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Impact of the COVID-19 pandemic on influenza vaccination coverage in Latin America: Mexico and Central America

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ABSTRACT

Objective: This study aimed to evaluate trends in seasonal influenza vaccination coverage in Mexico and Central America during the 2018–2023 period and analyze the specific impact of the COVID-19 pandemic on regional immunization programs.

Materials and Methods: A retrospective, descriptive, and longitudinal study was conducted across Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama. Data were triangulated from the WHO/UNICEF Joint Reporting Process, PAHO surveillance databases, and national administrative records from Ministries of Health. The analysis focused on high-risk priority groups: children (<5 years), older adults (≥60 years), pregnant women, healthcare workers (HCWs), and individuals with chronic underlying conditions.

Results: Influenza vaccination coverage showed significant regional variability and a widespread decline between 2019 and 2021 due to structural barriers (e.g., center closures) and psychological factors (e.g., public fear). While non-pharmacological interventions led to an unprecedented decline in influenza activity during the 2021–2022 season, a strong resurgence occurred in 2022–2023, primarily driven by influenza A(H1N1)pdm09. By 2023, no country in the region reported optimal vaccination coverage for the pediatric group. Conversely, coverage for HCWs and individuals with chronic conditions remained more stable in countries such as Mexico and Nicaragua. Significant regional disparities in vaccine procurement and gaps in epidemiological reporting were also identified.

Conclusions: The pandemic exposed critical vulnerabilities in health systems and significantly altered influenza-associated disease patterns. As the region faces a potential "tridemic" involving influenza, SARS-CoV-2, and respiratory syncytial virus (RSV), it is essential to strengthen program financing and procurement strategies. Enhancing healthcare provider training to combat vaccine hesitancy and maintaining adaptable surveillance systems are crucial to ensuring the resilience of immunization programs against future respiratory threats.

Introduction

During the COVID-19 pandemic, national immunization programs faced unprecedented global strain, leading to significant disruptions in routine vaccination services[1,2]. Despite these logistical challenges, influenza vaccination policies and reporting systems gained relevance. Its importance is fundamental due to the imminent threat posed by the simultaneous circulation of SARS-CoV-2 and influenza viruses. In response to this public health priority, the Global Health Consortium of the Global Health Department at the Robert Stempel College of Public Health & Social Work, Florida International University, commissioned a comprehensive series of studies to evaluate the pandemic's impact on influenza vaccination coverage in Latin America[3], specifically focusing on Mexico, Central America, the Andean Region, the Southern Cone, and Brazil.

The 2020-2021 period presented a unique epidemiological pattern: while influenza vaccination coverage rates were declining due to program disruptions, global influenza activity—including cases, hospitalizations, and deaths—dropped to historically low levels[4,5,6]. This decline has been attributed to widespread social isolation and to preventive measures implemented globally[7], as well as to non-pharmacological interventions, such as social distancing and enhanced hygiene measures[8]. However, as these preventive measures were relaxed, a strong resurgence of influenza emerged in the 2022–2023 season, driven primarily by influenza A (H_1N_1pdm09), underscoring the danger of diminished population immunity.

In Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama) and Mexico, targeted efforts were made to promote influenza vaccination during the pandemic, aiming to reduce unnecessary strain on health services that could arise from concurrent influenza outbreaks, supported by evidence, from health authorities the Pan American Health Organization (PAHO) Technical Advisory Group on Vaccine-Preventable Diseases in July 2021[9] reviewed evidence on the advantages of influenza vaccination during the pandemic. This evidence suggested potential benefits of influenza vaccination in reducing COVID-19 severity[10,11], particularly among the elderly population, including lower rates of hospitalization, reduced need for intensive care, and decreased mortality[9,10,11].

Despite these strategic efforts, routine vaccination coverage continued to falter due to structural and psychological barriers, including influenza, as observed during this period[7]. Factors contributing to this decline included temporary closure of vaccination centers, limited transportation, shortages of supplies, and fear among the population[12].

Understanding these local dynamics is essential for informing public policy and strengthening clinical resilience against the emerging threat of a "tridemic" involving influenza, SARS-CoV-2, and respiratory syncytial virus (RSV).

Materials and methods

STUDY DESIGN AND SCOPE:

We conducted a retrospective, descriptive, and longitudinal study to evaluate the trends in seasonal influenza vaccination coverage in Mexico and Central America, analyzing the impact of the impact of the COVID-19 pandemic on these vaccination coverage. The study area includes Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama. The period of analysis spanned from 2018 to 2023, allowing for a comparison between pre-pandemic baselines, the acute phase of the COVID-19 pandemic, and the subsequent recovery period.

DATA SOURCES AND COLLECTION

We triangulated information from three primary global and regional surveillance systems:

WHO/UNICEF Joint Reporting Process (JRF): Used to obtain standardized annual estimates of national immunization coverage. Pan American Health Organization (PAHO) Databases: We accessed the "Immunization in the Americas" annual summaries and the PAHO Influenza Vaccination Coverage, National Administrative Records: Data were complemented with official reports from the Ministries of Health (MoH).

VARIABLES AND DEFINITIONS

The primary outcome variable was the Annual Vaccination Coverage Rate, defined as the percentage of the target population that received the seasonal influenza vaccine according to each country's national immunization schedule. Analysis

focused on high-risk priority groups as defined by PAHO/WHO: Pediatric populations (<5 years); Older adults (≥60 years); Pregnant women at any gestational age. Healthcare workers. Individuals with chronic underlying conditions.

DATA ANALYSIS

Data were organized in a comparative matrix to identify longitudinal trends. To quantify the impact of the pandemic, we calculated the absolute and relative (%) change in coverage using 2019 as the reference (baseline) year. The timeline was categorized into three phases: Pre-pandemic Phase (2018–2019): Baseline period of routine immunization. Pandemic Disruption Phase (2020–2021): Period marked by lockdowns, redirected health resources, and social distancing. Recovery and "Tridemic" Context (2022–2023): Period of transition back to routine services and the emergence of co-circulating respiratory viruses (SARS-CoV-2, Influenza, and RSV).

Epidemiological data on viral circulation were cross-referenced with vaccination rates using the PAHO Interactive Influenza Reports to observe the correlation between coverage drops and viral resurgence.

ETHICAL CONSIDERATIONS

This study utilized secondary, de-identified, and publicly available data provided by international health agencies and national ministries. Consequently, it did not involve human subjects' intervention and was exempt from Institutional Review Board (IRB) review, in accordance with ethical standards for secondary data analysis.

Results:

The impact of the COVID-19 pandemic on influenza vaccination coverage and epidemiology in Mexico and Central America was analyzed across eight countries: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama. Administrative vaccination coverage data from 2018 to 2023 were reviewed, along with epidemiological surveillance reports from WHO, UNICEF and PAHO.

POSSIBLE CAUSES AFFECTING INFLUENZA IMMUNIZATION DURING THE COVID-19 PANDEMIC.

Factors Influencing Influenza Circulation and Viral Interplay during the COVID-19 Pandemic.

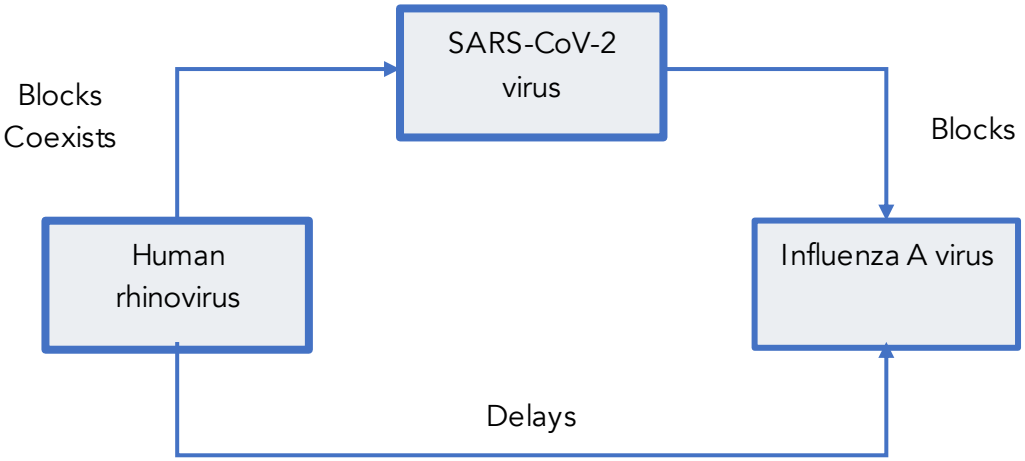
Respiratory viruses exhibit significant diversity in genomic structure, clinical severity, seasonality, and transmission dynamics[13]. In Latin America and the Caribbean, influenza remains a major public health burden, accounting for approximately 36,500 deaths and 400,000 hospitalizations annually[7]. However, the emergence of SARS-CoV-2 in 2020 fundamentally altered these trends. The implementation of non-pharmacological interventions led to a significant reduction in influenza-related cases and hospitalizations across North America, Central America, and the Caribbean during the 2019–2020 and 2020–2021 seasons in the Northern Hemisphere, and throughout 2021 in the Southern Hemisphere[7,8,14].

The effectiveness of these interventions varies depending on the virus. Both influenza and SARS-CoV-2 share similar transmission pathways, including direct contact, contaminated surfaces, aerosols (for SARS-CoV-2), and droplets. However, influenza has a higher basic reproduction number (R_0), ranging from 1.0 to 21.0, compared to 0.5 to 8.0 for SARS-CoV-2. Similarly, influenza shows a higher household secondary attack rate (1.4–38.0) compared to SARS-CoV-2 (0–38.2)[13].

A decline in influenza cases during the pandemic has also been attributed to the ecological displacement of respiratory viruses due to SARS-CoV-2 circulation. Before 2020, influenza and rhinovirus were the most common respiratory viruses. However, during the first wave of SARS-CoV-2, rhinovirus became the dominant circulating virus[15]. Rhinovirus is known to coexist with other respiratory viruses and may inhibit influenza circulation by blocking its replication in the upper respiratory tract[16].

Additionally, SARS-CoV-2 circulation may delay the appearance of influenza, while rhinovirus can inhibit SARS-CoV-2 replication, potentially through an interferon-mediated response. This phenomenon could also influence COVID-19 severity and disease burden (Figure 1)[17].

Figure 1. Interaction between respiratory viruses. Adapted from COVID-19 Shuts Doors to Flu but Keeps them Open to Rhinoviruses. Kiseleva I, Ksenafontov A. Biology (Basel). 2021;10(8).



Source: Adapted from COVID-19 Shuts Doors to Flu but Keeps Them Open to Rhinoviruses. Kiseleva I, Ksenafontov A. Biology (Basel). 2021;10(8). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8389621/

Efficacy of surveillance systems on epidemiology of influenza during the COVID-19 pandemic.

Epidemics have impacted human populations throughout history.[18] Epidemiological surveillance of influenza remains one of the most critical challenges for national health systems. They serve as a foundation for modeling potential pandemics, developing strategic response plans, implementing prevention and control mechanisms, and enhancing preparedness. Notably, Mexico and Central America leveraged lessons learned during the 2009 H_1N_1 influenza pandemic, including maintaining strategic drug reserves for treating respiratory infections.

The surveillance mechanisms established during the 2009 influenza pandemic proved invaluable for countries in Central America and Mexico. These mechanisms enabled local health authorities to effectively identify and monitor respiratory pathogens such as influenza. During the 2019 pandemic, these pre-existing systems continued to play a crucial role. Despite increased workloads on healthcare providers, they remained sensitive and robust, facilitating the detection and local characterization of COVID-19.

As detailed in Table 1, the majority of most countries in the region have implemented surveillance systems to monitor influenza-like illness (ILI),and Severe Acute Respiratory Infections (SARI). These systems incorporate virological diagnostics through reverse transcription polymerase chain reaction (RT-PCR) and report findings to international platforms such as Flu ID and FluNet, except for Panama[2].

Table 1. Epidemiologic surveillance indicators of influenza per country

Country	SARI surveillance	ILI surveillance	National Center of Influenza	RT-PCR surveillance	External quality evaluation program	Last evaluation year	Flu ID report	Flu Net report
Belize	Yes	Yes	Yes	Yes	Yes	2021	Yes	Yes
Costa Rica	Yes	Yes	Yes	Yes	Yes	2021	Yes	Yes
El Salvador	Yes	Yes	Yes	Yes	Yes	2020	Yes	Yes
Guatemala	Yes	Yes	Yes	Yes	Yes	No data	Yes	Yes
Honduras	Yes	Yes	Yes	Yes	Yes	2021	Yes	Yes
Mexico	Yes	Yes	Yes	Yes	Yes	2021	Yes	Yes
Nicaragua	Yes	Yes	Yes	Yes	Yes	2020	Yes	Yes
Panama	Yes	Yes	Yes	Yes	Yes	2021	Yes	No

Influenza epidemiology depends on the agent, host, and environmental factors that influence seasonality, severity, and transmission. Vulnerable populations, such as the elderly, individuals with comorbidities, and those with incomplete vaccination coverage, require close monitoring.

As zoonotic diseases like avian influenza continue to emerge, integrating human and animal disease surveillance is critical. Although human-to-human transmission of recent zoonotic strains remains inefficient, preparedness and control measures are imperative. Surveillance systems must also anticipate potential "tridemics" involving influenza, SARS-CoV-2, and respiratory syncytial virus (RSV). Enhanced early detection, retrospective evaluation, and evidence-based interventions will be essential for future pandemic readiness.

Epidemiological surveillance systems play a critical role in public health decision-making, especially for assessing preventive measures like vaccination. These systems in Central America and Mexico are well-established, trusted, and capable of generating essential data.

Key epidemiological indicators include surveillance for SARI and influenza-like illness (ILI), the presence of National Influenza Centers, and RT-PCR diagnostic capacity. Evaluations conducted between 2020 and 2021 revealed gaps in reporting and data sharing, particularly with Panama excluded from FluNet submissions until 2023. Further refinement of these systems can improve the quality and utility of available information.

In Belize, the national surveillance system uses World Health Organization (WHO) case definitions, with sample testing conducted through the Belize Health Information System. In 2020, 1,078 tests were performed[2]. On the other hand, in Costa Rica, surveillance employs national definitions for (ILI) and severe acute respiratory infections (SARI), while WHO definitions are used for acute respiratory infections (ARI). A sample of 50 ILI cases is tested weekly, alongside all SARI cases, using the PAHO system and the national electronic medical record (EDUS). In 2020, 4,700 tests were conducted[2].

In El Salvador, the VIGEPES system uses WHO definitions for ILI, ARI, and SARI. Sentinel surveillance is carried out in 3–4 sites for ILI and 1,238 sites for SARI, with over 1,000 tests performed in 2020 (11). Guatemala uses a sentinel surveillance for ILI and SARI that conducted 1,714 tests in 2020. National surveillance covers ARI cases, testing 40% of SARI cases and 60% of ILI cases, with data reported online through the PAHO SIGSA 3 system.[2] Honduras uses WHO case definitions, with 21% sentinel sites tests of ILI cases and 100% of SARI cases. ARI cases are monitored nationally using the SINAVIS system. In 2020, 1,262 tests were conducted[2].

Mexico uses a robust surveillance system includes SISVER for ILI/SARI and SUIVE for ARI, using sentinel sites testing in 10% of ILI cases and 100% of SARI cases. In 2020, 68,165 tests were performed[2]. Nicaragua has a surveillance that utilizes sentinel sites for ILI and SARI, with 100% of SARI cases and three ILI samples weekly tested through the "Alerta" system. ARI cases are monitored nationally using SIVE, with 3,639 tests conducted in 2020[2]. Finally, Panama also uses WHO definitions for ILI, ARI, and SARI, with sentinel sites collecting 100 cases weekly across ten locations. In 2020, less than 1,000 tests were performed[2].

All eight countries conduct virological surveillance using standardized RT-PCR methods. However, Belize and Nicaragua do not share samples with WHO, while Panama and Honduras are the only countries performing economic analyses of healthcare costs related to influenza[19]. The surveillance systems in these eight countries provide reliable data, supporting public health decision-making and policy formulation. Nonetheless, underreporting remains a challenge in some regions, and burden-of-disease analyses are absent in most countries.

As mentioned before, the COVID-19 pandemic significantly impacted influenza activity. In the Americas, influenza seasons ended abruptly in 2019–2020, with minimal documented activity in 2020–2021 due to preventive measures. Cases remained unusually low in 2021–2022 but surged in 2022–2023, driven by influenza A, A(H1N1)pdm09, and isolated cases of influenza B. There are reports in Latin America that show the behavior of Influenza virus. For example, in Mexico and North America, similar trends were observed, with non-typified influenza A and B cases occurring during the final weeks of the season. In Central America and the Caribbean, influenza A exhibited prolonged circulation, with fewer influenza B cases in 2021–2022[19].

Influenza vaccination in Central America and Mexico before and after the COVID-19 pandemic.

The COVID-19 pandemic impacted countries differently. In Central America, adult mortality from

COVID-19 during the first half of 2021 surpassed that of 2020. In Costa Rica for example, there were 81% more COVID-19 related deaths, at ages under 60 as of June 2021 than in 2020. The dynamics of COVID-19 were similar across Central American and Mexican countries, showing a steady pattern in 2020, with an increase in cases and mortality in March-April[20]. Comorbidities and sociodemographic characteristics, especially in underserved areas, contributed to changes observed in COVID-19 morbidity and mortality during the pandemic, with dynamics of infections and deaths in Latin America that varied by country[21].

Behavior of COVID-19 also had an impact on the dynamics of respiratory viruses, including influenza, and had a major impact on prevention measures such as vaccination. It is known that influenza vaccination coverage decreased in Central America and Mexico from 2019 to 2021[4].

While influenza vaccines are not universally included in national immunization programs worldwide, they are incorporated into the vaccination schedules of most countries in the Americas, covering 41 countries and territories. Application varies across Central American countries and Mexico. Immunization schedules have been adapted following the WHO and PAHO recommendations, and considering epidemiological conditions, organizations, and financial realities for each country.

Belize, Guatemala, and Mexico apply the influenza vaccine with the northern hemisphere formulation between October and February, while Costa Rica, El Salvador, Honduras, Nicaragua, and Panama use the southern hemisphere formulation[22].

Based on epidemiological characteristics and the availability of economic resources[23], countries decide if trivalent (one antigen against influenza B and two against influenza A) or tetravalent (two antigens against influenza A and B) vaccines are used. In 2022, Costa Rica, El Salvador, and Panama used tetravalent vaccine[24,25], while Belize, Guatemala, Honduras, Mexico, and Nicaragua used trivalent vaccine in their national vaccination campaign.

According to the epidemiological situation and availability of resources in each country, prioritization of risk groups is used based on recommendations of the Technical Advisory Group (TAG) of PAHO and the Strategic Advisory Group of Experts on Immunization (SAGE-WHO), which prioritize pregnant women, children, elderly, people with underlying diseases, and healthcare workers[9].

Information regarding vaccine coverage against influenza varies among countries, depending on their policies to provide vaccination and their definition of high-risk groups. Report systems and the frequency with which information is updated are also different among regions. Considering these variations, the information available in Central America and Mexico is not complete. Vaccine coverage information is based on annual reports that countries make to PAHO, WHO, and UNICEF[26], and that are available in the PAHO database[27], WHO[28], and the "Immunization of the Americas" document from PAHO between 2018-22[12,29-31].

During the COVID-19 pandemic, influenza vaccination rates varied across countries in Central America and Mexico (Table 2). While social distancing measures contributed to a decline in influenza cases during this period, vaccination efforts had significant impact.

Vaccination against influenza in pregnant women has been a priority in American countries, especially after the influenza A H1N1 pandemic in 2009. All countries have pregnant individuals as a priority group. Available information shows that El Salvador, Honduras, and Mexico had steady coverage during 2020, while Panama increased coverage that year. Nevertheless, in 2021, Guatemala, Honduras, and Panama experienced a decrease in vaccines applied in this group. Comparing 2021 data with 2018 in Costa Rica, a decrease in coverage among pregnant women, children, and the elderly was observed, while there was an increase among healthcare workers, a trend that continued in 2022 and 2023 (Table 2). This highlights the variability in vaccine uptake across risk groups and underscores the need for targeted strategies to improve coverage among vulnerable populations.

Table 2. Influenza vaccine coverage for key groups in Central America and Mexico between 2017-2023.

Countries	Year						
	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)
Influenza vaccine coverage in pregnant women							
Belize	8	48	72	No data	6	5	8
Costa Rica	72	73	No data	No data	69	No data	82
El Salvador	61	78	48	49	60	100	87
Guatemala	23	No data	No data	16	10	14	16
Honduras	78	82	85	84	63	60	67
Mexico	62	81	No data	78	88	88	81
Nicaragua	51	91	98	No data	89	87	98
Panama	58	64	63	73	58	79	93
Influenza vaccine coverage in children							
Belize	73	70	83	54	85	41	43
Costa Rica	32	77	No data	No data	66	45	43
El Salvador	62	66	57	39	54	65	65
Guatemala	2	100	1	10	4	8	13
Honduras	No data	No data	62	53	47	38	47
Mexico	84	88	91	87	82	83	86
Nicaragua	No data	No data	No data	No data	No data	No data	No data
Panama	69	57	71	61	27	33	31
Influenza vaccine coverage in elderly							
Belize	2	41	36	6	2	1	3
Costa Rica	92	99	No data	No data	61	No data	56
El Salvador	35	No data	42	37	45	57	64
Guatemala	No data	No data	No data	No data	3	3	5
Honduras	88	79	68	56	45	100	73
Mexico	94	94	94	94	95	95	95
Nicaragua	No data	No data	No data	No data	96	97	No data
Panama	100	100	83	99	18	67	65
Influenza vaccine coverage in chronic conditions							
Belize	No data	No data	No data	No data	2	4	1
Costa Rica	No data	79	No data	No data	No data	No data	No data
El Salvador	No data	No data	No data	No data	No data	No data	No data
Guatemala	100	No data	No data	No data	25	33	53
Honduras	100	100	100	100	100	100	No data
Mexico	100	99	99	100	100	100	100
Nicaragua	No data	100	100	100	100	100	100
Panama	No data	No data	No data	No data	100	100	No data
Influenza vaccine coverage in health personnel							
Belize	No data	78	46	12	3	1	1
Costa Rica	88	72	No data	No data	88	No data	No data
El Salvador	61	84	100	100	100	100	99
Guatemala	74	90	No data	47	32	34	47
Honduras	100	100	85	82	59	88	91
Mexico	100	100	100	100	100	95	100
Nicaragua	88	100	96	100	100	100	100
Panama	92	94	95	89	42	53	70

Source: Data originate from World Health Organization WHO, https://immunizationdata.who.int/global/wiise-detail-page/influenza-vaccination-coverage. (July 18, 2024).

Vaccination coverage among children saw a decline in many countries during 2021, with partial recovery in Belize and El Salvador. However, by 2022 and 2023, no country reported optimal vaccination coverage for this group.

For elderly populations, vaccination coverage decreased in most countries, except Mexico and Panama, in 2020. By 2021, El Salvador and Mexico had returned to pre-pandemic coverage levels, while Honduras and Panama experienced consistent

declines. An increase in coverage was observed in most countries during 2022, but some, such as Honduras and Panama, saw decreases again in 2023.

Data on vaccine coverage for individuals with chronic underlying diseases is limited. Honduras and Nicaragua reported consistent maximum coverage for this group in 2020-21, while Mexico and Nicaragua maintained high and stable coverage through 2022-23.

Vaccination among healthcare workers remained stable from 2019 to 2020. However, a decrease was reported in Belize, Guatemala, Honduras, and Panama by 2021 compared to 2020. By 2022-23, most countries showed increased coverage for healthcare workers, but Belize, Guatemala, and Panama continued to report low rates.

A significant issue across the region is that countries do not procure enough vaccines to cover all defined high-risk groups, with doses purchased often falling short of actual needs. This discrepancy suggests countries may report administrative coverage rates—percentages of doses administered relative to the total procured—rather than true coverage among at-risk populations. The diversion of resources during the COVID-19 pandemic likely affected vaccine procurement and distribution.

There are several country-specific efforts and challenges during this period. Before the pandemic, Belize efforts to establish robust vaccination policies showed promise, using the Northern Hemisphere vaccine formulation between October and June. Coverage was severely impacted during the pandemic, except for children, where 2021 levels matched pre-pandemic figures. On the other hand, Costa Rican annual influenza vaccination is scheduled from May to July using the Southern Hemisphere formulation. Efforts to enhance public health policies have been ongoing. Vaccination campaigns in El Salvador uses the Southern Hemisphere formulation start between April and May. Although the number of doses increased over the years, vaccination coverage for children and the elderly declined in 2020.

Another example is Guatemala, which initially alternated between Southern Hemisphere vaccines (April-June) and Northern Hemisphere vaccines (November-December). Guatemala adopted the latter exclusively after 2018. Data on high-risk groups is limited, but coverage for children decreased during the pandemic. Honduras uses the Southern Hemisphere formulation and administers approximately 1.5 million doses annually. There was a slight increase in doses available between 2018 and 2021.

In Mexico, influenza vaccination coverage was impacted during the pandemic, with slight declines in pregnant women and children in 2020. By 2021, coverage for pregnant women returned to pre-pandemic levels and remained stable through 2022-23. High coverage was consistently reported among healthcare workers and individuals with chronic conditions. Vaccine coverage for healthcare workers and individuals with chronic conditions in Nicaragua remained steady, but coverage for pregnant women dropped compared to pre-pandemic levels. While no data are available for children, the country reported 100% coverage for groups with chronic diseases and for healthcare workers.

National vaccination policies in Panama guide influenza immunization, but vaccine availability declined between 2018 and 2021. Coverage for children and healthcare workers decreased, while slight increases were observed for pregnant women and the elderly. By 2022-23, coverage for priority groups showed improvement.

The findings highlight the importance of robust vaccination programs and surveillance systems to manage respiratory diseases, particularly in the context of pandemics like COVID-19. Regional disparities in vaccine coverage underscore the need for improved procurement strategies, consistent vaccination schedules, and enhanced reporting systems to ensure at-risk populations receive adequate protection.

Access to influenza vaccine in Central America and Mexico.

The Americas region is recognized by the WHO as the leading user of influenza vaccines worldwide, with over 300 million doses applied annually, including approximately 40 million doses in Central America and Mexico alone (1). Vaccine acquisition in the region occurs through local production, the PAHO Revolving Fund (RF) for Vaccines, direct purchases from producers, and donations. As of 2019, six countries in the Americas reported local

influenza vaccine production, with several initiatives launched during the COVID-19 pandemic to bolster regional self-sufficiency. However, this goal remains unmet[32].

The PAHO-RF plays a pivotal role in ensuring vaccine quality, cost-effectiveness, and uniformity across countries, regardless of vaccine formulation (trivalent or tetravalent). During the pandemic, the RF was instrumental in maintaining equity and supply continuity, including for influenza vaccines[33]. Countries can also procure vaccines directly from producers, adhering to WHO standards and often achieving competitive pricing. For instance, most southern hemisphere influenza vaccines are locally manufactured, allowing countries flexibility to combine PAHO-RF procurement with direct agreements. Additionally, vaccine donations serve as an important resource, though specific details on contributors or volumes could further illustrate their impact.

Discussion

Vaccination is a complex and priority process in need of new strategies and mechanisms for the continuous improvement of programs and public policies. Each vaccination program has differences among countries; nevertheless, they all have a core health system based on the prevention of diseases with sensitive epidemiological surveillance systems able to generate information that public policies can and should use for decision-making regarding vaccination.

Vaccination cannot be an isolated program from other interventional strategies or control of diseases. The 2019 WHO World Strategy against Influenza for 2019-30 has core elements so that every country can be prepared to face the risk of a new influenza pandemic.

Lessons learned by all health systems during the COVID-19 pandemic are relevant. Such an unprecedented event highlighted the strengths but also the weaknesses of health systems around the world. Even though in most countries, vaccination was a well-received strategy, it showed resistance among people, doubt, and a growing antivaccine force that affected vaccination campaigns. Nevertheless, there is a need to increase vaccination coverage against influenza in Central America and Mexico.

The objectives and priority actions of the World Strategy against Influenza are to strengthen national surveillance capacities, prevention, preparedness, treatment, and response; and to elaborate better instruments to prevent, detect, and control influenza disease using vaccines, antivirals, and effective treatments available in all countries[34].

This World Strategy contemplates all actions necessary to prepare and plan for influenza season, and the possibility of a future pandemic caused by influenza. Priority inclusion of vaccine processes is necessary, not only in the operations side, but in research and innovation.

It is important to emphasize the need for immunization programs to be separated from political decisions and become programs that endure and get stronger with time. It is essential to gradually establish a legal framework to provide vaccination policies and ensure adequate finance for their proper implementation.

Most countries in the PAHO region, particularly Central America and Mexico, carry out campaigns of massive vaccination, to reach identified priority groups. Influenza vaccine is not always offered in public health systems, and unlike other vaccines, it is only available during pre-defined high-risk epidemiological periods, that vary in every sub-region.

Before the COVID-19 pandemic, vaccination was mainly offered at health entities and mobile units to reach places of dense people concentration. For example, Honduras used to increase vaccination hours extending day and night service hours to improve access possibilities for the working force and their families.

In 2020-21, several strategies to maintain vaccine coverage were implemented, including vaccination in institutions with extended working hours, designated vaccine areas to avoid contact with COVID-19 patients, mobile units to visit communities, drive-through vaccination sites, and vaccines offered during other healthcare services.[7] For this purpose, countries adapted their health systems, using social and community leaders, and created health promotion campaigns through massive advertising[12]. Some countries continue to strengthen vaccination campaigns to achieve optimal population protection coverage.

Central America and Mexico's vaccination programs have a great history of success. Elimination of vaccine-preventable diseases has been accomplished in the region several times before, so the use of adequate resources in each country and region is not the current challenge to improve vaccine coverage.

There are important elements that could help improve the influenza vaccine in the region. Adequate training before, during, and after vaccine campaigns to healthcare providers is necessary, so they can understand the importance of immunization and encourage communities and high-risk populations. Skills to guide and inform the general public and to help address hesitancy or doubt could help prevent misinformation and improve vaccine acceptance. The COVID-19 pandemic has made evident the growing infodemic problem that people around the world is exposed to.

One of the biggest challenges for Central America and Mexico is to improve and maintain vaccination coverage, prioritize national immunization programs, and guarantee the human and economic resources necessary. An alliance between public, social, private, academic, and religious sectors, among others, could help in this process.

Conclusions

Vaccination remains a cornerstone of public health and requires robust strategies to improve coverage in alignment with local epidemiological policies. The COVID-19 pandemic clearly revealed vulnerabilities in health systems and vaccination campaigns across Central America and Mexico, evidenced by significant disruptions in influenza associated disease patterns. As shown in this study, the unprecedented decline in cases during the 2021 – 2022 season was followed by a sharp resurgence in 2022-23.

To address challenges such as limited resources and infrastructure, the region must focus on better training for healthcare providers, enhancing public awareness, and strengthening the financing of vaccination programs to ensure they remain resilient against political volatility. By building on the successes of previous campaigns and lessons learned from the pandemic—specifically the need to overcome vaccine hesitancy and the 'infodemic'—Central America and Mexico can strengthen their vaccination systems to effectively prevent and control respiratory diseases and safeguard their most vulnerable populations.

An earlier version of this manuscript was published as a pre-print[35].

Declaration of interests

We declare no competing interest.

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Author contribution statement

Carlos Espinal and Francisco Becerra-Posada conceptualized the revision and made substantial contributions and edits. Cuauhtémoc Ruiz-Matus, Lorena Suárez-Idueta, and Cuitlahuac Ruiz-Matus wrote the original first draft. Helena Brenes Chacon provided comments on the manuscript. Ruby Trejo Varon and Francisco Becerra provided comments on the manuscript and adjusted the final manuscript. All authors participated in the draft revisions and in approving the final draft for submission. The authors accept responsibility for the decision to submit the article for publication.

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