Early Transmission Dynamics, Spread, and Genomic Characterization of SARS-CoV-2 in Panama

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We report an epidemiologic analysis of 4,210 cases of infection with severe acute respiratory syndrome coronavirus 2 and genetic analysis of 313 new near-complete virus genomes in Panama during March 9–April 16, 2020. Although containment measures reduced R_0 and R_t, they did not interrupt virus spread in the country.

Coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was first reported in December 2019 in Wuhan, China (*1*,*2*). Of ≈23 million confirmed cases worldwide, as of October 20, 2020, a total of 28% (>6 million) had been reported in Latin America. SARS-CoV-2 was first reported in this region in São Paulo, Brazil, on February 25, 2020 (*3*).

In Panama, the first confirmed COVID-19 case was reported on March 9, 2020. Although Panama rapidly implemented disease control strategies, it is among the countries in Latin America with the highest cumulative rates of incidence and death (*4*). To elucidate the transmission and spread of SARS-CoV-2 in the region, we analyzed epidemiologic surveillance data and newly generated genetic data from Panama.

The Study

To perform molecular detection of SARS-CoV-2, the Panama Ministry of Health implemented a surveillance program on January 20, 2020. The National Committee on Bioethics of Research of Panama approved protocol EC-CNBI-202–04–46.

We evaluated the early transmission dynamics of COVID-19 in Panama for the first 62 days of the epidemic (February 15–April 16, 2020) based on reported dates of symptom onset. We estimated the daily growth rate, doubling time, and basic (R_0) and time-varying (R_t) effective reproduction numbers. We performed genome amplification and sequencing according to ARTIC Network protocol (https://artic.network) for Illumina Sequencing (https://www.illumina.com) (*5*). Details of epidemic parameters, sequencing, and genome analysis are described in Appendix 2 (https://wwwnc.cdc.gov/EID/article/27/2/20-3767-App2.pdf).

A total of 18,559 suspected cases of COVID-19 had been investigated in Panama by April 16. Of these, 4,210 (22.7%) patients tested positive for SARS-CoV-2 infection by qualitative reverse transcription PCR. The first confirmed case, on March 9, corresponded to a patient who had arrived in Panama from Spain on March 8 and had exhibited symptoms beginning on March 6. The first case not related to travel was

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confirmed after the death on March 7 of a patient in whom symptoms first appeared on February 22. Epidemiologic investigation showed that the date of onset of symptoms for the earliest local case related to that fatal case dates back to February 15, 2020 (Figure 1). In most locally detected cases, patients had mild disease symptoms (Appendix 2 Figure 1, panel A).

By April 16, a total of 341 patients had been hospitalized (77 at time of diagnosis confirmation) and 116 had died (31 by time of diagnosis confirmation) (Appendix 2 Figure 1, panels B, C). The highest proportion of confirmed cases was observed in the 20–59 year age group (Appendix 2 Figure 2, panel A). A higher proportion (55.3%) of patients tested were female, but among those with positive results, 1.45 times more were male (Appendix 2 Figure 2, panel B). A rapid growth rate of 0.13 cases/day (Appendix 2 Figure 3, panel A) and a short doubling time were observed during the early stages of the epidemic; doubling time increased over the study period (Appendix 2 Figure 3, panel B). We estimated an R_0 for SARS-CoV-2 in Panama of 2.22 (95% CI 2.08–2.37).

Panama was the 11th country in Latin America to report SARS-CoV-2 and implemented epidemic control strategies rapidly compared with other countries in the region (Appendix 2 Figure 4). After the first confirmed case (March 9), school closures were implemented within 1 day, social distancing measures within 6 days, and 24-hour stay-at-home curfew within 14 days. Over the course of the next 17 days, R_t dropped to 1.08 (95% Cl 1.00−1.17) (Appendix 2 Table 1, Figure 3, panel C). However, until April 16, Panama remained the country in Central America with the highest proportional number of cases and fatalities (Appendix 2 Figure 5).

