Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Effect of Omicron on the prevalence of COVID-19 in international travelers at the Mexico city international airport. December 16th, 2021 to January 31st, 2022

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ABSTRACT

Introduction: SARS-CoV-2 continues to have a high rate of contagion worldwide. The new variant of concern, Omicron, has mutations that decrease the effectiveness of vaccines and evade antibodies from previous infections resulting in a fourth wave of the pandemic. It was identified in Mexico in December 2021.
Methods: The Traveler's Preventive Care Clinic from the Faculty of Medicine UNAM at Mexico City International Airport has performed rapid antigen and PCR SARS CoV2 tests since January 2021 to comply with the new travel requirements. Demographic and clinical characteristics were collected from each passenger and the fourth wave of the pandemic in Mexico mainly caused by Omicron was analyzed in the travelers.
Results: A total of 5176 travelers attended the clinic between the second half of December 2021 and January 2022. Ten percent of all the tests performed were positive (13% of PCR and 9.3% of antigens, $p = 0.001$). Most of the SARS CoV2 positive cases were asymptomatic (78%), with a ratio of 3.5:1 over the symptomatic. By age groups, this ratio was higher for those under 20 years old (8.7:1).
Discussion: This study shows the rapid escalation of positivity that occurred in Mexico, detected in travelers, from the second half of December 2020 and throughout the month of January 2021. The incidence of COVID-19 was extremely high in travelers who were mostly asymptomatic for the period under study.

1. Introduction

Acute respiratory diseases in travelers are common, and can be characterized among them by age, sex, trip duration and type of travel to understand their impact and risk factors. These diseases have been observed in 7.8%–20% of the international travel population [1]. As globalization accelerates the mobility of infectious diseases far beyond national boundaries, many variants of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) have emerged.

On November 26th, 2021, two years after the first reported case, the World Health Organization (WHO) alerted about a new SARS-CoV-2 variant of concern: Omicron. On December 3rd, the first case of

Abbreviations: WHO, World Health Organization; SARS CoV2, Severe Acute Respiratory Syndrome Coronavirus 2; CAPV, Traveler's preventive care clinic (acronym in Spanish, Clinica de atención preventiva del viajero); SCU, Sample collection Unit; AICM, Mexico city international airport (acronym in Spanish, Aeropuerto Internacional de la Ciudad de Mexico); UNAM, Universidad Nacional Autónoma de México.

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Omicron in Mexico was identified and reported [2].

The new Omicron variant (lineage B.1.1.529) has shown that a large number of mutations in the S protein decreases the effectiveness of vaccines (although it protects against severe disease and death) and evades antibodies generated by previous infections (reinfections), causing a new wave of the pandemic. In a couple of months, it became the predominant variant in the world [3].

Following the identification of this variant, governments around the world took again steps to minimize its impact (entry restrictions that include border closures, bans by nationality, suspension of international flights; and conditions for entry, for example, medical requirements) [4,5]. However, Omicron has a much higher rate of infection, transmission, and asymptomatic carriers; this high prevalence of asymptomatic infection is likely a major factor in the rapid and global widespread, even among populations with prior high rates of COVID. It is worth mentioning that these asymptomatic carriers have high viral titers; suggesting that it is an important factor in the rapid global spread [6].

Recent studies have estimated that Omicron has double the reproduction number of the Delta variant, and that the absence of symptoms may not imply the absence of harm. Asymptomatic carriers represent a significant part in their early identification to prevent transmission [7], since the viral load in these asymptomatic patients is comparable to that of symptomatic ones [8].

Although effectiveness of epidemiological containment and mitigation measures have been well assessed in general population, few studies have been done to evaluate entry restrictions and conditions at international airports. Sociodemographic, migratory and health characteristics of COVID-19 travelers screened at the airports may play an important role to inform policy-making efforts in the context of international travel and health security for future epidemics [9].

The present study documents the prevalence of COVID-19 in international travelers at the Mexico City International Airport during the 2021–2022 holiday season and shows the effect of a new SARS-CoV2 variant during the fourth wave in this specific population. Social, migratory and health characteristics of the cases were assessed to find a possible association with COVID-19 test positivity.

2. Methodology

The Faculty of Medicine of Universidad Nacional Autónoma de México (UNAM) has managed for 10 years the Traveler's Preventive Care Clinic (CAPV, for its acronym in Spanish), which is located in Terminal 2 of the country's main airport: Mexico City International Airport (AICM, for its acronym in Spanish).

The clinic offers multiple high quality services to travelers at the AICM. As of the end of January 2021, the Clinic installed the Sample Collection Unit (SCU) in the vicinity of the AICM.

The traveler's flux is constant and increases along the holiday season, according to the regulations imposed by each country of destination, the SCU performs rapid tests of Antigen (Roche, Seegene and Landsteiner brand) of lateral flow. As a rule, these tests are currently requested within less than 24 h before boarding. In other cases, tests such as PCR (Reverse transcriptase polymerase chain reaction test) are requested, (Allplex 2019-nCoV Assay brand, Seegene) which is a multiple real-time PCR assay for the simultaneous detection of 4 genes; the assay is designed to detect the RdRP, S and N genes specific for SARS-CoV-2 and the E gene for all sarbecoviruses, including SARS-CoV-2.

All travelers are given a questionnaire to inquire their demographic and clinical characteristics, travel itinerary and symptoms suggestive of COVID-19. To obtain a travel certificate, a full name, sex, nationality, age and date of birth are required; in addition to the questionnaire and signs and symptoms that have been present in the last seven (7) days such as headache, cough, shortness of breath, runny nose, muscle pain, joint pain, fatigue, sore throat, diarrhea, nausea, vomiting; also the presence of some diseases or comorbidities such as cancer, systemic arterial hypertension, autoimmune diseases, pregnancy, kidney or liver failure and finally their weight and height.

All travelers are informed of their results personally; those who are positive are given guidance and basic isolation information, and a doctor from the CAPV contacts them to carry out personalized follow-up of their case. The time to perform a new test is suggested, and they are also given a discharge medical certificate by the CAPV at the end of the disease. The information of each traveler is stored in a secure database at the CAPV, and the cases are reported to the health authority.

For the present analysis, the database was selected between December 16th, 2021 and January 31st, 2022, which corresponds to the fourth epidemic peak in our country when Omicron was prevalent. Travelers' personal information was removed, and only statistical data was considered. The analysis was performed with the SPSS program (Statistical Package for the Social Sciences) version 28.0.

3. Results

Information was obtained from 5176 travelers who attended the SCU in the indicated period. This service is offered to anyone who comes to the facilities and meets the diagnostic requirements of each country to which travelers go. In general, the requirements are rapid antigen test for travelers to North America, PCR for travelers to Europe and mixed for other destinations. According to this distribution and given that the United States of America (USA) is the main destination for travelers leaving the AICM, most of the travelers require rapid antigen tests (4273 or 82.6%) and in a lower proportion PCR (903 for 17.4%). The positivity for antigens was 9.3% and 13% for PCR ($p = 0.001$) (Table 1). In contrast, the positivity observed during 2021, from January to March was 1%, April to June was 0.27%–0.44%, July and August was 4%, September was 1%, October and November 0.89% and 0.39% respectively, December was 2.78% and January 14.9%. July and August correspond to the Delta wave and December and January to the Omicron wave in Mexico.

The characteristics of the travelers are presented in Table 2, where the number of under 20 years of age represents a proportion close to a fifth (16.5%), since this season includes the winter vacation period in Mexico. The largest proportion of travelers is between 20 and 59 years of age (73.7%) and the population over 60 years represents a smaller proportion (9.8%). The distribution by sex shows no differences in the proportion of men and women. A little more than half of the travelers that were studied are Mexicans (57.3%), followed in frequency by those born in the United States (29.7%) and in the third group are Europeans (5.3%).

Regarding the characteristics of the trip (Table 2), most travelers reported tourism as the reason for their trip (48.9%), followed by emigration/returning home (37.2%) and to a lesser extent, business, and students. North America was the most frequent travel site followed by Europe.

Due to the low prevalence of symptoms, they were grouped for the analysis and the result is shown in Table 3. Most of the travelers are free of symptoms (95.0%). Of those who presented symptoms, they presented cough, headache, or fever. These three symptoms represent the combinations observed in Table 3. During the Omicron wave (December 16th to January 31st) 9.9% of travelers were positive; 2 times the Delta wave and 10 times the rest of the pandemic. Most of the positive cases

Table 1
Results of SARS CoV2 tests in travelers attending the CAPV. December 16th, 2021–January 31st, 2022.

		NEGATIVE n (%)	POSITIVE n (%)	Total n (%)
Test type	ANTIGEN	3876 (90.7)	397 (9.3)	4273 (100)
	PCR	786 (87.0)	117 (13.0)	903 (100)
Total		4662 (90.1)	514 (9.9)	5176 (100)

Chi squared dist. $p = 0.001$.

Table 2
Demographic characteristics of the travelers attending the CAPV for SARS CoV2 tests. December 16th, 2021 to January 31st, 2022.

		Number	Percentage
AGE GROUP	Less than 20	856	16.5
	20 to 29	1022	19.7
	30 to 39	1144	22.1
	40 to 49	854	16.5
	50 to 59	795	15.4
	60 and more	505	9.8
	Total	2332	100,0
GENDER	FEMALE	2509	48.5
	MALE	2667	51.1
	Total	2332	100,0
NATIONALITY	Mexico	2965	57.3
	EEUU	1539	29.7
	Europe	276	5.3
	Rest of America	263	5.1
	Another country	133	2.6
	Total	5176	100
REASON FOR THE TRIP	EMIGRATION/RETURNING HOME	1924	37.2
	STUDIES	153	3
	BUSINESS	187	3.6
	TOURISM	2116	40.9
	OTHER	796	15.4
	Total	5176	100
TRAVELING REGION	NORTH AMERICA	3953	76.4
	EUROPE	603	11.6
	OTHER	620	12
	Total	2332	100,0

Table 3
Suggestive symptoms of COVID-19 and test results in travelers attending the CAPV. December 16th, 2021 to January 31st, 2022.

		Number	Percentage
COVID-19 suggestive symptoms	None	4918	95.0
	One symptom	168	3.2
	Two symptoms	63	1.2
	Three or more	27	,6
	Total	2332	100,0
Results	NEGATIVE	4662	90.1
	POSITIVE	514	9.9
	Total	2332	100,0
Classification according to symptoms	No case of COVID-19	4662	90.1
	Asymptomatic case	399	7.7
	Symptomatic case	115	2.2
	Total	2332	100,0

were asymptomatic (7.7%), which represents a ratio of 3.5:1 over symptomatic cases, which means that 78% of the cases were asymptomatic.

The proportion of cases of asymptomatic COVID-19 is high from those under 20 years of age to rise slightly up to those over 60 years of age, where it reaches 9.9% of identified cases. The asymptomatic/symptomatic ratio is 8.7:1 for those under 20 years of age (Table 4 and Graph 1.).

According to nationality, most of the symptomatic cases correspond to the Mexican population. In the case of asymptomatic, it was lower for Europeans (3.3%) and North Americans (4.9%), and it was similar (10%) for Mexican travelers and the rest of the world.

Travelers who had various reasons for their trip had the highest proportion of cases, both symptomatic and asymptomatic, followed by those who traveled for tourism and for studies. When considering the regions of the trip, those traveling to Europe had the lowest incidence of COVID-19, both asymptomatic and symptomatic.

4. Discussion

Mexico has not adopted restrictions for the air entry of visitors and the return of Mexicans from other countries. It does not request test certificates or vaccination certificates; they only "invite" people who present symptoms associated with the coronavirus to take the corresponding protection and prevention measures. This is closely related to the increase in international arrivals of thousands of international tourists (especially from the United States), due to the lack of entry restrictions and conditions [10–13].

The COVID-19 pandemic has had multiple epidemic peaks due to the appearance and spread of new variants which have maintained the transmission of the SARS-CoV-2 virus [3], both asymptomatic [2] and in clinical cases of varying severity [14–16]. These variants, in general terms, have maintained a similar level of severity, except for the Alpha and Delta variants, which, due to their greater transmission capacity, caused a large burden of morbidity and mortality [17]. On the other hand, some variants had greater infectivity and some the ability to evade the immune system or both [18,19].

The last of the identified variants of concern, Omicron, was detected in Mexico on December 3rd, 2021, and began to spread in the Mexican population. This variant has multiple modifications in relation to the previous variants and is the most contagious of the variants, so its rapid transmission was expected in a population with medium vaccination levels [19–23].

The Omicron variant has also been pointed out as the one that is proportionally transmitted more asymptomatically [2,6,22] consequently, it is assumed that it would be common to find in the population. In this study it was found that 78% of positive cases are asymptomatic. It should be noted that travelers do not go for tests because they present symptoms but for health requirements at their travel destinations. Mexico had an alarming and increasing number of contagions, but testing was severely restricted. While most of the world continues to shift from entry restrictions to conditions for authorized entry, the last ones including single predeparture testing, quarantine upon arrival with or without discharge testing, reduced quarantine followed by testing, single PCR testing post arrival, or quarantine upon arrival, travelers arriving to Mexico are not required to present negative COVID results, moreover hotels, touristic facilities and restaurants do not have specific mandates in this area; therefore, visitors have no restrictions whatsoever and may spread or be infected almost anywhere [13]. World tourism registered 2020 as the worst year with 74% reduction, mainly because of COVID restrictions [24]. In 2021 world tourism grew only 4% [25]; but in Mexico, that has no restrictions there was a 30.2% increase of international travelers between 2020 and 2021 [26,27].

Mexico, through the General Directorate of Epidemiology has increased their limited capacity to perform COVID testing certifying 185 laboratories and hospitals to perform antigen and/or PCR testing [28]. However, most of them do not comply with guidelines to provide certificates for travelers; on the other hand, there are a number of improvised and not certified tents, modules in hotels, and laboratories that issue certificates that allow travelers to board airplanes to most destinations [29–31].

In Mexico, where very limited number of diagnostic tests are performed, and mainly on people with symptoms, failures in case follow-up and high transmissibility are common [32–35]. And the lack of COVID test requirements for entry contributes even more with the dissemination of the new variants [4,36].

The population that attends the SCU of the CAPV is comprised of international travelers leaving the AICM. This airport is the most important in the number of flights and passengers, even so, we must consider that the population that goes to the SCU is self-selected and includes only international travelers with an itinerary from Mexico City.

Most of the destinations had shifted to preferred medical conditions requirements instead of travel restrictions, all of them regulated by the national governments of the countries involved during the transit and

Table 4
Distribution of COVID-19 cases according to symptoms and demographic characteristics in travelers attending the CAPV CDMX. December 16th, 2021 to January 31st, 2022.

		No case		Asymtomatic		Symptomatic		Total	
		Number	%	Number	%	Number	%	Number	%
Gender	Female	2255	89.9%	189	7.5%	65	2.6%	2509	100.0%
	Male	2407	90.3%	210	7.9%	50	1.9%	2667	100.0%
p value = 0.202									
Age Group	Less than 20	780	91.1%	68	7.9%	8	0.9%	856	100.0%
	20 to 29	937	91.7%	63	6.2%	22	2.2%	1022	100.0%
	30 to 39	1022	89.3%	82	7.2%	40	3.5%	1144	100.0%
	40 to 49	753	88.2%	78	9.1%	23	2.7%	854	100.0%
	50 to 59	714	89.8%	68	8.6%	13	1.6%	795	100.0%
	61 nad over	456	90.3%	399	7.7%	115	2.2%	505	100.0%
p value = 0.006									
Nationality	Mexico	2577	86.9%	275	9.3%	113	3.8%	2965	100.0%
	EEUU	1463	95.1%	76	4.9%	0	0.0%	1539	100.0%
	Europe	266	96.4%	9	3.3%	1	0.4%	276	100.0%
	Rest of America	236	89.7%	26	9.9%	1	0.4%	263	100.0%
	Other	120	90.2%	13	9.8%	0	0.0%	133	100.0%
p value = 0.001									
Reason **for the trip**	Emigration/returning home	1826	94.9%	96	5.0%	2	0.1%	1924	100.0%
	Studies	143	93.5%	10	6.5%	0	0.0%	153	100.0%
	Business	180	96.3%	7	3.7%	0	0.0%	187	100.0%
	Tourism	1951	92.2%	146	6.9%	19	0.9%	2116	100.0%
	Other	562	70.6%	140	17.6%	94	11.8%	796	100.0%
p value = 0.001									
Traveling region	North America	3538	89.5%	324	8.2%	91	2.3%	3953	100.0%
	Europe	579	96.0%	24	4.0%	0	0.0%	222	100.0%
	Other	545	87.9%	51	8.2%	24	3.9%	620	100.0%
p value = 0.001									
Total		4662	90.1%	399	7.7%	115	2.2%	5176	100.0%

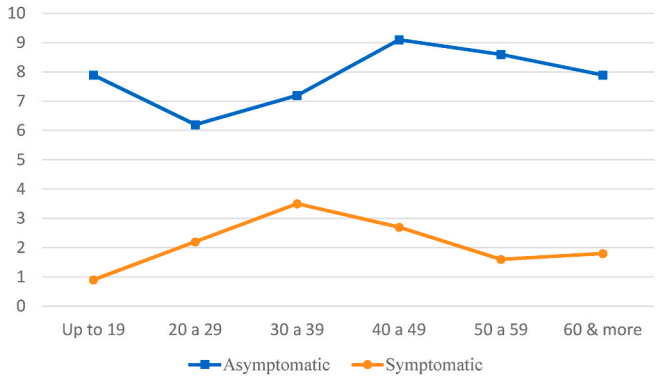

Fig. 1. Proportion of COVID-19 cases according to age group and symptoms. CAPV December 16, 2021–January 31, 2022.

final destination. It is not clear, like in the global health governance context, which international or national health authority (airport authority, international health airport office, or airlines) is in charge of the validation of these requirements (PCR or rapid antigen tests). Travelers must take a choice by their own in the type of test to be done based only on the requirements stated by each country visited instead of a medical prescription approach. At the time this paper was written, 78.8% of the travel measures were medical conditions for authorized entry (included PCR or rapid tests of Antigen), and only 12.5% entry restrictions [10]. Airlines are the only ones responsible of verifying the result of any diagnostic test or international certificate of vaccination and of authorizing the traveler to continue or not through the check in process based on each country's restrictions and conditions statement, and not in the effectiveness for preventing an in-flight transmission nor epidemiological usefulness in the prevention of an outbreak.

As noted in Table 1, the incidence of COVID-19 was extremely high in travelers who are mostly asymptomatic for the period under study. Unlike initial studies in Wuhan that reported a 1.3% prevalence in international travelers in the year 2020 [36] and another study in Canada that reports detection of SARS CoV2 in 2.15% of incoming international travelers in the year 2021 [37]. In international travelers leaving the international airport in Mexico City, we found a higher prevalence of 4% with the Delta variant, which increased to 10% during the epidemic peak caused by the Omicron variant. One in ten travelers tested positive, even though most travelers requested an antigen test due to the type of trip and destination, which has been identified as less sensitive than the PCR test. However, since the PCR is more sensitive, it will give us a greater number of positives, which in this case, in apparently healthy people, was from 13% while it was 9.3% with the antigen test. The entire population cannot be tested, but it is remarkable to find an increase of three times the maximum that the SCU had presented at any time during the pandemic, which should serve as an alert of the level of cases that must be occurring in the population.

The study period for this analysis corresponds to the winter vacation period in Mexico. This is the reason why so many people (4 out of 10) have tourism as the reason for their trip, it also explains why the number of children and adolescents occupies about a fifth of the travelers and that 87% are from Mexico or from the United States.

The first point to consider is the low presence of symptoms of COVID-19, 95% of travelers, who did not have any symptoms and those who did reported cough or headache as the most common. Screening tests for COVID-19 indicated an incidence of 9.9%, practically one in ten travelers. The asymptomatic versus symptomatic ratio being 3.5:1, indicating that transmission by asymptomatic patients is very important at this time. If the screening had not been carried out, these people could continue to infect. By not having an effective testing system, this same situation must be happening with the rest of the population in Mexico.

When analyzing the characteristics of the population according to symptoms, a strong association with age was found, which should be another alarm signal for the population. In Mexico, children under 15

years of age are not vaccinated and they have the highest asymptomatic/symptomatic ratio of all ages, since there were 8.7 asymptomatic for each symptomatic. Even though the incidence of COVID is not the highest according to the age group, the risk of transmission for this group is enormous.

According to nationality, Mexicans represent almost all the symptomatic; as for asymptomatic, Europeans presented this condition in 3.3%, North Americans 4.9% and the rest of the nationalities, including Mexicans, were close to 10% of travelers. This distribution merits characterizing the behavior patterns and the risks to which travelers are exposed while in Mexico. This situation can be associated with the region to which one travels. No symptomatic case was traveling to Europe and only a very low proportion (4%) were asymptomatic. Of the population traveling to North America, 10% tested positive, with asymptomatic cases being 4 times higher. Other international destinations have notably higher levels in both asymptomatic and symptomatic patients.

The results of the study show the rapid escalation of positivity that occurred in Mexico, detected in travelers, from the second half of December and throughout the month of January. Most of the cases are asymptomatic, and represent 78% of identified cases, with a ratio of 3.5 asymptomatic per symptomatic and predilection for the group under 20 years of age where this ratio was 8.7:1. This points to the absolute need to maintain sanitary measures and carry out good control of those exposed through rapid tests or, preferably, PCR to deal with the pandemic.

CRediT authorship contribution statement

Gustavo Olaiz-Fernández: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration. **Félix Jesús Vicuña de Anda:** Methodology, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing. **Jorge-Baruch Diaz-Ramirez:** Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Visualization, Supervision, Project administration. **German E. Fajardo Dolci:** Term, Conceptualization. **Patricia Bautista-Carbajal:** Methodology, Validation, Resources, Data curation. **Antonio Humberto Angel-Ambrocio:** Methodology, Validation, Resources, Data curation. **Miguel Leonardo García-León:** Methodology, Validation, Resources, Data curation. **Elena Gómez Peña:** Methodology, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review & editing. **Jorge Alejandro Camacho Morales:** Methodology, Validation, Data curation. **Rosa Maria Wong-Chew:** Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration.

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