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RESEARCH ARTICLE

Monkeypox in Latin America and the Caribbean: assessment of the first 100 days of the 2022 outbreak

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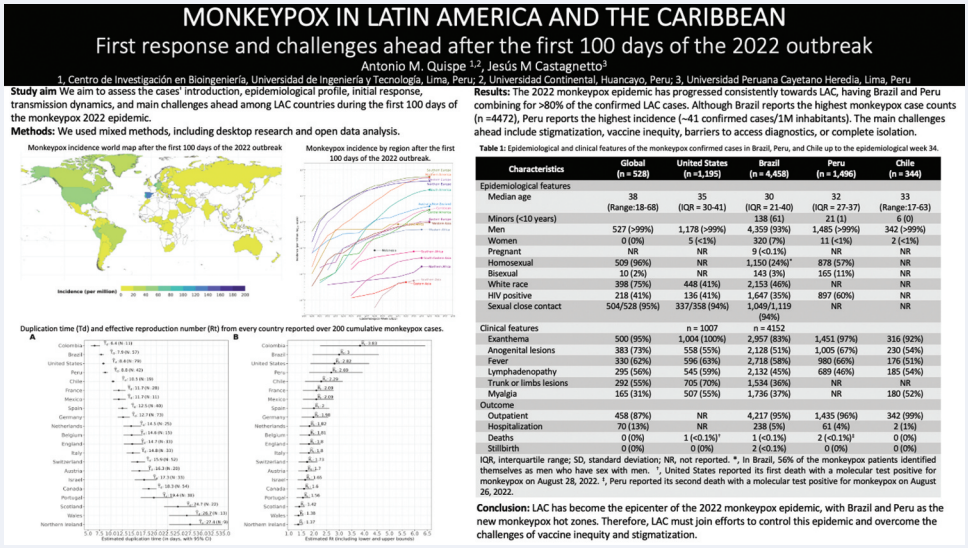
ABSTRACT

During the 2022 monkeypox (mpox) epidemic's first 100 days, 99 non-endemic countries, including 25 Latin American and Caribbean (LAC) countries, reported >64,000 cases. We aim to assess the cases' introduction, epidemiological profile, initial response, transmission dynamics, and main challenges ahead among LAC countries during the first 100 days of the mpox 2022 epidemic. We used mixed methods, including desktop research and open data analysis. The 2022 mpox epidemic has progressed consistently through LAC, with Brazil and Peru combining for over 80% of the confirmed LAC cases. Although Brazil reports the highest mpox case counts ($n = 4472$), Peru reports the highest incidence (41 confirmed cases per 1 million inhabitants). Initially, LAC missed the opportunity to focus on the high-risk population, including the people living with HIV (PLHIV) and gay, bisexual, and men who have sex with men (GBMSM). Moreover, the main challenges ahead include stigmatization, vaccine inequity, barriers to accessing diagnostics, and complete isolation. Furthermore, we estimated that Colombia, Brazil, the United States, and Peru are the world frontrunners in mpox duplication time (estimated between 6.4 and 8.8) and effective reproductive number (estimated between 2.7 and 3.8). In addition, Brazil reported its first case of inverse zoonosis in a dog and Peru its first autochthonous MPXV lineage, B.1.6. LAC has become the epicenter of the 2022 mpox epidemic, with Brazil and Peru emerging as the new mpox hot zones. Therefore, LAC countries must join efforts to control this epidemic and overcome the challenges of vaccine inequity and stigmatization.



Characteristics	Global (n = 528)	United States (n =1,195)	Brazil (n = 4,458)	Peru (n = 1,496)	Chile (n = 344)
Epidemiological features					
Median age	38 (Range:18-68)	35 (IQR = 30-41)	30 (IQR = 21-40)	32 (IQR = 27-37)	33 (Range:17-63)
Minors (<10 years)			138 (61)	21 (1)	6 (0)
Men	527 (>99%)	1,178 (>99%)	4,359 (93%)	1,485 (>99%)	342 (>99%)
Women	0 (0%)	5 (<1%)	320 (7%)	11 (<1%)	2 (<1%)
Pregnant	NR	NR	9 (<0.1%)	NR	NR
Homosexual	509 (96%)	NR	1,150 (24%)*	878 (57%)	NR
Bisexual	10 (2%)	NR	143 (3%)	165 (11%)	NR
White race	398 (75%)	448 (41%)	2,153 (46%)	NR	NR
HIV positive	218 (41%)	136 (41%)	1,647 (35%)	897 (60%)	NR
Sexual close contact	504/528 (95%)	337/358 (94%)	1,049/1,119 (94%)	NR	NR
Clinical features		n = 1007	n = 4152		
Exanthema	500 (95%)	1,004 (100%)	2,957 (83%)	1,451 (97%)	316 (92%)
Anogenital lesions	383 (73%)	558 (55%)	2,128 (51%)	1,005 (67%)	230 (54%)
Fever	330 (62%)	596 (63%)	2,718 (58%)	980 (66%)	176 (51%)
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Trunk or limbs lesions	292 (55%)	705 (70%)	1,534 (36%)	NR	NR
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Outcome					
Outpatient	458 (87%)	NR	4,217 (95%)	1,435 (96%)	342 (99%)
Hospitalization	70 (13%)	NR	238 (5%)	61 (4%)	2 (1%)
Deaths	0 (0%)	1 (<0.1%)†	1 (<0.1%)	2 (<0.1%)‡	0 (0%)
Stillbirth	0 (0%)	0 (0%)	2 (<0.1%)	0 (0%)	0 (0%)

IQR, interquartile range; SD, standard deviation; NR, not reported. *, In Brazil, 56% of the monkeypox patients identified themselves as men who have sex with men. †, United States reported its first death with a molecular test positive for monkeypox on August 28, 2022. ‡, Peru reported its second death with a molecular test positive for monkeypox on August 26, 2022.

KEYWORDS

Monkeypox; Poxviridae infections; basic reproduction number; epidemiological models; Latin America; Caribbean region; Brazil; Peru

Background

Monkeypox (mpox) is a zoonotic disease endemic in 16 Central and West African countries, for which its animal reservoir is unknown [1]. The Monkeypox virus (MPXV) is a double-stranded DNA virus, a member of the Orthopoxvirus genus and Poxviridae family. The MPXV has two clades, commonly referred to as the 'West African' clade and the 'Central African' or 'Congo Basin' clade, with the latter causing more severe illness [2]. However, this classification seems stigmatizing and discriminatory. Hence, since August 13, the World Health Organization (WHO) has adopted a new naming convention for MPXV comprising the Clades I, IIa,

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and IIb, with the latter mainly circulating during the 2022 outbreak [3].

Since the first report of MPXV human infection in 1972, Western and Central African countries have reported periodic outbreaks, with rare outbreaks reported in non-endemic countries [4]. However, in 2022, an outbreak of MPVX of global proportions was declared without a clear link to Africa [5]. As of March 11, 2023 (epidemiological week 10–2023), 103 non-endemic countries and seven endemic countries have confirmed over 86,000 human cases of MPXV. Spill-over events typically cause MPXV infection in endemic countries to humans from animals such as rodents, squirrels, and non-human primates [6]. Yet, the MPXV can also be transmitted from person to person by direct contact with lesions, body fluids, respiratory droplets, and contaminated materials [7]. Case counts and epidemiological patterns suggest that the current global outbreak is sustained by human-to-human transmission through intimate contact among gay, bisexual, and other men that have sex with men (GBMSM) and within the community of people living with human immunodeficiency virus (PLHIV) [8].

Although the origin of the 2022 MPXV outbreak is still unknown, it rapidly extended to Latin American and the Caribbean (LAC) countries by travelers from the United States and European countries [9]. After initially affecting only developed countries, the mpox epidemic has begun to impact developing countries worldwide and within these countries, particularly those cities with the largest GBMSM and PLHIV communities [10]. It is essential to highlight that in Spain, the country with the most MPOX cases reported during the 2022 outbreak, around 25% of cases were reported among people born in LAC, according to the Spain Surveillance System (SiViES). In LAC, mpox is heavily impacting Brazil and Peru, two countries with large GBMSM and PLHIV communities but poor health coverage and increasing discrimination against these communities [11,12]. In this study, we aim to describe the milestones of the introduction of mpox in LAC and highlight some of the main challenges the region may face in controlling mpox transmission.

Materials and Methods

Ethical statement

Our study only used public documents and open data curated by the Global Health Data Science Initiative, which publishes this data without identifiers and keeps it updated under an open license (CC BY 4.0). For this reason, following good research practices, our study was exempted from revision by the Institutional Review Board at the Universidad Peruana La Unión.

Study design

We use mixed methods to assess the introduction of mpox in LAC and the main challenges the region initially faced in controlling mpox transmission. We executed the study in two stages: (i) desktop research and (ii) open data analysis of the incidence of confirmed mpox cases among regions and LAC countries.

Study procedures and data analysis

First, we collected and reviewed relevant mpox reports and documentation published up to 27 August 2022, focusing on the dates of the first mpox cases, deaths, and the initial response to the mpox epidemic across LAC countries. Additionally, we used surveillance strategy, milestones, initial measures, preventive measures, vaccination programs, and challenges as the subthemes of interest during our revision. Second, we characterized the LAC epidemiological situation in each country by using the mpox case counts from the Global Health Data Science Initiative open data repository [13], the 2022 annual estimated regions and countries' populations from the United Nations World Population Prospects, and the WHO region classification and the World Bank's country classification. Third, we estimated the duplication time (Td) by fitting a regression of the logarithm of the cumulative confirmed cases vs. the count of days since the initial date for each country. Fourth, we estimated the effective reproductive number (Rt) using the approach described by Bonifazi Get al. [14] and the generation time reported by Guzzetta G et al [15]. Finally, we explained the study data analysis in detail in our supplementary material.

Results

Mpox introduction in LAC

Like in Europe, the mpox epidemic in LAC, is highly concentrated in a few countries. While Europe reports over 80% of the mpox cases in Spain, the United Kingdom, Germany, France, and the Netherlands, LAC countries report over 80% of the cases in Brazil and Peru, following a perfect Pareto distribution (Figure 1). The first LAC country to register a confirmed case of mpox was Argentina on May 27 (Figure 2), followed by Mexico on May 28, exactly three weeks after the United Kingdom reported its first 2022 mpox case. The following countries reporting their first mpox-confirmed cases were Brazil (June 8), Venezuela (June 12), Chile (June 17), and Colombia (June 23). Peru reported its first case on June 26 but, sooner than expected, became the country with the highest mpox incidence in Latin America, with over 31 cases per million inhabitants. By 27 August 2022, LAC countries had reported at least 7252 mpox cases, with Brazil ($n = 4,472$), Peru

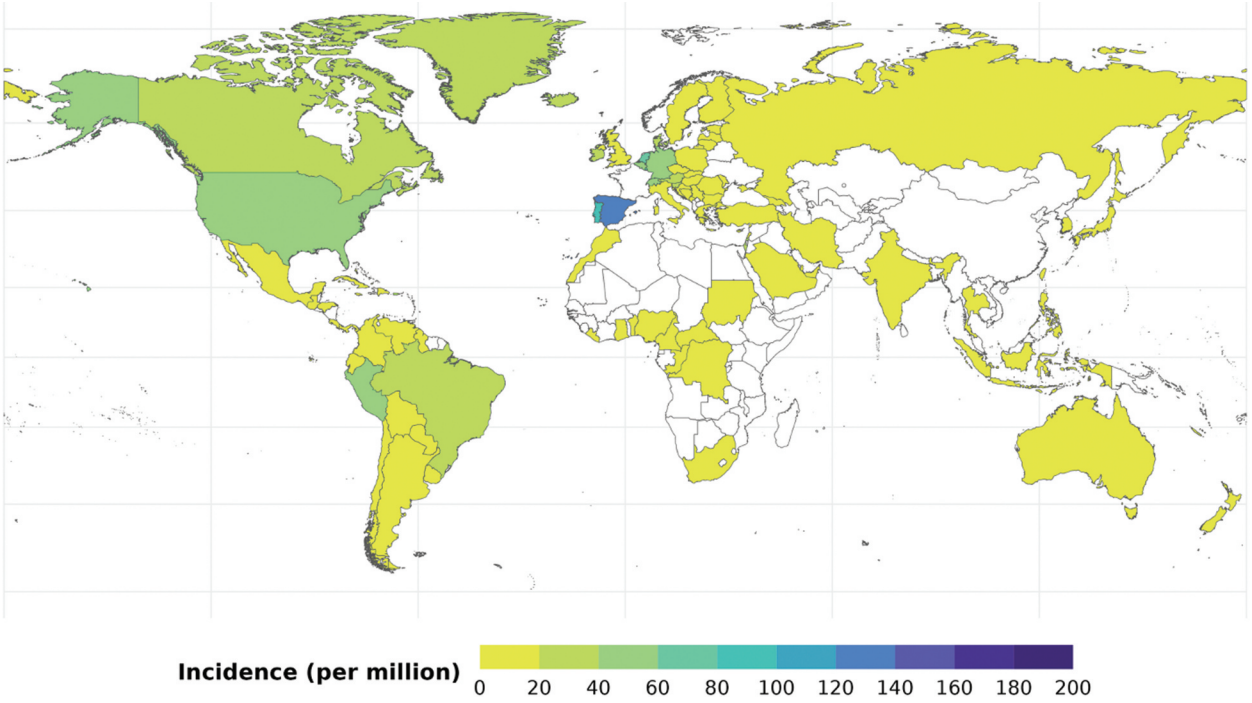

Figure 1. Mpox incidence world map after the first 100 days of the 2022 outbreak. The incidence of mpox was calculated as cases per million inhabitants per country. Notice that after 100 days of the 2022 mpox outbreak, 79 non-endemic countries (and eight endemic ones) reported communitarian transmission of mpox, and the total number of confirmed cases exceeded 28,900 worldwide.

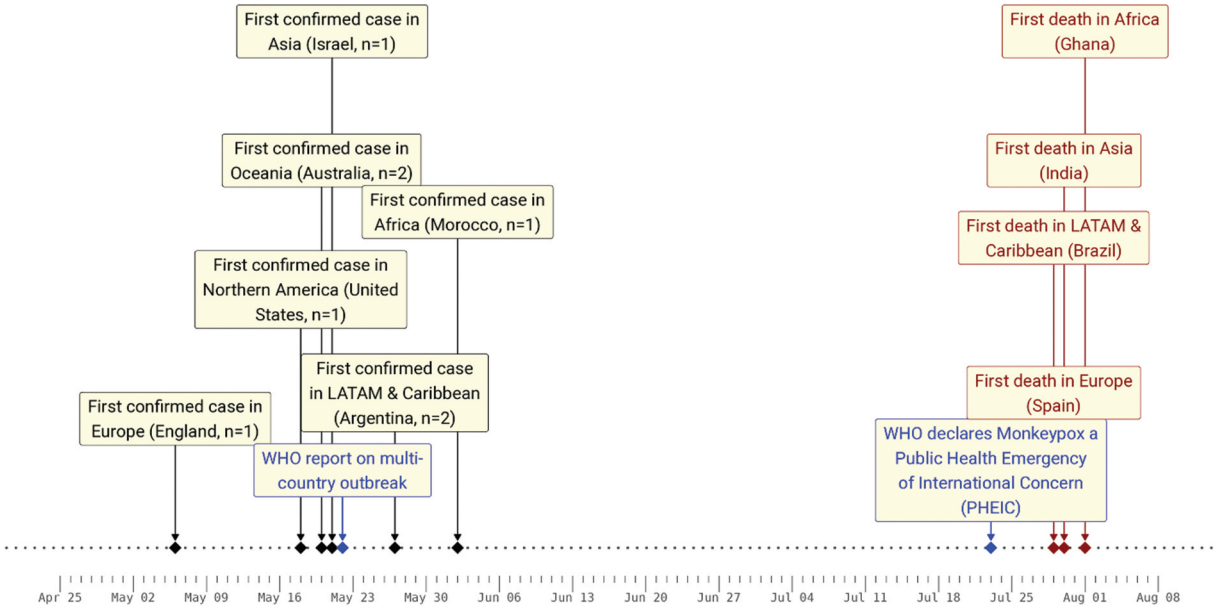

Figure 2. A timeline of the 2022 mpox outbreak. Notice that the timeline includes marks for the region's first confirmed cases and deaths by region and the relevant milestones of the 2022 mpox outbreak.

($n = 1,382$), Mexico ($n = 386$), Chile ($n = 344$), and Colombia ($n = 273$) as the only countries exceeding 200 cases. Furthermore, the region reported seven of the first ten deaths positive for MPXV from non-endemic countries, including two in Brazil, two in Peru, one in Mexico, one in Cuba, and one in Ecuador. Although Brazil reports the highest mpox cases in Latin America, Peru reports the highest incidence, with~41 cases per million inhabitants (*vide supra*) (Table 1). Furthermore, Latin America has the most accelerated mpox epidemic (Figure 3) worldwide.

Mpox cases epidemiological and clinical profile in LAC

Out of 4,458 confirmed cases documented in Brazil, according to the 'Special Epidemiological Bulletin – Monkeypox Nro. 10', most were men (>99%) and

Table 1. Epidemiological and clinical features of the mpox confirmed cases in Brazil, Peru, and Chile up to the epidemiological week 34.

Characteristics	Global [17] (*n* = 528)	United States [16] (*n* = 1,195)	Brazil (*n* = 4,458)	Peru (*n* = 1,496)	Chile (*n* = 344)
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identified as MSM (56%). Their most common symptoms were exanthema or skin lesions (83%), fever (58%), anogenital lesions (51%), lymphadenopathy (45%), myalgia (37%), and trunk or limb lesions (36%). Notably the Brazilian mpox cases included 320 women identified as cis (251) or trans (13), nine pregnant women, 138 cases between children from zero to 17 years old, and 36 between zero and four years old. In contrast, the first 1496 mpox-confirmed cases reported by Peruvian public health officers in its Mpox Situational Room (https://www.dge.gob.pe/sala-monkeypox) were men (>99%), MSM (68%), and PLHIV (60%). Their most frequent symptoms were generalized exanthema (97%), fever (66%), headache (50%), lymphadenopathy (38%), fatigue (37%), and throat pain (25%). Here, it is essential to highlight that the Peruvian series included so far nine women, 21 minors (8–20 years old), one child (8 years old), and two elderlies (>60 years old). Furthermore, upon contact tracing, Peruvian authorities reported 32 sexual networks, including 27 in metropolitan Lima. In Chile, according to the 'monkeypox epidemiological situation report 08/26/2022', the first 344 mpox confirmed cases were also mainly men (>99%). Their main symptoms were exanthema (92%), anogenital lesions (54%), lymphadenopathy (54%), myalgia (52%), and fever (51%). Ecuador communicated in a press release their first 51 mpox confirmed cases up to 29 August 2022, were also primarily men (82%), but included nine women (18%). Mpox cases from Brazil, Peru, and Chile showed strong similarities with cases previously reported in the United States [16] and globally [17], except for the higher mpox burden observed among the PLHIV in Peru (Table 1). While most mpox cases had a mild and self-limited disease, Brazil reported one death (<1%), one stillbirth from an infected pregnant woman (1/9, 11%), and 219 (5.4%) hospitalized cases, including six (0.1%) admitted to an intensive care unit. Also, Peru has reported its second death with a confirmatory mpox diagnostic, and 61 cases were hospitalized (4%). In Ecuador, the Ministry of Public Health said in a press release on August 8 that its first death was mpox positive, although they have not reported any hospitalization so far. Mexico and Colombia reported similar statistics. In Mexico, among the first 565 mpox confirmed cases by the Ministry of Health, most were men (97.2%) with a median age of 34 years, including 299 PLHIV (52.9%), ten healthcare workers (1.8%, all men), two minors<10 years old (0.4%), two adolescents, two pregnant women (0.4%), and one death (0.2%) [18]. In Colombia, of the first 3298 mpox confirmed cases by the Ministry of Health, most were men (97.3%), including eight minors<10 years old (0.2%), 62 adolescents (1.9%), 19 elders>60 years old (0.6%), and there were zero deaths. Finally, it is essential to highlight that most LAC countries reported the main clusters of cases observed in larger cities, including Sao Paulo, Rio de Janeiro, Lima, the Santiago de Chile metropolitan region, Mexico City, and Bogota.

First mpox preventive measures by LAC countries

Most LAC countries have updated their epidemiological surveillance protocols to detect, isolate, follow up, trace contracts, and manage, prevent, and control

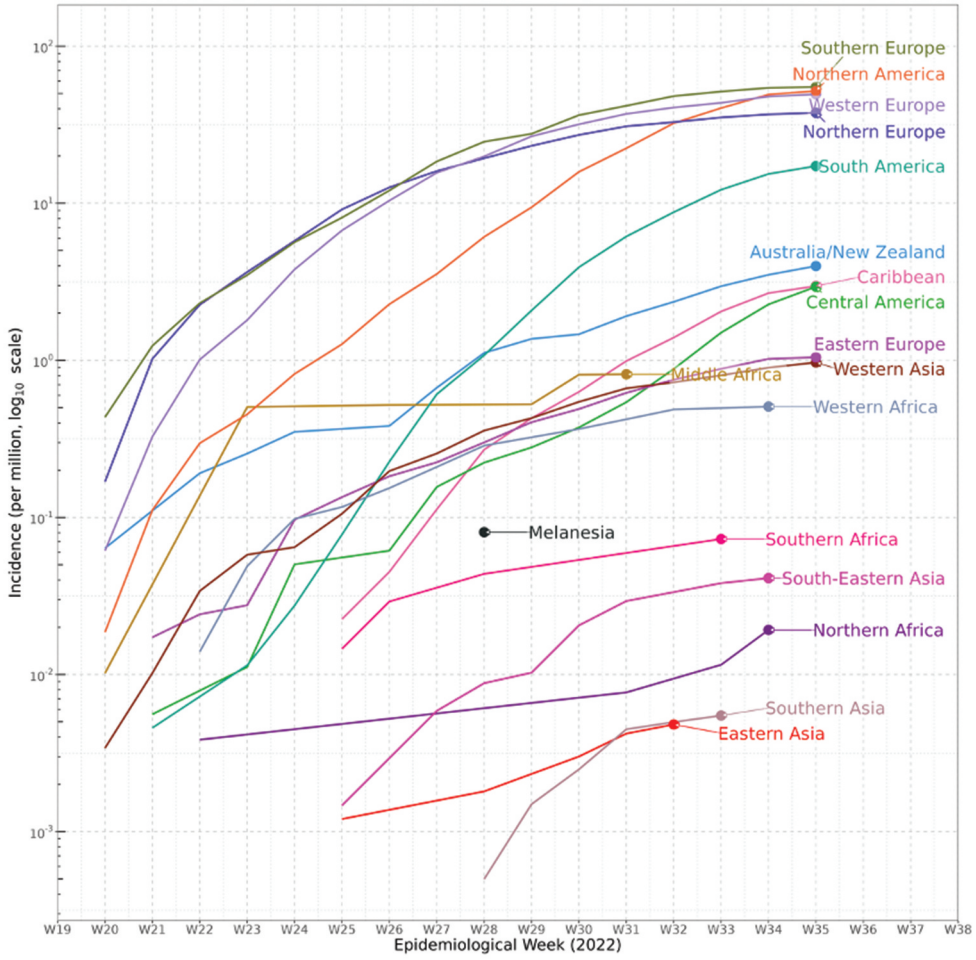

Figure 3. Mpox incidence by region after the first 100 days of the 2022 outbreak. Here we show the trajectory of the incidence of confirmed mpox cases per milling by region up to epidemiological week 34–2022. Notice how North and South America show a steeper increase than Central America or the Caribbean, but all show an incrementing trend.

typical mpox cases. However, LAC countries initially did not contribute to the global efforts to characterize the 2022 monkey outbreak. Its initial response focused mainly on the typical presentation of mpox rather than the atypical cases that marked the 2022 outbreak. For example, the Peruvian Ministry of Health considered implementing mandatory masking, social distancing, and handwashing without focalizing any measure on the high-risk population as its initial response. Likewise, in Brazil, the National Health Surveillance Agency (ANVISA) reinforced the need to adopt 'non-pharmacological' measures in airports and airplanes. These initial measures from ANVISA included physical distancing, protective masks, and frequent handwashing. Most LAC countries have adopted similar strategies and focused primarily on isolating the confirmed cases and their contacts upon confirmation, but not on policies to target the most vulnerable groups.

Estimation of the duplication time and effective reproduction number

The transmission dynamics of the mpox epidemic varied largely across countries between epidemiological weeks 22 and 34. To estimate the Td in the non-endemic countries with at least 200 reported cases, we use regression models with R^2_{adj} values in the 0.83–0.99 range (p-value<0.001), identifying three distinct groups of countries: i) Countries with a Td in the range of 6.4–8.8 days (Colombia, Brazil, the United States, and Peru); ii) the countries with a Td in the range of 10.5–19.4 days; and, iii) the countries with a Td >24.0 days (Figure 4a). Furthermore, we estimated that Colombia, Brazil, the United States, and Peru led the world in the worldwide rank of countries with the higher Rt, which we calculated in the 2.7–3.8 range. In contrast, the rest of the countries had values of 2.3 or less (Figure 4b).

B.1.6 as the new MPXV lineage original from LAC

The LAC region, specifically Peru, reported on 25 August 2022, its first prospect of a new B.1 sublineage, which GISAID experts proposed to be named B.1.6. The Peruvian National Institute of Health identified this new MPXV B.1* lineage as the seemingly dominant (122/160 sequenced genomes) MPXV lineage in Peru. It is characterized by the mutation

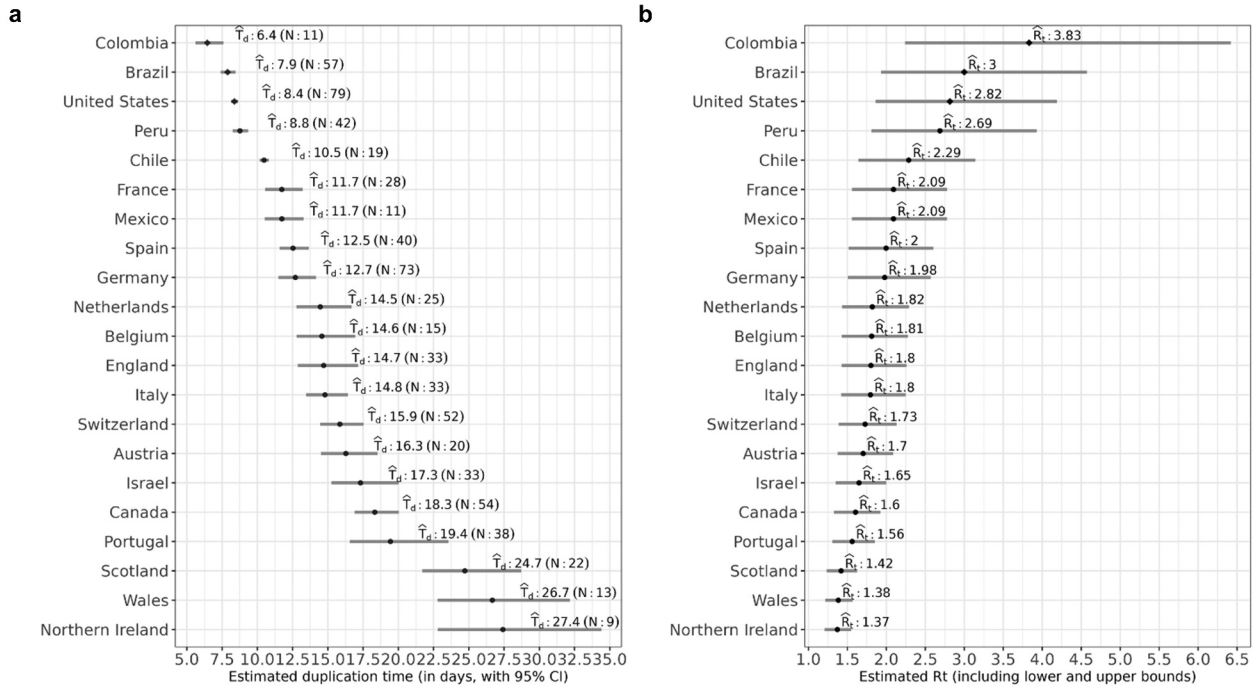

Figure 4. Duplication time (Td) and effective reproduction number (Rt) from every country reported over 200 cumulative mpox cases. Here we contrast the estimated duplication time (Td) (figure 5A) and the effective reproduction number (Rt) (figure 5B) of every country that, by August 27, 2022, reported over 200 cases cumulative mpox confirmed cases.

G111029A (nucleotide A at position 111,029) and as a nested sub-clade defined by G102694A. Other potential sublineages are B.1.7, which according to GISAID, circulates in various countries, including Germany, the UK, the United States, Portugal, South Africa, and Mexico, and B.1.8, which spreads in Germany, Spain, and the United States. Overall, during the first 100 days of the 2022 mpox outbreak, the countries in LAC have shown the first signs of the MPXV evolution with the emergence of new MPXV sublineages.

Vaccine inequity, stigmatization, inverse zoonosis, and other challenges ahead

Among the main challenges that LAC countries face are vaccine inequity and the rising stigmatization of the GBMSM and PLHIV communities. First, despite already having two MPXV vaccines that are FDA approved, ACAM2000 and JYNNEOS, vaccine inequity is again severely affecting the capacity of response capacity of LAC countries without any having access to mpox vaccines during the first 100 days of the 2022 outbreak. Second, although mpox is not a sexually transmitted infection (STI), GBMSM and PLHIV are victims of stigmatization and discrimination because MPXV has spread disproportionately among these communities across LAC countries. Furthermore, In Peru, one male employee (40 years old) was stigmatized and lost his job after testing positive for mpox. The case was reported on Twitter on 16 July 2022, by the Peruvian Congress, which also communicated that the worker's station was disinfected and all its coworkers were put on contact tracing without any secondary case confirmed. However, upon recovery, the Peruvian Congress fired the patient, released his data to the media, and he was banned from picking up their belongings because of the fear of 'contamination.' Third, on 24 August 2022, Brazil reported the first LAC case of reverse zoonosis when a five-month-old puppy got infected by having contact with a confirmed human mpox case in the municipality of Juiz de Fora. The animal started showing symptoms on the 13th day, with itching, presenting characteristic lesions of the disease, such as wounds and the formation of crusts on the back and neck. Lastly, another challenge is the lack of open data about mpox cases in LAC. To date, all LAC countries have refused to release open data about mpox cases fearing that open access to epidemiological data may stigmatize the GBMSM and PLHIV communities.

Discussion

The findings from this mixed-methods study indicate that LAC has become the epicenter of the 2022 mpox epidemic, with Brazil and Peru as the new mpox hot zones. During the first 100 days of the 2022 mpox epidemic, Brazil and Peru have combined for over 85% of the confirmed cases in LAC, with Brazil reporting the highest mpox confirmed case count in LAC and Peru reporting the highest incidence of daily mpox confirmed cases worldwide. To date, LAC countries have failed to control the mpox outbreak by missing the opportunity to focus their initial efforts on the

high-risk population, including the PLHIV and GBMSM communities. Moreover, the main challenges ahead for controlling the LAC mpox outbreak include stigmatization, vaccine inequity, barriers to accessing diagnostics, and complete isolation. Furthermore, Brazil and Peru have already joined the United States as the global frontrunners regarding the mpox duplication time and effective reproductive number, which we estimated around every seven to eight days and around three, respectively. More worrisome, there is a genuine risk of some countries like Brazil and Peru becoming the first non-African countries to become mpox endemic. This risk increased with Brazil reporting its first case of inverse zoonosis in a dog and Peru reporting the first autochthonous MPXV lineage.

The greater the mpox incidence, the greater the chances that mpox will evolve and become endemic in non-African countries. In this context, the emergence of the new lineages of MPXV during the 2022 mpox outbreak, including B.1.6 (autochthonous from Peru), B.1.7, and B.1.8, should spark a call for action, particularly in LAC countries that still can act to prevent this threatening scenario. Unfortunately, so far, we ignore what these new lineages represent regarding MPXV contagiousness and pathogenicity. Still, virus evolution is a double-edged sword if we learn anything from previous epidemics [19]. Although further studies are necessary to clear this hypothesis, the MPXV is evolving faster than expected for a presumably slow-evolving double-stranded DNA virus, potentially driven by the action of the apolipoprotein B mRNA-editing catalytic polypeptide-like 3 [3].

Mpox severity during the 2022 outbreak remains unclear. Typical mpox cases were mainly mild, with few cases developing severe mpox complications, such as phlegmon [20] and encephalitis [21]. However, during the 2022 outbreak, mpox was responsible for at least 17 confirmed deaths, including six from locations that have not historically reported mpox, such as Brazil and Ecuador. Moreover, this mpox death count could certainly increase in LAC countries if we add the one stillbirth, a second death reported in Brazil, and the two deaths reported in Peru (both in patients who tested positive for mpox). We believe that with these numbers, we cannot consider human mpox infections benign and that we should raise consciousness about the importance of not neglecting the deaths of any patient who tested positive for MPXV, particularly in those countries that do not report mpox deaths because MPXV-infected patients also tested positive for other comorbidities such as HIV or septic shock.

The 2022 mpox outbreak suggested an unusual and alarming public health issue, particularly considering that more than 70% of the global population is no longer vaccinated against smallpox, a vaccine proved effective against MPXV [22]. Furthermore, the 2022 outbreak occurred in a particularly challenging context, such as the COVID-19 pandemic, demanding a public health response with an exhausted healthcare system but also providing a valuable opportunity to apply COVID-19 lessons [22]. This context required prioritizing the public health response on the high-risk population, including the PLHIV and GBMSM populations, which in LAC countries are highly clustered in large cities, with targeted, empathic, and culturally accepted interventions. Theoretically, patient isolation was a required intervention; however, isolating these patients was unrealistic in LAC countries where the informal economy demanded constant working for food. Furthermore, in most LAC countries, health services for GBMSM are limited, so most MPXV public health interventions such as diagnostic, prevention, and vaccines were deployed through the PLHIV health services, increasing stigmatization and creating another barrier for opportunistic diagnostics, isolation, and treatment.

To prevent mpox deaths, it is critical to have access to mpox vaccines, which recently have been associated with an 86% (95% confidence interval, 59–95%) reduction in the risk for MPXV infection among the high-risk MPXV population [23]. However, the inequity in access to effective treatments and vaccines is one of the main factors responsible for the increasing mpox burden during the 2022 outbreak. No LAC countries had access to mpox vaccines during the first 100 days of the 2022 outbreak, severely limiting their capacity to effectively prevent and control their cases. Alternative mpox treatments for severe cases include antivirals (e.g. tecovirimat, brincidofovir, and cidofovir) and the vaccinia immune globulin intravenous. In contrast, the mpox vaccines include only the ACAM2000 and the JYNEEOS vaccine [24]. The inequity in access to these treatments and vaccines affects most LAC countries, with few having access to the mpox available treatments and none having access to vaccines yet [25]. In this scenario, developed countries such as Canada, UK, and U.S.A were the first to report successful mpox vaccination campaigns. Regardless, there is still an urgent need for effective treatments with high-quality evidence to support their recommendation.

Responding to a mpox outbreak will require training front-line healthcare workers, who must acquire the necessary knowledge to understand the disease and to suspect, confirm, and manage mpox cases [26]. Without the tools to interrupt the MPXV community transmission, LAC countries rely entirely on their capacity to change the risk behaviors of the high-risk population. However, mpox stigmatization as a 'gay disease' quickly sparked a déjà vu about what happened with the 'innocent victims' of the acquired immunodeficiency syndrome (AIDS) epidemic [27]. Although AIDS and mpox share some epidemiological similarities, the most crucial epidemiological difference is that mpox is

not a sexually transmitted infection. However, during the 2022 outbreak, the MPXV spread mainly through direct contact with active exanthema during sexual intercourse [28], which explains the disproportionate number of cases among GBMSM and PLHIV and their value as targets for focalized surveillance [16,17]. Here is essential to highlight that while nearly all LAC countries reported that most mpox cases infected the GBMSM, in Peru, most cases were detected among the PLHIV (60%). We believe that such observation could be explained by the fact that Peruvian authorities, in the absence of GBMSM health services, used their HIV clinics as the primary points of care for mpox patients raising stigmatization and creating healthcare access barriers for diagnostics and treatment. Furthermore, such stigmatization generated a set of disadvantageous repercussions for mpox-infected people's lives and health, as reported in Brazil [29]. A new infodemic sparked during the 2022 outbreak has stigmatized mpox patients including discrimination, discrediting, and depreciation of these patients in our societies. Consequently, during the 2022 mpox outbreak, both the GBMSM and PLHIV communities are at higher risk of mpox and the burden of societal discrimination [27].

With mpox freely transmitting without effective intervention deployed at the community level, it is unsurprising that LAC countries lead the T_d and R_t worldwide rankings. The first Rt estimate was reported by Italian researchers in 2.43 (95% CI: 1.82–3.26) using data from May-June 2022 [15]. However, at epidemiological week 34, we estimated that Italy's Rt decreased to 1.87 (95% CI: 1.46–2.38). Regardless both estimates represent a substantial increase compared to Rt of the clades I and II before 2022, which were estimated at 0.08 (95% CI: 0.02–0.22) [30] and 0.30 (95% CI: 0.21–0.42) [31]. Moreover, Rt estimates from the six countries that led the world in cumulative mpox incidence up to July 2022 ranged from 1.02 to 1.55. With the data updated to the epidemiological week 34–2022 (as of 29 August 2022), we observed that Colombia, Brazil, the United States, and Peru currently led the world in the Rt worldwide ranking, which we estimated in the range of 2.7–3.8. These estimates certainly must raise awareness that most LAC countries are just starting their mpox epidemics and the importance of controlling the transmission of mpox before the 2022 epidemic escalates further.

One challenge that should raise awareness about the importance of controlling the 2022 mpox outbreak is the recent reports of reverse zoonosis and the risk of the MPXV establishing itself in non-African animal species. This scenario is plausible, so the chance that inverse zoonosis contributes to perpetuating human infections and offers the conditions for more dangerous mpox variants to evolve [32]. So far, Brazil has become the only LAC country to report a case of inverse zoonosis in a dog, the second case of a dog infected by a human reported after the one reported in France [33], both during the 2022 mpox outbreak. So far, we ignore if dogs or other pets may become MPXV animal reservoirs rather than only accidental hosts. Still, we know that contaminated pets such as prairie dogs (herbivorous burrowing ground squirrels native to the North American grasslands) can cause significant outbreaks such as the one reported in 2003 (72 zoonotic cases in six states, 47 confirmed cases) [34].

Our study's key strength is that we expanded our study scope by using mixed methods to overcome the lack of mpox literature in LAC, which is limited to editorials and very few original studies. This way, we could picture the current LAC epidemiological situation without missing critical information from each official source and health ministry. Even when we report each LAC country´s official cases and death counts, we should highlight that the operational definitions vary widely across LAC countries. Some including probable cases in their counts or deaths indirectly linked to mpox. We encourage LAC countries to report sensitive case definitions rather than specific ones because of the underreporting and several barriers that prevent patients from accessing opportunistic diagnostic and health care. To date, most LAC countries report scarce cases of mpox, which most likely implies that the mpox epidemic is occurring under the radar rather than not occurring at all. Our analysis pictures LAC as the new epicenter of the 2022 mpox epidemic. This new epidemiological scenario may be a direct consequence of the inequity that has prevented most LAC countries from having access to vaccines, but also because of the stigmatization preventing infected men and women from confirming their diagnosis and accessing opportunistic health care. Regardless, it is essential to highlight that despite its strengths, our study is prone to the selection, information, and confounding bias that characterize the surveillance data coming from LAC countries.

Mpox in LAC continues rising, and after the first 100 days of the 2022 outbreak, it has become the region with the most significant cases among heterosexuals, women, teenagers, and children worldwide, according to the World Health Organization. Consequently, the possibility of LAC countries progressing toward community transmission is a real threat to global health that we should not neglect. The 2022 MPXV outbreak has changed the landscape of MPXV worldwide, with several non-African countries transitioning toward MPXV endemicity. Henceforward, for the world the LAC region must join efforts to mitigate its risk of mpox becoming endemic by supporting each other, particularly Brazil, Ecuador, Chile, Mexico, and Peru, which are the 2023 LAC hot zones. LAC urgently needs to prioritize these high-risk populations and communicate not to but with the GBMSM and PLHIV communities

about the importance of limiting sexual intercourse with multiple partners during the following coming months, without stigmatizing but in an assertive manner. LAC countries must work together to find a reasonable balance between deep epidemiological knowledge of transmission and avoiding stigmatization. Ministries of Health in the region must compromise to clear the barriers preventing these communities from free and full access to testing and medical care while addressing treatment and vaccine inequity, minimizing stigma, and maintaining vigilance for transmission in other populations.

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Data deposition

The data supporting this study's findings are open data curated by the Global Health Data Science Initiative, available under the Creative Commons Attribution 4.0 (CC BY 4.0) license. The data and code are freely available in the:

- Data: https://github.com/globaldothealth/monkeypox (accessed on 31 August 2022)
- Code: https://doi.org/10.5281/zenodo.6993411

References

[1] McCollum AM, Damon IK. Human monkeypox. Clin Infect Dis. 2014;58:260–267.
[2] Mauldin MR, McCollum AM, Nakazawa YJ, et al. Exportation of monkeypox virus from the African Continent. J Infect Dis. 2022;225:1367–1376.
[3] Isidro J, Borges V, Pinto M, et al. Phylogenomic characterization and signs of microevolution in the 2022 multi-country outbreak of monkeypox virus. Nat Med. 2022;28:1569–1572.
[4] Bunge EM, Hoet B, Chen L, et al. The changing epidemiology of human monkeypox-A potential threat? A systematic review. PLoS Negl Trop Dis. 2022;16:e0010141.
[5] Vivancos R, Anderson C, Blomquist P, et al. Community transmission of monkeypox in the United Kingdom, April to May 2022. Euro Surveill. 2022;27:27.
[6] Beer EM, Rao VB, Holbrook MR. A systematic review of the epidemiology of human monkeypox outbreaks and implications for outbreak strategy. PLoS Negl Trop Dis. 2019;13:e0007791.
[7] Yinka-Ogunleye A, Aruna O, Dalhat M, et al. Outbreak of human monkeypox in Nigeria in 2017-18: a clinical and epidemiological report. Lancet Infect Dis. 2019;19:872–879.
[8] Inigo Martinez J, Gil Montalban E, Jimenez Bueno S, et al. Monkeypox outbreak predominantly affecting men who have sex with men, Madrid, Spain, 26 April to 16 June 2022. Euro Surveill. 2022;27:27.
[9] Abed Alah M, Abdeen S, Tayar E, et al. The story behind the first few cases of monkeypox infection in non-endemic countries, 2022. J Infect Public Health. 2022;15:970–974.
[10] Liu X, Zhu Z, He Y, et al. Monkeypox claims new victims: the outbreak in men who have sex with men. Infect Dis Poverty. 2022;11:84.
[11] Romani L, Ladera-Porta K, Quinones-Laveriano DM, et al. Factors associated with the non-use of health services in LGBTI people from Peru. Rev Peru Med Exp Salud Publica. 2021;38:240–247.
[12] Reis Brandao E, Cabral CDS. Sexual and reproductive rights under attack: the advance of political and moral conservatism in Brazil. Sex Reprod Health Matters. 2019;27:1669338.
[13] Kraemer MUG, Tegally H, Pigott DM, et al. Tracking the 2022 monkeypox outbreak with epidemiological data in real-time. Lancet Infect Dis. 2022;22:941–942.
[14] Bonifazi G, Lista L, Menasce D, et al. A simplified estimate of the effective reproduction number Rt using its relation with the doubling time and application to Italian COVID-19 data. Eur Phys J Plus. 2021;136:386.
[15] Guzzetta G, Mammone A, Ferraro F, et al. Early estimates of monkeypox incubation period, generation time, and reproduction number, Italy, May-June 2022. Emerg Infect Dis. 2022;28:2078–2081.
[16] Philpott D, Hughes CM, Alroy KA, et al. Epidemiologic and clinical characteristics of monkeypox cases - United States, May 17-July 22, 2022. MMWR Morb Mortal Wkly Rep. 2022;71:1018–1022.
[17] Thornhill JP, Barkati S, Walmsley S, et al. Monkeypox virus infection in humans across 16 countries - April-June 2022. N Engl J Med. 2022;387:679–691.
[18] Nunez I, Garcia-Grimshaw M, Ceballos-Liceaga SE, et al. Epidemiological and clinical characteristics of patients with human monkeypox infection in Mexico: a nationwide observational study. Lancet Reg Health Am. 2023;17:100392.
[19] Hanley KA. The double-edged sword: how evolution can make or break a live-attenuated virus vaccine. Evolution (N Y). 2011;4:635–643.
[20] Anderson MG, Frenkel LD, Homann S, et al. A case of severe monkeypox virus disease in an American child: emerging infections and changing professional values. Pediatr Infect Dis J. 2003;22:1093–1096. discussion 6-8. DOI:10.1097/01.inf.0000101821.61387.a5.
[21] Sejvar JJ, Chowdary Y, Schomogyi M, et al. Human monkeypox infection: a family cluster in the midwestern United States. J Infect Dis. 2004;190:1833–1840.
[22] Di Gennaro F, Veronese N, Marotta C, et al. Human Monkeypox: a comprehensive narrative review and analysis of the public health implications. Microorganisms. 2022;10:1633.
[23] Wolff Sagy Y, Zucker R, Hammerman A, et al. Real-world effectiveness of a single dose of mpox vaccine in males. Nat Med. 2023;29:748–752.

[24] Rizk JG, Lippi G, Henry BM, et al. Prevention and treatment of monkeypox. Drugs. 2022;82:957–963.
[25] Rodriguez-Morales AJ, Lopardo G, Verbanaz S, et al. Latin America: situation and preparedness facing the multi-country human monkeypox outbreak. Lancet Reg Health Am. 2022;13:100318.
[26] Harapan H, Setiawan AM, Yufika A, et al. Knowledge of human monkeypox viral infection among general practitioners: a cross-sectional study in Indonesia. Pathog Glob Health. 2020;114:68–75.
[27] Gonsalves GS, Mayer K, Beyrer C. Deja vu all over again? Emergent monkeypox, delayed responses, and stigmatized populations. J Urban Health. 2022;99:603–606.
[28] Sah R, Abdelaal A, Reda A, et al. Monkeypox and its possible sexual transmission: where are we now with its evidence? Pathogens. 2022;11. doi:10.3390/pathogens11080924.
[29] Sousa AFL, Sousa AR, Fronteira I. Monkeypox: between precision public health and stigma risk. Rev Bras Enferm. 2022;75:e750501.
[30] Blumberg S, Funk S, Pulliam JR. Detecting differential transmissibilities that affect the size of self-limited outbreaks. PLOS Pathog. 2014;10:e1004452.
[31] Kucharski AJ, Edmunds WJ, Salathé M. Characterizing the transmission potential of zoonotic infections from minor outbreaks. PLoS Comput Biol. 2015;11:e1004154.
[32] Cohen J. Monkeypox could establish new reservoirs in animals. Science. 2022;376:1258–1259.
[33] Seang S, Burrel S, Todesco E, et al. Evidence of human-to-dog transmission of monkeypox virus. Lancet. 2022;400:658–659.
[34] Centers for Disease C, Prevention. Multistate outbreak of monkeypox–Illinois, Indiana, and Wisconsin, 2003. MMWR Morb Mortal Wkly Rep. 2003;52:537–540.