To determine the diversity of SARS-CoV-2 in Panama and Latin America, we generated SARS-CoV-2 genomes from 313 patients, representing 7.4% of the total confirmed cases by April 16, 2020 (Appendix 2 Figure 6, panel A). We obtained complete genome coverage for samples using reverse transcription PCR cycle threshold values <25 (Appendix 2 Figure 6, panel B) and found circulation of ≥10 virus lineages (Figure 2, panel A; Appendix 2 Figure 7) (*6*). The most frequently identified was A.2 (71.2%), followed by B.1 (16.7%) and A.1 (3.5%), in contrast to other studies in Latin America, where B-like lineages largely predominate (*7*,*8*). Lineages A.3, B, and B.1.5 were identified in 79 cases detected early on in the epidemic, 11 (13.9%) of the cases imported (Figure 2, panel A; Appendix 2 Figure 7). Lineage A.2 was found in 51 patients; 4 (7.8%) belonged to a cluster (Appendix 2 Table 2) from a school outbreak associated with the first detected local case and 9 (17.6%) were police officers (Figure 2, panel C).

Phylogenetic analysis identified 3 main virus lineages (Figure 2). Lineage A.2.1/19B (n = 60; posterior support = 0.69; C12815T) comprised 54.3% of the sequenced cases in the study (Appendix 2 Figure 8, panel A); lineage B.1/20A (n = 15; posterior support = 0.97; G26143A) and lineage A.3/19B (n = 12; posterior support = 1.00; C3177T, T26729C) was third. Molecular clock estimates of the time to most recent common ancestor calculated from lineage A.2.1, made up just of cases with local transmission, placed the median time of mutation during February 19–March 9, 2020, just 2 weeks before the first COVID-19 case was confirmed, and in line with the time of onset of symptoms of the first case of local transmission (Figures 1, 2).

Central and western Panama had more diverse lineage distributions (Figure 2, panel B). Those regions encompass the capital and its surroundings, where more than 50% of the national population lives and the main international airport is located. Lineage A.2.1

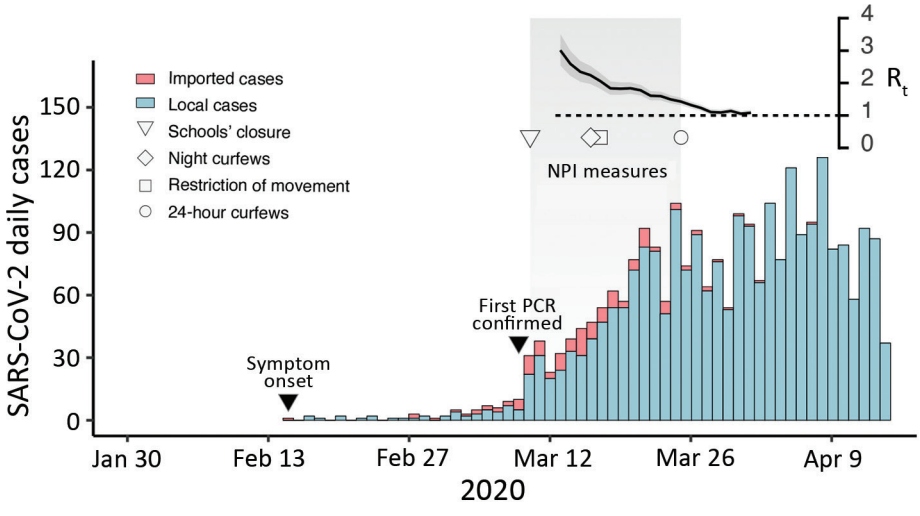

Figure 1. Epidemic curve of SARS-CoV-2 cases in Panama showing daily incidence of confirmed imported and local infections detected through April 16, 2020, with symptom onset during February 15–April 13, 2020. Gray shaded area indicates time period during which nonpharmaceutical interventions measures were initiated. Inset at top right shows the time-varying effective reproduction number (R_t) for a time frame of 45 days (x-axis); dark gray shading indicates 95% CI, and dashed line indicates threshold value $R_t = 1$. SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

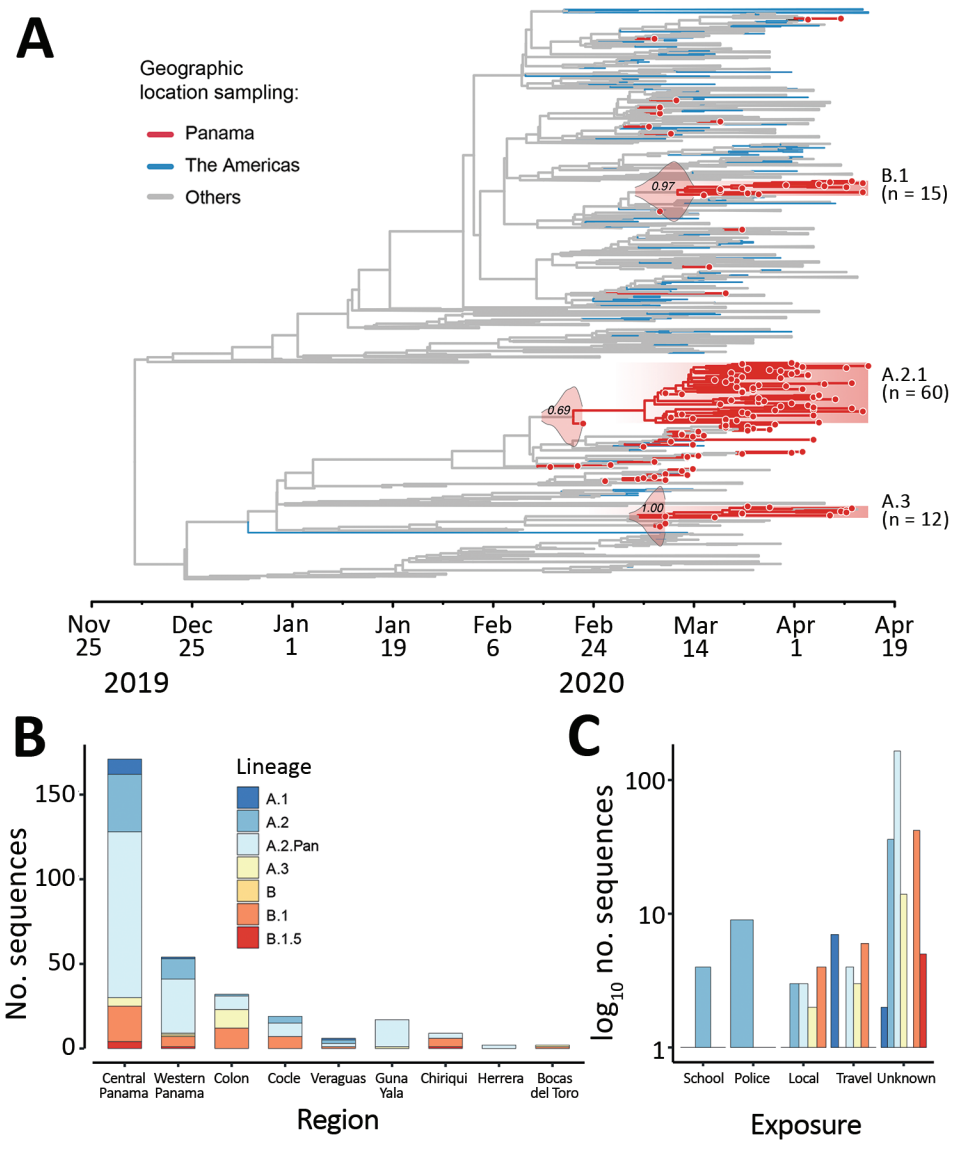

Figure 2. Genetic diversity of SARS-CoV-2 in Panama. A) Bayesian maximum clade credibility tree of 1,261 SARS-CoV-2 sequences: 133 from Panama; 492 from North or South America (443 genomes are from Brazil, 41 from the United States, 7 from Chile, 6 from Mexico, 3 from Argentina, 1 from Peru, and 1 from Canada); and 636 are from other locations. Posterior density estimates of time of the most recent common ancestor of each lineage with local transmission are shown in their branches. B) Distribution of lineages among regions in Panama. C) Distribution of lineages by channel of exposure detected by the surveillance system. SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

was found in all regions across the country with no obvious spatial pattern; according to a global analysis of SARS-CoV-2 lineages (https://cov-lineages.org), this lineage is composed of sequences predominantly from Panama. We also found that the spike glycoprotein variants D614 and G614 (*9*,*10*) were cocirculating early in the epidemic among all the regions analyzed and were comprised of multiple lineages (Appendix 2 Figure 8, panel B), but the G614 variant potentially associated with infectivity (*9*) was detected in only 18.8% of the sequenced cases (Appendix 2 Figure 8, panel C).

Conclusions

Epidemiologic evidence suggested cryptic circulation of SARS-CoV-2 in Panama with a probable introduction during early February. A high median transmission potential of SARS-CoV-2 was estimated at R_0 = 2.22 (2.08–2.37), similar to estimates from China, Brazil, and Europe (*11*–*13*). R_t rapidly dropped to 1.08 after implementation of control strategies.

Phylogenetic analysis detected circulation of ≥10 virus lineages, although the number of detected lineages could be underestimated because we did not sequence each positive case and there is a possibility of uncommon undetected lineages due to sample bias. Most of the lineages associated with imported cases (A.1, A.3, B, B.1, B.2.1) were detected and transmission controlled through active contact tracing. However, we detected early transmission of the lineage A.2.1/19B, which was introduced into the country ≥3 weeks before the first detected case. This lineage rapidly became widespread in Panama.

We conjecture that efforts to identify early suspected cases, which focused mainly in symptomatic travelers returning from China, precluded the opportunity to detect earlier cases imported from Europe and the United States, where the virus was already circulating at that time (*11*,*14*,*15*). Moreover, undetected early transmission occurring before control measures were implemented could help to explain the widespread distribution of SARS-CoV-2 across Panama.

Our findings on growth rates and R_t show that mitigation measures undertaken shortly after the first reported case in March helped to reduce virus transmission. Measures such as active contact tracing and isolation, social distancing, and quarantine targeted to regions where active transmission clusters are found will help to effectively control the spread of SARS-CoV-2 in Panama.

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References

1. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med. 2020;382:1199–207. https://doi.org/10.1056/NEJMoa2001316
2. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al.; China Novel Coronavirus Investigating and Research Team. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med. 2020;382:727–33. https://doi.org/10.1056/NEJMoa2001017
3. Jesus JG, Sacchi C, Candido DDS, Claro IM, Sales FCS, Manuli ER, et al. Importation and early local transmission of COVID-19 in Brazil, 2020. Rev Inst Med Trop São Paulo. 2020;62:e30. https://doi.org/10.1590/s1678-9946202062030
4. World Health Organization. Coronavirus disease (COVID-19) pandemic [cited 2020 August 26] https://www.who.int/emergencies/diseases/novel-coronavirus-2019
5. Quick J, Grubaugh ND, Pullan ST, Claro IM, Smith AD, Gangavarapu K, et al. Multiplex PCR method for MinION and Illumina sequencing of Zika and other virus genomes directly from clinical samples. Nat Protoc 2017;12;1261–76. https://doi.org/10.1101/098913
6. Rambaut A, Holmes EC, O'Toole Á, