World War. As a result of this, for many years, Venezuela was recognized as a country with solid infrastructure, not only in nutrition and food safety policies but also in terms of education, health services, roads, electricity, and potable water. During the last 20 years, Venezuelans have witnessed the progressive destruction of a wide range of institutions: public organizations, public and private industries, cattle and crop farms, universities and research facilities, and the national electric, domestic gas, and tap water networks. The socioeconomic situation can be described with a few words: low wages, unemployment, poverty, hunger, malnutrition, and hopelessness. For millions, particularly the young ones, the alternative has been the exodus to other countries; elders have been left behind and depend largely upon money transfers from their relatives living abroad. The COVID-19 pandemic has made things worse for Venezuelan migrants, making them defenseless and with little resources to support their families at home. Within this article's scope, the dismantling of institutions aimed to protect the constitutional right to receive an adequate food supply (in quantity, quality, and safety) has placed the Venezuelan consumers in a situation of vulnerability with little or no food security at all. Irregularities described here speak of a deficient role of the institutions in charge of ensuring the quality, safety, and compliance with standards and regulations of imported products for the Venezuelan population. Although ethically justified under this severe crisis, the CLAP program shows several distortions, inequalities, and lack of coverage and efficacy that make it practically useless. Humanitarian assistance is desperately needed; however, it should promote people's welfare without political submission. The task ahead of us is incommensurable. Rebuilding the lost institutionality would require decades. Thousands of Venezuelan migrants with solid professional backgrounds should return to help the reconstruction process. Global standards on the composition of essential products, globally harmonized labeling, and regulations should be recovered. Food safety and security are critical concerns. To achieve it, we need to build an ample alliance of active forces (government officials, politicians, the scientific community, and military establishment) able to recognize the significance of this deteriorating situation in order to protect the Venezuelan population. The authors are aware of this article's limitations: however, there are many constraints and difficulties to access information, not only because of political or institutional reasons but also for the closure of libraries and reference centers due to economic constraints and the COVID-19 pandemic.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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The authors dedicate this paper to the memory of José María Bengoa (1913–2010), teacher and guide of professionals in nutrition, a constructor of institutions, and an advocate of food security and safety, not only in Venezuela but also worldwide, from his activity as a WHO officer. Part of this work was presented at the Congress on Food Safety and Security, 24–28 March 2019, in Leiden, The Netherlands. Authors thank the Global Harmonization Initiative (GHI) and its president, Dr. h.c. Huub Lelieveld, for their economic and moral support.

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Assessment of Malnutrition and Intestinal Parasitoses in the Context of Crisis-Hit Venezuela: A Policy Case Study

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Venezuela is in the midst of a humanitarian crisis with a dangerous cocktail of hyperinflation, violence, minimal local food production, and policies that impact the nutrition for millions of Venezuelans. Independent data suggests that most Venezuelans are food insecure, with alarming rates of acute and chronic malnutrition, especially among children. A re-emergence of poverty-related intestinal parasitoses and anemia has aggravated their health. With little to no response from public authorities, Venezuela is now the lowest-ranked country in the world in deworming coverage. Modest independent and private epidemiological studies suggest prevalence rates as high as 60% in some regions. This article reviews public health policies regarding malnutrition and intestinal parasitoses and aims to provide a rational approach based on international recommendations for countries in crisis.

Keywords: Venezuela, malnutrition, policy, crisis, parasitoses, wash, water, sanitation

INTRODUCTION

Venezuela's humanitarian emergency demands a multi-sector approach aimed at reducing parasite-induced malnutrition. Over the last decade, Venezuela has transitioned from being one of the richest oil-producing countries in the world to becoming a crisis-hit nation amid a deep socioeconomic collapse. This complex situation primarily reflects three phenomena: (a) inadequate economic measures that have led to hyperinflation and increased poverty; (b) a spike in violence, sociopolitical turmoil, and massive migration; (c) and the decay of the public health care system.

The Venezuelan crisis has caused multidimensional impoverishment of most of its population, with a steady decay in education, quality of life, and employment rates that affect nearly 65% of Venezuelans (Encuesta Nacional de Condiciones de Vida, 2020). Hyperinflation has impacted food security and access to utilities (water, electricity, gas) for at least three-quarters of the population; in actuality, this rough estimate may be much higher given the political restrictions imposed by the national government on research concerning these topics (World Food Program, 2019).

Currently, Venezuelan public healthcare is practically non-existent as most facilities have critical shortages of medicines, equipment, supplies, and qualified medical staff. Furthermore, the majority of epidemiological surveillance and control programs have been abandoned, resulting in an unprecedented spike in vaccine-preventable and vector-borne diseases that, fueled by massive migration, have created the largest disease exodus of modern times (Grillet et al., 2019; Paniz-Mondolfi et al., 2019a). Intestinal parasitoses have also reached epidemic proportions among Venezuelans since these agents have an infectious life cycle that is propelled by poor water, sanitation, and hygiene (WASH) status. The arrival of SARS-CoV-2 has aggravated the situation as the remaining, already-limited resources have been diverted (or redistributed or rerouted) to try to lower the impact of Coronavirus Disease 2019 (COVID-19).

We aim to summarize the effects that poverty, malnutrition, and intestinal parasitoses exert on the most vulnerable populations in Venezuela: children and indigenous peoples. We also examine current policies and recommend measures to address these issues.

POLICY OPTIONS AND IMPLICATIONS

Malnutrition

In 2019, The World Food Program (WFP) reported that 2.3 million (7.9%) Venezuelans were severely food insecure, mainly in Zulia, Falcon, Delta Amacuro, and Amazonas states (World Food Program, 2019). Between December 2019 and March 2020, child malnutrition rates increased to 26% (Caritas Venezuela, 2020). General undernutrition rates skyrocketed to 21.2% by 2018, while the prevalence of stunted growth among children reached 13.4% in 2012 (FAO et al., 2019).

The prevalence of severe acute and chronic malnutrition exceeds critical thresholds in many states with a heavy presence of Amerindian peoples, including the states of Zulia, Amazonas, and Delta Amacuro (**Table 1**). In the last decades, indigenous peoples have disproportionally suffered as a consequence of the ongoing national crisis, particularly in isolated areas where access to healthcare facilities is most challenging (Paniz-Mondolfi et al., 2019b). In these areas, the already low healthcare coverage reaches critical rates (Gómez et al., 2019). Previous studies report that 45.5% of health centers that treat Indigenous Peoples lack adequate medical personnel and 22.7% have non-medical personnel providing medical care (Gómez et al., 2019).

The arrival of the SARS-CoV-2 pandemic deeply worsened the Venezuelan food crisis by increasing prices and reducing food availability for the general population. In border regions, the situation has been complicated by containment measures resulting in the closure of food centers managed by international agencies that supported Venezuelans in extreme poverty (González, 2020). Furthermore, the humanitarian corridor through the Colombian-Venezuelan border became bottlenecked. Illegal transit coupled with insufficient food and medical care are common in this region, which has witnessed an increase in violence as armed groups are constantly fighting to take control over the zone (Collins, 2020).

There is a similar scenario in the south, where poverty and marginalization have forced a massive exodus of Warao Amerindians in precarious nutritional status to Brazil. In an attempt to address cultural and linguistic barriers that hinder

TABLE 1 | Malnutrition prevalence studies in Venezuela between 2005 and 2020.

Authors	Year of publication	Study population	Age (Years old)	Region	Prevalence of malnutrition	References
Solano L, Baron MA, and Del Real S	2005	301 Children	2–18	Carabobo state	26,7%	Solano et al., 2005
Solano L, Acuña I, Sánchez-Jaeger A et al.	2011	257 Children	2–18	Carabobo state	36,6%	Solano et al., 2011
Verhagen LM, Incani RN, Franco CR	2013	390 Children	4–16	Carabobo State Orinoco River Delta Amazon State	13% 30% 84%	Verhagen et al., 2013
Caritas Venezuela	2018	5.457 Children	<5	Capital District, Vargas State, Miranda State, Zulia State, Lara State, Carabobo State, Sucre State	2% Severe acute malnutrition 5% Moderate acute malnutrition 16% Mild acute malnutrition	Caritas Venezuela, 2018
Caritas Venezuela	2019	1,325 Children	<5	Barinas State, Bolívar State, Carabobo State, Falcón State, Miranda State, Sucre State, Yaracuy State, and Zulia state	3% Severe acute malnutrition 9% Moderate acute malnutrition 23% Mild acute malnutrition	Caritas Venezuela, 2020
Caritas Venezuela	2020	NDA	<5		4% Severe acute malnutrition 13% Moderate acute malnutrition 26% Mild acute malnutrition	Caritas Venezuela, 2020

NDA, No Data Available.

the social adaptation of Indigenous Venezuelan migrants, public health authorities in Brazil have created humanitarian shelters just for this group (Prengaman, 2018).

Hunger, malnutrition, and obesity, are just some of the challenges Venezuela faces. Linear growth in children is a good marker to identify inequalities in human development and a sensitive indicator for the health and well-being of populations (Orellana et al., 2019). Early nutritional disturbances result in adverse effects for individuals in their adult lives and can also be transmitted to future generations. Studies carried out in Yanomami communities confirm the intergenerational transmission of low maternal height as a consequence of the most severe nutritional deficits (Orellana et al., 2019).

Intestinal Parasitoses

Public authorities in Venezuela have severely curtailed epidemiological surveillance activities, and the lack of equipment and reagents have hampered efficient diagnosis and reporting of nutritional status and infectious diseases. Due to the abandonment of most epidemiological programs, current data for the prevalence of intestinal parasitoses and the attributable morbidity is scarce and may be underestimated. Cross-sectional studies that used combined microscopy and PCR methods have reported prevalence rates of over 65% in rural communities (Incani et al., 2017). Others have pointed at *Blastocystis spp*, *Giardia intestinalis* and *Entamoeba coli*, *Trichuris trichiura*, and *Ascaris lumbricoides* as the most common agents (**Table 2**) (Hagel et al., 2001; Nastasi-Miranda, 2015; Orozco et al., 2019). Intensity of infection (measured as eggs/larvae per gram of feces) has also been reported in some Venezuelan communities with a tendency toward light-to-moderate parasite loads (Incani et al., 2020). Prevalence and intensity of infection are not necessarily related as they may share some—but not all—risk factors in an agent-specific fashion (Incani et al., 2020).

Intestinal parasitoses have become a persistent public health issue in Venezuela, remaining at high or unacceptable levels for the last 30 years (Chacín de Bonilla, 1990). Neighboring countries such as Colombia and Brazil have reported prevalence rates of 25.5 and 33.4% respectively, while Venezuela displayed a larger prevalence of 39.4% (Chammartin et al., 2013). Reports from indigenous populations have also shown elevated occurrence for several intestinal protozoa and helminths (Devera et al., 2005; Gastiaburu, 2019), with predominance toward polyparasitism in children from certain communities (Acurero-Yamarte et al., 2016; Gastiaburu, 2019).

The long-term effects of intestinal parasitoses on the general population—and especially on children—are considerable: anthropometric alterations, malnutrition, physical growth and mental impairment, anemia, and reduced community productivity (Crompton and Nesheim, 2002; Nastasi-Miranda, 2015). In poor urban and rural communities, intestinal parasitoses are related to overcrowding, inadequate hygiene, and precarious housing materials. Additional spatial clustering of "wormy houses" with individuals with high prevalence and intensity of helminth infection represent local hotspots for community transmission that should be heavily targeted in mass deworming strategies (Incani et al., 2020).

Chronic parasitoses may also elicit immunomodulatory effects on human hosts, which have been described in Amerindian peoples. Reports from Warao communities show Th2-skewed cytokine profiles that may facilitate *Mycobacterium tuberculosis* infection in patients with *Ascaris lumbricoides* (Verhagen et al., 2012). Other studies suggest that this cytokine shift could provide protection against other gastrointestinal agents such as *Helicobacter pylori* (Fuenmayor-Boscán et al., 2016) and modulate immunological responses in allergic or inflammatory processes (Gazzinelli-Guimaraes and Nutman, 2018).

Recently, the Pan-American Health Organization declared Venezuela the country with the lowest mass deworming coverage (Ault et al., 2011). Mass deworming is a technique recommended by WHO to improve children's health (World Health Organization, 2017) by drastically reducing the prevalence of parasites and slowly improving nutrition in low-income communities.

The cost of mass deworming is mitigated in part by the donation of classic deworming drugs such as albendazole/mebendazole by their pharmaceutical manufacturers including Merck, Johnson & Johnson, and GlaxoSmithKline. Emerging strategies, such as the massive use of oral ivermectin could potentially help tackle intestinal parasites, as well as other hyper-prevalent neglected tropical diseases (NTDs) such as river blindness, malaria, Chagas disease, and the Leishmaniases (Perez-Garcia et al., 2020).

Integrated WASH and NTD Strategy

The provision of safe water, sanitation, and hygiene (WASH) is one of the five key intervention methods within WHO's global roadmap for the elimination of NTDs (World Health Organization, 2020). Yet, the WASH component of this strategy and its potential role in reducing NTDs has received little to no attention globally. In Venezuela, this strategy is non-existent.

First, the collaboration helps to develop a large-scale needs assessment that can collect data needed for investment opportunities from the humanitarian sector. Water pollution and the interruption of water services across Venezuela have intensified in the past decade, and there is little documentation of its severity and impact, particularly toward the most vulnerable indigenous groups. Reports from local NGOs indicate that at least 82% of Venezuelans have very sporadic water access and the quality is far below WHO standards (CEPAZ, 2018). The risks of parasitic infections posed by poor water quality can be more threatening to a population already weakened by shortages of food and health services. Open defecation is also prevalent in many regions across the country, and about 70% of the wastewater volume produced in the country is not collected or treated (CEPAZ, 2018).

Second, the collaboration promotes joint planning and implementation of activities in a country where multisector action is needed to simultaneously control several NTDs (Perez-Garcia et al., 2020). Rapid reinfection after massive deworming can occur when poor hygiene practices exist and the environment is still contaminated with parasites

TABLE 2 | Parasitoses prevalence studies in Venezuela between 2001 and 2018.

Authors	Year of publication	Study population	Age (years old)	Region	Prevalence of parasitosis	Most prevalent STH's	References
Hagel I, Salgado A, Rodriguez O et al.	2001	1,190 children	5–14	Capital District, Delta Amacuro state, Miranda state, Sucre state, Trujillo state	97.4%	*T. trichiura* 74.1%.	Hagel et al., 2001
Devera R, Blanco Y, Cabello E et al.	2005	160 amerindians	0–60	Bolivar state	92.5%	*A. lumbricoides* 38.8%	Devera et al., 2005
Al Rumhein F, Snachez J, Requena I et al.	2005	334 children	6–15	Bolivar state	60–70%	*A. lumbricoides* and *T. trichiura*	Al Rumhein et al., 2005
Díaz I, Rivero Z, Bracho A et al.	2006	91 amerindians children	0–14	Zulia state	83.5%	*A. lumbricoides* 57.1% *T. trichiura* 20.8% *Hymenolepis nana* 14.2%	Díaz et al., 2006
Rodriguez Z, Hernandez A, Bracho A, et al.	2013	59 VIH+ individuals	21–79	Zulia state	67.8%	27.27% for all *lumbricoides* *T. trichiura* and *Strongyloides stercolaris*	Rivero-Rodríguez et al., 2013
Devera R, Blanco Y, Amaya I, et al.	2016	921 children	5–15	Bolivar state	62.9%	*T. trichiura* 2.8% *A. lumbricoides* 4.3%,	Devera et al., 2016
Nastasi-Miranda J.	2015	336 children	3–14	Bolivar state	63.1%	*T. trichiura* 4,8% *A. lumbricoides* 4%,	Nastasi-Miranda, 2015
Devera R, Cordero A, Uzcategui Y et al.	2016	118 children	0.1–14	Bolivar state	84.7%	*Hymenolepis nana* 15.3% *A. lumbricoides* 6.8%	Devera et al., 2016
Orozco M, Marchan E, Rondon R	2019	145 children	3–6	Aragua state	73.8%	*E. vermicularis* 20%	Orozco et al., 2019

STH, Soil Transmitted Helminths; NDA, No Data Available.

at infective stages. Having access to safe water, sanitation facilities, and improved hygiene can enhance the effectiveness of deworming campaigns. The WASH component of the strategy can plan and implement adequate access to WASH.

Third, it serves to track progress across multisectoral actions beyond the health sector. The multisectoral effort can use target indicators not only in vector control but also in transmission interruption through adequate access to WASH. For example, measuring access to safe collection and disposal of feces, access to potable water, and access to handwashing facilities.

Finally, the combined intervention can guide humanitarian response plans in education. Mass deworming together with educational WASH campaigns could effectively reduce the burden of intestinal parasitoses, by interrupting the reinfection cycle that involves contaminated soil, water, or food.

ACTIONABLE RECOMMENDATIONS

Combining WASH and NTD efforts is critical to target investments from the humanitarian sector needed for large-scale strategies to reduce parasite-induced malnutrition in Venezuela. This approach serves to create a robust collaboration platform among researchers and NGOs working to reduce the burden of parasitic infections in the country. Although international aid to Venezuela discretely increased in 2018, there is no coordinated strategy or agreement upon priorities to use these funds. An integrated WASH-NTD approach is key to create a strategy for long-term impact on communities' health and nutrition.

Achieving long-term impact requires proper diagnostics. More investment is needed to support research institutions working with nucleic acid-based methods for the detection and identification of parasitic infections. These methods provide higher sensitivity and specificity with simpler standardization of diagnostic procedures. Another advantage is that DNA samples can be stored and used for genetic characterization, posing as a valuable tool for surveys and surveillance studies that provide the basis for WASH-NTD interventions aimed at reducing parasite-induced malnutrition.

Finally, international humanitarian assistance should focus on coordinating strategies between stakeholders of multiple sectors to increase capacity in the WASH and NTD sectors. Capacity building is critical in Venezuelan research institutions, NGOs, and the private sector to search for international and technical support with scientific evidence-based proposals.

CONCLUSIONS

The humanitarian crisis in Venezuela requires a multi-sector approach aimed at reducing parasite-induced malnutrition. An integrated WASH-NTD strategy is essential to facilitate the planning, implementation, and

evaluation of large-scale programs that target a reduction of the parasite burden in the most vulnerable populations of Venezuela.

AUTHOR CONTRIBUTIONS

IM-C, AP-M, LD-N, EM-R, and LP-G contributed conception and design of the study. LD-N, EM-R, and LP-G organized the database. AP-M, LD-N, EM-R, and LP-G wrote the first draft of the manuscript. AP-M, LD-N, EM-R, IM-C, HU-M, LV-P, JH, ES, and LP-G wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Food Security in Venezuela: From Policies to Facts

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The 1948 Universal Declaration of Human Rights, approved by The General Assembly of the United Nations, recognized the right to food as a Basic Human Right. Consequently, at the national level, programs, norms, and laws were decreed to promote the population's health and nutrition. The 1999 Venezuelan Constitution explicitly included, for the first time, the term "Food Security" in Article 305. Subsequently, the government approved various laws and guidelines to regulate the right to food of the population. However, despite such laws, the well-being of the population has not improved. According to the 2020 State of Food Security and Nutrition in the World (2020), between 2017 and 2019, the undernourishment prevalence amounted to 31.4%. Also, reports from Caritas showed 14.4% of Global Acute Malnutrition in children under 5 years of age, and 20% of children were at risk of acute malnutrition for the period April–June 2020. Other factors have influenced the actual Venezuelan food insecurity condition. The current severe economic and social crisis has led to a Complex Humanitarian Emergency. This work aimed to consider if decreeing many laws related to food and nutrition is not enough to reduce this scourge, or if there is any guarantee that the Food and Nutrition Security (FNS) of the people would improve.

Keywords: food, nutrition, food security, food policies, malnutrition, children, Venezuela

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On December 10, 1948, 72 years ago, the right to food was recognized in the Universal Declaration of Human Rights by The General Assembly of the United Nations, Resolution 217 A (III).

Article 25 states: "Everyone has the right to an adequate standard of living that assures him, as well as his family, health and well-being, especially food…" (Naciones Unidas, 1948). Consequently at the national level, programs, norms, and laws were decreed to promote the population's health and nutrition. The 1999 Venezuelan Constitution, in its Article 305, explicitly included for the first time a Food Security statement, understood as the sufficient and stable availability of food at the national level, at all times, and its permanent access by the consuming public…" (República Bolivariana de Venezuela, 1999).

Subsequently, to favor the Right to Food of the Venezuelan people, various laws and regulations have been decreed. **Table 1** describes the regulatory basis of food security in Venezuela. Despite these laws, and after the decree of the right to food in the Venezuelan Constitution, the country still has significant nutrition deficiencies. For instance, the State of Food Security and Nutrition in the World 2019 (FAO et al., 2019) reported that the prevalence of undernourishment increased by 21.2%, rising to 31% the following year (FAO et al., 2020). According to Caritas, the Global Acute Malnutrition in children under 5 years of age (GAM) was 14.4% in 2020 (Caritas de Venezuela, 2020). Moreover, the national report jointly issued, in December 2018, by the Bengoa Foundation, the Venezuelan Health Observatory, and the Agri-food Network of Venezuela, 33% of children under 2 years of

TABLE 1 | Regulatory basis for food security in Venezuela.

Legal basis	Description	Validity since	Comments/considerations
Constitution of the Bolivarian Republic of Venezuela (República Bolivariana de Venezuela, 1999)	**Article 305 states:** ".. the food security of the population is guaranteed, understood as sufficient and stable availability of food at the national level and timely and permanent access to food by the population."	1999	It is the first time that Food Security is established as a right in Venezuela (República Bolivariana de Venezuela, 1999)
Venezuelan Land and Agrarian Development Law, Decree N°1.546 Official Gazette N°37,323 November 13, 2001 (República Bolivariana de Venezuela, 2001)	**Article 1 states:** "The purpose is to establish the bases of integral and sustainable rural development; understood as the fundamental means for human development and economic growth of the agricultural sector within a fair distribution of wealth and strategic, democratic and participatory planning, eliminating large estates as a system contrary to justice, the general interest and social peace in the field, ensuring biodiversity, agri-food security and the effective enforcement of environmental and agri-food protection rights of present and future generations."	2001	This law has been the basis for the expropriation of lands with dramatic consequences on agricultural food production, more than 243 expropriations in 2016 (Ballesteros, 2017; Tapia et al., 2017; Universidad Católica Andrés Bello, 2020)
Law N°38.094 on Food for Workers, Extraordinary Official Gazette, December 27, 2004 (República Bolivariana de Venezuela, 2004)	**Article 1 states:** "This is intended to regulate the benefit of food to protect and improve the nutritional status of workers, in order to strengthen their health, prevent occupational diseases and promote greater labor productivity."	2004	This law grants a food voucher to personnel who work for both the public and private sectors. The food voucher delivered at present is insufficient to cover the cost of food given the rampant hyperinflation in the country. (Landaeta-Jiménez et al., 2012; Tapia et al., 2017; Fundación Bengoa, 2018; Universidad Católica Andrés Bello, 2020). The cost of food in Venezuela exceeds by far the entire international poverty line of USD 1.90. The minimum monthly income is 800,000.00 Sovereign Bolivares (400,000.00 minimum salary plus 400,000 socialist ticket basket) (República Bolivariana de Venezuela, 2020) equivalent to 1,71 $ and the cost of the food basket for workers is 131,723,370.17 equivalent to $ 188.31 for November 2020 (Centro de Documentación y Análisis para los Trabajadores, 2020)
Organic Law on Food Security and Sovereignty, Decree Law N°6,071 Extraordinary Official Gazette July 31, 2008 (República Bolivariana de Venezuela, 2008)	"For the construction of the Social State of justice and well-being, it is essential to guarantee Venezuelan citizens to have timely access to quality food preferably those produced in the country. Among the General Provisions of the Decree there is the declaration of public order, public utility and social interest of the activities that ensure the availability and timely access to safe, quality food for the population, with special mention of the possibility of proceeding to the compulsory acquisition of the assets related to such activities, upon payment of the fair price, without the need to obtain authorization from the National Assembly"	2008	This law supported expropriations, and declared that all the steps in the productive chain were of "public utility" permitting the occupation of farms, enterprises, and productive units without due process. This law resulted in a dramatic fall of food production, food shortages, rural unemployment and higher prices for basic items of the diet. (Landaeta-Jiménez et al., 2012; Tapia et al., 2017; Fundación Bengoa, 2018; Universidad Católica Andrés Bello, 2020)
Law of Attention to the Agrarian Sector Decree N°1,062 Official Gazette N°40.440 June 25, 2014 (República Bolivariana de Venezuela, 2014b)	**Article 1 states:** "Debt restructuring and agricultural financing granted to beneficiaries whose items are strategic for the Food Security and Sovereignty that have been damaged by causes attributable to weather, meteorological, telluric, biological or physical agents"	2014	This law was intended to favor the restructuring and financing of agricultural loans, however, the agricultural loan portfolio decreased considerably to less than 20,000,000 dollars, from the 1,500,000,000 dollars needed which translated into a decrease of national production and an increase in imports (Chourio, 2020)
Creation of the National School Food Corporation, PAE Decree N°1,387 Official Gazette N° 40,538 November 11, 2014 (República Bolivariana de Venezuela, 2014a)	Creation of the National Corporation for School Food, (CNAE PAE S.A. in its Spanish acronym) whose purpose is formulation, execution, and follow-up of plans for the production, acquisition, and distribution, of food destined for the basic education subsystem, as well as supervising the activities aimed to guarantee feeding and nutrition of children and adolescents of this system	2014	This program was designed without considering the infrastructure of the schools receiving the benefit with spaces not suitable for safe preparation of food. The limitations range from failure to comply with the infrastructure design to the lack of adequate equipment and services for the preparation and preservation of food, drinking water, gas, electricity and trained personnel, contravening the General Food Regulation (RGA) and Good Manufacturing Practices Gazette 36,081 (República de Venezuela, 1959, 1996, 1998; Landaeta-Jiménez et al., 2012; Tapia et al., 2017)

(Continued)

TABLE 1 | Continued

Legal basis	Description	Validity since	Comments/considerations
Law of the Comprehensive National Agrifood System, Decree N°1,405 Official Gazette N° 6150 November 18, 2014 (República Bolivariana de Venezuela, 2014c)	The National Superintendency of Agrifood Management (Sunagro), entity attatched to the Ministry of Popular Power for National Commerce, is created to keep a national registry of natural and legal persons involved in production, processing, distribution, import and export of food, guaranteeing a fair and equitable distribution in terms of national production in coordination with the competent bodies.	2014	Single Guides issued for mobilization and monitoring of all food produced and transformed in the country are required in fields and industries, determining where to dispatch the products affecting availability, timely reception and favoring corruption (Tapia et al., 2017; Fundación Bengoa, 2018; Chourio, 2020; Universidad Católica Andrés Bello, 2020)
Law of the Great AgroVenezuela Mission, Decree N° 1,409 Extraordinary Official Gazette N° 6151 November 18, 2014 (República Bolivariana de Venezuela, 2014d)	**Article 1 states:** "it aims to strengthen national food production through scientific, technological, technical, financial, logistical and organizational support to producers, as well as to other actors and sectors of the agrifood production chain, mainly in the areas of produce, forestry, livestock, fishing and aquaculture to guarantee the Food Security and Sovereignty of the country"	2014	This law has not prevented the drop in Venezuelan food production, all agricultural sectors have been affected by lack of credit, expropriations of companies, currency devaluation, price controls and excessive regulations along each step of the value chain (Tapia et al., 2017; Fundación Bengoa, 2018; Chourio, 2020; Universidad Católica Andrés Bello, 2020). With a figure in the fall of national food production that exceeds 70%, due to these factors (Blanco, 2020). The Gross Domestic Agricultural Product per capita decreased between 1998 and 2018 by 58.8% and between 2008 and 2018 by 62.8%. According to the Confederation of Associations of Agricultural Producers of Venezuela (FEDEAGRO), between 2009 and 2018 the production of strategic agricultural commodities like rice decreased by 50.9% and corn in 55.9% (Gutiérrez, 2019)
Organic Law of Fair Prices Decree 600 Official Gazette N° 40,340 January 23, 2014 (República Bolivariana de Venezuela, 2014e)	**Article 1 states:** "it aims at the harmonious and sovereign development of the national economy, through the determination of fair prices of goods and services, the analysis of cost structures, the setting of the maximum percentage of profit and the effective control of economic and commercial activity, to protect the income of all citizens and especially the salary of workers. The law establishes administrative offenses, procedures and sanctions, economic crimes, their penalization and compensation for the damages inflicted on the consolidation of the productive socialist economic order."	2014	In 2008, the Decree-Law on Agro- Price controls through modifications to the legal framework (decrees, Law of Costs and Fair Prices with their reforms) were intensified, and expanded in terms of the food included and applied to various links in the agro production chain (producer, wholesaler, factory, retailer), making it difficult for markets to function properly. The Venezuelan Chamber of the Food Industry (CAVIDEA) has identified over 200 laws, decrees or resolutions that affect and influence final prices. Neither the legal frameworks for these controls, nor the organizations that regulate their application, functioned properly. The price control effect was worsened by the strict exchange/currency control policies installed in 2003 along with high inflation. At present there is limited access to the national currency, exchange control has been eased, the economy moves in US dollars. Venezuela Food Inflation is projected to trend around 3300.00% in 2021 and 4900.00% in 2022, according to some econometric models (Tapia et al., 2017; Chourio, 2020; FAO, 2020b; Trading Economics, 2021)
State of Exception and Economic Emergency Decree 2.323 Extraordinary Official Gazette N° 6,227 May 13, 2016 (República Bolivariana de Venezuela, 2016)	**Article 2 states:** "enables the executive to take appropriate exceptional and extraordinary measures to guarantee that citizens fully enjoy their rights, to preserve domestic order, ensure timely access to basic goods and services and mitigate the impact of natural circumstances that have affected power generation, access to food and other essentials. Among them: – Plan, coordinate and implement the urgent national and international procurement of goods or supplies essential to the health and feeding of citizens and upholding of basic services throughout the country, within the framework of trade or cooperation agreements – Allow the Bolivarian National Armed Forces and Local Supply and Distribution Committees (CLAPs) to intervene in the distribution and marketing of food and basic necessities."	2016	This decree facilitated the creation of food distribution committees (CLAPs) in which the communities themselves supply and distribute priority foods through a house-to-house delivery method. These foods were imported by expedited mechanisms while national food industries were compelled to destine 50% of their production to CLAPs Some problems emerged like distribution of low-quality products, little variety, and food imported without adequate and timely quality control without meeting current food safety and hygiene requirements (Tapia et al., 2017; Hernández et al., 2019; Universidad Católica Andrés Bello, 2020)

(Continued)

TABLE 1 | Continued

Legal basis	Description	Validity since	Comments/considerations
Constitutional Law of the Local Committee of Supply and Production CLAP Official Gazette N° 41.330 January 29, 2018 (República Bolivariana de Venezuela, 2018)	**Article 1 states:** Its purpose is to regulate the operation of the Local Committee of Supply and Production (CLAP), as well as the recognition of grassroots organizations of People's Power, to ensure production, supply, and distribution of food to guarantee the independence, the social welfare of the People, the food security, and the integral development of the Nation.	2018	After the creation of the CLAP committees, they are converted into a law with the main objective of dealing with food shortages and hoarding, but the growing economic crisis in the country made evident their ineffectiveness. The distribution of CLAP bags or boxes is very irregular in time, variety and quality of food (Tapia et al., 2017; Universidad Católica Andrés Bello, 2020). Also, corruption flourished in non-transparent importation procedures facilitated by laxity in quality control procedures, expedited importation mechanisms favored by foreign currency assignments at preferential rates for these operations (Hernández and Rivas, 2021)

age showed growth retardation when using the Size/Age indicator (Fundación Bengoa, 2018), that is, according to the data provided by these NGOs, that malnutrition is a foremost Public Health concern in Venezuela.

Likewise, other aspects of Food Security have been affected, such as the availability and access to food (Fundación Bengoa, 2018; Universidad Católica Andrés Bello, 2020), the quality of the diet, the adequate consumption of proteins of high biological value (Caritas de Venezuela, 2020), mainly as a consequence of the economic and social crisis not recognized by the executive branch of the country. The Gross Domestic Product fell by 70% between 2013 and 2019, and 79.3% of Venezuelans have no sufficient income to cover the basic-food-basket (set of basic-foods necessary to ensure the nutrition of a family group of 5.2 members, consisting of eight subclasses of foods: meats and their preparations, fish and shellfish, cereals and their products, roots, and tubers, milk, cheese and eggs, fats and oils, fruits, and vegetables) (Landaeta-Jiménez et al., 2012; Tapia et al., 2017; Universidad Católica Andrés Bello, 2020).

Neither the food acquisition of Venezuelans, nor their nutritional-status, has improved even with the wide range of programs and laws enacted in the last 20 years. Recent statistics do not show any improvement in the malnutrition or undernourishment figures, much less in food-purchasing power since a 20-fold increase of the minimum salary is required to cover the food basket (Tapia et al., 2017). Figures reported by Caritas Venezuela indicate that 57% of households were food-deprived (Caritas de Venezuela, 2020). These indicators demonstrate the extent of Venezuela's Complex Humanitarian Emergency (Tapia et al., 2017; Universidad Católica Andrés Bello, 2020). It means that decreeing one or more laws related to food and nutrition is not enough to reduce this scourge.

Venezuela requires cohesive, integrated, continuous, and progressive state-policies and laws rather than government initiatives that change according to political interests. Experts, statespersons, and health professionals should design the food policies. To properly set objectives and goals, an accurate diagnosis is required. The particular needs of each age-and-vulnerable-group should receive special consideration.

To further develop these Food and Nutrition Security-policies, a few aspects should be considered (FAO, 2012a): ample availability, physical and economic access, sustainability, and stability of the agri-food system, nutritional and cultural adequacy, and other considerations to promote the biological utilization of consumed food. Moreover, several bioethical considerations apply: equity, distributive justice, and beneficence (Beauchamp and Childress, 1994; Giovane Mendieta-Izquierdo, 2020).

These moral values, as well as the principles of the FNS, must be an essential part of any program in Nutritional Public Health so that they can be continuous, assessable, measurable, and adaptable, that is to say, that all the programs that are developed can be monitored, adjusted, and controlled.

Bioethical principles aim to protect the human dignity of man. The association of these principles with food security improves the design of food policies. Initiatives developed using these approaches are real, fair, and well-balanced without disparagement or discrimination of any age group. **Table 2** includes several recommendations for improvement of food security in Venezuela based on the principles of the food security and bioethics.

In Venezuela, actual experience is to develop nutrition care programs that lack clear and precise objectives (Delgado and Herrera-Cuenca, 2019), with scope and goals that cannot be evaluated in a given period of time. They are usually developed as part of a policy plan, and subsequently forgotten or replaced by other faulty proposals following the same pattern.

Upon all these food insecurity problems, the country now faces the SARS-CoV-2, a highly aggressive Coronavirus that causes the Covid-19 pandemic, declared as such in March 2020. Limitations imposed because of Covid-19 further aggravate the delicate food situation in Venezuela.

The World Health Organization (WHO) has specified recommendations and guidelines to contain the virus spread. Among these are 14-day quarantine for suspected cases and isolation of cases confirmed; use of a face mask, hand-washing with soap and water, hand disinfection with alcoholic gels, thorough-domestic cleaning, and disinfection, as well as the maintenance of a 2 m physical-distancing.

TABLE 2 | Recommendations for improvement of food security in Venezuela based on the principles of the food security and bioethics.

Recommendation	FNS Principles	Bioethical principles	Impact
Adopt and invest on a multi-sectoral, multi-stakeholder, integrated approach to improve nutrition, like the one fostered by SUN* in order to promote food systems sensible to nutrition in the country. (Scaling Up Nutrition, 2021) *Is a movement that advocates a multi-sector and multi-stakeholder approach to improving nutrition by promoting dialogue on food systems and obtaining the results that are needed.	Nutrition-sensitive agriculture and food systems to improve the availability, accessibility, and consumption of nutritious foods and to protect hard-won gains in the fight against all forms of malnutrition.	Experts in food security should promote ethical questions and define food security values that impact nutrition outcomes and the ethical trade-offs between environmental sustainability while meeting individual dietary and nutritional needs. (Fanzo, 2015)	Food Security programs sensitive to nutrition Decrease of nutrition, inequities. Provide for people's nutritional needs, while contributing to sustainable growth. Decrease the prevalence of undernourishment, and chronic malnutrition Improvement of the height/age indicator Decreased risk of short stature due to malnutrition
Design of nutritional care programs, based on the principles of FNS, carried out by experts in Food and Nutritional Security. Diagnostic evaluation of the nutritional situation in urban (80% of the population) and rural communities.	Know which population is at risk or in frank nutritional deterioration and which of the FSN principles are affected would help to design programs focused on improving the main problems, according to each age group.	Beneficence is the relevant principle in this recommendation since it is necessary to benefit the entire population at risk or in frank nutritional deterioration, determining their needs.	Have real-time figures of the nutritional status of Venezuelan children provided by official entities. A real commitment of government institutions to comply with designed programs within the legal framework established by them.
Define clear and measurable nutritional goals	By defining clear and measurable nutritional objectives, it would be possible to direct efforts in the right direction allowing their modification according to the results obtained during their execution	The bioethical principle par excellence would be distributive justice, to protect all beneficiaries according to the set objectives.	Design of inclusive food security programs for the entire population without the need for a political or government-related card
Execute programs designed according to the initial diagnosis, indicating the start date and date evaluation schedule to measure the effectiveness	An initial diagnosis allows the FSN programs to be executed in a precise and oriented way to achieve the set objectives	Equity is the bioethical principle that supports this recommendation to address the needs of each individual.	
Control and monitoring of all foods and nutritional designed programs.	All the principles benefit from the application of this recommendation. It diminishes the possibility to abandon programs for unknown causes.	Distributive justice is highlighted in this recommendation since an unmonitored program cannot be adjusted and modified according to the needs of the target population.	
Timely report of results of the programs executed.	Timely communication is essential to develop food security programs that are updated and consider all the principles.	All bioethical principles benefit from this recommendation, particularly transparency, by promoting adequate information to achieve the goals of executed programs.	
Guarantee of continuity and stability of the food programs already established.	Knowing how biological consumption and the nutritional adequacy of programs impact FNS principles will help to improve each program according to the results obtained while preventing the abandonment of successful programs.	All bioethical principles benefit from this recommendation. It is necessary to assist in a just and equitable way all the members of a population.	
Expansion of Food Security programs to cover the entire population without discrimination by political reasons.	Food security depends on the commitment to prevent hunger in all population groups	True social and distributive justice benefits ample coverage programs that do not discriminate for political, religious, or social reasons.	
Timely publication of data on consumption, availability, and access to foods from government-managed-food programs.	Reliable and timely publication of data on consumption, availability, and food access is of utmost importance to determine the impact of a program and select variables to update it according to the results of successive evaluations.	In this recommendation, a combination of bioethical principles contributes to the common good of the entire population.	

(Continued)

TABLE 2 | Continued

Recommendation	FNS Principles	Bioethical principles	Impact
Improvement of the national health system	Improvement of the population's health status begins with adequate food and nutrition security, which is also a constitutional right.	The bioethical principle of beneficence is universal and inalienable; therefore, political or religious factors should not condition food security.	
Resurface and update of the National Food Council to transform it into an inclusive-normative-and-independent organism. This way, it could supervise national policies to eradicate malnutrition and hunger.	The integration of public and private institutions that work for food security.	Applying bioethical principles promotes the highest ideal: the eradication of malnutrition and hunger.	

The asterisk is the link between the word SUN and the definition.

Venezuela rapidly imposed these measures. Confinement of the country started on March 13, 2020, after the first cases were confirmed. Quarantine measures required many adjustments, particularly in food collection, storage, distribution, and delivery, both to the general and vulnerable population groups to avoid the surging of nutrition problems.

The pandemic has increased food insecurity and poverty, as many people have lost their jobs and or have insufficient income to cover the basic food basket. The National Survey of Living Conditions (ENCOVI) surveyed the impact of COVID-19 on employment and income. Figures show that 43% of the surveyed households report the inability to work or have lost income (Universidad Católica Andrés Bello, 2020).

According to the World Food Program July–September-2019 survey (World Food Program, 2019), 7.9% of the population (2.7 million) is in Severe Food Insecurity, and 24.4% (7 million) are in moderate Food Insecurity. These figures are previous to the onset of the pandemics. In addition, other factors contribute to aggravate the effects of confinement little availability of cash, shortage of gasoline, installation of police and military control posts and barricades and severely impact food security.

As shown by ENCOVI in its latest publication (March 2019–March 2020), rampant inflation exceeds 3,365% and 73.9% do not have enough income to cover the food basket in Venezuela. Rising unemployment figures in Venezuela are comparable to those of countries such as Nigeria, Chad, Congo, and Zimbabwe (Universidad Católica Andrés Bello, 2020).

Updated official figures on food availability, access, and consumption are not available. Therefore evaluation of pandemic-impact cannot be estimated. Different expert committees in Food and Nutritional Security (FNS) have declared that the Covid-19 pandemic will have severe repercussions on food security in the world (FAO, 2020b; FAO-CELAC, 2020; OXFAM, 2020), especially in countries that were already experiencing economic and social crises.

In Venezuela, multiple maladies (hyperinflation, unemployment, low wages, food and gasoline shortages, deficient public services) pave the current humanitarian crisis and forecast the nutrition and health problems assuredly prevalent shortly. Worrisome is the change in the eating pattern due to the intake of cheaper-starchy foods while sacrificing expensive high biological value proteins.

What has been missing is a strong political motivation to enforce the approved legislation. Unfortunately, government initiatives are short-sighted and aimed to strengthen the political grip on the population. For instance, Clap boxes reach their beneficiaries but do not satisfy their food and nutrition needs. The program to sell subsidized gasoline is very significant, but gas supply is scarce encouraging under-the-counter corrupt transactions (Abuelafia and Saboin, 2020). At present, there are at least 10 laws and programs which address food security issues. Nonetheless, acute malnutrition is rampant.

As sustained in this work, decreeing many laws related to food and nutrition is not enough to reduce hunger, malnutrition, inequity, etc. An attempt was made to demonstrate through the Venezuelan case, that States and the legal framework of a country are not always the guarantors the Food and Nutrition Security of the people, particularly if their design and enforcement disregards the advice of the health and nutrition experts.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Challenges in Food Security, Nutritional, and Social Public Policies for Venezuela: Rethinking the Future

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Food security in Venezuela presents signs of individual, family, community and national deterioration. The food and nutrition system has been weakened by the decrease in the production and the installation of parallel, irregular and insufficient distribution networks. Economic turmoil, political instability, hyperinflation, and poverty, the highest in recent history, limit the population's income and the access to quality food. The transition from capitalism to state-centered socialism has not been successful in ensuring enough foods for Venezuelans and the effect on the well-being of the population has been detrimental. This study proposes to design a public policy model based on the analysis of food security indicators, to generate an integrated framework of actions. The proposed model considers Dunn's classic public policy approach (2017) and the criteria of the Public Health Tools/Community Nutrition Program-Nutritional Care Process: Nutrition Care Process (NCP) of the Academy of Nutrition and Dietetics, 2012. The World Food Program survey on food security in Venezuela 2019, and the HumVenezuela.com 2020 platform were used. The integrated model includes two levels, one for bringing assistance to the most vulnerable and the other for strategic planning of structural, legal and institutional problems, and health and food safety gaps, in an ethical and moral framework that challenges corruption and promotes education and culture of peace. It is necessary for public policies to have parallel levels of actions to assist those most in need and to face long-term structural changes, which should begin as soon as possible, to ensure the correct path toward development.

Keywords: Venezuela, food security policies, nutrition policies, poverty, hunger

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INTRODUCTION

Venezuela's current economic, political and social crisis is the most severe since its days of independence. In the last 20 years, the ruling party has been taking wrong policy decisions that had negative consequences such as the disappearance of the infrastructure that contributed to establish and maintain the country's food security. The National Food Council (Carmona, 2000) estimated that Venezuela produced ∼70% of the agriculture and livestock required for domestic consumption, importing the rest. The latest FAO report on Venezuela's agricultural livelihoods and food security in the context of Covid-19, shows that at national level the 2020 cereal harvest, rice, and maize, was almost complete but the production outlook is unfavorable due to

considerable reduction of farmed areas and low expected yields. Shortages of agricultural inputs and fuel significantly affected yields, and these factors are not exclusive from the pandemic period, but emerged as significant problems in recent years (FAO, 2020). All this was hindered by the Government by creating parallel markets for the importation of food from Turkey, Iran, Nicaragua and more recently from Brazil and Mexico (CSIS Center for Strategic & International Studies, 2020; Transparencia Venezuela, 2020), to compete in an unfair way with the national production, which lacks the primary inputs (seeds, fertilizers, and agrochemicals). In addition, these actions do not consider the Venezuelan cultural food traditions and the preservation of specific characteristics of our food availability.

Recent history indicates that when oil prices rise, the port economy supersedes domestic production. Imports reached 53,023 million dollars in 2014 (Gutiérrez, 2017), while, after the fall in oil prices, the Venezuelan economy contracted and fell to 18,630 million dollars in 2019 (CEPAL - Comisión Económica para América Latina y el Caribe, 2019). Economic activity fell by 25.5% in 2019, representing a cumulative contraction of 62.2% compared to the 2013 level, and the 6th consecutive year of decline. The GDP of both the public and private sectors showed a considerable fall and a deterioration in private activity of 32.2% in the first quarter of 2019. Likewise, 2019 represented the 5th consecutive year in which oil production decreased [44, 5% according to the Organization of the Petroleum Exporting Countries (OPEC); CEPAL - Comisión Económica para América Latina y el Caribe, 2019].

Besides all of the above, hyperinflation began in November 2017 and has continued, reaching an annualized inflation rate of 113% as of September 2019, and according to the International Monetary Fund (2020) reached 6,500% and continues to be the highest hyperinflation in the world with a current 9,986% estimated by the World Population Review (2021). A study by Su et al. (2020), concludes that Venezuela's dependence in oil prices, contributes to geopolitical destabilization which in return contributes to higher inflation, in a sort of economic vicious circle.

This resulted in an accelerated loss of quality of life, widespread impoverishment, a shrinking middle class, and the emergence of a corrupt economic elite, widening the gap between the lowest-income populations and the wealthiest. This elite, close to the ruling establishment, is getting rich rapidly by accessing international markets, where multimillion dollar accounts have been opened. According to experts such as Hausmann, a renowned Venezuelan economist: "Venezuela is the greatest human catastrophe that has been generated in a period of peace. The erosion of the living standards of Venezuelans, the fall in GDP, the collapse of the food supply, the deterioration of health conditions and the increase in crime. A situation like the Venezuelan has occurred in very few moments in world's history and much less while in peace. In this context, and given the evidence of mismanagement and implementation of erroneous public policies, the Democratic Charter of the Organization of American States (OAS) must be applied to a government that has violated international agreements and standards that must defend." (Hausmann, 2017).

As a consequence, the country was declared within a complex humanitarian emergency (CHE) which, as Klugman (1999) points out, a CHE is not the result of a natural disaster or an armed conflict but arises from a catastrophic deterioration of public services (electricity, water, etc.), lack of financing opportunities, hyperinflation, fall of real wages, loss of institutional rectory, and other conditions that define the quality of life in a country and allow the exercise of the human rights of its citizens.

In Venezuela, most of the salaries, even adding the food benefit represented <$ 1 a month, while the basic basket accelerated its increase to more than $ 200/month in 2020 (CENDA - Centro de Documentación y Análisis para los Trabajadores, 2020), and as per the last report in January 2021, the hypothetical acquisitive purchase power of the family income is 0.38% while the basic basket of foods, goods and services is 406.66 USD (CENDA - Centro de Documentación y Análisis para los Trabajadores, 2021).

In addition to all of the above are the sanctions imposed by the international community, particularly by the US, which had been the perfect excuse for the Government to continue justifying its very opaque management of the economy, especially those related to the importation of food (Kirschner, 2020) and the arrival of the COVID-19 pandemic in a country that was not prepared to face any emergency but was already challenged by a severe crisis, deepens pre-existing deficiencies in food availability, access and the shortage of public services. The social distancing measures adopted to reduce the risk of infection by COVID-19 did not help alleviate the country's food insecurity crisis (Van Praag and Arnson, 2020), however it is understandable why these measures are being taken.

The social control of the population, before and after the COVID 19 pandemic, has been implemented through the Committees of Local Supply and Production (CLAP for is acronym in Spanish), by political activists controlled by the government. Theoretically, the government covers 75% of the distributed food in the CLAP box, the rest 25% is covered by beneficiaries and the food distribution occurs in a period of every 30–60 days or more in some cases (ENCOVI, 2020a). Distributors receive the payments from beneficiaries for the subsidized products and maintain close relationships with the military establishment in charge of the supply centers. At the beginning, the program used to distribute 12 kg of products per family and the CLAP boxes included rice, corn flour, pasta, cereals, sugar, oil, tuna, sardines, and powdered milk. Last year (2020) however, the variety and quality of food fell, including basically five or six foods like cornmeal, rice, pasta, sugar, lentils, and sometimes oil.

The supplied food provides 1,300 Kcal/day, compared to the average Venezuelan requirement of 2,200 Kcal/person/day. These requirements are much higher in adolescents, pregnant, and lactating women (Landaeta-Jiménez et al., 2012). The CLAP box content is only enough for five days, for a family of five members, which is an important problem if the box is being distributed every 30–60 days as previously explained. It is a carbohydrate-based diet that can cause harm to the population since it does not discriminate between groups with underlying pathologies

(diabetes, kidney disease, and hypertension) or population groups with special needs such as the elderly, pregnant women and children. In addition, there is evidence that the food distributed did not meet the safety and quality standards, as an example: dairy products distributed as milk were not (Hernández et al., 2019).

The relevance of the above events is due to the fact that a large proportion of Venezuelans depend on this food distribution network, and beneficiaries cannot meet their nutrient needs. Food shortages cause malnutrition in children and adults and have promoted increased general, infant and maternal morbidity and mortality (UNICEF., 2019; Turkewitz and Herrera, 2020). In this context, this study aims to design and conceptualize a public policy model by analyzing existing food security, nutrition, and social indicators and generating an integrated framework of actions to address the country's food insecurity crisis.

METHODS

This study is based on a descriptive approach to understand the food and nutrition security situation in Venezuela and used data generated from different sources during 2019 and 2020. The authors reviewed the data and carried out their analysis. Due to the current critical situation in Venezuela, the public policy model was designed, integrating one of the classic public policy approaches of Dunn, the problem structuring analysis (Dunn, 2017), and the criteria of the Public Health Tools/Community Nutrition Program-Nutritional Care Process: Nutrition Care Process (NCP) of the Academy of Nutrition and Dietetics (AND, 2012) (Academy of Nutrition and Dietetics Toolkit (formerly American Dietetic Association) (2012). The NCP was originally developed for use with patients requiring nutritional advice. Since then, it has been proven useful in disease prevention and health promotion, and it is being used in the US to establish standardized procedures in the provision of care (Academy of Nutrition Dietetics, 2012).

First, the priority of the structuring analysis of the problem from Dunn was developed (Dunn, 2017), and was followed by the steps of the NCP: evaluation, diagnosis, intervention and, monitoring and evaluation (Academy of Nutrition and Dietetics). Both methods allow to systematize the diagnosis of a situation and guide actions aligned with real problems to find adequate solutions. Although the NCP (Swan et al., 2017) focuses on nutrition aspects, the classic policy approach described by Dunn is more social and policy-oriented, so the integrative approach was useful for this analysis. Furthermore, prioritizing problem structuring ensures that a complex multidimensional problem is accurately analyzed.

The evaluation of the factors that could affect the nutritional status according to the NCP were the following: (1) biology (factors such as sex and age), (2) lifestyle (factors such as physical activity, diet, use of medications among others), (3) living, work, and social conditions (housing, education, income, occupation, among others), (4) community conditions (water supply, type and conditions of housing, socioeconomic inequalities/disparities), and (5) background conditions (national food and nutrition policies, minimum wage, cultural beliefs).

The first phase was to develop the prioritization process of problem structuring and based on the flow chart established by Dunn, the steps are as follows: 1- Problem detection, problem situation 2- Problem structuring 3- Policy problem 4- Is this the correct problem to be solved? Yes or No; if No, go back to the problem structuring step; if so, continue as follows: 5- Troubleshooting 6- Policy solution 7- Correct solution. If not, go back to troubleshooting. If yes, return to the problem situation for evaluation.

The second phase was: the NCP diagnostic step which includes a structured statement called PES by its acronym P: Problem, E: Etiology, S: Signs/Symptoms. It requires defining a problem (describing the alterations of the individual or group of the population); the etiology (list of factors or risks that contribute to the problem); and its signs and symptoms (consisting of objective and subjective data to determine whether the individual or group has the specified nutritional diagnoses). After obtaining the PES, based on symptoms, it is necessary to assign a nutrition category assessment based on the language pattern for the NCP (Academy of Nutrition and Dietetics, 2013). For the purposes of this study, the research will focus on the standardized process described for the design of the public policy model and will not refer in detail to specific domains that could be used in NCP in clinical application. The specific domains addressed constitute the reference for public policy solutions and to guide the reorientation in matters of food security, nutrition and their social components in Venezuela.

A matching procedure between the prioritization analysis and the NCP diagnosis was developed in two steps one for matching both methodologies, and the second to confirm that the right problem was being addressed. Based on the indicators that resulted from the matching procedure that justify the reorientation of policies, a model of public policies was suggested.

Data Sources

The data sources come from the latest World Food Program survey on food security in Venezuela (World Food Programme (WFP)., 2019), and from the recently launched platform: HumVenezuela.com (Hum Venezuela, 2020), which constitutes an initiative that aims to contribute to emergency measurements with an independent, comprehensive, exhaustive, and systematic approach. It is a compilation of factors that could impact food and nutrition in Venezuela, from the most relevant data existing in the country such as ENCOVI 2017, 2019, 2020 (ENCOVI, 2020a,b); WFP (World Food Programme (WFP)., 2019); Cáritas Venezuela (Caritas Venezuela., 2020), and the Bengoa Foundation for Food and Nutrition (2020) (Tapia et al., 2017), among others. WFP-specific results were considered separately due to their importance and relevance, as it is the only specific national study on food security.

A matching between social and food and nutrition security variables was performed between the NCP factors that could affect nutrition and the variables for prioritizing the problem. Some variables were selected for the conceptualization and design

of a model public policy to address food security. No bioethics approval was required for this study.

RESULTS

Based on the matching between the factors that can impact nutrition, according to the NCP and the variables established by the sources and the prioritization of the problematic situation, a set of variables were selected for the conceptualization and design of a public policy model to address food safety. The selected variables were included within the following categories: levels of food insecurity: marginal food security (MS), moderate food insecurity (MFI), and severe food insecurity (ISF), means of life, food consumption, and nutrition, as can be observed in **Tables 1, 2**.

As mentioned above in correspondence with the purposes of this study, the authors addressed only specific domains as a reference for nutrition interventions that contribute to the reorientation of public policy on food security, nutrition and their social components in Venezuela, without going into depth in the specific domains used in NCP for clinical outcomes.

Results From Data Review

In **Table 1**, results from the WFP survey during 2019, and published in the 2020 Report on Venezuela can be observed, which shows that 32.3% of the population are either in Moderate Food Insecurity (MFI) (24.4% or 7 million persons) or SFI (7.9% or 2.3 million), and 59.7% of the population is Marginally Food Secure (MFS).

Hum Venezuela is a new platform on information of the CHE launched by a network of organizations of Venezuelan civil society. This initiative intents to contribute to the measurements of the emergency in an independent, integral, exhaustive, and systematic approach (Hum Venezuela, 2020). The platform gives data and evidence on the CHE from a multidimensional model that comprises: *Impacts*: measurement of severity of the needs, damage, and gaps on capacities. *Response:* access, operativity, levels of protection, and efforts for the humanitarian response and *Complexity*: environmental factors, security, rights, and trends that promote the installation and protraction of the emergency (Hum Venezuela, 2020).

Hum Venezuela included data from relevant sources such as ENCOVI 2017, 2019, 2020 (ENCOVI, 2020a); WFP (World Food Programme (WFP)., 2019); Caritas Venezuela (Caritas Venezuela., 2020), and Bengoa Foundation for Food and Nutrition (Fundación Bengoa, 2020) among others.

For the purposes of this study's analysis affected population, population in need and persons with damage were included as can be observed on **Table 2**.

The highlights from **Table 2** are that 13.1 millions of persons (45.9%) had irreversibly lost their means of life and 37% lost their income. 60% invested their savings buying foods, 33% worked in exchange for foods, and 20% was forced to sell goods for covering basic needs.

Regarding food consumption, it was observed that 74% of households decreased the food portions, and there were a 34% of persons with decreased caloric intake. 74% of households had a reduction in variety and quality of consumed foods, and 17.8% of persons had unacceptable deficit of food intake. 40% of children had reduced served portions of foods, 31.5% of persons were in chronic hunger or undernourished, and 55.7% of children under five reported chronic undernutrition or were at risk.

Also, 16.7% of children under five showed acute global malnutrition and the newborn mortality was 18.3 per 1,000 live newborns. 57% of pregnant women were malnourished, 14% of newborns were low birth weight and maternal mortality was calculated on 140.2 per 100,000 born alive.

Designing a Model of Public Policy

From the above reported data, a diagnosis following the PES and matching to the prioritization of problems, described in the Methodology section was conceptualized as shown in **Table 3**.

For better description of the factors and determinants involved in the complex situation of food security on Venezuela, after the variables were selected previously, a matching between the prioritization of problems and PES diagnosis was developed according to the methodology described in the **Table 3** as a first step, and a second step was performed including the prioritization last steps for reassuring that the right problem was addressed.

In **Table 4**, the limited access to water and food is being addressed as the right public problem and the most urgent for ameliorating Venezuelan's well-being.

This analysis shows that the public policy model should include two levels: first, assistance to the most vulnerable and for those who have their lives at risk, and secondly, a strategic planning that integrates, the institutional structural problems, and a legal basis that guarantees health and food safety. All this within an ethical and moral framework that faces corruption, promotes education and a culture of peace.

Figure 1 shows the factors of food security, nutrition and social determinants of well-being, development, productivity, and dignity, as a result of the selection of the team of researchers, which require a comprehensive approach within the framework of public policy.

DISCUSSION

Based on the review of the available data, through the matching of indicators analysis, it was possible to select a set of variables that justify the conceptualization and design of a public policy model to address food insecurity at its different levels: marginal, moderate and severe, in addition, means of life, food consumption and nutrition were integrated to propose actions to be performed when possible.

Phase one on this analysis showed that the public problem was the food insecurity to which the majority of the population is being exposed, as can be observed in **Table 2**, through indicators such as the 59% of households with insufficient income for buying foods, 33% of persons who are working in exchange for foods, and 40% of children with reduced served portions of foods. The second phase, reinforced that the right problem was being addressed and showed elements to be introduced as structural changes which will only give results over time.

TABLE 1 | World Food Program 2019 survey: food security classification.

		Food secure	Marginally food secure	Moderately food insecure	Severely food insecure
Current capacity	Food consumption	82.2		12.3	5.5
	Food coping strategies	21.1	47.4	31.5	
Coping capacity	Livelihood coping strategies	6.8	31.9	45.9	15.4
	Economic vulnerability	8.7	34.8	41.8	14.8
	Food security classification	**8%**	**59.7%**	**24.4%**	**7.9%**
	24.4% (7 million) + 7.9% (2.3 million) = 32,3% (9.3 million)*				

Venezuela's households. World Food Programme 2020 Report on Venezuela.
**Food security classification as of October 2019.*
Source: WFP 2020 Report on Venezuela [World Food Programme (WFP)., 2019].

TABLE 2 | Food and nutrition security indicators of Venezuelan complex humanitarian emergency.

Category	Affected population	Population in need	Persons with damage
Means of life	Population in economic vulnerability to afford basic goods 91.4%	Persons with irreversible loss of means of life (45.9%)	Persons investing more than 65% of their income in foods (56.6%)
Means of life	People who lost their means of life 61.3%	Persons with extreme loss of means of life (15.4)	Persons that invested their savings in foods (60%)
Means of life	Households with decreased means of life 75.0%	People with total loss of income sources (37%)	Persons working in exchange for foods (33%)
Means of life	Households with insufficient income for buying foods 59.0%	People with total loss of income sources (37%)	Persons selling their family goods in order to cover basic needs (20%)
Food security	Population with decreased food security 59.6%	Persons with acute food insecurity (32.6%) With moderate food insecurity (24.4%) With severe food insecurity (7.9%)	Persons depending on government assistance (18%) Persons depending on money transfer from overseas (32%)
Food consumption	Households with insufficient foods for elevated cost or scarcity 70.8 %	Persons going to sleep in hunger (61.2%)	Persons with decreased body weight due to insufficient foods (64.3%)
Food consumption	Households in poverty in food crisis 67.0%	Poor households in food emergency (58.0%)	Households with some degree of food deprivation (56.0%)
Food consumption	Households with a reduction in variety and quality of foods 74.0%	Persons with unacceptable deficit of food intake (17.8%)	Households using unconventional sources for obtaining foods (51.0%)
Food consumption	Households with decreased food portions 60.0%	Persons with borderline food consumption (12.3%)	Persons with decreased caloric intake (34%)
Nutrition	Children with reduced served portions 40.0%	Undernourished persons or chronic hunger (31.5%)	Undernourished persons gap 2015–2019 (313.8%)
Nutrition	Children under 5 years with chronic undernutrition Or at risk 55.7%	Children under 5 years with chronic undernutrition Or growth impairment (30.0%)	Children under 5 years, that stepped into school age phase with growth retardation (23.8%)
Nutrition	Children 7–13 years with chronic undernutrition or at risk 27.1%	Children that had one meal per day (26%.0)	Children 7–13 years which are not going to school due to lack of foods at home (16%)
Nutrition	Children under 5 years with acute global malnutrition 16.7%	Newborn in poverty with GAM (31%)	Newborn mortality (Rate x1,000 born alive) 18.3
Nutrition	Malnourished pregnant women 57%	Low birth weight newborns (14%)	Maternal mortality average (Rate x 100.000 born alive) 140.2

HumVenezuela.org (Hum Venezuela, 2020).

TABLE 3 | Diagnosis and problem prioritization integration.

NCP diagnosis (PES)	**Problem (P)**	**Etiology (E)**	**Sign and symptoms (S)**
Problem prioritization			
Problem sensing Problem situation	Undernourished people, particularly vulnerable groups	Impaired access to foods	Chronic and acute malnutrition in children under five malnourished pregnant women maternal mortality, infant mortality
Problem structuring	Undernourished population, households with food insecurity	Elevated cost of foods Insufficient income Unemployment rising	Persons with unacceptable deficit of food intake Households with a reduction of a variety and quality of foods
Policy problem	Unequal distribution of food program Lack of health promotion and nutrition education	Weakened employment and entrepreneurship programs Weakened rector and guiding institutions	Increased poverty and economic vulnerability

TABLE 4 | Limited access to food and/or water as a public problem (NB-3.2) (NCP).

Is this the right problem to be solved?	**Problem solving**	**Policy solution**	**Right solution?**
YES	Empowering people Education Dignified salaries Strengthening the institutions	Integrating coordination of actions toward different levels including social determinant of health, people values, education, diversification of the economy	To be checked over time
	At the same time Improving assistance for those whose life is compromised	Strengthen monitoring and evaluation of actions with motivation, education, and anti corruption values	Monitoring and evaluation to define what works best and what can be improved

Limited availability of foods and/or electricity/gas and stability of the dimensions of Food security.

By only addressing the specific domains of public health and nutrition, a model is suggested to reorient public policies located at the center of the deep Venezuelan humanitarian crisis. The results presented in this study intents to give a new route on the policies and require the design of a comprehensive policy for the country in terms of food security, nutrition and social welfare to achieve the future that all Venezuelans deserve.

Policy planning in the coming years and decades will require a parallel course of action. One immediate task is to provide assistance to those in need and the other to address long-term structural changes, which must begin as soon as possible to pave the right path of development. For the well-being and happiness of people, it is necessary to guarantee food and nutritional security, as well as adequate access to public services and living conditions.

The situation in Venezuela shows a general deterioration in the coverage of basic needs that is affecting the daily life of citizens. The fact that 91.4% of Venezuelans present economic vulnerability to pay for basic goods is a figure that speaks for itself of the critical situation (Hum Venezuela, 2020). The present, and other studies (Red Agroalimentaria de Venezuela, 2014; CODHEZ - Comisión para los derechos humanos del Zulia, 2020) agree that an important component of the food insecurity crisis in Venezuela is the high cost of food, thus limiting access that has led to a decrease in the variety and quality of the diet and the malnutrition of the most vulnerable groups.

In addition, the economic crisis of recent years has had an impact on the productive sector (all goods: food, manufacturing, services), has increased unemployment and has altered the livelihoods of at least two-thirds of the population (Salman, 2020). Tourism is also devastated, since the economic slowdown and the lack of public services in the country have led to a decrease in gastronomic and tourist activities, contributing to the general increase in unemployment in the country (Uzcátegui, 2020).

The biological damage caused by the deprived environment that vulnerable people and groups must face every day, has an epigenetic impact from the prenatal stage to the end of the first

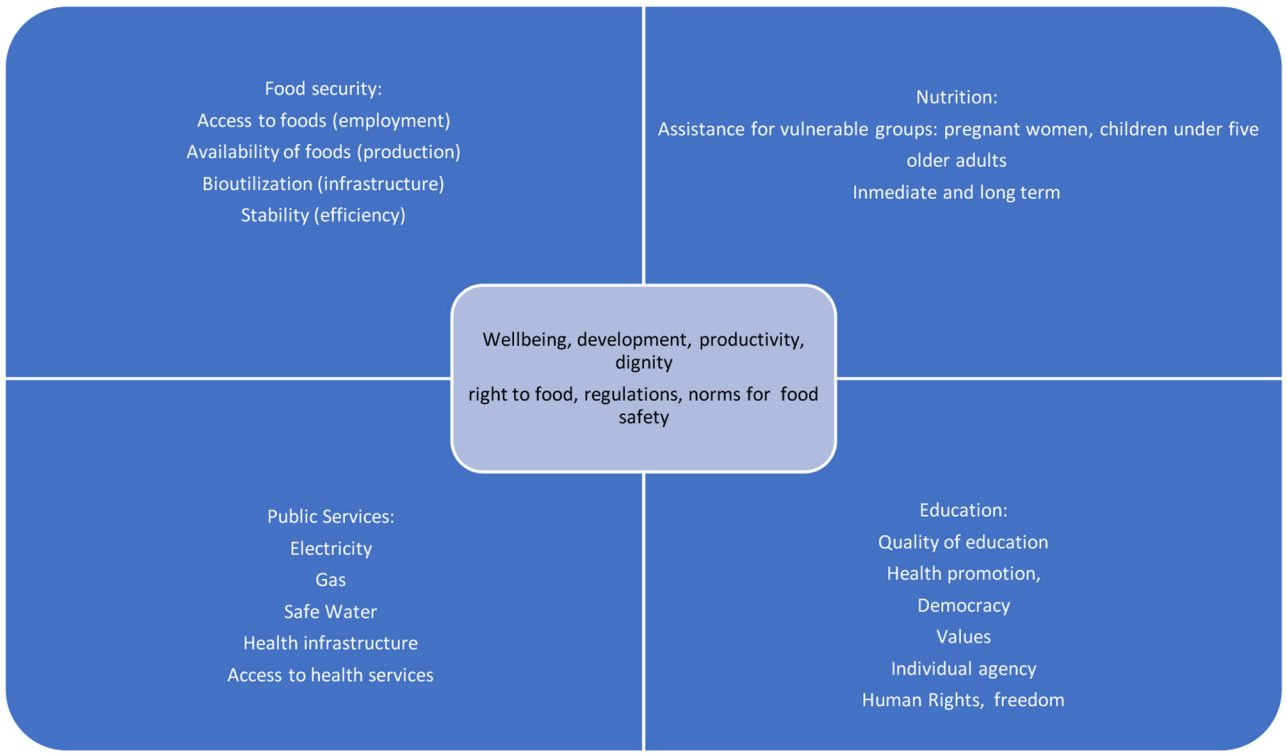

FIGURE 1 | Food security, nutrition, and social determinants of well-being, development, productivity, and dignity (Source: researchers' team own work).

1000 days of life (Victora et al., 2008). In the Venezuelan case, there is an increase in maternal and infant mortality, an increase in acute malnutrition in children under 5 years of age and a deterioration in livelihoods, food consumption and an increase in poverty, which are determinants of future health, nutrition, and well-being (World Food Programme (WFP)., 2019; ENCOVI, 2020b; Hum Venezuela, 2020). Also, consequence derived from the type of diet consumed by Venezuelans today includes not only the nutritional consequences described, but also a loss in the country's culinary traditions, since high prices are a real obstacle to accessing them (León, 2020).

In Venezuela, it is estimated that between 267,000 and 384,000 children under the age of five suffer from malnutrition and the number could exceed 400,000 if the crisis passes into the critical category. But the most difficult thing is to help them, due to the obstacles imposed by the government on humanitarian aid NGOs and the few funds available for this purpose (Doocy et al., 2019).

Corruption and the deviation of goods from reception channels to final beneficiaries has been controversial not only in Venezuela, but throughout the world when it comes to addressing subsidy and assistance policies (Aziz, 2001; Transparencia Venezuela, 2019). The CLAP food subsidy distribution network is full of opacities, and obstacles for reaching the people who really need the help (Landaeta-Jiménez et al., 2018). Consequently, a line of actions intended to cover the good use of resources is mandatory.

For this reason, the urgency of reorienting public policies that aims to improve the well-being of the Venezuelan people, addressing the real problems and identified needs of its citizens.

Venezuela, once the strongest economy in Latin America, needs to rebuild public actions in an integrated way that promotes new sources of income, development and even energy. As oil production declines and its use and controversies arise over climate change (Kopp, 2006), an exclusive base of the oil economy will not be the alternative that the country needs to overcome the crisis. An integrated approach is needed to build an evidence-based public policy model that takes into account a cross-sectoral approach, and always reminding: framed in the human rights to food, health and life.

As already commented, policies for the Venezuela's rebuilding must include two levels: on the one hand, assistance to the most vulnerable and for those who have their lives at risk, on the other, strategic planning for the structural issues of the reconstruction of the country with an economy sustainable that promotes alternative sources of national income such as tourism (Alcántara et al., 2004), not sufficiently exploited at present, gastronomy, events, arts, humanities and scientific developments and capacities for all. All of this will require sources of funding that, in some way, will be provided by international funding, at least at the very beginning of a new era.

Restrictions and controls must also be eliminated to recover the operation of primary production and the agri-food industry

and reactivate oil production, taking into account the new climate, environmental and energy standards.

Also, some lessons from other countries can be inserted in this reorientation of public policies. Interestingly, Yu et al. report in their study on food security policies in India and China that Indian food security is a much more serious concern than in China. First, India uses price-based input subsidies to support agricultural incentives compared to China's adoption of direct transfers to support agricultural incentives, which are more efficient (Yu et al., 2015). But second, as India uses a widely criticized public food distribution system to help the poor, China is using direct income transfers and other social safety nets that have been more beneficial to the poorest (Yu et al., 2015).

As we continue to observe, the challenges are immense, so are the possibilities if the proper and evidence based actions are taken in a reasonable time frame.

CONCLUSIONS

The future planning of policies must integrate parallel levels of actions: an immediate one to provide assistance to those most in need and another to establish long-term structural changes that should begin as soon as possible, to ensure the correct path toward development. It is necessary to guarantee the human right to food and health within the framework of a comprehensive policy, which includes from the primary production of food to its access, in a policy of strengthening employment and the physical and mental well-being of Venezuelans. The call must be for food security integrated with good nutrition and a social protection policy to achieve the country of the future that all Venezuelans deserve.

AUTHOR CONTRIBUTIONS

MH-C and ML were involved in the design of the study along with data collection and analysis. MH-C led the writing including collaboratively drafting all content. ML and YS contributed to review the literature. The final manuscript for submission was read and approved by MH-C, ML, and YS. All authors contributed to the article and approved the submitted version.

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Recent Patterns of Stunting and Wasting in Venezuelan Children: Programming Implications for a Protracted Crisis

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This study aims to assess the patterns of wasting and stunting and their concurrence among vulnerable Venezuelan children. We performed an analysis of 46,462 anthropometric records captured by Caritas Venezuela between 2017 and 2019 and relating to children under 5 years old in the poorest parishes. Based on the WHO 2006 child growth standards, we identify 31.7% and 11.5% of the records from 2019 as stunted and wasted, respectively. Our unconditional analysis shows that stunting was more frequent among boys and shows an inverted U-shape association with age. The prevalence of stunting increases from 0.28 in 2017 to 0.32 in 2019. By contrast, the wasting prevalence decreases from 0.15 in 2017 to 0.11 in 2019. The concurrence of stunting and wasting slightly decreases over the same period from 0.045 to 0.039, all three trends being statistically significant. Using multilevel regression models, our conditional analysis shows that the odds of wasted children being stunted are 1.079 times greater than for non-wasted children. Similarly, the odds of stunted children being wasted are 1.085 times greater than for non-stunted children. While age is not statistically associated with stunting, it reduces the likelihood of being wasted. Furthermore, each additional month of age reduces by 1.16% the odds of facing the simultaneous concurrence of stunting and wasting instead of not facing it. The children's sex is also found to have a significant association with the probability of stunting and wasting. The odds of stunting and wasting amongst boys are found to be 1.19 and 1.084 times greater than for girls, respectively. We also found a significant and sizeable association between food insecurity and both stunting and wasting. Although lack of access to clean water is not associated with stunting, it is associated with higher levels of wasting. Protracted humanitarian crisis in Venezuela has brought considerable damage to child growth. Findings have policy and programming implications: stunting should be targeted as a humanitarian priority in protracted crisis, not only to mitigate the growth failure in children facing multiple nutritional deficiencies, but also as an approach for preventing persistent acute malnutrition.

Keywords: stunting, wasting, malnutrition, Venezuela, humanitarian crisis, protracted crisis, wasting and stunting concurrence

INTRODUCTION

Malnutrition and crises go hand in hand: malnutrition both impacts on and is impacted upon by crises. Acute malnutrition (wasting) has been used as a marker in several food crisis classification frameworks and is the common criterion for child enrollment in humanitarian programs.

Over time in protracted crises, the problem of persistent acute malnutrition becomes increasingly evident and humanitarian programs are caught in a bind. Unfortunately, programs that tend to treat acute malnutrition have limited impact on the underlying causes that contribute to its persistence and on mitigating chronic malnutrition. These issues stimulate both the debate on the performance and efficacy of humanitarian programs and also the debate on the challenges for exit strategies and transition from short term humanitarian responses (Young and Marshak, 2017).

A further area of debate that finds relevance here is the urgent need to consider stunting itself as a target in protracted crisis. Childhood stunting in protracted crises is a double burden. On the one hand, stunting has a multiplying effect on wasting and mortality risks (ENN, 2020), and on the other hand, due to its well-documented association with impaired physical, cognitive, and socioeconomic development of affected populations, stunting undermines programmatic approaches toward resilience (Galasso and Wagstaff, 2016; WFP ECLAC, 2017).

Stunting results from a complex interaction of household, environmental, socioeconomic, and cultural influences that are described in the World Health Organization Conceptual Framework on Childhood Stunting (Stewart et al., 2013). Poor patterns of breastfeeding and complementary feeding practices, combined with high rates of diarrhea, set the stage for short stature. Underlying this are food insecurity, inadequate maternal and child healthcare, insufficient access to safe water and sanitation services, as well as a lack of dietary quality and diversity (Martorell, 2012).

Although usually described separately, stunting, underweight, and wasting frequently co-exist (concurrence) and children with multiple measures of anthropometric failure have a compounded risk of morbidity and mortality. Thus, although stunting and wasting have tended to be viewed separately, there is a growing impetus to consider both conditions together (Prendergast and Humphrey, 2014).

A limited number of studies suggest that wasting may be a direct cause of stunting: studies suggest that growth in height takes place only when the body has a certain minimum of energy reserves (Schoenbuchner et al., 2016). Evidence for the role of stunting as a direct cause of wasting, or alternatively as a protective factor of wasting, was not available in first literature reviews, however recent studies have observed that, at the population level, the periods of lowest linear growth follow the periods of lowest weight acquisition. Some analysis indicates that most children admitted into programs for treatment of acute malnutrition are also stunted (Khara and Dolan, 2014).

Prevalences of wasting and stunting were found to be positively associated in children 12–23 months of age in Asia and Eastern Mediterranean countries, but not in Latin America or Africa. Moreover, the prevalence of stunting at 18–24 months of age was correlated with a history of periods of wasting (Khara and Dolan, 2014).

The divide between wasting and stunting at program, policy, and financing level ultimately has profound implications for how children receive nutritional support and services and may well contribute to the lack of nutritional impact seen in programs that only address acute malnutrition (Khara and Dolan, 2014; Wasting-Stunting Technical Interest Group, 2018).

Several factors have been outlined as problematic when addressing stunting in complex contexts during protracted crisis (Khara et al., 2015). Nutritional needs, and not just food insecurity and acute malnutrition recovery, might need to be integrated into humanitarian responses in order to build the nexus between short-term crisis management and longer-term development, and to make management of wasting more effective (FAO, 2016). This is not an easy challenge: weight-for-height tends to reflect more short-term inadequacy of dietary intake or utilization, and the effectiveness of therapeutic feeding for wasted children is well-established. However, the mechanisms underlying linear growth failure and interventions to prevent or mitigate stunting are less clearly defined.

By ignoring stunting not just as an indicator of the chronicity and severity of food and nutrition crises, but also as a target, we are failing to tackle the increased mortality risk that arises from the multiplicative effects of concurrent wasting and stunting (ENN, 2020). Gaining a clearer and common understanding of the relationship between wasting and stunting has the potential to support organizations to better justify, design, and evaluate humanitarian programs in improving childhood nutrition in protracted crisis (Khara and Dolan, 2014).

This paper reviews the pattern of stunting and wasting among children under 5 years old screened in Caritas Venezuela's Points of Care over a 3-year period (2017–2019). Its aims are also to contribute to the evidence that supports the understanding of the relation between wasting and stunting and the necessity of bridging the division between the two, and to furthermore identify drivers of malnutrition in order to improve nutrition programming and outcomes in protracted crisis.

THE CONTEXT

Venezuela has been submerged in a complex humanitarian emergency over the last 5 years. This was belatedly included as an emergency for the first time in the "Global Humanitarian Overview (GHO) 2020" (UN OCHA, 2020).

The Assessment Capacities Project (ACAPS) estimates the number of people facing humanitarian needs at almost 14 million (more than half of the population), those affected by the crisis at 27.36 million (100% of population), and the number of people displaced at more than 5 million. This is now increasing the pressure of food insecurity, health, and sanitary risks all over Latin America (ACAPS, 2020).

According to the Humanitarian Response Plan and Humanitarian Needs Overview 2020 (UN OCHA Venezuela, 2020), the humanitarian situation has reduced people's access to

food and nutrition. The preventive measures implemented in the country to deal with the COVID-19 pandemic impacted the income and livelihoods of the most vulnerable people.

According to the *State of Food Security and Nutrition in the World 2019*, Venezuela has seen an increase in the undernourishment rate since 2012. Recently, the "Latin America Food Security and Nutrition Outlook 2020" by the UN interagency group reported that the undernourishment rate escalated from 21.2% (6.8 million people) in 2016–2018 to 31.4% (9.1 million people) in 2017–2019 (FAO, 2020).

Additionally, the "Global Report on Food Crises" stated that Venezuela presents the fourth-largest food crisis in the world (FSIN, 2020), and the World Food Program reported in its national food security assessment 2019 that one out of three Venezuelans (32.3%) is food insecure and in need of assistance (WFP, 2019).

The "Humanitarian Response Plan 2020" also reported that limitations on access to food, safe water, hygiene items, and basic information on good feeding practices in the most vulnerable households have affected the nutritional status of children under age 5, with repercussions for their physical and cognitive health and development. According to data from the National Institute of Nutrition (INN), 4% of this population group were affected by severe acute malnutrition in 2019 before the Covid-19 pandemic (UN OCHA Venezuela, 2020).

In October 2020 UNICEF Venezuela registered a global acute malnutrition (GAM) rate of 15.3% based on data collected by implementation partners and using anthropometric screenings in children under 5. Severe acute malnutrition was 3.9%. In December 2019, the data show a stunting rate of 26.5% among children under 5 and that 30.6% of all children are at risk of stunting. While this information is not statistically representative at the national level it provides guidance for decision-making and prioritization of interventions (UNICEF Venezuela, 2019, 2020).

In the view of the Academies of Sciences on Challenges and Opportunities for Food and Nutrition Security in The Americas (IANS), Venezuela's crisis affected the entire food system in Venezuela. With an unstable and deficient food supply and galloping hyperinflation, the population depends highly on social protection programs and remittances from displaced Venezuelans. Venezuela's economic crisis is also affecting researchers, with science under siege, however the scientific community continues to investigate and report (IANAS, 2017).

METHODS AND DATA

Data Collection

This study is informed by a pattern analysis of anthropometric records for children under 5 years old and in the poorest parishes in Venezuela, captured over 3 years of operations (2017, 2018, 2019) at Caritas Venezuela's Points of Care[1]. Children's parents signed their informed consent allowing the program to perform the anthropometric children's measurement as well as consenting to the anonymized use of the collected data for humanitarian and academic purposes.

[1]Data analysis was performed using STATA 15.1.

Weekly nutritional screening procedures for children under 5 are conducted in each Caritas at district and community level in the poorest parishes of Venezuela. These include nutrition fairs, individual assessments of children brought to Caritas spontaneously by their caregivers, and screening of children that attend weekly community kitchens. Therefore, the data has been collected via a self-selection process that necessarily includes some of the most vulnerable children in the poorest parishes, rather than a nationwide survey based on probability sampling procedures.

Our data is not strictly representative of all Venezuelan children but rather of those attending the Caritas program. However, the assumed negative self-selection of children, or in other words the assumption that those attending Caritas Venezuela's Points of Care are likely to be on average the worst-off children, could be challenged. At least four factors suggest to us that many other children are dealing with extremely precarious conditions without access to any care: (i) The coverage of Caritas' humanitarian response is still small in comparison with the demands of a nationwide crisis, especially in remote areas and in neighborhoods away from Caritas' Points of Care. (ii) Families that are aware of Caritas' program nonetheless face transportation costs and scarcity of cash, public transportation, and fuel. Therefore, the worst-off families may not be able to send their children to the Caritas Points of Care. (iii) Adaptation and mental conditioning. As pointed out by Sen (1999): "The deprived people tend to come to terms with their deprivation because of the sheer necessity of survival [...] and may even adjust their desires and expectations to what they unambitiously see as feasible." In this context, the adaptation of caregivers in poor families feeds into the "normalization" of wasting and stunting. There is not enough awareness of the nutritional risks, and small and wasted children are not necessarily seen as unhealthy. (iv) Many poor families see the government and third-party food programs as substitutes for rather than complements of one another. Thus, recipients of government support may exclude themselves from the possibility of enrolling in Caritas' humanitarian response program on the assumption that being a Caritas beneficiary could result in exclusion from the official schemes of social protection. The above four conditions could challenge the assumption that our dataset consists mostly of the worst-off children. In that sense, although our data can only represent those groups of children included in the dataset, it is also possible that our analysis may reflect the nutritional hardship of a substantially higher number of children in the country.

For the screening procedures, weight and height of all children aged 0–59 months were measured following WHO and UNICEF guidelines (WHO, 2019). Caritas' staff had been trained and standardized twice a year in the proper management of anthropometric measurements. Birth dates were obtained directly from caregivers and/or from birth certificates.

We used the 2006 Child Growth Standards of the World Health Organization (WHO) to calculate the following anthropometric indices: length-for-age z-score in children under 2 years old, height-for-age z-score in children under 5 years old (referred to hereafter as "HAZ"), and weight-for-height z-score in children under 5 years old (referred to hereafter as "WHZ").

Children were classified as "wasted" if they had a WHZ <-2 standard deviations from the median of the 2006 WHO Child Growth Standards. Following the same standards, children were "stunted" if they had a HAZ <-2 standard deviations from the median. Children were defined as "severe wasted" if they had a WHZ <-3 standard deviations from the median, and "severe stunted" if they had a HAZ <-3 standard deviations from the median.

The information collected from Caritas' beneficiaries during the reported period does not include information on the socio-economic profile of children's households. However, we complemented the children-level anthropometric data captured at Caritas' Points of Care, merging it to a district-level dataset on food insecurity in households and access to running water from the World Food Program Food Security Assessment, Venezuela (WFP, 2019). Descriptive statistics of the merged dataset are presented in **Table 1** in the section FINDINGS. It contains children's anthropometric information alongside the percentages of households facing moderate food insecurity, severe food insecurity, and no access to running water.

WFP defined food insecurity by exploring food consumption patterns, food and livelihood coping strategies, and economic vulnerability. Based on the combination of these indicators, moderately food-insecure households are identified as those showing significant food consumption gaps or being marginally able to meet minimum food needs only with the use of irreversible coping strategies. Severely food-insecure households are those that show an extreme food consumption gap or have experienced extreme loss of livelihood assets that will lead to food consumption gaps (WFP, 2019).

Anthropometric Analysis

Anthropometric data were analyzed using height-for-age and weight-for-height z-scores and prevalence of stunting, wasting, and their concurrence, comprising 46,462 observations. This analysis takes into account the literature in terms of scale, severity, age, and seasonality from other protracted crises.

Regression Analysis

The focus of the empirical analysis is to achieve a conditional descriptive outlook for programming decisions rather than to investigate the causes of malnutrition. With this aim, we perform two types of conditional analyses. First, we identify the conditional association between wasting, stunting, and the concurrence of the two using the set of available individual predictors (demographic and anthropometric information) as well as the drivers of malnutrition at district level (food security and access to water). The aim is to explore how different explanatory variables at individual and district level affect the probability of being stunted, wasted, and of being wasted and stunted simultaneously (concurrence). Second, we assess association of the same vector of predictors with the height-for-age z-score, and the weight-for-height z-score as dependent variables. The objective of this second analysis is to assess the factors that are associated with the level of the z-scores.

In our first type of analysis, we rely on two alternative estimation methods: a logistic regression model and a multilevel logistic model. In the logistic model, the nested structure of the dataset is neglected and consequently the linear model assumption of independence of the residuals is violated; in other words, children nested in the same districts are more likely to function more similarly than children nested in other districts (Bressoux, 2010). In order to overcome this structural limitation, we move forward by using a multilevel logistic model in which the 46,462 children are nested in 19 districts (see **Table 1**).

The dependent dichotomous variables are *stunting*, *wasting*, and *concurrence*. These dependent variables take the value of 1 if a child is stunted, wasted, or is stunted and wasted simultaneously, and 0 otherwise. The explanatory variables consist of dummy variable ($wasting_i$) for the stunting equation, and ($stunting_i$) for the wasting equation. These dummies take the value of 1 if a child is wasted or stunted and 0 otherwise. The list of explanatory variables continues with the continuous variable (age_i) in months. The sex of a child is captured by the variable (sex_i). To be born during the rainy season of a given year is captured by ($rainy_i$), and dummy variables for the year in which the anthropometric information was collected ($year_t$), with screening in 2017 as the reference category. The explanatory variables at the district level include the percentage of households facing moderate food insecurity in the correspondent district (mfi_j), the percentage of households with severe food insecurity (sfi_j), and the percentage of households with no access to running water ($nowater_j$).

In the logistic regression model for the underlying probability π_{ij} of being stunted, wasted, or both is a linear function of the predictors. Then, Equation (1) displays the saturated model for the log-odds of being stunted instead of being non-stunted:

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 wasting_i + \beta_2 age_i + \beta_3 sex_i + \beta_4 rainy_i + \beta_5 mfi_j + \beta_6 sfi_j + \beta_7 nowater_j + \beta_8 year_{2018} + \beta_9 year_{2019} \quad (1)$$

Similarly, Equation (2) shows the saturated model for the log-odds of being wasted instead of being non-wasted:

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 stunted_i + \beta_2 age_i + \beta_3 sex_i + \beta_4 rainy_i + \beta_5 mfi_j + \beta_6 sfi_j + \beta_7 nowater_j + \beta_8 year_{2018} + \beta_9 year_{2019} \quad (2)$$

As for the multilevel logistic model, we estimated four model specifications for each dichotomous dependent variable indicating if a child is stunted, wasted, or faces stunting and wasting simultaneously.

Firstly, as shown in Equation (3), we estimate the empty multilevel logistic regression model, with associated district-level probabilities π_{ij}, and $(1 - \pi_{ij})$.

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + U_{0\_j} \quad (3)$$

The chance that a child i from district j is stunted or wasted instead of not being either is explained by the fixed intercept β_0

TABLE 1 | Descriptive statistics.

Indicator	Year			Total
	2017	2018	2019	
Children-level information				
Girls	1,509	5,195	16,907	23,611
Boys	1,506	5,182	16,163	22,851
Total cases	3,015	10,377	33,070	46,462
Girls (%)	50.0	50.1	51.1	50.8
Boys (%)	50.0	49.9	48.9	49.2
Mean age (months)††	29.6 (17.3)	28.8 (16.9)	27.1 (16.9)	27.7 (16.9)
Children aged 0–6 months (%)	7.7	9.2	10.5	10.1
Children aged 6–24 months (%)	33.7	32.7	36.2	35.2
Children aged 24–60 months (%)	58.6	58.1	53.3	54.7
Mean height-for-age z-score††	−1.26 (1.40)	−1.31 (1.43)	−1.34 (1.43)	−1.33 (1.43)
Mean weight-for-height z-score†	−0.51 (1.46)	−0.53 (1.29)	−0.46 (1.32)	−0.48 (1.33)
Stunting prevalence††	0.28 (0.45)	0.31 (0.46)	0.32 (0.47)	0.31 (0.46)
Wasting prevalence††	0.15 (0.36)	0.12 (0.33)	0.11 (0.32)	0.12 (0.32)
Simultaneous prevalence of stunting and wasting†	0.045 (0.21)	0.040 (0.20)	0.039 (0.19)	0.039 (0.19)
Overweight prevalence	0.13 (0.34)	0.10 (0.30)	0.12 (0.32)	0.12 (0.32)
Stunted non-wasted children (%)	0.24 (0.43)	0.27 (0.44)	0.28 (0.45)	0.27 (0.45)

District-level information

District	Cases	Percentage of households with…			Prevalences		
		Moderate food insecurity	Severe food insecurity	No access to running water	Stunting	Wasting	Stunting and wasting (concurrence)
Capital	3,037	19.4	6.5	5.6	0.27 (0.44)	0.09 (0.28)	0.03 (0.17)
Anzoategui	871	25.0	10.2	14.2	0.37 (0.48)	0.14 (0.35)	0.06 (0.23)
Apure	1,421	29.6	6.6	8.9	0.35 (0.48)	0.12 (0.32)	0.04 (0.20)
Aragua	121	21.5	5.7	11.9	0.28 (0.45)	0.07 (0.25)	0.01 (0.09)
Barinas	2,593	25.2	9.1	7.6	0.29 (0.45)	0.09 (0.28)	0.03 (0.17)
Bolívar	2,730	30.0	10.5	17.9	0.28 (0.45)	0.11 (0.32)	0.04 (0.19)
Carabobo	5,889	25.1	5.1	5.7	0.32 (0.46)	0.11 (0.32)	0.04 (0.19)
Falcon	417	27.4	13.4	5.6	0.38 (0.49)	0.15 (0.35)	0.06 (0.24)
Guarico	5,237	19.0	5.5	42.6	0.24 (0.42)	0.20 (0.40)	0.03 (0.17)
Lara	801	14.9	3.3	18.1	0.29 (0.45)	0.09 (0.28)	0.03 (0.16)
Merida	5,578	15.4	7.5	14.6	0.31 (0.46)	0.08 (0.27)	0.03 (0.16)
Miranda	509	21.6	5.2	0.3	0.34 (0.47)	0.13 (0.34)	0.05 (0.22)
Monagas	555	32.5	9.5	6.1	0.33 (0.47)	0.19 (0.39)	0.06 (0.24)
Portuguesa	3,463	19.8	7.6	8.3	0.40 (0.49)	0.12 (0.32)	0.03 (0.18)
Sucre	620	32.2	5.1	7.8	0.28 (0.45)	0.13 (0.34)	0.04 (0.19)
Trujillo	5,138	32.6	9.9	8.4	0.27 (0.49)	0.09 (0.29)	0.02 (0.14)
Yaracuy	4,726	24.6	8.4	5.4	0.38 (0.49)	0.12 (0.33)	0.04 (0.19)

Standard deviations in parentheses. Source: Caritas Venezuela data (anthropometric data of beneficiaries attending Caritas' points of care) and Food Security Assessment WFP (2019), Venezuela (District Level Information).

† The difference between 2017 and 2019 is significant at the 5% level.

†† The difference between 2017 and 2019 is significant at the 1% level.

and a deviation of the 19 district-specific intercepts U_{0_j} from the fixed intercept, assuming that the mean of such deviations is zero. These parameters provide information about the extent of the variation of the intercepts. Here, the higher the variance of the random intercept $\sigma_{U_{0\_j}}$, the larger the variation of the log-odds of being stunted or wasted from one district to another. In other words, it is a measure of the degree to which children are more likely to be stunted or wasted in some districts than in others.

Second, we estimate multilevel logistic regression models using the vector of predictors allowing only for random intercepts. The associated probabilities are π_{ij}, and $(1 - \pi_{ij})$. The equations for stunting and wasting are shown in Equations (4)

and (5), respectively.

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 wasting_{ij} + \beta_2 age_{ij} + \beta_3 sex_{ij} + \beta_4 rainy_{ij} + \beta_5 mfi_j + \beta_6 sfi_j + \beta_7 nowater_j + \beta_8 year_{2018} + \beta_9 year_{2019} + U_{0\_j} \quad (4)$$

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 stunting_{ij} + \beta_2 age_{ij} + \beta_3 sex_{ij} + \beta_4 rainy_{ij} + \beta_5 mfi_j + \beta_6 sfi_j + \beta_7 nowater_j + \beta_8 year_{2018} + \beta_9 year_{2019} + U_{0\_j} \quad (5)$$

Third, Equations (6) and (7) show the multilevel logistic regression models for the associated probabilities π_{ij}, and $(1-\pi_{ij})$ for stunting and wasting, respectively. They use the vector of predictors allowing for random intercepts and for a distinct random slope for the continuous variable *age*.

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 wasting_{ij} + \beta_2 age_{ij} + \beta_3 sex_{ij} + \beta_4 rainy_{ij} + \beta_5 mfi_j + \beta_6 sfi_j + \beta_7 nowater_j + \beta_8 year_{2018} + \beta_9 year_{2019} + U_{0\_j} + U_{age\_j} age_{ij} \quad (6)$$

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 stunting_{ij} + \beta_2 age_{ij} + \beta_3 sex_{ij} + \beta_4 rainy_{ij} + \beta_5 mfi_j + \beta_6 sfi_j + \beta_7 nowater_j + \beta_8 year_{2018} + \beta_9 year_{2019} + U_{0\_j} + U_{age\_j} age_{ij} \quad (7)$$

Four, following the Barr et al. (2013) approach, we estimate the maximal multilevel logistic regression model that includes all random slope variance parameters. Equations (8) and (9) show the models for stunting and wasting, respectively.

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 wasting_{ij} + \beta_2 age_{ij} + \beta_3 sex_{ij} + \beta_4 rainy_{ij} + \beta_5 mfi_j + \beta_6 sfi_j + \beta_7 nowater_j + \beta_8 year_{2018} + \beta_9 year_{2019} + U_{0\_j} + U_{age\_j} age_{ij} + U_{sex\_j} sex_{ij} + U_{rainy\_j} rainy_{ij} \quad (8)$$

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 stunting_{ij} + \beta_2 age_{ij} + \beta_3 sex_{ij} + \beta_4 rainy_{ij} + \beta_5 mfi_j + \beta_6 sfi_j + \beta_7 nowater_j + \beta_8 year_{2018} + \beta_9 year_{2019} + U_{0\_j} + U_{age\_j} age_{ij} + U_{sex\_j} sex_{ij} + U_{rainy\_j} rainy_{ij} \quad (9)$$

The models for stunting showed in Equations (1), (4), (6), and (8), were also estimated excluding the explanatory variable ($wasting_i$). Similarly, the models for wasting in Equations (2), (5), (7), and (9), were also estimated excluding the explanatory variable ($stunting_i$).

The inclusion of the endogenous explanatory variables ($wasting_i$) and ($stunting_i$) aims to test the endogeneity of both conditions. That is, the fact that the probability of stunting can be affected by wasting conditions in children, and vice versa. Moreover, there are good reasons to believe that although they are not identic, the drivers of stunting and wasting are correlated. If so, the implications for programming are that neither condition should be treated as though it were independent of the other. To investigate this issue, we create a new dependent variable that takes the value of 1 if a child faces wasting and stunting simultaneously (so-called concurrence) and 0 otherwise. The probabilistic model for concurrence is described in Equation (10):

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 age_i + \beta_2 sex_i + \beta_3 rainy_i + \beta_4 mfi_j + \beta_5 sfi_j + \beta_6 nowater_j + \beta_7 year_{2018} + \beta_8 year_{2019} \quad (10)$$

The empty multilevel logistic regression model, with associated district-level concurrence probabilities π_{ij}, and $(1-\pi_{ij})$ is similar to the one presented in Equation (3).

Finally, the Equations (11) and (12) show the multilevel logistic regression models for the associated concurrence probabilities π_{ij}, and $(1-\pi_{ij})$ allowing for random intercepts and for the random slope in the variable (*age*), and also including the random slopes for (*sex*), and $\left(rainy\right)$, respectively.

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 age_{ij} + \beta_2 sex_{ij} + \beta_3 rainy_{ij} + \beta_4 mfi_j + \beta_5 sfi_j + \beta_6 nowater_j + \beta_7 year_{2018} + \beta_8 year_{2019} + U_{0\_j} + U_{age\_j} age_{ij} \quad (11)$$

$$logit\left(\pi_{ij}\right) = \log\frac{\pi_{ij}}{1-\pi_{ij}} = \beta_0 + \beta_1 age_{ij} + \beta_2 sex_{ij} + \beta_3 rainy_{ij} + \beta_4 mfi_j + \beta_5 sfi_j + \beta_6 nowater_j + \beta_7 year_{2018} + \beta_8 year_{2019} + U_{0\_j} + U_{age\_j} age_{ij} + U_{sex\_j} sex_{ij} + U_{rainy\_j} rainy_{ij} \quad (12)$$

Although not strictly necessary, and given the fact that we are interested in the effect of the district-level explanatory variables and also in the absolute (between-children) impact of the individual predictors, we decided to grand-mean center the predictor variables (Sommet and Morselli, 2017). Consequently, the fixed intercept β_0 corresponds to the log-odds that the dependent variable equals 1 when all predicted variables are set to their mean values. On the other hand, the associated slope coefficients correspond to the average general effect. For instance, in Equations (11) and (12) a one-unit increase in the grand-mean centered individual-level variable age_{ij} translates into an average change of β_1 in the log-odds that the dependent variable equals 1 for the whole sample. In other words, the fixed slope of the grand-mean centered age_{ij} indicates the general between-children effect of age_{ij}, regardless of the district in which children were screened.

All multilevel logit models report the Interclass Correlation Coefficient defined as $= \frac{var(U_{0\_j})}{var(U_{0\_j})+(\frac{\pi^2}{3})}$. The ICC is used as a measure of the between-district variation in the total variation. An $ICC = 0$ indicates perfect independence of the residuals, that is, the observations do not depend on the children's district.

By contrast, $ICC = 1$ indicates that the observations only vary between districts.

In all probabilistic models, the vector of slopes β_k captures the change in the logit of the probability associated with the one-unit change in the k-th predictor. Additionally, $\exp\{\beta_k\}$ represents an odds ratio: that is, the ratio of the probability to its complement or the ratio of stunted, wasted, and concurrence cases to non-stunted, non-wasted, and non-concurrence cases associated with the k-th predictor.

In our second type of analysis, we estimate linear regression equations having as dependent variables the continuous height-for-age and weight-for-height z-scores. The vector of explanatory variables is the same as the one used in the logit and multilevel logit models for stunting and wasting. In this empirical exercise, beside the impact of the mentioned predictors, it is of crucial interest to assess the impact that the stunting condition has on the weight-for-height z-score, and the impact that the wasting condition has on the height-for-age z-score. These models are estimated using robust standard errors allowing for intragroup (district) correlation.

It is important to note that all empirical analyses deal with the following limitations: (i) The lack of information on the broad socio-economic situation in the households of the children screened at Caritas' Points of Care. In consequence, the omitted variable is an issue. In particular, the possibility that unobserved socio-economic characteristics could be correlated with some of the predictors. (ii) The self-selection of vulnerable children into the program (Caritas' Points of Care are located in the poorest parishes of the country). We are positive that these limitations, in particular the lack of representativeness of the data at the national level, do not prevent the possibility of identifying conditional correlations with malnutrition drivers that affect vulnerable children and guide us to relevant programming conclusions. Thus, we advocate the view by Amartya Sen and Martha Nussbaum: it is preferable to be vaguely right than precisely wrong.

FINDINGS

Anthropometric Analysis

Table 1 summarizes descriptive statistics and provides a summary of the anthropometric information. Records used for the analysis were 46,462. The total number of children screened increased dramatically between 2017 and 2019 following the expansion of Caritas' humanitarian response.

The observed difference in the height-for-age and weight-for-height z-scores between 2017 and 2019 are statistically significant at the 1% and 5% level, respectively. Prevalence of stunting is above the "very high" threshold for the severity of malnutrition, according to WHO classification (WHO, 2000; de Onis et al., 2019).

Pattern of Stunting

Unconditionally, stunting prevalence shows an inverted U-shape when plotted against the age of children in months. Both total and severe stunting increased with increasing age up to 20 months.

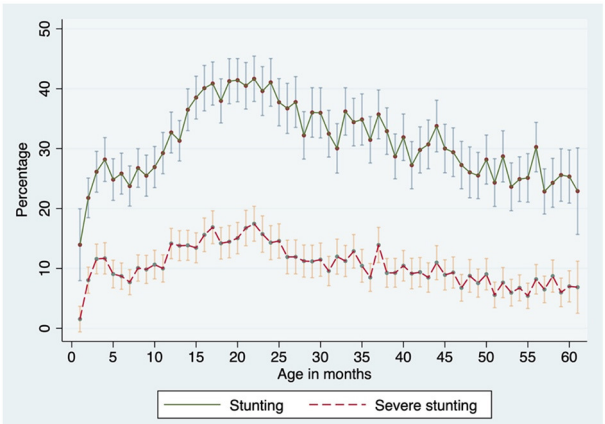

FIGURE 1 | Prevalence of stunting over children's age in 2019. Source: Own elaboration based on Caritas Venezuela data. 95% confidence intervals. Stunting was defined according to the 2006 WHO growth standards.

In 2019, the pattern of stunting (shown in **Figure 1**) in the first 1,000 days of life is consistent with the pattern demonstrated in many countries facing chronic poverty. Stunting prevalence after year 2 (24th month) declines slightly. At the age of 20th month, the stunting prevalence reaches the highest level (41% for total stunting and 16% for severe stunting). Severe stunting shows a similar pattern but with a less sharp trend. Stunting prevalence reaches near 25% for total stunting and 7% for severe stunting in children aged 50–60 months.

Table 2 shows that the stunting prevalence is statistically higher (4.2 percentage points) among boys than among girls in 2019. The gap bias against boys is still significant in severe stunting, reaching 2.9 percentage points in the same year. Prevalence of stunting and severe stunting is statistically higher in 2018 and 2019 when compared with 2017. The prevalence of stunting increased from 28.7% in 2017 to almost 32% in 2019.

In children under 6 months of age (not shown in the table), stunting prevalence reaches 25% in 2019. In that year, stunting figures at this age reveal themselves to be statistically significantly higher among boys (27.5%) when compared to girls (22.6%). Similarly, in 2019, the prevalence of severe stunting at 9.5% is statistically significantly higher among boys (10.7%) than among girls (8.3%).

To better understand the stunting pattern, **Figure 2** shows that the entire length-for-age/height-for-age z-score distribution is shifted to the left as compared with the WHO Child Growth Standards in each of the analyzed years.

According to the 2019 z-scores analyzed for HAZ shown in **Figure 3** (based on 33,070 valid observations), 95% confidence intervals allow us to state that the HAZ-scores decrease from childbirth up to the 23rd month of age among boys, and up to the 37th month of age among girls. Then, the trend remains stable before it starts to slightly improve in both sexes after the 45th month of age. This trend shows a strong correspondence with the trend of stunting prevalence shown in **Figure 1**. Moreover,

TABLE 2 | Prevalence of stunting and severe stunting in program's children.

Year	Obs.	Stunting (<−2 HAZ std. dev.)				Severe stunting (<−3 HAZ std. dev.)			
		Mean	Std. err.	[95% Conf. Interval]		Mean	Std. err.	[95% Conf. Interval]	
ALL CHILDREN									
2017	3,015	0.287	0.008	0.271	0.303	0.098	0.005	0.087	0.108
2018	10,377	0.312	0.005	0.303	0.321	0.112	0.003	0.106	0.118
2019	33,070	0.317	0.003	0.312	0.322	0.109	0.002	0.106	0.113
GIRLS									
2017	1,509	0.284	0.012	0.261	0.306	0.091	0.007	0.077	0.106
2018	5,195	0.298	0.006	0.286	0.311	0.094	0.004	0.086	0.102
2019	16,907	0.296	0.004	0.289	0.303	0.095	0.002	0.091	0.100
BOYS									
2017	1,506	0.291	0.012	0.268	0.314	0.104	0.008	0.088	0.119
2018	5,182	0.325	0.007	0.312	0.338	0.130	0.005	0.121	0.139
2019	16,163	0.338	0.004	0.331	0.346	0.124	0.003	0.119	0.129

Source: Own elaboration based on Caritas Venezuela data. Stunting was defined according to the 2006 WHO growth standards. 95% confidence intervals.

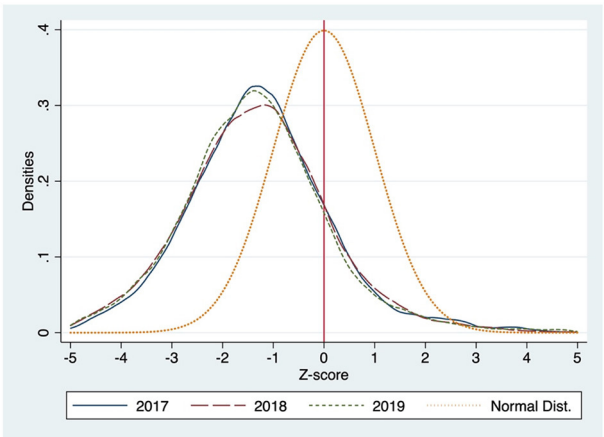

FIGURE 2 | HAZ-Score densities 2017–2019. Source: Own elaboration based on Caritas Venezuela data.

FIGURE 3 | Height-for-age z-score by sex in 2019. Source: Own elaboration based on Caritas Venezuela data. 95% confidence intervals.

the data shows a statistically significant bias against boys until the 30th month of age. Thereafter, the gender gap dissipates.

When assessing the stunting in absolute terms as the total deficit of the linear growth faltering, 95% confidence intervals confirm a mean deficit in 2019 of around 5 cm by the age of 24 months and around 6 cm by the age of 60 months. Moreover, boys tend to be statistically slightly worse-off than girls during the first 24 months of age (see **Figure 4** and Victoria et al., 2014).

Figure 5 shows seasonality patterns of linear growth faltering and HAZ-scores by age in 2019. Infants born in the first semester of the year (January to June) showed greater linear growth faltering until the 30th month of age. Thereafter, the gap closes. Similarly, those children born during the first 6 months of each year tend to present statistically significantly lower HAZ-scores than their counterparts born during the second 6 months of each year.

Pattern of Wasting

In 2019, wasting prevalence peaks at the first month of age and then it decreases with increasing age up to 24 months of age (shown in **Figure 6**). At the age of 24 months the wasting prevalence stabilizes around 10%. Severe wasting prevalence shows a similar pattern but with a less sharp trend.

Table 3 shows the wasting information. Ninety-five percent confidence intervals (95% CI) show that the wasting prevalence among boys is not statistically higher than their female counterparts. Wasting prevalence decreased significantly over the period of analysis (2017–2019), from about 15% in 2017 to 11.5% in 2019.

Regarding the distribution of the WHZ score over age in 2019 (shown in **Figure 7**), children exhibit the lowest z-score, on average, during the first months of age. Then, it increasingly levels off up to the age of 5 months. Thereafter, the score remains

somewhat constant. Confidence intervals of 95% don't allow us to detect a fundamental difference between the trends experienced by children according to their birth season and according to their sex. On average these children have a WHZ score of −0.96, and 22.5% of them are wasted. Thus, our data confirms that low birth weight is a substantial problem among vulnerable children in Venezuela.

Worryingly, the mean z-score for WHZ and prevalence of wasting are above the "CRITICAL" threshold for the severity of malnutrition according to WHO classification over the entire period[2].

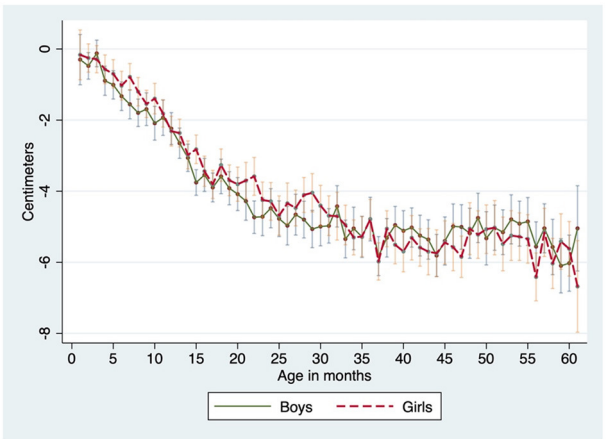

FIGURE 4 | Linear growth faltering over children's age by sex in 2019. Source: Own elaboration based on Caritas Venezuela data. 95% confidence intervals.

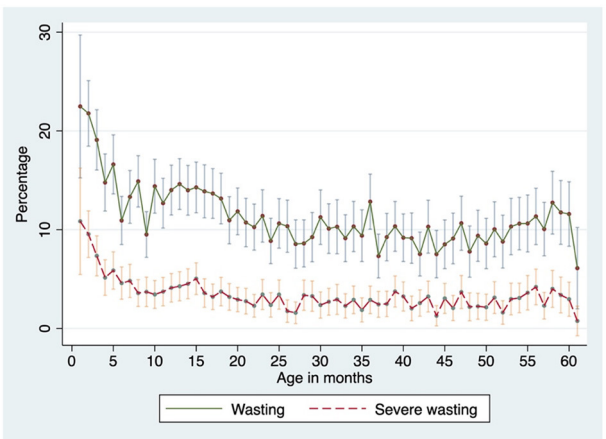

FIGURE 5 | Prevalence of wasting over children's age in 2019. Source: Own elaboration based on Caritas Venezuela data. 95% confidence intervals. Wasting was defined according to the 2006 WHO growth standards.

[2]According to the WHO (2000), the classification of severity of malnutrition for children under 5 years of age consists of the following categories: Mean weight for height Z-score: >−0.40 (acceptable); −0.40 to −0.69 (poor); −0.70 to −0.99 (serious); ≤ −1 (critical).

Wasting and Stunting Concurrence

Table 4 shows that from the 46,462 valid entries in our dataset, 1,823 children (3.92%) are simultaneously stunted and wasted, and of them (not shown in the table) 11.5% are severely wasted and severely stunted. We found that 12.51% of all stunted children are simultaneously wasted. Meanwhile, 33.05% of all wasted children are at the same time stunted. It is worth noting that the prevalence of stunting among wasted children is, on average, above 2.6 times higher than the prevalence of wasting among stunted children. The prevalence of stunting conditional to wasting is higher among boys at the 1% confidence level. Similarly, the prevalence of wasting conditional to stunting is higher among boys at the 5% confidence level.

Figure 8 shows the concurrence of stunting and wasting over age for all children in 2019. Confidence intervals of 95% show that it is statistically higher between the 10th and 20th month of age (within the 1,000 days).

Regression Analysis: Drivers of Wasting and Stunting

Drivers of Stunting

The findings of the logit and multilevel logit models for stunting are displayed in **Table 5**. Our preferred model (the saturated one) in column (9) shows that age is not significantly associated with stunting.

The children's sex is also found to have a significant association with the probability of stunting. The odds of boys being stunted are about 1.19 times greater than for girls.

Interestingly, we found that the period of the year in which a child is born can predict their likelihood of being stunted. The odds of children born between January and July (rainy season) being stunted are 1.13 times greater than the odds of their counterparts born between August and December being stunted.

We find that an increased share of households with food insecurity in the district increases the probability of stunting. Given the positive Pearson's correlation of 0.4178 between moderate and severe food insecurity, the coefficient results should be interpreted not in isolation but together. Our results show that if an increase in severe food insecurity goes hand in hand with an increase in moderate food insecurity, then the probability of stunting increases at a decreasing rate. Just for reference, when there is a 1 percentage point increase in the share of households with severe food insecurity, we expect to see about a 4.2% increase in the odds of being stunted.

Although not statistically significant, in districts where there is a 1 percentage point increase in the share of households with lack of access to running water, the odds of being stunted increases by 1.1%. Note that the lack of significance of this result should be interpreted with caution as this association only uses between-district variation. If children-level data were available, one might well find a significant association between clean water and stunting.

Finally, the year dummies tell us about the relationship between the year in which the child was screened and the

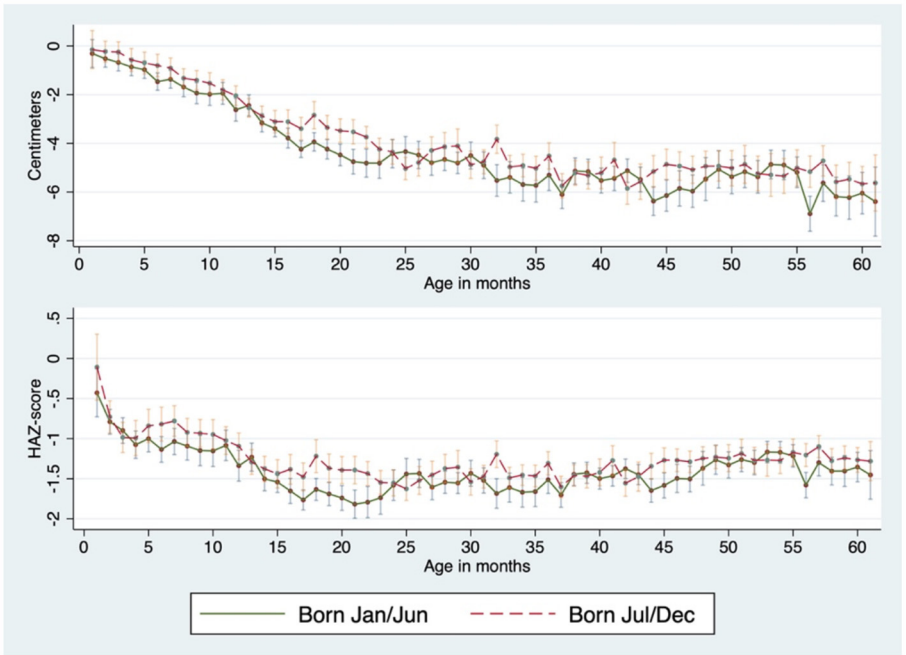

FIGURE 6 | Linear growth faltering in centimeters and height-for-age z-score by birth season in 2019. Source: Own elaboration based on Caritas Venezuela data. 95% confidence intervals.

TABLE 3 | Prevalence of wasting and severe wasting in program's children.

Year	Obs.	Wasting (<–2 WHZ std. dev.)				Severe wasting (<–3 WHZ std. dev.)			
		Mean	Std. err.	[95% Conf. Interval]		Mean	Std. err.	[95% Conf. Interval]	
ALL CHILDREN									
2017	3,015	0.148	0.006	0.135	0.161	0.049	0.003	0.041	0.057
2018	10,377	0.122	0.003	0.116	0.128	0.039	0.002	0.035	0.042
2019	33,070	0.115	0.002	0.112	0.118	0.034	0.001	0.032	0.036
GIRLS									
2017	1,509	0.144	0.009	0.127	0.162	0.052	0.006	0.041	0.064
2018	5,195	0.116	0.004	0.108	0.125	0.038	0.003	0.033	0.043
2019	16,907	0.112	0.002	0.107	0.117	0.030	0.001	0.028	0.033
BOYS									
2017	1,506	0.151	0.009	0.133	0.170	0.046	0.005	0.035	0.056
2018	5,182	0.128	0.005	0.119	0.137	0.040	0.003	0.034	0.045
2019	16,163	0.118	0.003	0.113	0.123	0.038	0.002	0.036	0.041

Source: Own elaboration based on Caritas Venezuela data. Wasting was defined according to the 2006 WHO growth standards.

probability of being stunted or not being stunted. When compared with 2017, the odds of children screened in 2018 and 2019 being stunted are about 1.156 and 1.195 times greater, respectively. The self-selection into the screening program does not allow us to dismiss the possibility that the stunting has become more prevalent among all children in Venezuela since 2017. However, our data shows that among the group of screened children, stunting has become more prevalent, and thus our conditional analysis confirms the unconditional information presented in **Table 1**.

Drivers of Wasting

The findings of the logit and multilevel logit models for wasting are displayed in **Table 6**. According to our preferred model (the saturated one) in column (9), we find that age is significantly associated with wasting. Each additional month of age reduces by 1.44% the odds of being wasted. This finding also holds in all other specifications.

The children's sex is also found to have a significant association with the probability of wasting across all models. The odds of boys being wasted are about 8.4% higher than for girls.

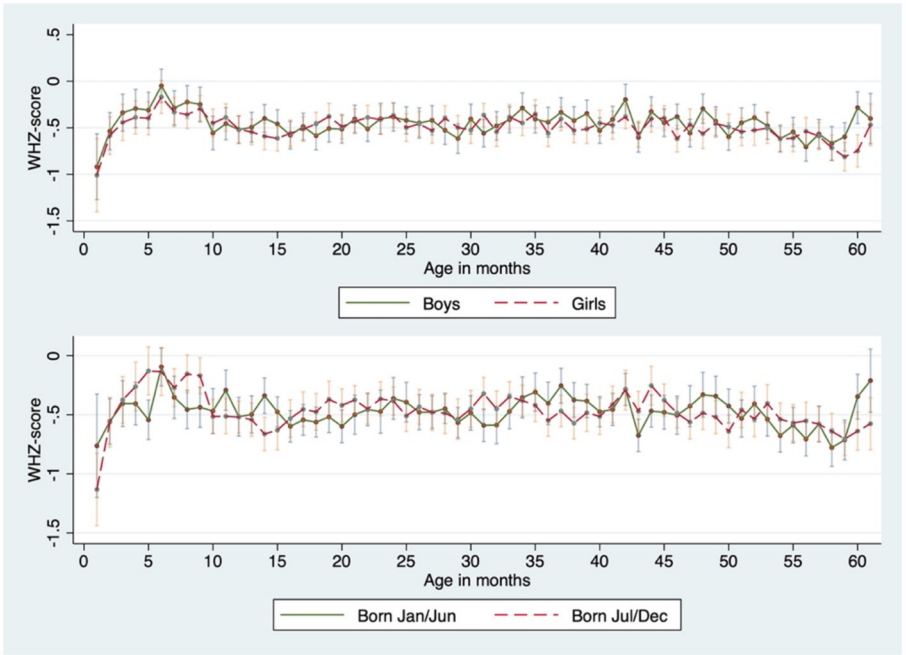

FIGURE 7 | Weight-for-height z-score by sex and by birth season in 2019. Source: Own elaboration based on Caritas Venezuela data. 95% confidence intervals.

TABLE 4 | Contingency table: stunting, wasting, and concurrence (whole sample).

	N	Percentage of total	Percentage among wasted children	Percentage among stunted children
ALL CHILDREN				
Stunted	14,574	31.37	33.05	–
Wasted	5,516	11.87	–	12.51
Concurrence	1,823	3.92	100	100
GIRLS				
Stunted	6,984	29.58	30.73	–
Wasted	2,714	11.49	–	11.94
Concurrence	834	3.53	100	100
BOYS				
Stunted	7,590	33.22	35.3	–
Wasted	2,802	12.26	–	13.03
Concurrence	989	4.33	100	100

Source: Own elaboration based on Caritas Venezuela data. Stunting and wasting are defined according to the 2006 WHO children growth standards. Concurrence is defined as children facing stunting and wasting simultaneously.

We also found that the season of the year in which a child is born is not a predictor of the probability of being wasted.

On the determinants related to food insecurity, we find that the district shares of households with severe food insecurity is not associated with the probability of wasting. By contrast, moderate food insecurity increases the probability. A 1 percentage point increase in the district share of households with moderate food insecurity increases the odds of being wasted by 2.7%. Similarly, the lack of access to running water is statistically associated to the probability of children being wasted. In districts where there is a 1 percentage point increase in the share of households with lack of access to running water, the odds of being wasted increase by 1.7%.

When compared with 2017, the odds of children screened in 2018 and 2019 being wasted are about 11.5% and 23.3% higher, respectively. This result confirms the unconditional analysis presented in **Table 1**.

Integrating our results for stunting and wasting, we find clear evidence that there is reverse causality between the condition of stunting and wasting. That is, the wasting condition increases the probability of a child of being stunted and vice versa. However, the predictors of stunting and wasting differ significantly. For

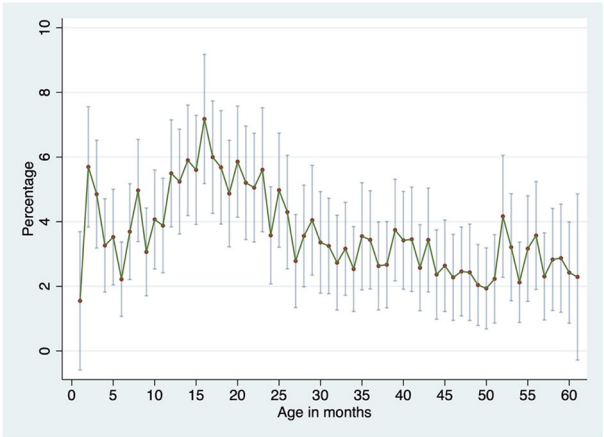

FIGURE 8 | Prevalence of wasting and stunting concurrence over children's age in 2019. Source: Own elaboration based on Caritas Venezuela data. 95% confidence intervals. Stunitng and wasting were defined according to the 2006 WHO growth standards.

instance, boys relative to girls are more likely to be stunted than wasted. We also find that food insecurity explains to a greater extent stunting than wasting. Moreover, although the lack of access to running water does not show up as a stunting predictor, it predicts the probability of a child facing wasting.

Drivers of Wasting and Stunting Concurrence

First, we find that a wasted child is more likely to be stunted. Using the odds ratios to interpret the results, we find that the odds of wasted children being stunted are 1.079 times greater than for non-wasted children (see **Table 5**). Similarly, the odds of stunted children being wasted are 1.085 times greater than for non-stunted children (see **Table 6**).

Table 7 shows our results regarding the drivers of the concurrence of stunting and wasting. We find that age, sex, the season of birth, and severe food insecurity have statistically significant impacts on the simultaneous occurrence of stunting and wasting. These impacts are robust to the different model specifications.

Our preferred specification in column (5) in **Table 7** shows that each additional month of age reduces by 1.2% the odds of facing the simultaneous occurrence of both wasting and stunting.

The children's sex is also found to have a significant association with the probability of concurrence. The odds of boys facing concurrence are 25.5% higher than for girls.

We find that the season of the year in which a child is born is a predictor of the probability of concurrence. In fact, the odds of children born between January and July (rainy season) facing concurrence are 1.11 times higher than the odds of their counterparts born during the rest of the year facing concurrence.

Finally, severe food insecurity at the district level is strongly associated with the simultaneous concurrence of stunting and wasting. For instance, a 1 percentage point increase in the district share of households with severe food insecurity increases by 4.7% the odds of facing concurrence of stunting and wasting.

The Determinants of the HAZ and WHZ-Scores

The results of our multiple linear regression models in **Tables 8**, **9** show that being wasted reduced the HAZ-score by 0.064, while being stunted reduces the WHZ-score by 0.054. This evidence supports the correlation between both conditions.

In contrast to what we found with the prevalence, age tends to reduce the HAZ- and WHZ-scores. Each month of age reduces the HAZ- and WHZ-scores in 0.0057 and 0.0019 standard deviations, respectively.

Conditional to the other covariates, on average boys have a 0.113 point lower HAZ-score than girls. They also have, on average, a 0.0236 higher WHZ-score. Season of birth is also relevant for explaining the HAZ-score. On average, those born during the first half of the year have a HAZ-score 0.13 points lower. When it comes to district-level food insecurity, this explains some variation in the z-scores. A 10 percentage point higher district prevalence of moderate and severe food insecurity reduces the average HAZ-score by 0.22 and 0.63 points. A 10 percentage point higher district prevalence of moderate food insecurity reduces the average WHZ-score by 0.13 points. At the district level, access to running water is not statistically associated to a lower HAZ-score.

Finally, on average, those children born during the first half of the year have a WHZ-score 0.14 points lower than children born during the rest of the year. Only severe food insecurity can explain the WHZ-score. A 10 percentage point higher district prevalence of severe food insecurity reduces the average WHZ-score by 0.32 points. Finally, a 10 percentage point higher district prevalence of households lacking clean water reduces the average WHZ-score by 0.05 points.

DISCUSSION

Our findings reveal that both wasting and stunting have been prevalent over the last several years of the protracted crisis in Venezuela, reaching alarming thresholds all over the analyzed period, following an evident pattern of concurrence and responding to strong predictors related not only to food security, but also to age, sex, birth seasonality, and access to water.

The wasting and stunting prevalence we found over the entire period are labeled as "high" and "very high", respectively, in line with the prevalence categories that describe public health crisis according to the WHO criteria (WHO, 2000; de Onis et al., 2019).

The shift we found of the distribution curve of height-for-age z-score to the left is an indication that all children in the dataset are facing some degree of linear growth faltering, even if they do not qualify as stunted. They might be discharged from the program with a healthy weight-for-height, but their growth faltering persists. These findings are consistent with the results documented by de Onis and Branca (2016) in countries with a chronic poverty history. As Leroy and Ruel state, the risk of being stunted and suffering from its devastating consequences does not change dramatically simply by crossing a threshold line; significant deterioration within the 'normal' range may also occur (Leroy and Ruel, 2014).

TABLE 5 | Logit and multilevel logistic regression specifications for the probability of being stunted.

Variables/specifications	Dependent variable: stunting								
	Logit		Mixed-effects logistic regressions (MELR)						
	(1)	(2)	(3) Empty model	(4) R.I	(5) R.I	(6) R.I + age [R.I/slope]	(7): R.I. + age [R.I/slope]	(8): R.I. + age, sex, b. rainy s. [R.I/slope]	(9): R.I. + age, sex, b. rainy s. [R.I/slope]
FIXED EFFECTS (ONLY MELR)									
Wasting		0.0854*			0.0713**		0.0757**		0.0756**
		(0.0468)			(0.0309)		(0.0309)		(0.0309)
Age (months)	−0.00199	−0.00188		−0.00208***	−0.00199***	−0.00223*	−0.00213	−0.00224*	−0.00213
	(0.00123)	(0.00123)		(0.000598)	(0.000599)	(0.00129)	(0.00130)	(0.00129)	(0.00130)
Sex	0.173***	0.172***		0.174***	0.174***	0.175***	0.175***	0.175***	0.175***
	(0.0171)	(0.0170)		(0.0201)	(0.0201)	(0.0201)	(0.0201)	(0.0201)	(0.0201)
Born during rainy season	0.114***	0.114***		0.120***	0.120***	0.120***	0.120***	0.121***	0.121***
	(0.0219)	(0.0218)		(0.0201)	(0.0201)	(0.0201)	(0.0201)	(0.0222)	(0.0221)
Moderate food insecurity	−0.0137*	−0.0139*		−0.0148*	−0.0150*	−0.0149*	−0.0151*	−0.0149*	−0.0151*
	(0.00820)	(0.00813)		(0.00860)	(0.00856)	(0.00863)	(0.00859)	(0.00863)	(0.00859)
Severe food insecurity	0.0449***	0.0449***		0.0419**	0.0419**	0.0411**	0.0411**	0.0411**	0.0411**
	(0.0156)	(0.0155)		(0.0168)	(0.0167)	(0.0169)	(0.0168)	(0.0169)	(0.0168)
No access to running water	0.00875	0.00883		0.0112	0.0113	0.0112	0.0113	0.0112	0.0113
	(0.00477)	(0.00472)		(0.00462)	(0.00460)	(0.00464)	(0.00461)	(0.00464)	(0.00461)
Surveyed in 2018	0.153	0.156		0.144***	0.145***	0.144***	0.145***	0.144***	0.145***
	(0.117)	(0.117)		(0.0470)	(0.0470)	(0.0470)	(0.0470)	(0.0470)	(0.0471)
Surveyed in 2019	0.147	0.150		0.173***	0.175***	0.176***	0.178***	0.176***	0.178***
	(0.0958)	(0.0956)		(0.0437)	(0.0437)	(0.0438)	(0.0438)	(0.0438)	(0.0438)
Intercept (constant)	−0.788***	−0.788***	−0.776***	−0.803***	−0.803***	−0.802***	−0.802***	−0.802***	−0.802***
	(0.224)	(0.222)	(0.0483)	(0.0411)	(0.0408)	(0.0412)	(0.0410)	(0.0412)	(0.0410)
RANDOM EFFECTS (MELR)									
Intercept (u_{0j}): σ^2_{u0}			0.0395†	0.0242†	0.0239†	0.0244†	0.0241†	0.0244†	0.0241†
Age (months) (u_{1j}): σ^2_{u1}			–	–	–	0.00002†	0.00002†	0.00002†	0.00002†
Sex σ^2_{u2}								0.00000	0.00000
Born 1st semester: σ^2_{u3}								0.001†	0.0009†
−2LogL (deviance)			57,555	57,558	57,400	57,388	57,392	57,390	57,384
LRχ^2			244.2	150.5	150.51	171.62	169.91	168.67	166.94
p-Value			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Residual interclass correlation (ICC)			0.0119	0.0073	0.0072	0.0073	0.0073	0.0073	0.0072
Log likelihood	−28,779	−28,775	−28,778	−28,703	−28,700	−28,694	−28,690	−28,695	−28,692
Pseudo-*R*-squared	0.00417	0.00430							
Wald chi2	209.4	245.6							
Prob > chi2	0	0							
Observations	46,462	46,462							
Number of clusters	19	19							

*Source: Own elaboration based on Caritas Venezuela and Food Security Assessment, WFP 2019 data. Robust standard errors allowing for intragroup (district) correlation in parentheses ***p < 0.01, **p < 0.05, *p < 0.1 in the logit model. †p < 0.05 (Wald test). R.I.: random intercept.*

TABLE 6 | Logit and multilevel logistic regression specifications for the probability of being wasted.

Variables/specifications	Dependent variable: wasting								
	Logit		Mixed-effects logistic regressions (MELR)						
	(1)	(2)	(3): Empty model	(4): R.I.	(5): R.I.	(6): R.I. + age [R.I/slope]	(7): R.I. + age [R.I/slope]	(8): R.I. + age, sex, b. rainy s. [R.I/slope]	(9): R.I. + age, sex, b. rainy s. [R.I/slope]
FIXED EFFECTS (ONLY MELR)									
Stunting		0.0882*			0.0733**		0.0817***		0.0814***
		(0.0464)			(0.0309)		(0.0309)		(0.0309)
Age (months)	−0.0122***	−0.0122***		−0.0129***	−0.0129***	−0.0145***	−0.0145***	−0.0145***	−0.0145***
	(0.00289)	(0.00292)		(0.000877)	(0.000878)	(0.00237)	(0.00239)	(0.00237)	(0.00239)
Sex	0.0768*	0.0731*		0.0780***	0.0748***	0.0775***	0.0740**	0.0839**	0.0802**
	(0.0395)	(0.0393)		(0.0289)	(0.0289)	(0.0289)	(0.0289)	(0.0381)	(0.0379)
Born during rainy season	−0.0334	−0.0356		−0.0287	−0.0306	−0.0263	−0.0285	−0.0263	−0.0285
	(0.0232)	(0.0228)		(0.0289)	(0.0289)	(0.0290)	(0.0290)	(0.0290)	(0.0290)
Moderate food insecurity	0.0207*	0.0210*		0.0251*	0.0254*	0.0260*	0.0263*	0.0261*	0.0264*
	(0.0112)	(0.0111)		(0.0131)	(0.0130)	(0.0141)	(0.0140)	(0.0141)	(0.0140)
Severe food insecurity	−0.00164	−0.00254		0.00852	0.00776	0.0115	0.0108	0.0115	0.0107
	(0.0170)	(0.0170)		(0.0256)	(0.0254)	(0.0275)	(0.0273)	(0.0275)	(0.0273)
No access to running water	0.00899	0.00915		0.0159**	0.0161**	0.0166**	0.0168**	0.0166**	0.0168**
	(0.00891)	(0.00884)		(0.00679)	(0.00674)	(0.00726)	(0.00722)	(0.00727)	(0.00723)
Surveyed in 2018	−0.240*	−0.243*		−0.124**	−0.126**	−0.119*	−0.122**	−0.119*	−0.122**
	(0.138)	(0.138)		(0.0617)	(0.0617)	(0.0617)	(0.0617)	(0.0617)	(0.0617)
Surveyed in 2019	−0.351**	−0.355**		−0.265***	−0.269***	−0.261***	−0.265***	−0.263***	−0.266***
	(0.148)	(0.148)		(0.0569)	(0.0569)	(0.0569)	(0.0569)	(0.0569)	(0.0569)
Intercept (constant)	−1.983***	−2.008***	−2.003***	−2.038***	−2.039***	−2.062***	−2.062***	−2.062***	−2.063***
	(0.344)	(0.338)	(0.0667)	(0.0627)	(0.0623)	(0.0674)	(0.0670)	(0.0675)	(0.0671)
RANDOM EFFECTS (MELR)									
Intercept (u_{0j}): σ^2_{u0}			0.0748†	0.0570†	0.0562†	0.0666†	0.0657†	0.0667†	0.0659†
Age (months) (u_{1j}): σ^2_{u1}			–	–	–	0.00008†	0.00008†	0.00008†	0.00008†
Sex σ^2_{u2}								0.00731†	0.00715†
Born 1st Semester: σ^2_{u3}								0.0000	0.0000
−2LogL (deviance)			33,858	33,430	33,424	33,362	33,356	33,364	33,357
LRχ^2			169.52	141.38	138.8	207.84	206.59	206.69	205.39
Prob > chi2			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Residual interclass correlation (ICC)			0.0222	0.0170	0.0168	0.0198	0.0196	0.0199	0.0196
Log likelihood	−16,786	−16,781	−16,929	−16,715	−16,712	−16,681	−16,678	−16,682	−16,678
Pseudo-*R*-squared	0.00849	0.00873							
Wald chi2	51.85	76.23							
Prob > chi2	0.0000	0.0000							
Observations	46,462	46,462							
Number of clusters	19	19							

*Source: Own elaboration based on Caritas Venezuela and Food Security Assessment, WFP 2019 data. Robust standard errors allowing for intragroup (district) correlation in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. †p < 0.05 (Wald test). R.I.: random intercept.*

TABLE 7 | Logit and multilevel logistic regression specifications for the probability of being simultaneously stunted and wasted (concurrence).

Variables/specifications	Dependent variable: simultaneous stunting and wasting				
	Logit		Mixed-effects logistic regressions (MELR)		
	(1)	(2): Empty model	(3): R.I.	(4): R.I. + age [R.I/slope]	(5): R.I. + age, sex, b. rainy s. [R.I/slope]
FIXED EFFECTS (ONLY MELR)					
Age (months)	−0.0106***		−0.0112***	−0.0117***	−0.0117***
	(0.00254)		(0.00145)	(0.00215)	(0.00215)
Sex	0.218***		0.218***	0.218***	0.227***
	(0.0553)		(0.0481)	(0.0481)	(0.0574)
Born during rainy season	0.119**		0.126***	0.128***	0.106*
	(0.0570)		(0.0479)	(0.0480)	(0.0619)
Moderate food insecurity	0.00435		0.00992	0.00971	0.00985
	(0.0124)		(0.0139)	(0.0142)	(0.0142)
Severe food insecurity	0.0462**		0.0454*	0.0458*	0.0462*
	(0.0205)		(0.0263)	(0.0269)	(0.0268)
No access to running water	−0.00394		−0.00158	−0.00177	−0.00168
	(0.0103)		(0.00766)	(0.00781)	(0.00780)
Surveyed in 2018	−0.107		0.00259	0.00593	0.00649
	(0.136)		(0.104)	(0.104)	(0.104)
Surveyed in 2019	−0.212		−0.0748	−0.0686	−0.0693
	(0.143)		(0.0962)	(0.0963)	(0.0964)
Intercept (constant)	−3.287***	−3.235***	−3.291***	−3.301***	−3.303***
	(0.358)	(0.0695)	(0.0662)	(0.0677)	(0.0676)
RANDOM EFFECTS (MELR)					
Intercept (u_{0j}): σ^2_{u0}		0.0679†	0.0517†	0.0544†	0.0540†
Age (months) (u_{1j}): σ^2_{u1}		–	–	0.00003†	0.00003†
Sex σ^2_{u2}					0.00815†
Born 1st semester: σ^2_{u3}					0.01302†
−2LogL (deviance)		15,380	15,218	15,214	15,213
LRχ^2		67.05	48.47	52.74	52.75
Prob > chi2		0.0000	0.0000	0.0000	0.0000
Residual interclass correlation (ICC)		0.0222	0.0154	0.0163	0.0162
Log likelihood	−7,634	−7,690	−7,609	−7,607	−7,607
Pseudo-*R*-squared	0.00733				
Wald chi2	287.0				
Prob > chi2	0.0000				
Observations	46,462				
Number of clusters	19				

*Source: Own elaboration based on Caritas Venezuela and Food Security Assessment, WFP 2019 data. Robust standard errors allowing for intragroup (district) correlation in parentheses ***p < 0.01, **p < 0.05, *p < 0.1. †p < 0.05 (Wald test). R.I.: random intercept.*

Confirming the concurrence of wasting and stunting in our dataset is an indication of the protracted duration of the crisis, evidence that the onset of the population's nutritional hardship dates back at least to 2014, and a warning regarding the urgency of adapting programming frameworks toward targets beyond the recovery of acute malnutrition and beyond the "food-first" focus.

The concurrence of wasting and stunting we found suggests that the two should not be treated as independent conditions. We assume that the overall failure of feeding patterns and care patterns in households of children facing stunting underlies the concurrence of both conditions. It is likely that poor energy intake in a wasted child goes hand in hand with poor dietary diversity impairing a child's growth, but also that growth faltering is happening in children who have not been hungry but rather exposed to a nutritionally poor diet.

Descriptive findings on wasting prevalence by age are consistent with findings of the analysis from cross-sectional national surveys in 54 countries, which demonstrate that height-for-age decreases throughout the first 2–3 years of life, whereas weight-for-height tends to falter during a more limited age

TABLE 8 | Linear regression models for the height-for-age z-score.

Variables/specifications	Dependent variable: HAZ-score									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Wasting condition	−0.0578***									−0.0638***
	(0.0160)									(0.00497)
Age in months		−0.00559***							−0.00559***	−0.00570***
		(0.000998)							(0.000391)	(0.000390)
Sex			−0.114***						−0.115***	−0.113***
			(0.0137)						(0.0132)	(0.0131)
Born during rainy season				−0.121***					−0.125***	−0.125***
				(0.0130)					(0.0132)	(0.0132)
Moderate food insecurity					−0.00241				−0.0215**	−0.0219**
					(0.00658)				(0.0100)	(0.0100)
Severe food insecurity						−0.0252*			−0.0612***	−0.0631***
						(0.0127)			(0.00801)	(0.00800)
No access to running water							0.00532		−0.000942	−0.00128
							(0.00505)		(0.00149)	(0.00149)
Surveyed in 2018								−0.0555	−0.0723**	−0.0744**
								(0.0868)	(0.0303)	(0.0302)
Surveyed in 2019								−0.0807	−0.131***	−0.128***
								(0.0740)	(0.0281)	(0.0280)
Constant	−1.355***	−1.172***	−1.271***	−1.270***	−1.271***	−1.157***	−1.391***	−1.257***	−0.0224	−0.0199
	(0.0396)	(0.0532)	(0.0379)	(0.0420)	(0.163)	(0.0924)	(0.0484)	(0.0974)	(0.178)	(0.177)
Observations	46,462	46,462	46,462	46,462	46,462	46,462	46,462	46,462	46,462	46,462
F	12.97	31.38	69.19	86.42	0.134	3.943	1.110	0.778	37.63	43.05
Prob > *F*	0.00204	2.57e-05	1.40e-07	2.71e-08	0.718	0.0625	0.306	0.474	0.000	0.000
R-squared	0.003	0.004	0.002	0.002	0.000	0.002	0.001	0.000	0.018	0.022
Root MSE	1.428	1.427	1.429	1.429	1.430	1.429	1.430	1.430	1.418	1.415
District dummy	No	No	No	No	No	No	No	No	Yes	Yes

*Source: Own elaboration based on Caritas Venezuela and Food Security Assessment, WFP 2019 data. Robust standard errors allowing for intragroup (district) correlation in parentheses in models (1) to (8). Robust standard errors in specifications (9) and (10). ***p < 0.01, **p < 0.05, *p < 0.1.*

TABLE 9 | Linear regression models for the weight-for-height z-score.

Variables/specifications	Dependent variable: WHZ-score									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Stunting condition	−0.0497***									−0.0554***
	(0.0134)									(0.00432)
Age in months		−0.00180*							−0.00161***	−0.00192***
		(0.000885)							(0.000364)	(0.000364)
Sex			0.0317*						0.0300**	0.0236*
			(0.0156)						(0.0123)	(0.0123)
Born during rainy season				−0.00444					−0.00672	−0.0136
				(0.00864)					(0.0123)	(0.0123)
Moderate food insecurity					−0.0100**				−0.00699	−0.00819
					(0.00443)				(0.00935)	(0.00934)
Severe food insecurity						−0.0133			−0.0287***	−0.0321***
						(0.0103)			(0.00747)	(0.00746)
No access to running water							0.00382		−0.00535***	−0.00540***
							(0.00347)		(0.00139)	(0.00139)
Surveyed in 2018								−0.0180	−0.0326	−0.0366
								(0.0800)	(0.0282)	(0.0282)
Surveyed in 2019								0.0500	0.0427	0.0354
								(0.0707)	(0.0262)	(0.0261)
Constant	−0.545***	−0.430***	−0.495***	−0.477***	−0.248**	−0.390***	−0.525***	−0.511***	0.0392	0.0380
	(0.0348)	(0.0387)	(0.0322)	(0.0322)	(0.111)	(0.0893)	(0.0443)	(0.0685)	(0.166)	(0.165)
Observations	46,462	46,462	46,462	46,462	46,462	46,462	46,462	46,462	46,462	46,462
F	13.84	4.114	4.142	0.265	5.130	1.666	1.207	0.750	16.75	22.97
Prob > *F*	0.00157	0.0576	0.0568	0.613	0.0361	0.213	0.286	0.487	0.000	0.000
R-squared	0.003	0.001	0.000	0.000	0.001	0.001	0.001	0.000	0.008	0.012
Root MSE	1.324	1.326	1.326	1.326	1.325	1.326	1.326	1.326	1.321	1.319
District dummy	No	No	No	No	No	No	No	No	Yes	Yes

*Source: Own elaboration based on Caritas Venezuela and Food Security Assessment, WFP 2019 data. Robust standard errors allowing for intragroup (district) correlation in parentheses in models (1) to (8). Robust standard errors in specifications (9) and (10). ***p < 0.01, **p < 0.05, *p < 0.1.*

window in the first year of life, after which it stabilizes. That the greatest prevalence of wasting occurs over this first month supports the idea that this is a key moment on which to focus protection interventions.

Differences according to sex are surprising. To the best of our knowledge there is no evidence of this gender gap in South America. Greater prevalence and severity of wasting and stunting among boys, as compared to girls, might reflect a situation in which boys are likely to face greater nutritional risks. This gender gap could be an indication that households prioritize girls for health-seeking behaviors. However, no other factors were analyzed that explain these differences. Further research should investigate this important issue.

The seasonality we found for stunting (higher severity during the first half of the year) is consistent with previous studies showing that malnutrition levels vary with seasonal variations, perhaps reflecting variations in pattern of diseases, food availability, and even time for childcare. Months of higher prevalence match with the rainy season in Venezuela (May–June), a period of high incidence of infectious diseases, especially respiratory infection, diarrhea, and malaria, that contribute to the depletion of nutritional status of both children and their caregivers. These findings are consistent with the pattern described by Schoembechler's retrospective cohort analysis of longitudinal data in Gambian children from 1976 to 2016 studying the relationship between wasting and stunting.

We support the assumption of Schoembechler regarding the seasonality we found; infants born during the wet season did not catch up in weight during the first 3 months of life to the same extent as their peers born in other months. These infants might be facing more wasting during childhood and an increased risk of becoming stunted before 2 years of age. No other factors behind this were analyzed, but may include seasonal increments of infectious diseases, effects on maternal nutritional status and on infant feeding and care practices. The months of poorest linear growth after periods of high wasting might indicate that children do not grow in height if their weight-for-height declines (Schoenbuchner et al., 2016).

In the case of the regression analysis of wasting and stunting, we confirm considerable differences that explain wasting and stunting variations among districts. High prevalence of severe food insecurity and lack of access to water at district level reduce the average WHZ- and HAZ-scores and might be reflecting inequalities in living conditions as confirmed by other authors in Latin America (Flores-Quispe et al., 2019).

Although the "food-first" focus still tends to over-bias practice in preventing malnutrition in emergencies, we found in our observations that food security really determined the anthropometrics we found. Severe food insecurity is a main driver of persistent acute malnutrition, a driver also of stunting, and a driver of the concurrence of both, but with a stronger effect on wasting.

Although we don't find any considerable effect in terms of access to water being a central driver of stunting, the fact that our empirical exercise only uses between-district variation means we cannot reject access to water as an essential factor in nutritional protection in early childhood. It is highly probable that a more disaggregated dataset would yield results consistent with programs and campaigns that promote improved access to water, as well as with recent analysis of multiple Demographic Health Surveys by Headey and Palloni exploring water and sanitation as a predictor of child morbidity, mortality, and nutrition (Headey and Palloni, 2019).

At the time of the research, child anthropometric data including a comprehensive set of covariates was not available. This prevents researchers from implementing methodologically clean approaches to studying causes of malnutrition. Given this difficulty we believe that limited data is better than no data, and, furthermore, we believe that using limited data is better than rejecting empirical research that has programming implications because of data weaknesses. We propose that our observations be considered for programming improvements, rather than neglecting the reality of thousands of children at risk of malnutrition. Although our estimates are not statistically representative of the entire children's population, they are strongly consistent and allow us to be deeply concerned about the future of thousands of children. In any case, we strongly believe that improvements in data collection, as well as our empirical findings, open further research possibilities for strengthening the evidence for programs and policies.

We see research priorities relating to the influence of other household predictors, mainly the household structure in the face of the huge outmigration process, the access to remittances, and the enrollment to social protection programs. An important area for future research is further investigation on factors that best suit the mitigation of stunting in this protracted setting.

IMPLICATIONS FOR PROGRAMMING

Our findings suggest the need for a stronger way of working in our humanitarian programs that includes more long-term approaches, more networks, and expanded support for addressing the challenge of the persistency of acute malnutrition and the increasing rates of stunting, based on strategies with explicit nutritional goals.

Children are admitted to and discharged from Caritas' Points of Care and from other programs already stunted. Even if the stunting is more difficult to reverse over the usual timeframe of humanitarian response, it is hoped that within the areas of targeting criteria, enrollment and discharge protocols, and preventive interventions there will be new possibilities for programming aimed at protecting children identified as moderately stunted against further deterioration. Both wasting and stunting should be managed as a priority issue, especially for a preventive/protective approach.

The programming targets in such a fragile and protracted crisis as Venezuela should focus not only on livelihoods and food resilience, but especially on nutritional resilience to prevent further growth decline, including the management of stunting drivers within the policy and programming scope.

The findings on the pattern of wasting and stunting by age indicate the necessity of focusing on both preventive and therapeutic intervention in children under 2 years of age as well as in pregnant and lactating women.

Predictability should be integrated into humanitarian programming. Humanitarian inputs, logistics, and personnel

should be anticipated and located well before the period of highest wasting prevalence (first half of the year), especially in the face of upcoming mobility restrictions due to further outbreaks of Covid-19 and/or further crisis in the access to gasoline and public transportation.

A sound humanitarian response directed toward nutritional protection is relevant for both girls and boys, but it is crucial to have a broader understanding of cultural drivers that explain the negative bias toward boys.

The severity of the damage and the protracted character of the Venezuelan crisis demand a humanitarian response on preventive and therapeutic lines, articulating interventions that target not only the drivers of food insecurity, but also nutritional demands. The mitigation of the risks to health and care capacities for maternal and child nutrition is also central. The management of acute malnutrition is important but not enough.

The priorities should be supporting women in effective breastfeeding; protecting maternal nutrition and health; social protection measures for improving household food security and livelihoods, as well as dietary diversity; early detection and management of acute malnutrition; protecting the micronutrient status while food insecurity is severe; and strengthening access to safe water.

In order to address these priorities, humanitarian teams should overcome obstacles such as the usual reliance on short-term funding, funding biased toward food aid, stunting being seen as anything but a development issue tackled by livelihood interventions, extremely challenging operating contexts, and the lack of an evidence base for stunting prevention in these contexts.

It is not only the severity of the crisis, but also the velocity of Venezuela's nutritional deterioration which is a true catastrophe. This is an indication that the situation in Venezuela should be rigorously monitored and broadcasted. Venezuela's deterioration is not isolated. If this rapid trend of decline continues without a strong national and regional response, the regressive impact will be on the food security and nutrition goals of the entire Latin-American region.

The opportunity is for the academies, the scientific community, international cooperation, donors, UN agencies, and for the state to support, compel, and guarantee the protection of the ultimate right to food and nutrition of Venezuela's children.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: Dataset property of Caritas Venezuela. Requests to access these datasets should be directed to janethmar0107@gmail.com.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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frontiers in Sustainable Food Systems

REVIEW
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Ethics and Democracy in Access to Food. The Venezuelan Case

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The humanitarian emergency that Venezuela is experiencing, one of whose edges is the food insecurity of more than 80% of the population, coincides with the serious institutional deterioration of the country and with the rupture of the constitutional order under the so-called "socialism of the 21st century" (2005 to the present), as reflected in various reports, including that of the United Nations High Commissioner for Human Rights. Access to food as a fundamental human right is better valued and guaranteed in democracies, where free media and independent public powers function as counterweights to the central executive power and act as effective instruments for correcting the wrong policies in food and nutritional matters, and officials responsible for direct and indirect damages to the general population or to vulnerable groups, are sanctioned. This topic has been studied by Nobel laureate Amartya Sen. In functional democracies, the ethical dimension of the right to food is also better guaranteed, since this right is realized not only by ensuring sufficient, balanced and healthy food, to meet the nutritional needs of the population, but that food is supplied in a culturally acceptable manner and seeking ways, mechanisms and procedures that are not contrary to the dignity of human beings. As a human right, the State has the greatest responsibility in guaranteeing the right to food, but not to fulfill a mere welfare duty or as a benefactor, but to guarantee that no one suffers from hunger or severe malnutrition, providing safe, nutritious and sufficient food, to those who cannot do it themselves, prevent all forms of discrimination in access to food or resources that are used to produce them, such as land, and take measures to ensure that families and their members can feed themselves in a dignified manner. As the Venezuelan regime closed the door to freedoms, malnutrition, hunger and non-fulfillment of the right to food also grew, according to FAO reports and Sen's assumptions under these scenarios seem to hold in the country.

Keywords: right to food, ethics, democracy, Venezuela, food security

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INTRODUCTION

Amartya Sen, Nobel Peace Prize winner (1998) established a thesis in which he affirms that, in functional democracies, with free and uncensored information, there are no famines or food crises. As will be seen in this work, democracy in Venezuela is under severe scrutiny, looking far from functional, and information does not circulate freely. While democracy in Venezuela is challenged, the population suffers from an unprecedented food insecurity crisis among other hardships derived from the lack of freedoms.

The Bolivarian Republic of Venezuela, re-founded in 1999 from the promulgation of the first constitution voted in a popular referendum since independence in 1811, became a State governed by a regime that has become every time more authoritarian, which violates human rights, without full guarantee of civil liberties, including freedom of expression and information, as has been denounced by several agencies and organizations. Various United Nations reports, which have been published consecutively in recent years, especially from the [Office of the United Nations High Commissioner for Human Rights (OHCHR), 2017, 2019], have recorded these multiple violations and have made severe warnings and recommendations to the government to stop the transgressions. The regime, self-proclaimed as "21st century socialism" by president Hugo Chávez in 2005 at the V World Social Forum of Porto Alegre or Forum of São Paulo in Brazil, promoted a constitutional amendment to remove presidential term limits that even if not approved in a national referendum in 2007, was circumvented, presented again and in 2009, the indefinite presidential reelection was approved. As stated by Grijalva Jiménez and Castro-Montero (2020), the indefinite presidential reelection is an institutional scheme that can distort and even eliminate the alternation of a presidential and democratic government. Factors as hyper-presidentialism, lack of judicial independence and flexible rules for amending constitutions are instrumental for allowing the president to avoid constitutional limitations and remain in office. The evasion of constitutional term limits can thus be seen as a way of collapsing democratic regimes as stated by the cited authors.

This affected the holding of elections, with the balance and autonomy of powers that characterizes a democracy, with the persecution and imprisonment of the main leaders of the opposition, in addition to the judicialization of political parties opposed to the regime who are disqualified or conditioned on their participation in electoral events. It also affected the opinion of Venezuelans as shown in a study by Latinobarómetro (2018) that indicates that the perception of "a government for the well-being of the entire people" reached a peak of 55 percent precisely in 2005, to drop to 39% at the end of the Chávez government period and dropped even further to 17 percent in 2018 with Nicolás Maduro in office since 2013 (to the present). The "21st century socialism" was proposed as an alternative model to capitalism and market economy (Guerra, 2006; Biardeau, 2007; Contreras, 2007).

In this context, we believe that Sen's thesis is verified. In closing this investigation, Venezuela was considered among the 5 countries in the world that could suffer a famine in 2020, aggravated by the Covid-19 pandemic according to the United Nations World Food Program (WFP) from the ONU. The other countries that accompany Venezuela in this unfortunate situation projected by the WFP are: Afghanistan, Democratic Republic of the Congo, South Sudan, and Yemen [BBC News Mundo, 2020; WFP (Programa Mundial de Alimentos), 2020a]. This registry is the corollary of a series of reports by the Food and Agriculture Organization of the United Nations (FAO) on the food and nutritional situation of Latin American and Caribbean countries, which have been warning of the deterioration of food insecurity in Venezuela, reaching 80% of the population, and therefore violating the right to food.

The situation has triggered a true regional crisis due to the magnitude of migrations to neighboring countries and beyond, which has been classified as a humanitarian emergency. Free, transparent, competitive, internationally supervised elections, conditions requested by the representative and legitimate opposition, and supported by the vast majority of the population, which allows the transition to a reinstitutionalization of democracy in the country, would change peacefully this state of affairs, significantly improving food security and moving the country away from the risk of famine, if Sen's thesis is correct. Behind the WFP figures there are persons suffering severely from hunger and children who eat well below their caloric requirements, aspects that collide with the ethical foundation of a political regime of full freedom. Only the return to functional democracy in the country, which fully guarantees, among other rights, freedom of expression and information could significantly improve food security in the country and, consequently, the right to food. The lack of official information, its deliberate outdating or manipulation to the convenience of the government, as the reports and studies also point out, although it makes analytical work very difficult, has not impeded, however, rigorous scrutiny, not only by specialized agencies of the United Nations or by non-governmental organizations, but by researchers and academies, all of whom coincide in registering the institutional collapse of Venezuela and its adverse effects on the economy and society, but especially on the availability of food for the population that has reached extreme levels of need and emergency (Tapia et al., 2017). As stated and demonstrated by Tapia et al. (2017), for many years, Venezuela was recognized as a country with solid infrastructure, not only in nutrition and food safety policies but also in terms of education, health services, roads, electricity, and potable water. Unfortunately, during the last 20 years under the "21st century socialism," Venezuelans have witnessed the progressive destruction of a wide range of institutions: public organizations, public and private industries, cattle and crop farms, universities and research facilities, and the national electric, domestic gas, and tap water networks. Also, in the 1999 Venezuelan Constitution, "Food Security" was explicitly included for the first time (Article 305). Subsequently, the government approved various laws and guidelines to regulate the right to food of the population. However, decreeing many laws related to food and nutrition is not enough and does not guarantee the Food and Nutrition Security of the Venezuela, with a declared a Complex Humanitarian Emergency and the installation in 2019 of the international humanitarian coordination architecture of the UN, composed by OCHA (United Nations Coordination Office for the Coordination of Humanitarian Affairs) and a humanitarian country team with eight clusters activated, food security and livelihoods; health; nutrition; water, sanitation, and hygiene among them (OCHA, 2019).

VENEZUELA'S INSTITUTIONAL COLLAPSE: FROM AUTOCRATIC DRIFT TO FOOD INSECURITY AND THE RISK OF FAMINE

Venezuela reached its democracy in 1958 with the overthrow of the last military dictatorship. Between 1958 and 1998, Venezuela experienced the longest period of political stability, human and institutional, and economic development that the country has known after its independence achieved in 1811. In 1999, the Republic was re-founded with the promulgation of the current Constitution, the product of a constituent process and approved by way of a referendum, the first in national history for a constitution. What should have been the transition from a system based on principles that guaranteed all the freedoms proper to a democracy, such as that founded on the Constitution promulgated in 1961, to an even better one, more elaborate from the point of view of constitutional theory and which constituted the country in a democratic and social state of law and justice, when the current political charter came into force in 1999, has resulted in an unfortunate process of deinstitutionalization of Venezuelan democracy that today is reaching signs of institutional collapse (Rachadell, 2015).

Venezuela is a cause for concern because of the authoritarian deviation that the leadership of the state has taken, and it has been the subject of questioning in the United Nations system. Recent reports from the specialized body for human rights question the flagrant violation of fundamental rights in the country, the lack of civil, political and economic liberties, the arrests for political reasons and a serious deterioration of the social conditions of the population. The UN commissioners have made recommendations to the Venezuelan State so that the situation changes without the suggested reforms taking place. At the same time this is happening, the food insecurity crisis in Venezuela is recognized by specialized agencies of the United Nations such as the FAO, which have warned of the consequences on the population, especially vulnerable groups. The magnitude of the crisis, the reports indicate, is reflected in the region and causes destabilization of health and food systems in neighboring countries, due to the large number of displaced people that the crisis has generated. There has been the destructuring of all public powers and this has led to an authoritarian, interventionist, autocratic military-style political regime, which cornered the public with arbitrary arrests of citizens for expressing their political opinions, imprisonment of opposition political leaders and journalists, who has suspended broadcast licenses to radio and television stations, torture detainees, carry out murders by security officials in the framework of citizen protests, which constitutes a constant violation of human rights by the Venezuelan State [Office of the United Nations High Commissioner for Human Rights (OHCHR), 2017, 2019]. Some studies report the use of hunger as a mechanism of political control and discrimination under an apparatus of domination that corresponds to the totalitarian logic, in societies where power has no counterweights or these are systematically annulled, as is the case in Venezuela today (Cartay and Dávila, 2020). The vicious practice of criminalizing citizens claims using the courts has become general, through sentences accommodated to the exercise of autocratic power, especially from the constitutional chamber of the Supreme Court of Justice, the highest court, and formally the guarantor and ultimate interpreter of the constitution [Brewer-Carías, 2012, 2017; ICJ (International Commission of Jurists), 2017, 2019]. A report by [IDEA (International Institute for Democracy and Electoral Assistance), 2017] on the state of democracies in the world, corroborates with respect to Venezuela a declining process of its democratic institutions, to the point of being one of the few cases in the world of a democracy of more than 40 years that as of 1999, it entered a reversion process with clear autocratic tendencies due to the extremist and populist leadership of the so-called 21st century socialism that has eroded the system of freedoms. Despite the votes, there are serious questions about the integrity and impartiality of the body that serves as electoral referee. The gradual concentration of power that began under the Chávez administration (1999–2013) and continued under the presidency of Nicolás Maduro, who has governed since 2013, seeks the displacement of parliament and its replacement by bodies made up of unelected allied members or designated through the manipulation of electoral laws that are interpreted in an interested way and manipulated by the courts of justice, among which, in 2016, the Supreme Court of Justice, usurped the functions of the National Assembly. Venezuela has significantly regressed in its democracy, both from the qualitative point of view and in the measurement indexes, the report states.

The institutional deterioration of the country has coincided with a series of erroneous macroeconomic and agri-food policies that, seeking to improve the food production, distribution, supply and consumption system, have caused, on the contrary, a progressive but accelerated worsening of the availability of food, generating as a result, a severe crisis of food insecurity suffered by large sectors of the population, which is only comparable to what happened in other regions of the world as a consequence of natural disasters or war conflicts (Morales, 2019). To the extent that the government has reinforced repression and intervention in the economy, the well-being of the people has also declined, especially, access to food. The decline of the economy has become clear, especially since 2012, with a fall in the Gross Domestic Product (GDP) that exceeds two digits, estimated in 2018 at a value of a third of the year 2013 and a remarkably high rate of inflation. An [IMF (International Monetary Fund), 2019] report indicated that deep humanitarian crisis and economic implosion in Venezuela had a devastating impact, and the economy was expected to shrink about 35 percent in 2019.

Possibly the most obvious reflection of this situation, which is configured as an indicator, is the exodus of almost 4 million Venezuelans in the last 5 years. It is the largest migration in the recent history of Latin America according to the Office of the United Nations High Commissioner for Refugees and mainly linked to the food insecurity crisis according to the FAO. Half of the citizens, 53 percent according to the Latinobarómetro report (2018), express that they would migrate to another country with their family. The situation in Venezuela reaches levels of complex humanitarian emergency, as recognized by the United

Nations Human Rights Council in 2018, when the Venezuelan State was asked to grant access to international humanitarian assistance to face the shortage of food and medicines due to increased malnutrition and the resurgence of infectious diseases that had been eradicated or under control (FAO and OPS, 2017; FAO et al., 2018; Fundación Bengoa, 2018; ACNUR. Agencia ONU para Refugiados, 2019; IFPRI (International Food Policy Research Institute), 2019; Raffalli and Castro, 2019). According to FAO et al. (2019) Venezuela shows a significant increase in the prevalence of malnutrition in recent years, going from 6.4 percent in the 2012–2014 period to 21.2 percent in 2016–2018, being one of the Latin American countries whose economic decline and increase in malnutrition has negatively affected regional figures (**Table 1**). This report also refers that during the same recessive period (2016–2018) Venezuela reached hyperinflation levels of 10 million percentage points and the GDP went from −3.9 percent in 2014, to an estimated −25 percent in 2018. Eighty six percent of people state that the salary and the total family income does not allow them to satisfactorily cover their needs, in comparison with 50 percent of those surveyed for Latin America, according to a report by Latinobarómetro (2018). For the third consecutive year, eight out of 10 people do not have subjective income, in such a way that the economic and food crisis encompasses almost the entire population, says the report. According to the Living Conditions Survey (ENCOVI, 2020), 93.4 percent of households are food insecure, reaching moderate to severe levels in 62.1 percent of cases.

The main findings of a field study, evaluating food security in Venezuela, carried out between July and September 2019 by the United Nations World Food Program [WFP (World Food Programme), 2020b], recorded the following: 32.3% of the population, the equivalent of 9.3 million people are food insecure. Of this number, 7 million people (24.4%) are moderately food insecure and 2.3 million (7.9%) are severely food insecure. It should be noted that the report defines moderate food insecurity as a state in which there are significant gaps in food consumption or is marginally able to meet minimum food needs only with irreversible coping strategies. Whereas, severe food insecurity means that you have extreme gaps in food consumption, or you have extreme loss of livelihood assets that will lead to gaps in food consumption, or worse (**Table 2**). Another significant result of the study shows that Venezuelan families consume cereals, roots, or tubers daily and supplement the daily intake of cereals with legumes (beans, lentils) 3 days a week and dairy products 4 days a week. The total consumption of meat, fish, eggs, vegetables, and fruits is <3 days a week for each of these food groups. The lack of dietary diversity and the consumption of protein of animal origin below the requirements, is an alarm signal because it indicates an inadequate nutritional intake. The report also records that hyperinflation is affecting the capacity of families and other basic needs to the point that 59% of households do not have enough income to buy food and 65% do not have the possibility of acquiring other essential goods such as hygiene products, clothes, and shoes. Although seven out of 10 Venezuelans according to the study perceive that food is available, however, access is difficult because prices are too high when compared to the income of families. The situation in Venezuela according to the respondents has impacted the sources of household income. Fifty one percent declare a partial loss of their income due to a reduction in salary or the loss of one or two jobs and 37% of those who responded have experienced a total loss of their income such as losing their only job or losing their business. The results also show that 18 percent of households depend on government assistance and social protection systems. Permanent emigration allows families to depend on remittances, but it translates into a worrying loss of human capital and social capacity, which includes teachers, doctors, scientists and other skilled workers among the migrants, the report says.

TABLE 1 | Undernourishment (%) and population in millions.

	2000–2002	2010–2012	2013–2015	2016–2018
Undernourishment (%)	16.3	3.7	9.5	21.2
Population (MM)	4.1	1.1	2.9	6.8

Venezuela 2000–2018. Source: FAO et al. (2019); p. 8.

THE ROLE OF DEMOCRACY IN PREVENTING EXTREME FOOD CRISES

When a famine or an acute food crisis occurs, it is wrong to think, as Sen (1981) has pointed out, that the phenomenon is simply due to a mechanical imbalance between the amount of food and the volume of the population. Famines and the consequent suffering from hunger and malnutrition, can even occur with an abundance of food if the economic power of individuals and

TABLE 2 | Food insecurity.

	Definition	(%)	Population (MM)
Food secure	Able to meet essential food and non-food needs without engaging in atypical coping strategies	8	—
Marginally food secure	Has minimally adequate food consumption without engaging in irreversible coping strategies; unable to afford some essential non-food expenditures	59.7	—
Moderately food insecure	Has significant food consumption gaps, or marginally able to meet minimum food needs only with irreversible coping strategies	24.4	7
Severely food insecure	Has extreme food consumption gaps, or has extreme loss of livelihood assets that will lead to food consumption gaps, or worse	7.9	2.3

Venezuela July–September 2019. Source: WFP (World Food Programme) (2020b); p. 2.

families to buy food is lost, or in other words, as the author proposes, the fundamental freedom that it allows the right to own a sufficient quantity of food, either because it is obtained by growing it or because it is acquired in the market, it has been lost or disappears. Losing the purchasing power is losing the economic right to buy food and in such a situation, even with food stocks, one can die of hunger. Hunger is a chain of deprivation of qualifications to which one is entitled, since to reach a situation of famine, rights have been lost, especially the rights to property between the subject and the goods that serve as food. In the referred work, Sen questions that hunger, starvation and malnutrition, have to do mainly with the expansion of agriculture and total food stocks. Rather, it is the functioning of the entire economy and political institutions that have a decisive influence on people's abilities to acquire food; and ends by stating that individuals suffer from hunger when they cannot demonstrate their economic right to a sufficient amount of food. FAO (1996) agrees by emphasizing that, despite the existence of sufficient food supply, many people may be food insecure because they do not have the income or lack the resources to produce or buy the food they need to lead an active and healthy life. In urban areas, the accessibility of the population will depend on having enough jobs and real income to obtain food. In rural areas, especially in the poorest communities or those groups whose economic base is family farming, self-consumption, eating food that these same groups produce, is an important part of food intake and therefore of their food security.

Hence, the corollary of the reasoning behind this approach is that the prevention of famines largely depends on the political mechanisms that exist to protect the rights of individuals and their families. Any measure that contributes to economic expansion through increased production, diversification and growth reduces the need to protect economic rights, but increases the resources to protect them, especially when necessary. Among the successful measures that Sen (1981) refers to avoid or prevent famines, are incentives to increase production and incomes, such as the creation of jobs to increase employment, whether the production of food increases. This is the point where the role of democracy as a political system and, of course, the design of successful policies to combat poverty, begins to be perceived and understood, as the author claims. Democracy acts as a protective shield against inequalities, and Sen's approach to capabilities works best under a regime of freedoms, not only political but also economical, since his approach to ownership focuses on people's capabilities to have access to food through the legal means available in society, either through their own means to produce food, the purchase in the market, through trade in exchange for other products, by means of their own work or by rights granted by the State such as pensions or subsidies. The link with human rights and well-being becomes clear, when we observe the need for citizens to effectively exercise their rights, preventing deprivations that lead to hunger and malnutrition, when you cannot have access to food for precisely the reason of denials in access to rights and therefore ownership of food (Pérez, 1996; Vizard, 2006).

The central idea of Sen (2006) around the issue that links a government regime with the nutritional status of the population, is that the system of political, economic, and social freedoms that better adjusts to the form of government that we know as democracy, is of cardinal importance in the prevention of extreme food crises and particularly famines and in any case in correcting these when they occur. For the author, the value of democracy resides in that it functions as an early warning system for famines and other food security crises, as long as it is in the presence of a democracy with a balance of powers, respect for individual rights and guarantees, particularly in this case, those of freedom of expression and information. Following the line of his thinking, a government responds to the demands of its people largely by the pressure employed on the exercise of political rights through voting, criticism and protest, in such a way that the opposition can make a real difference and profoundly influence government performance. There is no evidence that refers to the existence of famines in those countries of the world where there is a functional democracy. There are no known famines that have occurred in an independent and democratic country enjoying relative freedom of the press. On the contrary, the evidence of famines all points to dictatorial, autocratic countries, where freedoms, in particular that of opinion and information in the media, are seriously limited or non-existent, as the historical cases of freedom have been in the 20th century. Soviet Union in the 1930s, in China of the "Great Leap Forward" (1958–1961) under Mao Tse Tung or India under imperial rule. More recently, in the 21st century, the evidence of the famines in Ethiopia, Somalia, and North Korea all point to a common thread: regimes without freedoms of any kind, especially of the press.

However, not only the lack of freedom of the press is responsible for the limitations in access to food. From a broader point of view, integral development is not possible without freedoms and even less with repression. Sen (2000) himself had already pointed this out when he refers that development requires eliminating the main sources of deprivation of freedom, which are poverty and tyranny, the scarcity of economic and social opportunities, intolerance or the intervention of the repressive states. The lack of fundamental freedoms, the author points out, is causally related to economic poverty that deprives individuals of the freedom necessary to satisfy hunger. He adds that is misleading to assert that to eradicate poverty and hunger, economic rights and material needs must first to be met before political freedoms and human rights. The links between political freedoms and the satisfaction of economic needs must be understood, which for the author are, on the one hand, instrumental, because they contribute to improving the capacities of individuals to express and defend their political demands for the satisfaction of their economic needs, and on the other, constructive, because they allow the conceptualization of those economic needs in the social context. Not to mention the role that democracy itself has in human life and that is related to basic capacities, such as political and social participation. The practice of democracy, the researcher points out, must be conceived as the creation of opportunities for individuals, which in turn are related to the practice of political rights, the success of which will depend on how these freedoms are used and exercised. The political freedoms and the guarantees of human rights that are achieved in a functional democracy have proven effectiveness

against economic disasters and these are avoided with the right measures, even if they are problems as serious as hunger.

The relationship between democracy and the role it plays in development is even consolidated as a general principle of the United Nations since it is recognized that democratic institutions create the possible environment for citizen control, demanding that the government and its entities surrender their accounts and the correction of their actions, establishing the necessary link for those responsible for policies to act in accordance with the general interest (Tommasoli, 2013). There seems to be no doubt about the positive links between democracy and development, and in a certain way Sen has contributed to making this issue part of the global agenda of the commitments under debate. Democracy and development are complementary and mutually reinforcing. The link between the two is all the stronger because it stems from people's aspirations and their rights. Historical evidence shows that when democracy and development have fallen apart, the result is mostly failure. The legitimacy of democracy as a political system and its consolidation go through the design of economic and social measures that favor development and any development strategy must be ratified and reinforced by democratic participation in order to be implemented (Boutros-Ghali, 2002).

Democracy seems, then, to be the best political system to provide a solution to the problem of food insecurity and hunger, also clearing the path to human development. Even so, democracy should not be confused only with an electoral act. Universal suffrage, certainly, is a necessary condition, but it is not enough for the existence of a democratic regime. Elections are not a sufficient condition as they can be a fallacy if they take place in a framework where the different parties do not have an adequate opportunity to present their views and programs, or if the electorate does not have the freedom to inform themselves and consider the approaches of the contestants in the election. Democracy is a demanding system and not just a mechanical condition such as that referred to a majority rule taken in isolation (Sen, 2006). The contribution of political pluralism that is characteristic of democracies and that manifests itself as contradictory or adversarial politics and social criticism, is related to the possibility of influencing state decisions to correct wrong policies and achieve greater sensitivity to the welfare of the population, as has been pointed out by Drèze and Sen (1989). These authors have also pointed out that the scope for an effective and decisive influence on the actions of the State occurs in systems where there is greater space for opposition and criticism, and when this is considered. To which they also add a leadership committed to change and to effective social transformations.

Hence when referring to democracy, the outline is that of a system that functions as expected of it, that is one where at least, as indispensable preconditions are met, that the entire society can participate, in each decision-making level and can maintain control, where there is full observance of human rights, freedom of expression and thought, in addition to the promotion of those rights and respect for differences. Without independent public powers and especially without an autonomous judicial system, there can be no democracy, nor can there be without institutions that guarantee freedom of expression and the existence of free media. Likewise, the power to legislate must be exercised by legitimately elected representatives of the people and the laws emanating from parliament must be implemented by legally responsible persons and the entire administrative apparatus must be accountable to the elected representatives (Boutros-Ghali, 2002).

ETHICS IN ACCESS TO FOOD AND THE RIGHT TO FOOD

Food was enshrined as a fundamental right in the Universal Declaration of Human Rights (United Nations, 1948). In the chart food is especially recognized as a means to achieve an adequate standard of living, which in itself already forms part of the rights of the human being. This declaration has an ethical value and of binding content for the signatory states, which would later sign the International Covenant for Social, Economic and Cultural Rights (United Nations, 1966) as a way to bind compliance agreed in 1948. In addition to food, this agreement recognizes the fundamental right of every person to be protected against hunger. Unfortunately, the 142 signatory states of the Pact established progressivity for the fulfillment of the rights preserved there, including that of food, so such fulfillment is conditioned on the economic resources that each country has (Prosalus, 2009). Venezuela has validly signed and ratified both international conventions, that is, both the Universal Declaration and the Pact, for which the Venezuelan State is committed to guaranteeing their compliance in the territory of the Republic, in particular, evidently, the right to food.

The right to food is closely linked to what is possibly the most important of all human rights, which is the right to life, for the simple reason that without food there is no possibility of guaranteeing it. It can be stated that since life depends on food, it is not only linked to, but also conditional on, the overriding fulfillment of the right to food, so the violation of this right is not only a formal transgression of international law to any signed covenant. In this regard, it is also an axiomatic contravention of ethical principles. The ethical element linked to food, therefore, becomes visible and understandable if we see it from the perspective of human rights and in this sense Borghi et al. (2004) categorically points out that the right to food is the most sensitive and ethically significant of human rights. Vizard (2006) recognizes Sen's contribution to both ethics and economics and particularly the enormous influence that he has had on current international debates, in which, based on his research, the themes of poverty and hunger have been introduced from the ethical perspective of human rights. In particular, Sen has put at the center of the debate for several decades the fact of whether adequate food and a standard of living can be substantially and consistently analyzed as basic human rights, a matter that he has considered not only as possible but necessary as part of a global human development agenda, concentrating its vision around the capabilities approach that links quality of life and well-being with freedom (Pressman and Summerfield, 2000). Some attribute to Sen's ideas even having inspired the Human Development Report published annually by the United Nations Development

Program (UNDP) since 1990 (Fukuda-Parr, 2003), something that the economist himself has humbly denied claiming that he has just been one of many who have contributed to giving relevance to the idea of human development with a focus on the richness of the entire human life with predominance over the economy in which human beings live, which is just a part of that (Shaikh, 2006).

At present, it is common to see more frequently in the global development schedule the ethical considerations in relation to the food issue, especially the aspects that arise regarding production and consumption, within the framework of sustainable practices and management, that guarantee environmental biodiversity and respect for the customs and culture of each society, to guarantee food security. The international debate and integration programs currently discuss reflections on ethical issues raised by food production and consumption. This should be done in the context of food security, sustainable use of agricultural resources, safeguarding biodiversity, and a balanced mix of traditional and modern technologies to increase food security and promote sustainable agriculture (FAO, 2001a,b,c, 2006). Food security, however, is not a guarantee of nutritional security by itself, since it depends on non-food factors such as water quality, infectious diseases, access to health services, among other factors (Pinstrup-Andersen, 2009). In this sense, food security, is the means to achieve nutritional security, when there is sufficient, permanent and stable availability and access to safe food and whose quantity and quality allow meeting the requirements of food and nutrients to lead a healthy life. Other elements to consider and assess the state of family food security or insecurity are the conditions in which these foods are consumed, including the health status of each individual (FAO, 2011).

Now, as Savater (1999) points out, ethics is an attitude, an individual reflection on one's own freedom, individual, in relation to the freedom of others and with respect to the social freedom in which we move. Hence, as this author points out, the ethics that underpin democracy is a reflection on freedom, which implies a deep knowledge of what it means to be human, which goes through recognizing the other, the humanity of others, privileging our relationship with the subjects above the goods or objects. What would be the contribution of ethics within democracy, it is worth asking. For the author, it would be none other than what a person within the system can ask for, that he is not denied and that he can continue to be a person. Those would be ethical claims that any country can afford regardless of its degree of development, no matter how poor it may be, because these demands do not depend on resources but on the way of organizing social life and the will to be based on principles. Democracy is the guarantee that human rights will not be subjected, says the author. Many of the individual and social demands depend on the economy, hence the criticism of Sen (1987) that the distancing of the economy from ethics has impoverished the welfare economy and weakened a good part of its bases, especially descriptive and predictive economics. This distance can be shortened through mutual enrichment, which is useful and necessary for both disciplines. In this, Gabás (2016) agrees when he states that, indeed, ethics and economics need each other, since both focus on the good, since it is not possible to provide well-being to citizens, what this author calls as good life, as it corresponds to the ethical demands, without the help of the initiatives and human activities that are proper to a solid economy. For its part, ethics makes strong demands on the economy, since it acts as a brake on it insofar as it distinguishes between licit and illicit activities and censors certain forms of wealth distribution to that extent as it creates areas that this author calls of public shame, that economic activities must avoid such as air pollution or poverty. Therefore, ethics without the activities of the economy is incapable of carrying out what it demands, at was stated previously.

Food would fall within the framework of these possible, enforceable demands, to which the aforementioned authors refer, which, following the logical sequence of Sen's ideas, can only be met and satisfied within the framework of freedoms provided by a functional democracy. This is where another cardinal idea is articulated in Sen's thought, when he points out that, to guarantee social objectives, they must necessarily be integrated as rights within the legal system and in this way the normative order is filled with moral content, in such a way that the ethical principles underlying the system be vindicated through legal or political mechanisms that the system itself establishes to achieve the capabilities that allow access to rights that in turn allow access to food in an otherwise correct way (Sen, 2002). The right to adequate food is primarily the right to eat with dignity and this should not be confused with a welfare duty of the State, but rather it should be understood that the State is obliged to: (i) that no one suffer from hunger or serious malnutrition; (ii) provide sufficient, safe and nutritious food to those who cannot do it themselves; (iii) prevent all forms of discrimination in access to food or the resources used to produce it, such as land; (iv) adopt measures to guarantee that all individuals and their families can feed themselves in a dignified way (FAO, 2013). Eide (1987) agrees with Sen in pointing out that food is a human right and must be viewed from this perspective. He calls for conscience on the subject, using a dramatic image when he points out that we rarely realize that many of those who seek their daily food do so by searching through the garbage, standing in long queues or simply ignoring the origin of what they consume and this violates the moral requirement to obtain food in a way that is not contrary to human dignity.

If food is a human right, then the State has a fundamental role in ensuring that this right is effectively materialized and that citizens can make it justiciable, that is, that they can enforce that right before the administration or before the courts if necessary. The State must guarantee the justice of the right to food, which also requires expanding Sen's thesis, guaranteeing an efficient and fair rule of law, and this also goes through a functional democracy. The ideal state for this is one of the democratic types. A question for discussion arises: is it possible to enforce the right to food, reverse the malnutrition of vulnerable sectors, reassure the food security of the population under the current political regime in Venezuela, characterized by censorship and repression?

DISCUSSION

This research reviews the relationship between functional democracies and extreme food insecurity crisis in a population. The starting point was the analysis of the institutional decline of Venezuela under the so-called 21st century socialism that was progressively established from the promulgation of the current constitution, linking it with a cardinal contribution from Amartya Sen that relates the prevailing government regime with the nutritional status of the population. In his long career on the economics of development, Sen has established that the system of political, economic and social freedoms that best adjusts to the form of government that we know as democracy, is of capital importance in the prevention of extreme food crises and, in particular, of famines and in any case, it is the system that works best to correct them when they occur. Sen shows that it is not the decline in food availability that is the cause of famines or acute food insecurity crises, but that it is insufficient income or its total absence that compromises economic access to food and, consequently, its physical access. Sen, however, goes further in his analysis, pointing out that it is the lack of capabilities of some social sectors or families to produce food or acquire it in the market that causes inaccessibility to food, and this inability is due to the fact that they suffer or simply do not have what the author calls the entitlement to the food, which in short is nothing other than a right of access to the food or the inputs necessary to produce it. In turn, for Sen, the limitations to entitlement are a consequence of a severe democratic deficit, the product of a prevailing political system that does not allow the exercise of fundamental freedoms, especially those of expression and discussion, since they are not only decisive for inducing social responses to economic needs, but essential in the conceptualization of those needs. Hence the importance of democracy for the economist, as the most effective system to correct extreme food situations that occur as a consequence of both wrong policies and disrespect for political and economic rights, being the latter in the causal axis of the former.

Here appears another fundamental contribution of Sen by linking hunger and malnutrition as a serious violation of human rights, in particular the right to food. In this review, it was stated that since life depends on food, the right to food is intricately linked to the most important of all human rights, which is the right to life. Therefore, the violation of the right of access to food also violates the international law of any agreement signed in this regard and contravenes ethical principles. The concepts of capabilities, entitlement and human rights are at the center of Sen's research as a welfare and development economist, especially in dealing with poverty and hunger, having challenged the neoclassical approach to the utility of consumers in economics. In this sense, Desai (2001) recognizes his contributions to development economics, imposing a rigorous and intensive line of research that led to the concept of entitlement, addressing toward the study of the real causes of poverty and deprivation, with transdisciplinary foundations of economic science and philosophy, which place human concerns at the center of his studies. Amartya Sen's ideas constitute central principles of a paradigmatic approach to development that has influenced and evolved in the United Nations Human Development Reports, which are now based not so much on planning or the delivery of public services, but on political empowerment of people, as previously referred to in the review in the recognition made by Fukuda-Parr (2003).

On the other hand, Sen's defense of democracy has its roots in the role that the researcher assigns to freedom, because the democratic practice of participating in decision-making processes is not understood without such processes being based on the freedom. Only under a regime that recognizes and guarantees fundamental freedoms and human rights, citizen scrutiny is possible and effective. The investigation noted that Sen incorporates democracy as part of his system of analysis due to its instrumental role in advancing the cause of freedom, as expressed in his famous observation that hunger has never occurred in a well-functioning democratic society. Sen is not only a researcher of democracy, but a militant committed to its cause, who is recognized for his respect for the diversity of values and for people's preferences. It is only through a democratic process that the choice between policies and institution building can be made with respect for diversity. Diversity deference requires that the social choice between alternative policies, institutions, and rules, be determined through a democratic process, as Osmani (2009) points out, explaining Sen's ideas. In short, Sen assigns three essential virtues to democracy that for the author make it a political system of universal value. The first of these virtues refers to the value that participation and political freedom have in human existence. The second virtue is the importance of the political participation of citizens as an effective tool to guarantee the responsibility of governments and accountability. The third virtue is the constructive value of democracy in the formation of values and for the achievement of agreements for the understanding of needs, rights, and obligations.

The early warning system against famines and food crises, an instrumental role that Sen assigns to democracies, has not worked in Venezuela since freedom of the press is highly restricted, and the work of the media is conditioned on messages that only please to the regime. The exercise of freedom of expression has serious consequences for those who exercise it, be they journalists or media owners. The investigation cited various reports that point to the autocratic drift of the once stable and thriving Venezuelan democracy. All freedoms have been violated and among the most conspicuous assessments used in the review to support this assertion, the reports of the United Nations High Commissioner for Human Rights stand out, which, together with the revisions of different institutions and investigations also cited, coincide in pointing out the progressive decline of the country's democratic institutions to levels that are persistently violating human rights. Food insecurity, which affects almost 90% of the population and the drop in GDP is −35% at the end of 2019 [IMF (International Monetary Fund), 2020], have generated a forced migration for this cause of more than 4 million people, a little more than 10% of the population, according to references from specialized United Nations agencies such as FAO, UNHCR and various investigations, also cited in the review.

The figures that denote the patent degeneration of Venezuelan democracy toward an autocratic regime, are too manifest to allow it to pass unnoticed. To the extent that the regime has infringed the guarantees of freedoms on which the democratic governments born in 1958 were based, the evidence indicates that an acute crisis of food insecurity, hunger, and malnutrition, has occurred and it will surely continue if the regime does not open itself to respect for essential freedoms or continues to criminalize the demands of the population, many of them containing solutions to the causes of food insecurity.

In the world of economics and politics, a door was opened for several decades with Amartya Sen's research, which is not only useful to understand what is happening in Venezuela, but even more useful to provide a solution. The democratic deficit in Venezuela must be discovered and revealed to the international community, since the consequences come at an extremely high cost for the population. Ignoring it would be unethical.

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All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Association Between Socioeconomic Status, Food Security, and Dietary Diversity Among Sociology Students at the Central University of Venezuela

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Venezuela is currently in a difficult social, political, and economic situation that has exposed people to many factors, including socioeconomic disadvantages, food insecurity, and lack of access to healthy and nutritious foods. These factors are associated with low dietary diversity, especially for economically dependent university students. In this study, we aimed to identify the associations between socioeconomic status, food security, and dietary diversity among sociology students at the Central University of Venezuela (UCV). This cross-sectional study was conducted between June and November 2016 on a simple random sample of 270 students. Indicators were calculated using data collected by the Mendez-Castellano socioeconomic questionnaire, the Community Childhood Hunger Identification Projects Scale of Food Security adapted and validated for Venezuelans (Cronbach's alpha = 0.898), and the validated dietary diversity scale for individuals. The rate response was 100%. It was observed that most of the sample is located between the socioeconomic status of the rich and middle class (82.6%), presents some degree of food insecurity (85.9%), and maintains a diet with low dietary diversity (54.8%). Our main finding is that the socioeconomic status in the households of those students is not associated with either their food security level or their dietary diversity, but these constructs are related in a significant statistical way. In particular, the odds of a student household having a diverse diet instead of a monotonous diet are 3.92 (95% CI: 2.91; 4.93) times greater for those in food security instead of moderate/severe food insecurity. It is concluded that these students have a multifactorial critical food situation, in which the food right is violated, which could affect their permanence and academic performance.

Keywords: Venezuela, university students, socioeconomic status, dietary diversity, food security

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INTRODUCTION

Food security (FS) is a construct defined by the Food and Agriculture Organization of the United Nations as "the situation when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preference for an active and healthy life" (FAO, 2020). Therefore, food insecurity is the lack of food security, and it may occur when access to or availability of sufficient amounts of healthy, culturally appropriate, and

nutritious foods is compromised, when individuals cannot access these foods in socially acceptable ways or when nutrient utilization is compromised (Gallegos et al., 2014; Terragni et al., 2020). FS is commonly assessed using different measurement tools or applying different classification criteria (Shi et al., 2021). It could be classified at different severity levels: low insecurity when a household worries about not having enough food; moderate insecurity when a household sacrifices food quality more frequently; and severe insecurity when a household cuts back on the food quantity or experiences hunger (Lorenzana and Mercado, 2002).

In light of the last 8-year events in Venezuela such as massive protests, unemployment, poverty, low wages, hunger, and malnutrition (Doocy et al., 2019), it is not possible to ignore the existence of a difficult social, political, and economic situation that reduces many families' chances to meet their minimum caloric requirements. According to an international report on food (FAO, 2020), there were nearly 6.8 million people in hunger, and more than 70% of the population is food insecure in Venezuela. Most recently, an independent study (UCAB, 2020) states that this percentage is higher, especially due to the COVID pandemic, reporting 97% of food insecurity in the population.

In this food crisis, the need for food competes with other necessities such as health services, transportation, housing, etc. (Tapia et al., 2017). For this reason, socioeconomic status is also relevant for having good food (Gupta and Mishra, 2018). Some studies have found that wealthier households have the resources to purchase more and diverse food than poor households (Codjoe et al., 2016).

A food-insecure household often decreases the quality and quantity of food, which directly affects nutrient adequacy (Lorenzana and Mercado, 2002). Dietary diversity (DD) is another construct defined as the number of different foods or food groups consumed by the household over a reference period, not regarding consumption frequency (FAO, 2011). As a result, DD can be used as a proxy measure of the diet's nutritional quality when it is used in children or adults, in an individual measuring, using a 24-h recall (Steyn et al., 2006).

DD has been identified as a key predictable element of high-quality diets in terms of nutrient adequacy globally, and it probably reflects the economic accessibility of different food items (Wanyama et al., 2019). Resource-poor communities usually experience difficulty achieving DD as they typically consume a monotonous diet (Ruel, 2003a). The National Survey on Living Conditions (ENCOVI, by its Spanish acronym) is a study conducted by three major Venezuelan universities, Universidad Central de Venezuela, Universidad Católica Andrés Bello, and Universidad Simón Bolívar, to provide an independent set of national social indicators; this study reports a monotonous diet, plenty of starches with little fish, meat, egg, vegetables, and fruits (Landaeta-Jiménez et al., 2018).

DD is positively linked with FS and socioeconomic status, and it is much easier and cheaper to use than traditional food security measures (FAO, 2011). Additionally, households with higher total monthly expenditure on food are expected to have higher DD and FS (Ruel, 2003a). However, there are different ways to define and measure DD that operate with different methods and background assumptions, and it is difficult to compare DD score methods between studies (Ruel, 2003b).

For university students, food choice and food consumption are determined by taste, health, and economic reasons (Ukegbu et al., 2019). This group of people could be vulnerable regarding food because they are vulnerable to poor socioeconomic status, poor eating patterns, and undernutrition (Gallegos et al., 2014). It is in individuals' and universities' interests to address this, given the possible impact of food insecurity on health and academic outcomes. Some students come from different Venezuelan regions and live in rental accommodation, have additional study-related expenses, and have lower-income due to less time to work and having lower-paid jobs due to lower skills. A cross-sectional study states that in comparison with students living in their parents' homes, students living in rental accommodation were 2.4 times more likely to be food insecure. Also, compared with postgraduate students, undergraduate students were 3.5 times more likely to be food insecure (Whatnall et al., 2019).

While the association between sociodemographic factors and dietary practices has been established in different settings (Hoddinott and Yohannes, 2002; Ali et al., 2019), several studies have suggested that the association of DD with structural factors like FS in the local context is needed (Ruel, 2003b; FAO, 2011). There is limited evidence about the relation between household food security, DD, and socioeconomic status among university students in Venezuela. Therefore, the present study was carried out to identify the possible association between those constructs among sociology students at the Central University of Venezuela (UCV).

MATERIALS AND METHODS

Sampling

This is a cross-sectional study among a representative sample of university students at the Sociology School of the Central University of Venezuela. It was decided to use only one school because of certain difficulties and logistics due to the students' protests around the country and limited financial resources for research at the university. The study took place in the first academic semester of the year 2016 when there was a total of 905 students registered from the first semester until the tenth semester of sociology. Because we have no information on the proportion of university students in food insecurity or low DD, we initially assumed that 50% of the households have these conditions to estimate the sample size. Considering this assumption, a 95% confidence level, and a 5% margin of error to estimate the proportion of students in food insecurity and/or low DD, the required minimum sample size was 270 students (with finite population correction). Students were randomly selected from a sample frame of student IDs. In total, 270 students answered the interview-based questionnaires, so the response rate was 100%. The data collection was performed from September 19, 2016 to November 25, 2016.

All students gave written consent to participate. The study was conducted according to the Declaration of Helsinki guidelines and ethical guidelines for research and approved by the Institutional Ethical Committed under the number 1204-16

protocol. Data were collected by trained enumerators in face-to-face interviews, using a pre-established questionnaire. The survey consisted of four modules: 1—items regarding students' identification, 2—a socioeconomic status section, 3—a food security module, and 4—a dietary diversity section. Each part is described below.

Socioeconomic Status

The construct socioeconomic status (SES) was measured by using the Mendez-Castellano and Mendez (1994) socioeconomic questionnaire, which includes items about the occupation of the head of the family, mother's educational level, income source, and accommodation conditions. Household SES is calculated by the summation of the score in each item. This method results in a categorical indicator that classifies households into five strata: I or richest (score 4–6), II or rich (score 7–9), III or middle (score 10–12), IV or poor (score 13–16), and V or poorest (score 17–20). The numerical indicator of SES is denoted by SES# and the categorical one by SES5.

Food Security

Household food security, in the last 6 months, was determined using the Community Childhood Hunger Identification Projects Scale of Food Security adapted and validated for Venezuelans by Lorenzana and Sanjur (2000).

The scale has 12 questions related to worry about lack of food, insufficient quality and quantity meals, and going to sleep hungry, both in adults and children of the household. For each item, the respondent may select a frequency of the experience (never, rarely, sometimes, or always). The maximum score possible is 36, which would represent the highest level of food insecurity. Therefore, if a household has zero points, it indicates food security; if it has between 1 and 12 points, there is low insecurity; from 13 to 24 points, it has moderate insecurity; and, based on this score, the home is considered severely insecure if it gets more than 24 points. We denote the numerical indicator of FS by FS# and the categorized version by FS4.

Dietary Diversity

DD was measured using a single 24-h recall of the student, using only unquantified data. A licensed nutritionist and dietitian administered the qualitative 24-h recall. All recalls reported 54 food types that were categorized into nine different standardized food groups: (1) cereal-based and tubers; (2) dark green leafy vegetables; (3) vitamin A-rich fruits and vegetables; (4) other fruits and vegetables; (5) organ meat; (6) fleshy meat and fish; (7); eggs; (8) legumes, nuts, and seeds; and (9) milk and dairy products, according to FAO's guidelines (FAO, 2011). With this measure, food items such as oil and fat are excluded, as their contribution to micronutrient density is limited (FAO, 2011).

The nine food groups were dichotomized. A score of one (1) was given to each food group consumed and zero (0) when certain that no foods in that group were eaten in a single day. Dietary diversity score was calculated, for each person, by the summation of the number of times different food items under each food group was eaten on a day. There are no established cutoff points in terms of the number of food groups to indicate adequate or inadequate dietary diversity. However, we establish three categories, considering that the maximum is a score of 9. The student had low DD if three or fewer groups were eaten on the addressed day, four and five food groups as medium DD, and six or more food groups indicated high DD. The numerical indicator of DD is denoted by DD# and the categorized version of the variable by DD3.

Data Analysis

The approach we used was descriptive and exploratory. Instead of assuming the existence of a possible causal relationship between the constructs considered (SES, FS, and DD), we aimed to find a possible multivariate interdependency among them in the particular context of a sample of Venezuelan university students.

Descriptive characteristics of the categorical versions of SES, FS, and DD were assessed by percentage distribution to highlight the important differences across all household characteristics. We also summarized the joint distribution of counts of the categorical versions in a three-way contingency table.

To establish how the categorized version of three variables SES#, FS#, and DD# are related, we performed an analysis using log-linear modeling to determine the significant associations between variables (Agresti, 2018). A log-linear model is a way to represent how each expected count of a contingency table depends on levels of the categorical variables included in the table and of the associations and interactions among these variables. For a three-dimensional table for variables X, Y, and Z, the saturated log-linear model, that is the model which perfectly fits the data, can be written as follows:

$$\log\left(\mu_{ijk}\right) = \lambda + \lambda^{X} + \lambda^{Y} + \lambda^{Z} + \lambda^{XY} + \lambda^{XZ} + \lambda^{YZ} + \lambda^{XYZ}$$

We can see that the natural log of the ijk cell count is explained by the main effects of variables X, Y, and Z ($\lambda^{X}, \lambda^{Y}, \lambda^{Z}$), two-way interaction effects ($\lambda^{XY}, \lambda^{XZ}, \lambda^{YZ}$), and a three-way interaction effect (λ^{XYZ}). This model is written in shorthand notation as $[XYZ]$. A smaller model in short notation, for example $[X][YZ]$, is a model in which

$$\log\left(\mu_{ijk}\right) = \lambda + \lambda^{X} + \lambda^{Y} + \lambda^{Z} + \lambda^{YZ}$$

which says that the ijk cell count is explained by the three main effects of variables X, Y, and Z ($\lambda^{X}, \lambda^{Y}, \lambda^{Z}$) and the two-way interaction effect λ^{YZ}. In other words, we are saying that variable X is independent of Y and Z, but that Y and Z are dependent variables. Log-linear models have been used in this particular way in other studies on nutritional status (Gupta and Borkotoky, 2016; Ngwira et al., 2017; Kassie and Workie, 2019) and consumer attitudes (Brosig and Bavorova, 2019). However, to our knowledge, this is the first study analyzing food security and dietary diversity associations with a log-linear model.

Since we did not assume any directional associations among the variables, we did not assign the role of explained or explicative variables to the categorized version of SES#, FS#, and DD#. We fitted the eight possible log-linear reduced versions of the model with all main effects and interaction terms necessary to produce a good fit for the three-way table of counts. To select

TABLE 1 | Socioeconomic characteristics of students' households in Caracas, 2016.

Variable	Categories	*n* = 270	Percentage (%)
Student characteristics			
Sex	Female	179	66.3
	Male	91	33.7
Household socioeconomic characteristics			
Occupation of the head of the family	University profession	109	40.4
	Higher technical profession	52	19.3
	Employees without profession	72	26.7
	Specialized workers	30	11.1
	Unskilled	7	2.6
Mother's educational level	University and workers above	129	47.8
	Complete secondary education	83	30.7
	Incomplete secondary education	47	17.4
	Complete primary education	11	4.1
Income source	Fortune	1	0.4
	Freelance fees	57	21.1
	Monthly salary	176	65.2
	Weekly salary	33	12.2
	Donations	3	1.1
Accommodation conditions	Luxury home	7	2.6
	Housing in optimal conditions	118	43.7
	Housing in good condition	133	49.3
	Housing with some deficiencies	12	4.4
Socioeconomic status (no students in stratum V)			
Strata	I	20	7.4
	II	122	45.2
	III	101	37.4
	IV	27	10
Food security			
Levels	Secure	38	14.1
	Low insecurity	200	74.1
	Moderate insecurity	29	10.7
	Severe insecurity	3	1.1
Dietary diversity			
Levels	High	4	1.5
	Middle	118	43.7
	Low	148	54.8

the model that best fits the data, we used three criteria: (1) acceptance of the null hypothesis that the model explains as well as the saturated model of the table's counts using a likelihood ratio goodness-of-fit chi-squares test, (2) parsimony, and (3) the smallest value of the Bayesian information criterion (BIC). The same model was obtained using conditional tests of log-linear models embedded in hierarchical chains. We did all statistical analyses using the SPSS® software (version 21.0). Results were considered significant at the 0.05 level.

RESULTS

The mean (±SD) age of the participants was 21.6 ± 3.2 years, and 66.3% were female. **Table 1** summarizes household socioeconomic characteristics and the relative frequencies of SES5, FS4, and DD3.

About 22.2% of students come from outside Caracas, 18.9% do not live with their family, and only 7% were heads of the family. Most households have three or four members (54.4%), followed by 32.3% with five or more members.

Of sociology students, 85.9% were categorized as food insecure. The mean (±SD) DD# score was 3.5 ± 0.9, and 54.8% of students had low DD (**Table 1**). The internal consistency of the FS scale was 0.898 using the Cronbach's alpha coefficient.

As shown in **Table 2**, most households experienced a lack of money to buy food (67.4%) or that some of their members eat less than they want due to the lack of money (65.9%). Those questions about the decrease in children's dietary quantity and quality were less frequent in the sample.

Figure 1 represents the patterns of consuming food from the nine groups evaluated in a single day. The graphic shows that food groups with the highest levels of consumption by students were starches from cereals and tubers, followed by fleshy meat/fish, and milk and milk products. Those with a high DD (those who consumed six to nine food groups in a day) represented only 1.5% of the sample. Most students ate three or fewer food groups on the evaluated day (**Figure 2**).

Table 3 shows the cross-classification of the categorized version of FS#, DD#, and SES#. Due to low numbers in the severely food insecure and the high food diversity categories, they were joined together into one with moderate food insecurity (FS3) and middle dietary diversity (DD2), respectively. There were no student household in stratum V, so we denote the categorical version of SES# used in the analysis as SES4. The raw data can be found in **Supplementary Data Sheet 1**.

The relationship between SES4, FS3, and DD2 was analyzed by obtaining the best log-linear model, which fits the three-way contingency table as shown in **Table 4**. We considered all the log-linear models that can be obtained with these three variables with the exception of the saturated model. We selected the log-linear model [SES4][FS3•DD2] as the model that best fits the three-way table in which socioeconomic status (SES4) is jointly independent of dietary diversity (DD2) and food security (FS3). Furthermore, the pair FS3 and DD2 is dependent. There are several good models (see **Table 4**). When testing the sequence of hierarchical models 1, 2, 6, and 8, we found that all of them fit better than complete independence. However, testing model 6 against model 8 shows no reason to select the larger model. The same can be said about [SES4] [FS3•DD2] against [SES4•FS3] [FS3•DD2].

Furthermore, the model selected has the smallest value of BIC (Bayesian information criterion). Also, it has fewer terms and can

TABLE 2 | Frequency of occurrence on indicators of the Venezuelan Food Security Scale of student's households in Caracas, 2016.

Variables	Frequency			
	Never *n* (%)	Rarely *n* (%)	Sometimes *n* (%)	Always *n* (%)
Lack of money at home to buy food	88 (32.6)	137 (50.7)	36 (13.3)	9 (3.3)
The number of meals for an adult decreases due to a lack of money to buy food	135 (50.0)	103 (38.1)	27 (10)	5 (1.9)
The number of usual meals at home decreases due to lack of money to buy food	112 (41.5)	123 (45.6)	25 (9.3)	10 (3.7)
Some adults eat less at the main meal because food is not enough for everyone	124 (45.9)	103 (38.1)	35 (13.0)	8 (3.0)
Some members of the household eat less than they want due to lack of money in the household	92 (34.1)	117 (43.3)	42 (15.6)	19 (7.0)
Less essential food for children is bought because the money is not enough	220 (81.5)	20 (7.4)	22 (8.1)	8 (3.0)
A child goes to bed hungry because they can't afford food	259 (95.9)	9 (3.3)	2 (0.7)	0 (0.0)
Decreases the number of meals per child due to lack of money to buy food	250 (92.6)	19 (7.0)	0 (0.0)	1 (0.4)
Some children eat less at the main meal because the foods are not enough for everyone	246 (91.1)	21 (7.8)	3 (1.1)	0 (0.0)
A child complains of hunger due to a lack of food at home	247 (91.5)	14 (5.2)	6 (2.2)	3 (1.1)
An adult goes to bed hungry because they can't afford food	167 (61.9)	75 (27.8)	21 (7.8)	7 (2.6)
An adult complains of hunger due to a lack of food at home	130 (48.1)	85 (31.5)	40 (14.8)	15 (5.6)

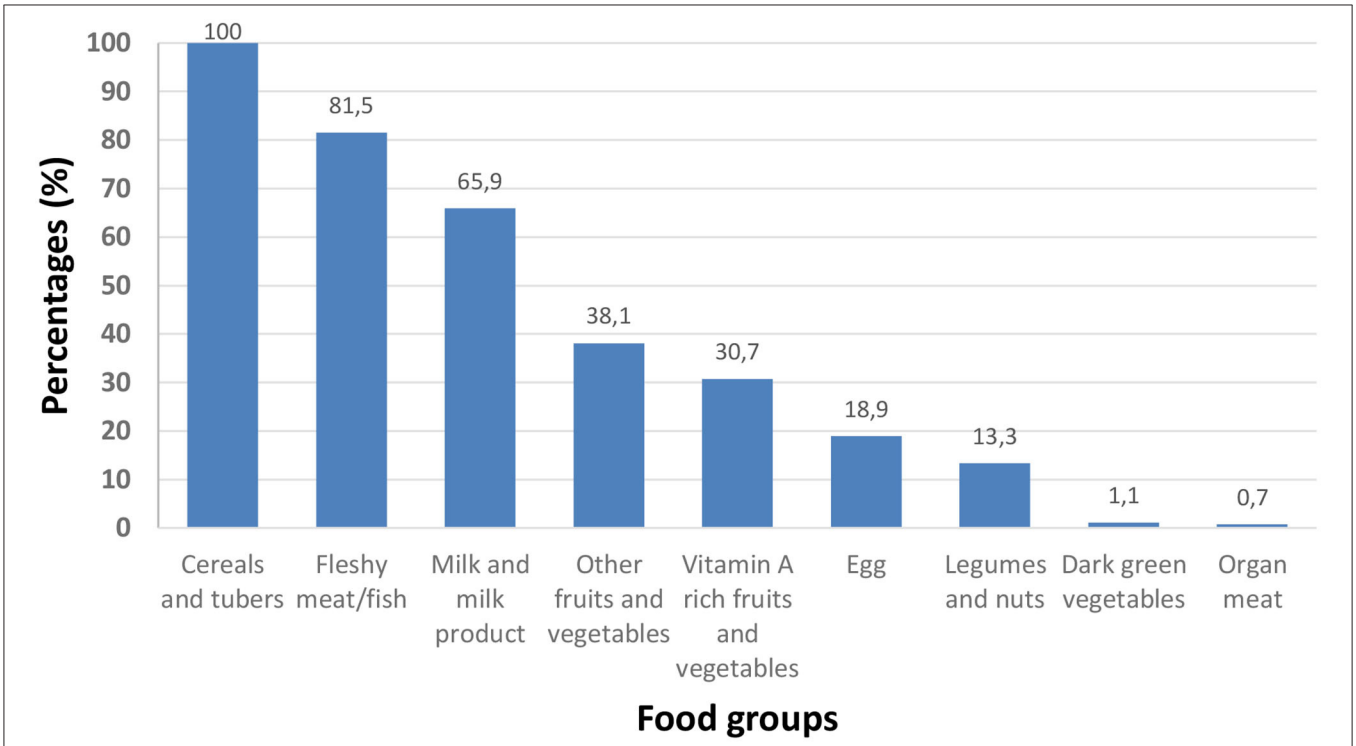

FIGURE 1 | The proportion of consumed foods groups in the past 24 h in sociology students of Caracas, 2016.

be easily interpretable. **Table 4** shows the results of comparing the different models fitted.

According to **Table 5**, which we generated by collapsing on SES4, the odds of a student household being in food security instead of low food security when the household has a diverse diet are 1.87 (95% CI: 1.17; 2.58), about twice as large as the odds of a household that has a food intake with a monotonous diet.

Similarly, the odds of a student having a diverse diet instead of a monotone diet is 3.92 (95% CI: 2.91; 4.93) times greater for those who are in food security instead of moderate/severe food

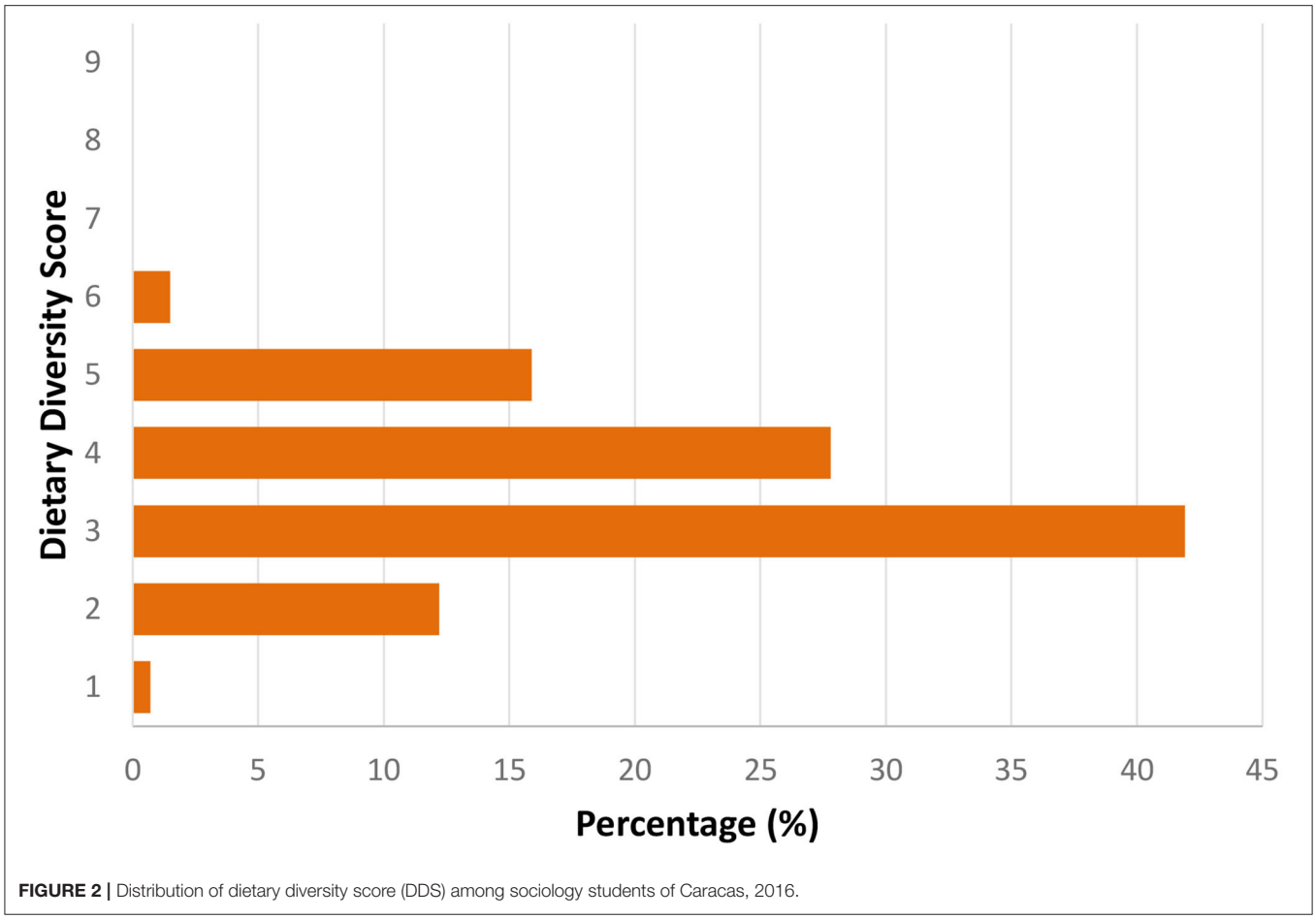

FIGURE 2 | Distribution of dietary diversity score (DDS) among sociology students of Caracas, 2016.

TABLE 3 | Cross classification of FS3, DD2, and SES4.

Socioeconomic status (SES4)	Dietary diversity (DD2)	Food security (FS3)			Total
		Secure	Low insecurity	Severe–moderate insecure	
Strata I	High–middle	4	3	1	8
	Low	4	8	0	12
Strata II	High–middle	12	41	5	58
	Low	5	49	10	64
Strata III	High–middle	5	36	3	44
	Low	4	44	9	57
Strata IV	High–middle	2	10	0	12
	Low	2	9	4	15
	Total	38	200	32	270

insecurity. Furthermore, the odds of a student household being in low security instead of moderate/severe insecurity when the household has a diverse diet are 2.09 (95% CI: 1.27; 2.91) times greater for those who have a diverse diet than for those who have a monotonous diet.

DISCUSSION

The present study was designed to examine associations among socioeconomic status, household food security, and dietary diversity among a sample of university students in Caracas, Venezuela. Most of the sociology students of the UCV were strata II and III in the categorized version of SES, in some categories of food insecurity and low DD. Notably, we found an association between FS3 and DD2. These findings may help us understand the complex interaction among these factors in university students. It represents a start for other important questions related to the consequences of these conditions over academic performance.

This study supports evidence from other observations about SES in Venezuelan university students. Ledezma et al. (2016), showed that most of the UCV student households evaluated were in strata II and III, both in the years 2013 and 2014, with 64.77 and 81.11%, respectively. Additionally, Arteaga and Bastidas (2017) found that in medical students of Carabobo, Venezuela, 77.4% were in strata II and III. We report an 82.6% of sociology students between strata II and III. None of these studies mentioned report university students in strata V or extreme poverty. This could be related to students' basic needs of food, economy, and housing. Those students in strata

TABLE 4 | Log-linear models adjusted to explain the relationship structure among SES4, FS3, and DD2.

Model	Log-linear model	Degrees of freedom	G^2	*p*-value	R^2 adjusted	BIC
1	[SES4] [FS3] [DD2]	17	27.53	0.051	0.00	−13.81
2	[SES4] [FS3•DD2]	15	19.99	0.172	0.27	−16.47
3	[FS3] [SES4•DD2]	14	26.92	0.020	0.02	−7.12
4	[DD2] [SES4•FS3]	11	16.27	0.131	0.41	−10.48
5	[SES4•DD2] [FS3•DD2]	12	19.39	0.079	0.30	−9.78
6	[SES4•FS3] [FS3•DD2]	9	8.74	0.462	0.68	−13.14
7	[SES4•FS3] [SES4•DD2]	8	15.66	0.047	0.43	−3.79
8	[SES4•FS3][SES4•DD2][FS3•DD2]	6	7.47	0.279	0.73	−7.12

Expression [SES4] [FS3•DD2] represents a model with main effects of SES4, FS3, and DD2 and one interaction term between FS3 and DD2. This model can be interpreted as saying that SES4 is independent of FS3 and DD2, but FS3 and DD2 are dependent.

TABLE 5 | Student's distribution between FS3 and DD2 categories.

			Dietary diversity (DD2)		Total
			High–middle	Low	
Food security (FS3)	Secure	*n*	23	15	38
		%	60.5	39.5	100
	Low insecurity	*n*	90	110	200
		%	45.0	55.0	100
	Moderate–severe insecurity	*n*	9	23	32
		%	28.1	71.9	100
	Total	*n*	122	148	270
		%	100	100	100

V cannot meet their needs, so they will be unable to engage in the higher-level learning required of them in university (Raskind et al., 2019).

Instability in acquiring food necessary for daily consumption is reflected in 85.9% of students' households with food insecurity. In Venezuela, there are very few studies that evaluated the food insecurity status among university students. Hernández et al. (2011) described that 70.5% of children and adolescents' households in Caracas' sub-urban areas were in some level of food insecurity. In contrast, Aliaga et al. (2015) found 57% of food insecurity in adolescents between 11 and 13 years old of a rural state in Venezuela. Additionally, the ENCOVI survey (Landaeta-Jiménez et al., 2017), the most important study in socioeconomic status among Venezuelans, with national representation, shows that 93.3% of Venezuelan households were in food insecurity for the year 2016. These results evidence the degree of inflation at the national level, the difficulties of access to food due to the shortage, and irregularities that occur in its distribution, such as the appearance of secondary, unofficial markets, which has produced negative scenarios involving inequitable access to food for all Venezuelans.

The DD construct is hardly evaluated in Venezuela. We did not find studies about DD in Venezuelan university students. In this study, the DD was low. The mean DD# for all households is 3.5 foods, which suggests that on average, every household consumed almost four different food groups (out of nine) the day before the survey. This confirms the theory of a monotonous diet in the country (Landaeta-Jiménez et al., 2018). According to this, the population consumes only a few foods with a high rate of satiety and calories as cereals and fats.

In this observational study, a log-linear modeling analysis was used. This technique has the advantage of assessing all high-order interactions and, in doing so, rule out a result known as Simpson's paradox by which, for example, conclusions from two-dimensional marginal tables can be contradicted by the three-dimensional information (Christensen, 1997).

The fitted model indicates that SES4 is independent of FS3 and DD2 in a statistically significant way. In contrast, a recent study conducted by Wanyama et al. (2019) established that households with higher socioeconomic status have better food security and that derives from a healthier diet with the inclusion of more kinds of foods.

Besides, we found that FS3 is related to DD2. A result which is in line with some studies that proposed that dietary diversity score is a proxy measure of food security and *vice versa* (Ruel, 2003b; Hasan-Ghomi et al., 2015; Schwei et al., 2017), so a low dietary diversity could indicate a potential risk for food insecurity.

A possible explanation for the joint independence of SES4 with FS3 and DD2 might be the harmonization of the diet due to the low income and food scarcity that affects Venezuela (Landaeta-Jiménez et al., 2018). This finding is contrary to previous studies, which have suggested that DD is associated with higher socioeconomic status (Lo et al., 2012). However, in this case, food scarcity could play a relevant role in food choice. If food is not available, the socioeconomic status does not matter because everyone will eat the same, simply what is available. For those reasons, one can infer that these students' food situation is multifactorial and critical, in which the food right is violated, which could affect their academic performance and permanence in university studies.

These data must be interpreted with caution because the association does not mean causation. Being limited to the sociology students of only one public university, these findings are based on a small sample of participants and can neither be extrapolated to all the UCV students nor the population of

university students of Venezuela. We use a single 24-h recall period that does not indicate a student's habitual diet. The selected FS instrument asks several questions about children, which could affect the household FS measurement in the 20% of students living away from home, especially those from outside the region. The study data analysis uses qualitative variables, which may differ from a quantitative approach, e.g., through standard regression models or structural equation modeling. We have not had the opportunity to adjust for sex, age, living arrangements, or other potential confounder variables. Future research should include how each gender influences some of these items. Additionally, it was not possible to assess the biochemistry and nutritional anthropometric status; therefore, despite its exploratory nature, this study offers some insight into the food and dietary indicators among some university students.

The study concludes that there is an association between food security and dietary diversity among a sample of sociology students at the Central University of Venezuela. Whereas, the socioeconomic status in households of those students was not associated with their food security level or dietary diversity. Most of them are in food insecurity with a low dietary diversity, which could affect their nutritional status, academic performance, and permanence in the university.

Ensuring appropriate systems, services, and support for university students at UCV should be a priority for the educational systems, especially in this crisis context. Reactivation of the university dining at UVC should be considered a priority strategy to improve food security and dietary diversity.

Further studies are required to fully understand the multifactorial food situation of Venezuelan university students. Other types of nutritional assessment indicators could be included such as dimension and composition anthropometric indicators along with blood concentration of iron, retinol, and folate.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Review Committee of the Central University of Venezuela. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2021.623158/full#supplementary-material

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Food and Nutrition Insecurity in Venezuelan Migrant Families in Bogotá, Colombia

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Venezuela has had the largest migration in recent history, with 4.8 million people displaced due to sociopolitical, economic, electrical blackouts, and health crises. Nine out of 10 migrants are facing food insecurity during the COVID19 pandemic. Colombia has received the largest number of Venezuelans migrants, counting officially 1,764,883 to date. This study aims to analyze the changes in the migration process regarding the availability, access, and food consumption of Venezuelan migrants in Bogotá, before and after their arrival. This study uses a naturalistic approach, with a convenience sample ($n = 15$ families) who participated in in-depth semi-structured interviews about their experiences related to diet and nutrition, and the migratory process. Information was recorded, transcribed, and analyzed using grounded theory. Findings reflect that Venezuelan migrants leave the country due to severe lack of access to food which in turn affects the supply, acquisition, consumption, and nutritional status: *"The main reason I left Venezuela was that I couldn't get groceries like milk to feed my granddaughter. When that happened, I couldn't stand it anymore."* After arrival in Colombia, dimensions of food and nutrition security, such as availability, physical and economic access, and consumption improved. However, families are still struggling to acquire basic food items. Households have access to a culturally adequate diet, but with insufficient nutritional quality, as noted by one participant: *"The biggest difference is that in Venezuela you can't get the groceries to feed your whole family with the salary that you get. Here in Bogota, you can buy cheap food, to feed the whole family."* After their arrival, migrants still face difficulties that include legal issues, finding a place to stay, employment, access to high-quality foods, and xenophobia. They have regained the freedom to choose the food they want to buy in a dignified and socially accepted way; two elements that were no longer possible in Venezuela.

Keywords: migrants, food and nutrition security, food insecurity, food availability, food assistance, humanitarian aid, Venezuela, Colombia

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INTRODUCTION

In the last 25 years, the international migrant population has been growing, currently representing 3.5% of the world population [Organización Internacional para las Migraciones (OIM), 2019]. International migration is one of the most important social, political, economic, and cultural phenomena of the twenty-first century caused by the precarious living conditions in some countries. Currently in Venezuela,

because of food shortages, illegal food marketing, unauthorized distribution networks, and high food prices, the usual diet composition was altered (decrease in the number of daily meals and portions) (Landaeta-Jimenez et al., 2015). Venezuelan migration has become the largest migratory movement in the recent history of the Latin America region, and the second in the world after Syria (ACNUR, 2020). Colombia has received the largest number of Venezuelans migrants, where 1,764,883 Venezuelan migrants are now living; of whom 19.6% arrived in Bogota. The immigration of Venezuelan citizens has increased by 110% since 2017 (Migración Colombia, 2020), as a result of the difficulties that migrants face to access, acquire, and eat basic food (ACNUR, 2020). However, this migration constantly fluctuates, as witnessed during the pandemic, during which some Venezuelans in Colombia wanted to return home (Migración Colombia, 2020).

The constant food shortages and lack of food access are violations of the Right to Food and Nutrition Security (Sen, 2002). According to the Food Agriculture Organization (FAO), Food and Nutrition Security is achieved when: *"all people have food availability and access, in a timely, dignified, and permanent manner. All people have access to safe water in sufficient and adequate quantity and quality, to ensure its consumption and biological use. The goal is to achieve an optimal state of nutrition, health, and well-being that contributes to their human development and allows them to be happy"* (OBSSAN, 2016).

Violations of human rights occur in all stages of migration: from preparation, to departure, transportation, borders, and the arrival at the place of destination (Tizón, 1989). Global migration is related to multiple issues, including lack of food (Aguilar et al., 2015; Carmona et al., 2017). There is a growing interest in including the human rights perspective in migration studies. Although international migration is seen as a social problem, the Economic Commission for Latin America and the Caribbean affirms that "migration is the exercise of the individual right recognized in article 13 of the universal declaration of human rights to seek opportunities abroad, which gives rise to intense transnational activity that enriches experiences and favors cultural exchange" (CEPAL, 2008). However, the rapid increase in migration has made visible that migrant populations face a constant lack of protection, far removed from the universality of human rights which prevents them from being recognized by and enjoying the status of subjects of law (Organización Internacional para las Migraciones (OIM), 2019).

Venezuela appeared as the world's fourth-largest food crisis with 9.3 million people acutely food insecure, seven million moderately food-insecure, and 2.3 million severely food-insecure, representing 92% of the total population (FSIN, 2020). Data from the National Survey of Living Conditions reveal that the Venezuelan population has been experiencing food insecurity since 2012, which increased to 93% during the pandemic (ENCOVI, 2020). There is a constant shortage of basics foods like pasteurized powdered and liquid milk, rice, oil, sardines, sugar, beans, chicken, eggs, cornmeal, and beef; as well as shortages of essentials services such as water and electricity. The availability of sources of animal protein has continuously declined, followed by vegetables, sugar, milk, tuna, sardines, cheese, and eggs.

The Venezuelan diet is low- quantity and quality due to insufficient consumption of animal protein, dairy products, and fruits and vegetables; a consequence of accessible or affordable foods for purchase are mainly highly caloric (flours, cereals, and fat; Landaeta-Jimenez et al., 2015; ENCOVI, 2020). The purchase of food is directly proportional to availability and access and this is a very complex situation in Venezuela with an increase in price monthly of 51% and an inflation rate of 506% (CARITAS Venezuela, 2020). Furthermore, the child population is seriously affected by the limited variety of foods, which do not provide essential nutrients (proteins, iron, folic acid, calcium, zinc, and vitamin B12).14.4% of children under 5 years of age are wasted and 29% are stunted (CARITAS Venezuela, 2020). In mid-2018, a dozen eggs cost the equivalent of 2 weeks pay in a minimum wage job (Doocy et al., 2019). Since 2016, social food programs are limited to those agreed with the government (the main is named CLAP: Local supply and production committees) and provides a food box with nonperishable foods which are limited and unreliable (Doocy et al., 2019; Aponte, 2020). In 2019, this subsidized imported food box, low-quality weighed 22 pounds and reached 39% of the population (Efecto Cocuyo, 2019; ENCOVI, 2020).

In Colombia, Venezuelan migrants found a place to overcome the difficulties they faced in their country (Migración Colombia, 2019). They expect an improvement in their availability, access, and consumption of adequate food, as well as a better quality of life. However, Colombia is also facing the same problems because 54.2% of Colombian families are also living with food insecurity (ENSIN, 2015), had an inflation of 3.8% in 2019 (DANE, 2019), and received migrants from Venezuela, Ecuador, Brazil, and United States (Expansión, 2019).

This study aims to analyze the changes caused by migration in the availability, access, and consumption of food in Venezuelan households settled in Bogotá and to determine whether their food and nutritional security status improved after their arrival.

MATERIALS AND METHODS

This research was developed with a naturalistic qualitative approach, to explore migration movements, causes, and changes. The study was undertaken in four phases: preparatory, fieldwork, analysis, and informative (**Figure 1**). In qualitative research, there are no established criteria for number of participants. However, the principle of data saturation was used, such that data collection was finished when new information was no longer obtained (Miles and Huberman, 1994; Salamanca and Martín-Crespo, 2007). In this study, saturation of data occurred after 15 subjects were interviewed.

Setting and Subjects Studied

Subjects were interviewed in three different settings: San Cristóbal, Tunjuelito, and Rafael Uribe, towns distinguished as low-economic stratum, in Bogotá DC. These municipalities were the arrival locations of a significant number of Venezuelan migrant families. The families were linked to the Colombian social childcare program and selected on suggestion of the program coordinator.

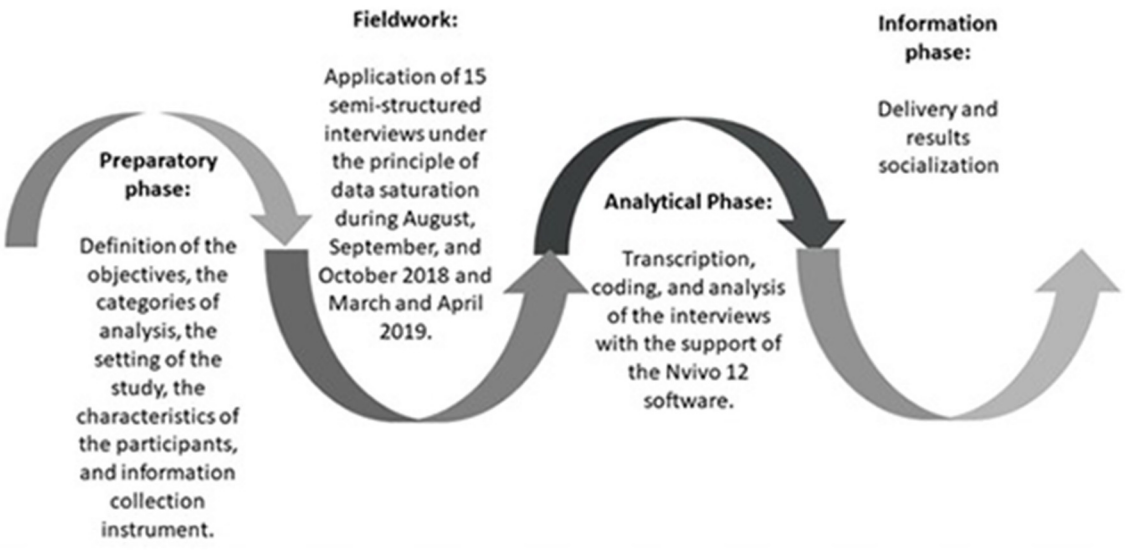

FIGURE 1 | Phases of the study.

Purposeful sampling, a technique used in qualitative research for identification and selection of information-rich cases, was used. The strategy of snowball was implemented to select cases of interest from people who know people that generally have similar characteristics and who, in turn, also know people with similar characteristics (Patton, 2002; Palinkas et al., 2015). Using this sampling technique, data saturation occurred at a sample size of 15 families, which means that no new information emerged from the additional of new participants. Four families lived in San Cristóbal, six in Tunjuelito, and five families in Rafael Uribe, all located in Bogotá DC. All the families invited to take part in the research agreed to participate.

The families participating in the study had to meet three inclusion criteria: 1. Not having family ties in Colombia; 2. At least 3 months of living in Bogota by the time the study took place; and 3. At least one member of the family receiving child food assistance. The food program provides beneficiary children with food during weekdays, three times a day (morning snack, lunch, and afternoon snack). The rationale of including families with children participating in this program was to be able to draw comparisons between the access to food available at home and food available through the program, and how this extra food benefitted the rest of the family (**Table 1**).

Data Collection

Semi-structured interviews were conducted as a qualitative research instrument. The data collected includes characteristics of families, information related to the migratory process, and the availability, access, and food consumption in the territory of departure (Venezuela) and arrival (Bogotá). A field test of the semi-structured interview to determine the accuracy and relevance of the questions was conducted. The semi-structured list of questions was tested in three migrant families to help refine and improve the interview scripts and questions. This procedure produced a final instrument of 15 questions, helped determine the length of time to conduct the interviews, and how to best engage the participants. These field-test interviews were not part of the analysis.

Data collection took place from August to October 2018, and March and April 2019. A first approach was made to the head of the family or adult with knowledge of the migration process and changes in the patterns of the family food consumption. Informed consent was obtained from participants who were notified about the study objectives and potential risks of participating in this study.

Most of the interviews were conducted in the migrant families' homes, which revealed additional aspects to those found in the conversations. Interviews were conducted by the principal investigator, who is a nutritionist trained through qualitative courses at the UNAL University and supervised by the second and third author who hold Ph.D. degrees, are nutritionists and educators and have more than 15 years of experience in the area of food security and qualitative research.

Ethics Statement

This research has approval concept No. 009-123-18 of the Ethics Committee of the Faculty of Medicine of the National University of Colombia, Bogotá and according to Resolution 8430 of 1993 of the Ministry of Health of the Republic of Colombia which corresponds to risk-free research (Ministerio de Salud, 1993). Subjects approved and signed their consent to participate in the study. All processes were confidential, and the participants could drop out of the research at any time.

Data Analysis

The 15 interviews were transcribed, coded, categorized, and analyzed using the qualitative software Nvivo 12. The coding

TABLE 1 | Semi-structured interview and categories of analysis.

Questions used in the semi-structured interview	Analysis subcategory	Analysis category
How did you feel in Bogotá?	Introductory question	
Tell me about your family (how many people are there? How many are in Venezuela? How many are in Colombia and Bogota?)	Characterization of migrant families	Migratory process
In what state and city of Venezuela did they live?	Characterization of migratory dynamics	Migratory process
What was the main reason why you left Venezuela?	Characterization of migratory dynamics	Migratory process
What did you do for a living in Venezuela?	Characterization of migratory dynamics	Migratory process
How did you get food in Venezuela?	Availability of food in the territory of departure	Food and nutrition security
Of your total monthly income in Venezuela, approximately what percentage did you spend on food?	Access to food in the territory of departure	Food and nutrition security
Describe the daily diet that you and your family ate just before leaving Venezuela.	Food consumption in the territory of departure	Food and nutrition security
What do you do for a living in Bogota?	Characterization of migrant families	Migratory process
How do you get food in Bogota?	Availability of food in the territory of arrival	Food and nutrition security
Of your total monthly income in Bogotá, approximately what percentage are you spending on food?	Access to food in the territory of arrival	Food and nutrition security
Describe the daily diet that you and your family currently consume in Bogota	Food consumption in the territory of arrival	Food and nutrition security
Do you or any member of your family belong to social programs with food assistance (food packages, redeemable vouchers, prepared meals)?	Access to food in the territory of arrival Food consumption in the territory of arrival	Food and nutrition security
Did the migration to Bogotá change your family's situation regarding the acquisition and consumption of food? how?	Characterization of migratory dynamics	Migratory process Food and nutrition security
Are you planning to settle permanently in Colombia or in another country?	Characterization of migratory dynamics closing question	Migratory process

permitted disaggregation and aggregation of the data to construct emerging themes such as changes in food consumption, and the intention of returning to the origin country. The coding process was done by the first author in advance and checked by the rest of the authors. After interviews were completed, new information not originally hypothesized emerged from the data and was included, such as nostalgia to return home. The emerging themes were integrated in a logical way that will support the understanding of why Venezuelans migrate and changes that occur before and after migration, using as a basis the dimensions of food security and availability, access, and food consumption. Analysis of the data was iterative and integrated until saturation of the theory was reached. Two specialists (first and third author) in nutrition and food security read and captured the emerging themes and analyzed the data.

RESULTS

Household Characteristics

The 15 migrant families interviewed arrived to Colombia from various states of the Bolivarian Republic of Venezuela: Caracas DC: 4, Zulia: 3, Lara: 2, Táchira: 2, Carabobo: 2, Yaracuy: 1 and Anzoátegui: 1 (**Figure 2**). Thirteen families had a different household composition and two families had a similar composition in comparison to their households in Venezuela. In their country of origin, they were nuclear or composite families (mother, father, and children) and extended (mother, father, cousins, grandparents, uncles, etc.), but this changed with migration. The migrant family often suffered a separation from mothers, fathers, grandparents, children, and partners. Some family members stayed in Venezuela due to the impossibility of obtaining a passport to enter Colombia legally or to take care of the goods and belongings they have in their country. Others stayed in regions of Colombia that did not allow them to be reunited as a family because they found jobs such as domestic work or as a waiter.

Five out of 15 families had a woman as head of the household, with a male presence at home. Eight families consider the headship to be shared between females and males, and in two families there is no female presence, therefore, the head of household is a male. In Venezuela, the heads of households worked as a trader, baker, butcher, driver, messenger, stylist, manicurist, dealer, cashier, and cleaning personnel. Of the 11 families that had the Colombian special residence permit (named PEP), only one family had a formal job in Bogotá. The other members of the households worked in informal jobs like selling food and beverages on the street, and one family was unemployed. These informal jobs were performed between two and five times a week and the payment range was from 20,000 to 30,000 COP daily (5–7 US dollars).

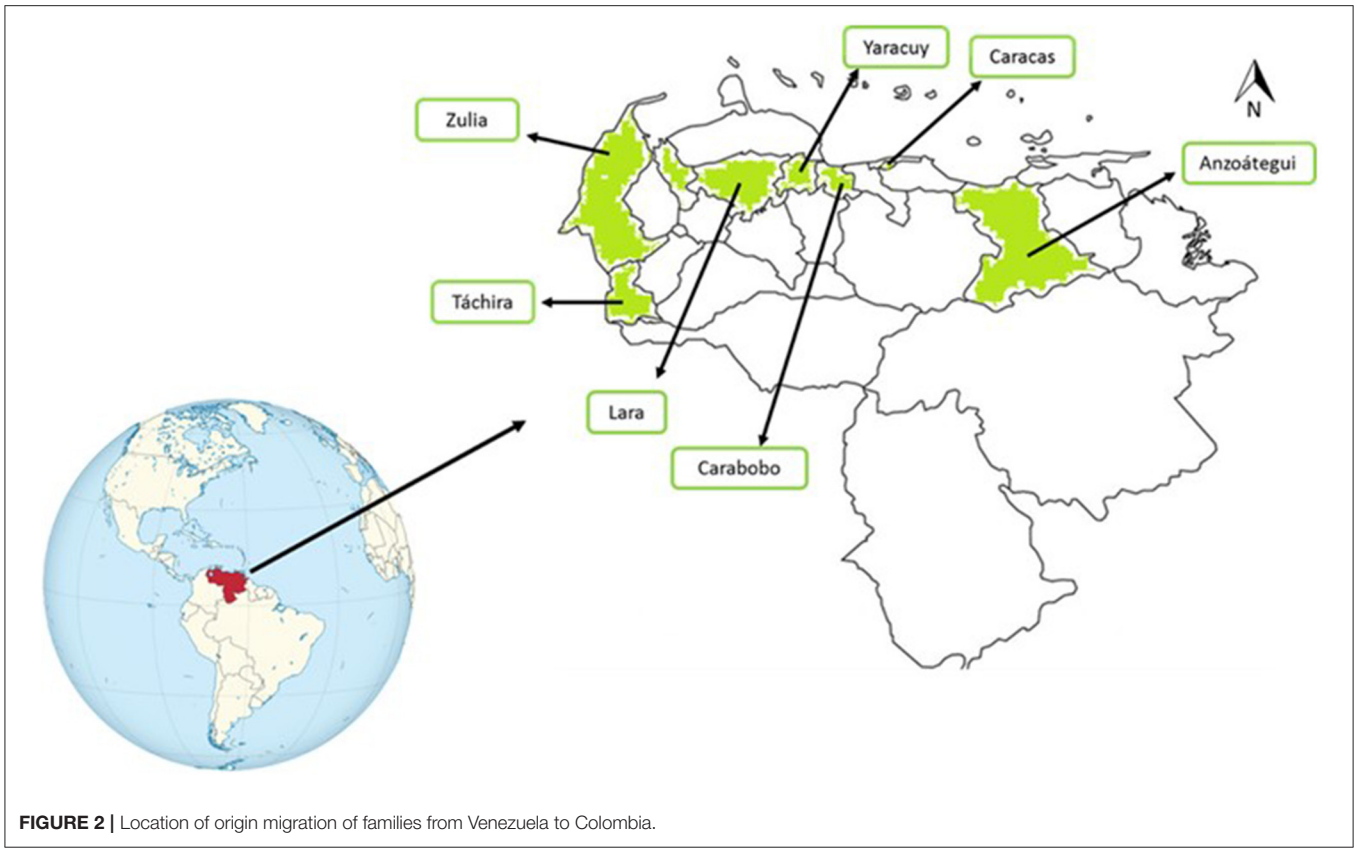

FIGURE 2 | Location of origin migration of families from Venezuela to Colombia.

TABLE 2 | Elements of food insecurity in Venezuelans before and after the migration process.

Elements of food security	Before migration process (in Venezuela)	After migration process (in Bogotá)
Availability	• Frequent shortage of food basket (milk, dairy, eggs, cornmeal, chicken, and meat). • Permanent concern to obtain food.	• Stable and permanent food supply • Reduces the concern to get food.
Food access	• High food prices. • Insufficient food access. • 100% of economic resources are insufficient to acquire food. • Marketing and distribution systems inhibit the freedom to choose preferred food. • Illegal marketing networks. • Extensive and exhausting food buying processes.	• Insufficient economic resources for the acquisition of food due to low income and lack of job opportunities. • The economic resources allow to buy enough inexpensive food for the whole family but not varied. • Close to half of income are used to buy foods. • Freedom to choose the foods you want to consume.
Food consumption	• Insufficient food consumption. • Changes in food patterns (omission of some food groups, skipping meals and changes in mealtimes). • Diet based on calories derived from carbohydrates and low intake of animal proteins, fruits and vegetables. • Mistrust of food delivered by the government (named CLAP box).	• In adults, the diet based on carbohydrates and low consumption of animal proteins, fruits and vegetables persists due to insufficient resources and/or refrigerator. • Children eat a more balanced diet through the Colombian food assistance programs. • Frequent consumption of processed foods and "baby food" of children to compensate the lack of food experienced before migration. • Wish of culturally accepted food that allows the preservation of Venezuelan identity. • Low food intake in children whose parents remain in Venezuela.

Causes of migration to Bogotá, Colombia

All the participating Families expressed that the main reason for leaving Venezuela was the impossibility of obtaining food and/or acquiring it in the quantities that their families needed. The families stated that they chose Bogota because they found work and better living conditions in the city.

The decisive point to migrate was when they could no longer purchase food even for their children, after long facing food

shortages and high prices. This limited adult food consumption as well. One participant stated:

> *"The main reason I left Venezuela was that I couldn't get groceries like milk to feed my granddaughter, and when that happened, I couldn't stand it anymore"* (Female, 50 years old, Tunjuelito, Bogotá).

Of the 15 families interviewed, 12 expressed their hopes to return to Venezuela no matter how long it takes and when the social and economic situation of their origin country changes favorably. Two families hope to settle in other countries and one family expressed their intention to stay in Colombia with no intent to return to Venezuela.

Changes in Food Security Components: Availability and Access to Food

Fourteen families expressed that in their places of origin in Venezuela they faced constant food shortages of milk, dairy products, eggs, corn flour, chicken, and meat, resorting to various search strategies to obtain food. One family stated that although their desired food items were available in Venezuela, the prices were very high and food access was very difficult. They also stated that 100% of their monthly income was not enough to afford food for the whole family.

In Venezuela, families prefer to purchase food from the "bachaqueros" or illegal traders, to avoid long waits, long lines, searching in various warehouses, and to choose the food they wanted. Using this strategy increases the food price up to five times. Subjects expressed their discontentment at not being able to freely choose their food, that they had specific days each week during which they could make purchases and a restriction of food quantity available to acquire.

Regarding the food availability for migrants after arrival in Bogotá, interviewed families recognized a significant improvement food access, encountering a great variety and affordable prices allowing them to select freely the foods they desire. Families consider that food is "cheaper" in Bogotá. However, for those without stable employment, the money available to buy food is still insufficient to purchase varied, nutritious, and sufficient food for their families. Overall, families felt that they recovered some of the dignity lost in Venezuela.

Families living in Bogota reported spending between 40 and 50% of their monthly income on food. More money is needed for food, but their income is low due to informal or unstable employment and prioritizing the payment of rent and utilities. Therefore, inexpensive food that is affordable for the whole family, for example, rice, pasta, oil, eggs, potatoes, bananas, cornmeal, and powdered milk, was often purchased but the purchase of foods such as chicken, meat, fish, dairy, fruits, and vegetables, was impractical, leaving participants without proper nutrition for a well-functioning body and ideal health status.

In all families, children under the age of five were linked to public kindergartens in Colombia. They received three meals (lunch and two snacks) from Monday to Friday. These foods are intended for the exclusive consumption by children, however, the families acknowledged that the whole family often partook. Below are some quotes from the subjects:

> *"Getting food in Venezuela is difficult. You have to wait, visit various stores, and negotiate with the bachaqueros (illegal vendors), so you can find food. The problem is that everything is very expensive"* (Female, 34 years old, San Cristobal, Bogotá).

> *"The biggest difference is that in Venezuela you can't get the groceries to feed your whole family with your salary. Here in Bogotá, you can buy food cheap to feed the whole family, although those foods are not healthy"* (Female, 36 years old, San Cristobal, Bogotá).

> *"That the children can go to a kindergarten where they are given a healthy diet is a great relief. From Monday to Friday, we worry about the food of two and not four. Also, the food basket that is delivered once a month helps us all"* (Female, 33 years old, Rafael Uribe, Bogotá).

Changes in the Food Security Components: Food Consumption

In Venezuela, adults consumed between 2 and 3 meals a day before embarking on their migratory route to Bogotá. Parents used the following strategies to maintain offering food to their children three times daily: limit the frequency and amounts of food consumed and change the schedule of food consumption (late breakfast, use lunch as the first meal, skip dinner). Families recognized that the possible food consumption in Venezuela was very limited in quantity and variety, which could be affecting the health status of their families. This situation generated constant concern and dissatisfaction. The gradual change in the composition of meals in Venezuela was a theme highlighted by the interviewees, who attested that they progressively went from originally eating four meals to one or two.

In Bogotá, families showed a significant improvement in food consumption after arrival. At the time of the interview, the families expressed that all family members ate at least three times a day. However, they recognized that their diets were high in carbohydrates and lacked fruits, vegetables, dairy, meat, and chicken due to economic constraints. Most families expressed they did not have a refrigerator to store and preserve perishable foods, nor blenders to make juices and soups, so they preferred not to buy items requiring these appliances. Participants reported intake of sugary drinks, sweets, bakery products, and unhealthy snacks because they had been difficult to buy in Venezuela, so upon arrival in Bogotá they "compensated" for lack of "pleasure," food consumption. This excessive behavior can cause weight gain and other chronic diseases.

In Bogotá, these families were able to offer some types of foods to their children for the first time, including yogurt, petit-Suisse type cheese, compotes, and baby food, which they called *"good for children."* This reinforces that migration has been worthwhile because it has increased the food variety, they are able to offer to their children.

Most families felt that foods and food preparations in Colombia were very similar to those in Venezuela. This similarity

supports adaptation to the country, through the commonalities in food. In Bogotá, families are able to purchase ingredients for typical Venezuelan preparations and are able to buy ready-to-eat foods such as arepas, hallacas, cachapas (cornbread), and the typical main dish pabellón, with rice, meat, and black beans. When they consume these preparations, they feel closer to their country. The ability to maintain dietary habits and customs in Colombia triggered joy and satisfaction for migrants. However, this joy is at times overshadowed because food assistance programs in Colombia urged families to adapt to "Colombian food." Here are quotes from some interviews:

> *"Before we came, the last weeks we only ate cassava and water, cassava in the morning, in the afternoon and at night, there was nothing else. The adults in the family ate twice a day, and the children ate three times, but they no longer wanted to eat. They told us they were tired of cassava, they wanted to eat something different"* (Male, 35 years old, San Cristóbal, Bogotá).

> *"Here, we have been able to eat better. We eat more times a day and more varied, sometimes we can buy vegetables, chicken or meat but at least we are never short of rice, arepas, eggs, and bananas"* (Female, 34 years old, Tunjuelito, Bogotá).

> *"In Bogotá, my daughter tasted healthy food for children like yogurt for the first time, it is one of her favorite foods. Every time I can give her a yogurt it makes me happy because the quality of food that she eats has improved and I feel coming here was worth it. In Venezuela, you couldn't choose"* (Female, 30 years old, Rafael Uribe, Bogotá).

DISCUSSION

Household characteristics is key for the analysis of food and nutrition security since members of households support the acquisition, preparation, and distribution of food. It has been identified that 52% of the Venezuelan migrant population in Colombia are men and 48% are women (Migración Colombia, 2019). The importance of the proportion of men and women in migrant families lies in the fact that in recent decades a "feminization" has emerged, that is, the participation of women in migratory movements (CEPAL, 2007). Food has a social role in strength relations. Families not reunited in their usual dietary customs has negative repercussions on food intake, especially in children, which is associated with emotional deterioration due to not being able to share food as a family (Haukanes, 2007).

Women's participation in the migration process has increased. For centuries, migration was led by men because women were more vulnerable to various forms of violence during the process mainly due to the risk of sexual violence faced by migrants and refugee women, since, to guarantee food for their families, they resort to sexual work (Shedlin et al., 2016). This vulnerability is still faced by women, who are at risk of sexual violence, illegal jobs, and prostitution. Venezuelan migrants report having experienced xenophobia and 15% have had difficulties feeding themselves in the last month (Organización Internacional para las Migraciones, 2019). However, none of the families and women interviewed mentioned it. Probably the fact of having small children protect them.

The visibility of women in migration has been driven by the growing number of families with women as the head of the household. In our study, five households had a female head of the family, and eight households had a shared head of the family, meaning that women play a strong role in 13 out 15 families interviewed. Several authors state that women contribute to the well-being of migrant families because they preserve their role of caring for and protecting other family members through practices like food preparation. Besides, women transmit cultural symbols and maintain the desire for family reunification (Aguinaga, 2012).

Causes of migration to Bogotá, Colombia reflects a violation of human rights. The situations reported by families regarding the strategies and measures that they had to carry out in Venezuela to obtain food, violates human rights. Food and nutrition security, seen as a right, establishes that the State must guarantee people food availability and access, in a timely, dignified, and permanent manner. The reality of families living in Venezuela is the opposite, confirming previous findings of other researchers (Bernal et al., 2012; Landaeta-Jimenez et al., 2015), who highlighted the violation of Food Security recognized as a right in article 305 of the Constitution of the Bolivarian Republic of Venezuela. However, in Bogotá, the food and nutrition security of these families is neither guaranteed nor understood as a right. This is evidenced by the lack of job opportunities, difficulties with the legalization of the migrant status, and the limited access to food assistance for the new arrivals. Recently, in 2021, President Duque instituted a temporary legal status for Venezuelans that will hopefully improve the stability of migrants.

Changes in Food Security Components

Availability and access to food. The existence and worsening of food shortages in Venezuela such as milk, rice, corn flour, chicken, and meat lead to a decrease in purchases of foods with a high a content of protein, vitamins, and minerals. These nutrients are replaced with subsidized products, whose nutritional contribution is calories and carbohydrates. Informal food distribution networks, organized by "bachaqueros" who illegally buy, resell and distribute subsidized food at much higher prices (ENCOVI, 2020) further contribute to the food and nutrition security problems and motivates migratory movement.

A diet high in carbohydrates and low in vitamins and minerals was prevalent in study participants and continue after completion of the migration process. In Bogotá, although there is a wide variety of food, families do not have sufficient resources to purchase better food items for their families.

Even so, families interviewed consider that migrating was positive because a variety of food is permanently available and with little money, hunger can be satisfied. In contrast, in Venezuela, an entire income was insufficient to buy food for the whole family. However, the lack of job opportunities in Bogotá makes it difficult to buy diverse, varied, and nutritious food. This

reality means that families are not completely satisfied with their situation in Bogotá.

Moreover, the food assistance that children received in childcare centers helped families by partially improving their food and nutrition security. Assistance programs reduce the pressure on families to procure enough food on a daily basis. However, this concern only diminishes when children attend the care centers, which does not happen on weekends or holidays.

Food consumption. After arriving in Bogotá, a significant improvement in the quantity of food eaten was observed, but not a correlating increase in variety. Although all families increased number of daily meals, due to economic limitations, they still did not have appliances such as a refrigerator or blender, and consequently, the consumption of food sources of proteins, vitamins, and minerals provided by fruits, vegetables, cheese, dairy products, chicken and meat was infrequent. In contrast, foods high in carbohydrates prevailed.

Skipping breakfast was a common practice in Venezuela, which was recovered after migration. The price of breakfast in Venezuela has increased by 2210% since 2015 and its usual composition has changed. 61% of Venezuelan families have changed their usual way of eating and 80% have had some food deprivation (Bernal, 2017). The lack of a varied diet that includes sufficient fruits, vegetables, and sources of protein were aspects that did not favorably change after migration. Due to the lack of job opportunities and low economic income, families buy mainly carbohydrate-based food sources. As such, the need for diet and nutrition education aimed at migrant families was evident given the reports of frequent consumption of processed products because of these products' unavailability in Venezuela.

In the migratory process "adequate food" can be approached from two points of view. First, the focus on the nutritional contribution and the satisfaction of calorie and nutrient needs. Second, consideration of cultural traditions so that food is socially accepted. In Bogotá, the interviewed families consumed a diet culturally appropriate but not nutritionally appropriate since a diet that is not very varied and based on foods high in carbohydrates does not satisfy nutritional needs. Eating typical Venezuelan preparations helps Venezuelans to maintain their food identity and provides contentment.

As indicated by the families, one of the elements of food and nutrition security managed by OBSSAN (Medina, 2014; OBSSAN, 2016) states that food is a central element of the identity of migrants.

Food affects health status. Migrant families stated that in Bogotá they could offer their children "baby foods," which generally have high amounts of sugar. They also frequently consume sugary drinks, sweets, cakes, and unhealthy snacks because they have not had access to these products for a long time and they consider it inexpensive. As a result, they do not consume foods such as fruits, vegetables, cheese, dairy, chicken, and meat daily, arguing insufficient income. This situation reveals the need to carry out nutrition education actions with the migrant population. Although the purchase and consumption of food are personal decisions, there are structural factors such as advertising and commercial policies that also influence consumers (**Table 2**).

Childcare centers in Bogota receive migrant children and provide them with food assistance which improves their consumption of healthy food. This is a positive sign of openness to migrants, and caretakers recommend that parents accustom their children to "Colombian food" at home, to avoid rejection of meals offered in these centers. Having food roots is important to families and their cultural identity and preserves a connection with their country of origin. This situation highlights one of the criticisms made of food assistance: the overlooking of the cultural meaning of food (Pérez, 2006).

This study has limitations regarding methodological aspects. First, the family participants were those who accessed food assistance programs through childcare centers, so they had social protection from the government. Families not covered by any program were not part of this research, and surely are less protected. Second, the process of coding and categorization of interviews was done by the first author and verified by the third author, both of whom are experienced qualitative researchers. The analyses were done by all authors. Surely another qualitative researcher could have enriched the analysis. Third, due to the qualitative nature of this study, results only will apply to the participants, however, qualitative studies do not seek generalization of results. Common patterns were detected that will contribute to emerging topics in the area of migration and food security.

CONCLUSION

Migration is a process related to food insecurity. Most elements of food insecurity, from difficulties in availability and economic access, to consumption of foods, were present as reasons to leave Venezuela. Food insecurity experiences faced daily in Venezuela were described as obstacles to obtaining the quantity, quality, and preferred food for children and constituted causes for moving to Colombia for millions of Venezuelans. Bogota was the first city selected as a place where good conditions, including jobs, could be obtained for newcomers.

The migratory process partially improved the food and nutrition security of migrant families. After the migration, access to food was recovered, economic access and food consumption in terms of quantity improved, but the quality of food needs to be optimized since it affects the satisfaction of families and their children. The number of meals per day, the quantity, the access, and the participation of children in social programs, which includes food assistance, are some of the major positive changes. Venezuelan families achieve a culturally adequate diet since both countries have similar meals and ingredients. Typical Venezuelan meals can be prepared and contribute to the maintenance of their cultural identity and diminish the nostalgia for their country. In Bogotá, some children ate foods such as petit queso and yogurt for the first time, which is considered important and nutritious for families. This situation was impossible in Venezuela, which suggests that migration was necessary. They have regained the freedom to choose the food they want to buy and access food in a dignified and socially acceptable way, two key food

security elements that were commonly unobtainable while living in Venezuela.

Our findings highlight the need to include the human rights approach in migration policies, including job opportunities, the maintenance of the cultural identity, equity, and protection of xenophobia against migrant populations.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: https://repositorio.unal.edu.co/handle/unal/78054 (Pico, 2020).

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by concept No. 009-123-18 of the Ethics Committee of the Faculty of Medicine of the National University of Colombia, Bogotá Headquarters and according to Resolution 8430 of 1993 of the Ministry of Health of the Republic of Colombia corresponds to risk-free research (Ministerio de Salud, 1993). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

RP, SC, and JB conceived the research and contributed and approved the final manuscript. RP and JB wrote, discussed, and analyze the data. All authors contributed to the article and approved the submitted version.

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Plant Disease Diagnostic Capabilities in Venezuela: Implications for Food Security

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Venezuela is currently experiencing the most severe humanitarian crisis in the Americas of this century. Little food is being produced locally, despite the population's right to food. Plant disease outbreaks are causing substantial declines in major staple food and cash crops, and this impacts on rural livelihoods, and poses a significant and growing threat to the already complex food insecurity crisis in the country. Nonetheless, phytosanitary services and hence the control of plant pests and diseases have been substantially weakened over the recent years as a consequence of the collapse of the economy and the substantial deterioration of government services. Therefore, most of the pathogens associated with symptoms-causing diseases remain unidentified or uncharacterized, and no surveillance or crop protection strategies have been implemented. In this review, we address the country's issues and challenges in diagnosing, monitoring and managing plant diseases to restore national food security.

Keywords: plant health, pathogen detection, diagnostics, food security, phytosanitary system, Venezuela

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INTRODUCTION

Venezuela is experiencing a profound humanitarian emergency that has led more than 9.3 million people (a third of the population) to be acutely food insecure and in need of assistance since July-September 2019 [World Food Program (WFP), 2019], making this the current fourth-largest food crisis in the world (Global Network Against Food Crises, 2020). The current state of hunger in Venezuela is a result of multiple societal collapses. From 1999 to date, the transition from a capitalist to a socialist State-centered mode of production impaired agricultural and food production systems (reviewed in Rodríguez-García, 2021). The situation is now aggravated by the total collapse of public services, fuel shortages, and by the impact of the global COVID-19 pandemic which has affected logistics and agricultural activities across the country (FAO and WFP, 2020).

Access to agricultural production data in Venezuela has been restricted by government agencies in recent years. Official figures record an average 27% shortage and fall in agricultural production between 1999 and 2014, while other figures report 70% drop (Rodríguez-García, 2021). According to The Confederation of Agricultural Producers Associations of Venezuela (FEDEAGRO), between 2009 and 2018 the production of strategic agricultural commodities like rice decreased by 50.9% and corn 55.9% (Gutierrez, 2019) (**Figure 1**). The low productivity is caused by shortage of agricultural supplies (seeds, fertilizers, agrochemicals, etc) and other factors (Tapia et al., 2017). This review raise the issue of crop losses due to pathogens, linked to the dismantling of the plant diagnostic network across the country.

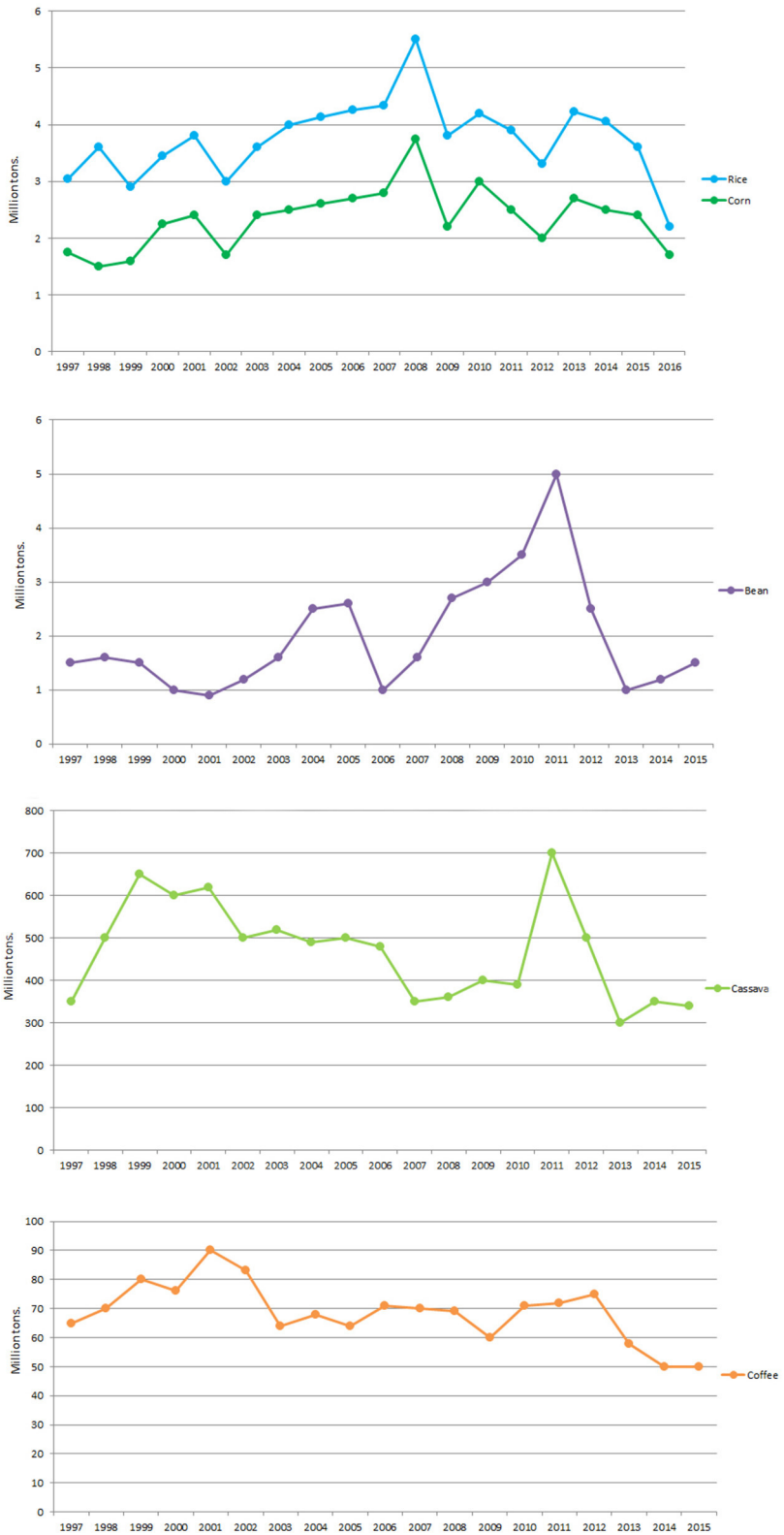

FIGURE 1 | Production of principal crops in Venezuela in the period 1997–2015. Source: FEDEAGRO (Confederación de Productores Agropecuarios de Venezuela), 2017.

The emergence of novel plant pathogens, as well as the expansion of the geographic range of known pathogens are causing a significant disruption in food production, threatening livelihoods of people depending on these crops for their income. Although quantification of crop losses due to pathogens in Venezuela is limited, symptoms associated with rice leaf and panicle blight, potato moth, coffee rust, wilts of banana and cacao frosty pod, have been reported to have caused important crop losses in each crop (González et al., 2011; Sequera, 2019; Martínez-Solórzano et al., 2020). The ongoing outbreak of citrus huanglongbing (HLB) caused by a bacterial pathogen, has devastated the national citrus industry (Marys et al., 2021). Other invaders are in the horizon: the recent arrival of the transboundary disease "Fusarium wilt," tropical race 4 (R4T) in the Colombian Guajira near the Venezuelan border, could heavily damage national banana and plantain plantations. Regulatory command of plant health services to reduce the risk of new and emerging threats to crops should ideally involve accurate detection, reliable surveillance and immediate intervention (Miller et al., 2009). However, due to a lack of investment in basic research and the dismantling of the national plant health network, most of the pathogens associated with symptoms causing diseases remain unidentified or poorly characterized. The goal of this article is to provide a perspective on the current status of the capacities for plant diagnostics in Venezuela.

THE VENEZUELAN PLANT HEALTH SYSTEM: BRIEF OVERVIEW

The plant health system in Venezuela has evolved under the influence of deep changes in the country's political and economic situation, as well as external international trends. From 1947 to 1952 the country was moving away from a traditional agricultural system, from isolated family farms (conucos) toward a modern, mechanized system with new and expensive equipment and large mono-cultivated estates. With this new era of agricultural development came new phytopathological problems. At that time, many phytopathologists under the auspices either of the Venezuelan government or their own countries, devoted their time and effort to the recently created Plant Pathology Department of Maracay, which was the only phytopathology center in Venezuela. Then, the creation of the National Centre for Agricultural Research (CENIAP, which is now part of the National Institute for Agricultural Research, INIA), established the first official plant health service with Sanitary Police and Phytopathological Supervision Services in 1950 (Malaguti, 1990).

In 1993, the plant health service was restructured as the Autonomous Agricultural Health Service (SASA), which was the governing body of solid agricultural health policies, serving as the country's National Plant Protection Organization (NPPO). The role of the SASA was to ensure phytosanitary protection by organizing plant quarantine, plant protection (phytosanitary surveillance, phytosanitary emergencies, and response plans), surveillance and maintenance of pest free areas and areas of low pest prevalence; conducting pest risk analyses; ensuring the maintenance of phytosanitary security of consignments after certification and staff training [SASA (Servicio Autónomo de Sanidad Agropecuaria), 1993]. The SASA in collaboration with individual state departments of agriculture, research institutes and laboratories including the INIA, agricultural universities (UCV, ULA, LUZ, UCLA), the Institute of Advanced Studies (IDEA) and the Venezuelan Institute for Scientific Research (IVIC) developed a coordinated, robust diagnostic network that shared expertise and technical capacity and served national plant protection services in the country. Then in 2008 a new law replaced the SASA by the National Institute of Integral Agricultural Health (INSAI), which became the governing body regulated by the Ministry for Productive Agriculture and Land (MPPAT) (República Bolivariana de Venezuela, 2008). As a result the institutional framework governing plant health descended into sectarianism and politicization, and resulted in dismantling of major institutions that aimed to ensure plant protection (see below). As a consequence a number of epidemiological surveillance, diagnostics, management and germplasm health programs were abandoned (Enríquez, 2013). A new collective of 18 plant disease and pest diagnostic facilities known as the National Plant Health Laboratories Network (Red Nacional de Laboratorios de Salud Vegetal, RNLSV), was established with presence across the country to provide scientific and technical support to the INSAI [INSAI (Instituto Nacional de Salud Agrícola Integral), 2008]. However, the challenge of equipping the new units and training new diagnosticians was never truly met. Unfortunately, the decline in oil prices and erratic macroeconomic policies caused, particularly from 2008, a deep socioeconomic and institutional collapse, from which the plant health system did not escape.

PLANT DIAGNOSTIC LABORATORIES: AN EXPLORATORY CAPACITY EVALUATION

In order to document the status of plant diagnostic laboratories (PDLs) capabilities, we made an exploratory survey of active diagnosticians affiliated with PDLs from June 11 to July 2, 2020. Participation was solicited through an email with a link to a questionnaire in Google Form (one respondent per PDL). Survey responses of 18 diagnosticians assessing their perceived levels on the availability and quality of public services they are able to provide, their equipment, human resources and funding are shown in **Table 1**. The results showed that physical infrastructure, equipment, reagents and the lack of human resources were all obstacles to plant protection work. The crisis has affected the provision of basic services: most network facilities have critical shortages in electric, water and gas supply and lack electricity generators and water purification systems. Infrastructure is in a critical condition. Transportation infrastructure has notoriously deteriorated after years of disinvestment and little maintenance, hampering mobility and surveillance. This is now aggravated by fuel shortages in the country. Internet access is also very limited in most facilities. Currently, most laboratories have either obsoleted or a complete lack of low-temperature freezers, reducing storage capacity and reference collection maintenance. Only a very few laboratories are stocked with minimal equipment

TABLE 1 | Survey respondents' rating of the exploratory phytosanitary capacity evaluation.

	Absent	Inadequate	Adequate
Laboratory/Institution services			
Water supply	39% (7)	61% (11)	0% (0)
Electrical supply	11% (2)	89% (16)	0% (0)
Electric generators	94% (17)	0% (0)	6% (1)
Gas supply	22% (4)	72% (13)	6% (1)
Internet access	17 % (3)	39% (7)	44 % (8)
DNA sequencing/bioinformatic analysis facility	100% (18)	0% (0)	0% (0)
Reference collections	83% (15)	17% (3)	0% (0)
Laboratory/Institution equipment			
Low temperature storage capacity	22% (4)	78% (14)	0% (0)
Autoclave	17% (3)	50% (9)	33% (6)
Water purification /distillation systems	16% (3)	66% (12)	16% (3)
Glassware	0% (0)	100% (18)	0% (0)
Plastic ware	0% (0)	100% (18)	0% (0)
pH meters	22% (4)	78% (14)	0% (0)
Gel electrophoresis systems	38% (7)	44% (8)	16% (3)
Incubators	33% (6)	56% (10)	11% (2)
Spectrophotometers	44% (8)	50% (9)	6% (1)
Ice-making machines	34% (6)	66% (12)	0% (0)
Balances	22% (4)	39% (7)	39% (7)
PCR-machines	38% (7)	44% (8)	16% (3)
ELISA plate readers	78% (14)	11 % (2)	11% (2)
Reagents and laboratory chemicals	28% (5)	72% (13)	0% (0)
Light microscopes	17% (3)	11% (2)	72% (13)
Electron microscopes	34% (6)	55% (10)	11% (2)
Human Resources			
Human capital	0% (0)	94% (17)	6% (1)
Training	17% (3)	83% (15)	0% (0)
Funding			
Government	0% (0)	100% (18)	0% (0)
Other agencies	94% (17)	6% (1)	0% (0)

commonly used for diagnostic methods in plant pathology, such as Enzyme-Linked Immunosorbent-Assay (ELISA), transmission electron microscopy, and Polymerase Chain Reaction (PCR)-based assays; however, the impossibility to perform preventive maintenance leads to equipment's failure. Financial constrains limit the purchase of modern equipment in most laboratories, while supplies and reagents for routine microbiological culture are scarce (reviewed in Requena, 2010; Tapia et al., 2017).

In the past decade, pathogen detection methods throughout the world have swiftly advanced and diversified. In our survey, we asked diagnosticians to indicate which methods they used (**Table 2**). We found that traditional plant diagnostic methods, such as microscopic observation continue to be commonplace in PDLs, while bioassays, culturing and serological tests were less frequent. This could be explained by the lack of basic services for greenhouse maintenance and financial restraints to acquire supplies and reagents for pathogens culture and serology. Among molecular techniques, PCR is being used by 27% of the respondents, while more expensive techniques such as quantitative PCR and next generation sequencing are out of reach. Less costly tests utilizing isothermal amplification techniques have not been adopted. Due to the lack of genomic laboratory service at local level, some researchers in Venezuela often send genomic materials (DNA and RNA) for genomic analysis abroad (*e.g.,* to Europe). This is not just costly but time-wasting and inefficient.

TABLE 2 | Percentage of plant diagnostic laboratories using diagnostic methods, determined by the diagnostician survey1.

Method	Percentage of PDLs that use the method1
Bioassay	22% (4)
Biochemical	33% (6)
Light microscopy	77% (14)
TEM	16% (3)
Immunologic	22% (4)
PCR	27% (5)
qPCR	0% (0)
RT-PCR	11% (2)
Multiplex PCR	0% (0)
Sequencing	5% (1)
LAM	0% (0)
Next-Gen sequencing	0% (0)

THE PHYTOSANITARY STATUS OF TOP CROPS IN VENEZUELA

Active phytopathologists working in private practice, diagnostic laboratories, universities (research and extension) and agricultural consulting companies were asked to respond to a rapid online survey on the most prevalent diseases in strategic crops observed during 2020 (**Figure 2**). Rice leaf and panicle blight, bacterial and fungal wilts of banana, citrus huanglongbing (HLB) and fall armyworm pest on maize ranked among the most recorded diseases.

Rice Leaf and Panicle Blight

During 2011, rice (*Oryza sativa*) farmers complained about near 50% decline in production, associated to low grain yield caused by low grain filling, low fertility and low grain weight. The disease is referred to as "vaneamiento" (panicle blight). Pathogens isolated from disease panicles during sample collections were Fusarium and Curvularia, while bacterial genus Pantoea was isolated from 95% of samples, using pathogen culture, microscopic observation and biochemical methods (A. González, personal communication, July 21, 2020). Molecular methods (PCR) were used in order to identify *Burkholderia glumae* from diseased rice showing severe leaf and panicle blight during dry production seasons between 2009 and 2011 with 45–100% incidence (González et al., 2011), within collaborative research between DANAC Foundation for Agriculture Research in Venezuela and the International Center for Tropical Agriculture (CIAT) in Colombia. Actually, the disease affects all the major rice-growing regions of Venezuelan and is expected to contribute to the lowest

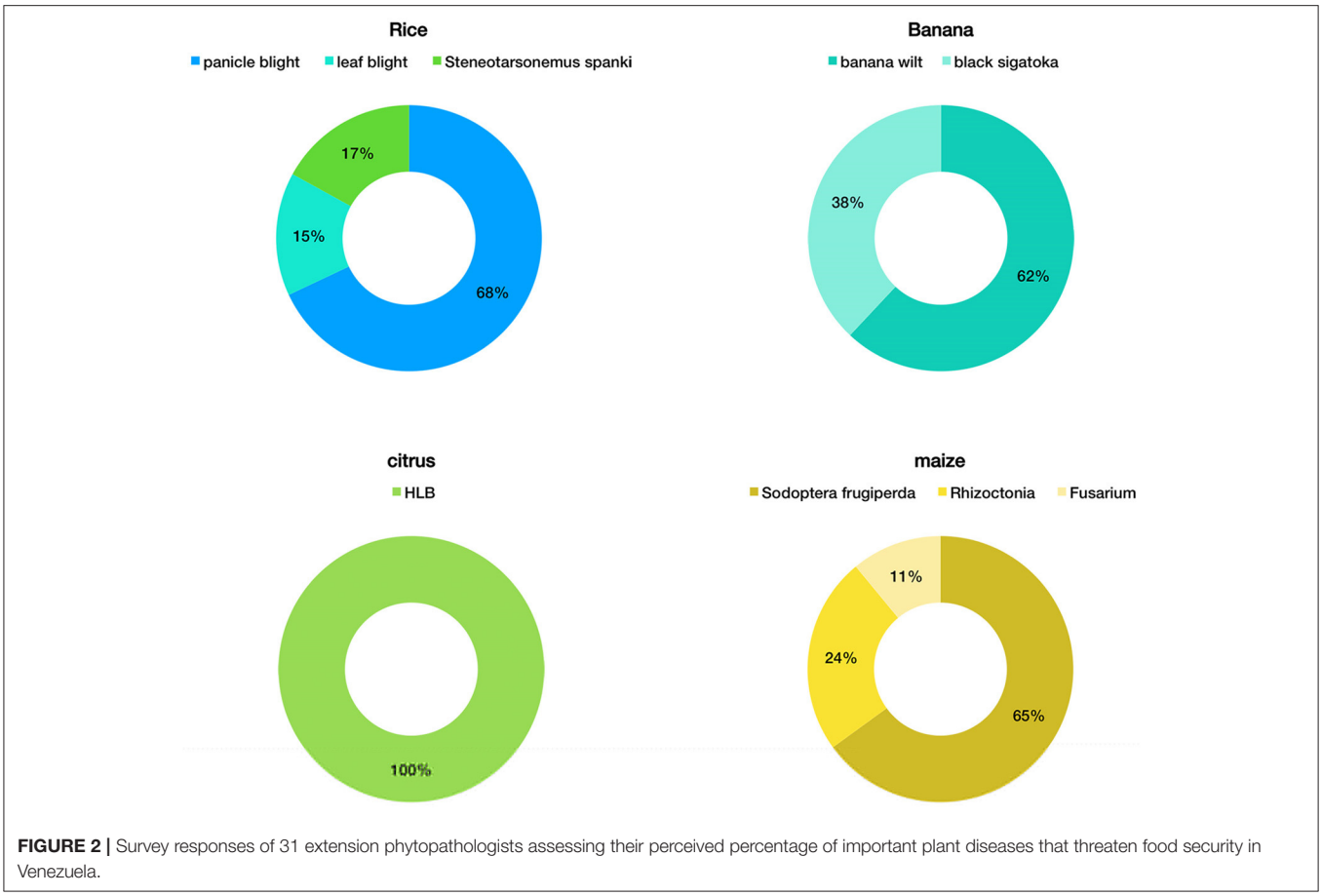

FIGURE 2 | Survey responses of 31 extension phytopathologists assessing their perceived percentage of important plant diseases that threaten food security in Venezuela.

output of rice since 1972 (FAOstats, 2020). Recent national efforts toward the molecular characterization of fungi and bacteria associated with rice and panicle blights have been stopped due to the lack of resources.

Bacterial and Fungal Wilts of Banana

Emerging fungal disease outbreaks of "Black Sigatoka" (BS), caused by *Mycosphaerella fijiensis* Morelet [anamorph: *Pseudocercospora fijensis* (Morelet) Deighton] and of "Fusarium wilt of banana," caused by *Fusarium oxysporum* f. sp. *cubense (Foc)* were associated with near 50% production decline and subsequent collapse of the export trade from Sur del Lago in 1991 and 2007 (Pineda et al., 1997; Martínez-Solórzano et al., 2020). A recent survey of the current and potential phytopathological problems in banana from inspections done during 2017–2019 in Sur del Lago, revealed a high incidence of BS (90%), *Foc* (36%) and Moko, caused by bacteria *Ralstonia solanacearum* (16%) (Martínez-Solórzano et al., 2020). Nationwide control of banana wilt diseases has been mainly based on frequent applications of chemicals, although there is no chemical control for *Foc* and there are limited other options for managing this disease (Aular and Casares, 2011). Due to the scarcity of agrochemicals and to disruption of phytosanitary public services such as extension diagnostic, monitoring and surveillance during the crisis period in the country, the incidence of diseases is expected to rise significantly beyond those reported, threatening national production. It is notable that BS, *Foc* and Moko were detected and surveyed using only conventional diagnosis methods, including symptomatology and morphology (Pineda et al., 1997; Rodríguez, 2000). To our knowledge, no information exists on the molecular population structure or genetic diversity of BS/*Foc* in this country.

Recently, the transboundary disease "FW Tropical race 4" (*Foc* TR4), a lethal variant of *Foc* that kills banana, plantains and other *Musa* species, was detected in La Guajira, northeast of Colombia, next to Zulia state (Colombia-Venezuela border) (García-Bastidas et al., 2020). The arrival of *Foc* TR4 to the Americas has triggered an enormous pressure on the regional plant protection agencies in Latin America. One year before, in 2018, the INSAI issued an administrative ruling on *Foc* TR4 prevention and management [INSAI (Instituto Nacional de Salud Agrícola Integral), 2018]. However, the country was poorly prepared and lacked the resources required to comply with this regulatory framework. The risk of introduction of *Foc* TR4 is very high because the Venezuelan migrants travel on foot back and forth across the frontier through La Guajira due to the COVID-19 pandemic. Also, banana smuggling and trafficking between the two countries, although denounced by SVIAA's agronomists, and despite the INSAI regulations (Palomares, 2020). Illegal trade could also lead to the entry of *Foc* TR4. Phytosanitary authorities

should step up farm biosecurity measures and border controls to prevent it, as it could mean the disappearance of one of the main elements of the Venezuelan diet.

Citrus Huanglongbling (HLB)

At the beginning of the 21st century, huanglongbing (HLB) emerged as the most destructive citrus disease and the single main threat to the future of the world citrus industry (Bové, 2006). In October 2016, first reports of early HLB-like symptoms such as leaf yellowing and yellow shoots in trees in Aragua state were alerted by citrus producer organizations and issued by researchers working at INIA to the respective phytosanitary authorities (Morales and Schmidt, 2016). The early detection of HLB is based on molecular, PCR methods, and it is one of the cornerstones for preventing incursion into disease-free countries. However, early and accurate diagnosis was not performed due to the lack of materials needed to conduct PCR tests in the country. Then in August 2017, the crop failed dramatically, and recurrent demands from citrus producers facing heavy crop losses forced the phytosanitary authorities (INSAI) to respond. International scientific cooperation among Venezuelan plant pathologists abroad, the Inter-American Institute for Cooperation on Agriculture (IICA) in Venezuela allowed the purchase of oligonucleotides and reagents needed for the molecular detection of HLB. The disease was diagnosed and exotic pest alert outbreak was issued by the INSAI (República Bolivariana de Venezuela, 2017). However, institutional approaches to plant health failed, and rules to prevent HLB spread were not established in the country. One year after the first reports of symptoms, HLB was widespread in the main citrus-producing states with an overall high incidence (Marys et al., 2021). As a result, citrus production has declined from 2016 to the present by more than 90% [FEDEAGRO (Confederación de Productores Agropecuarios de Venezuela), 2020]. According to fruit growers' associations, only 5% of the 35.000 hectares planted with citrus in Venezuela continued to exist in high mountain range Andean by 2020 [FEDEAGRO (Confederación de Productores Agropecuarios de Venezuela), 2020]. The disease not only reduced the availability of citrus fruits, but is also threatening the livelihoods of people depending on citrus crop for their income. The citrus industry landscape is uncertain in the actual context of the economical and institutional crisis. At this time hundreds of farms are no longer productive and have been abandoned. Some farmers have switched to the cultivation of other crops in order to salvage their livelihoods.

Maize Pests and Diseases

During 2020, major outbreaks of armyworms (*Spodoptera frugiperda*) were reported in many maize fields in Venezuela, with estimates of 20–50% yield loss (Colmenárez, 2020). Amid fuel and chemical shortages, and COVID-19 pandemic spread, controlling the pest has become even more difficult, representing a significant threat to food security and livelihoods.

Phytopathologists also identified symptoms associated with *Rhizoctonia* and *Fusarium*. However, very few investigations have been carried out on the molecular genetic characterization of the fungal population in maize in Venezuela (González-Vera et al., 2010).

Prospects

The globalization of trade, human mobility, climate change, pathogen and vector evolution, and political instability all combine to create a global environment with the increasing risk to food security. The social and economic consequences of the failure to recognize, contain, and/or control threatening plant pathogens require that every effort be made to engage in efficient and effective programs of surveillance, diagnosis, and detection (Miller et al., 2009). The development of a strong initiative in plant health in Venezuela is hampered by gaps in several critical areas, mainly due to the dismantling of the national plant health network. It is key to identify concrete strategic partnerships, both national and international, to boost the restoration of plant health research capacities in the country. Funding gaps could be bridged through public-private and donor partnerships with proper maintenance and supervision to invest in the improvement of scientific research by stocking and refurbishing pre-existing laboratories. A case in point was the huge investment made by Inter-American Bank of Development and the FONACIT (National Found for Science and Technology) in the biotechnology sector in Venezuela in the early 2000s [FONACIT (Fondo Nacional de Ciencia y Tecnología e Innovación), 2007; Tapia et al., 2017]. As a result, one of the authors (Marys) received funding for the development of a network for plant virus diagnostics. That investment allowed plant virology laboratories to adopt what were state-of-the-art technologies at the time for plant diagnostic (ELISA and PCR) for routine use. Unfortunately, the projects were not continued due to the lack of institutional support, which lead to the obsolescence of equipment and breakup of the network (Tapia et al., 2017). However, at least two of these laboratories retain certain baseline capacity (IVIC, UCV).

The accurate identification of causative agents is the foundation of phytopathology and the resolution of different methods, especially modern techniques, is an important consideration for plant disease epidemiology and diagnostics (Elshire et al., 2011). Therefore, genomic and bioinformatic approaches should be adopted in Venezuela. Investment in human resource capacity is desperately needed in the country. It is well-documented that Venezuela has lost 16% of its scientific research force through emigration mainly in recent years (Diez et al., 2021). Researchers in agricultural sciences accredited in PEII (Research Stimulus Program) accounted for 23% of all knowledge areas in 2012, falling to 11% in 2015 (Tapia et al., 2017). Graduate programs should emphasize training in applied plant pathology with a good foundation in molecular biology. Strengthening relations with the diaspora of researchers in plant pathology could allow the creation of fellowship-style programs that house Venezuelan researchers in universities abroad.

The spread of invasive plant pathogens in Venezuela is a growing emergency of national and regional scale, with pervasive and long-lasting harmful effects on food

supplies and livelihoods. This review is a call for action. There is a compelling need for integrated and coordinated responses at national, regional and international levels that aim to reduce the national gap in early and accurate plant pathogens diagnosis.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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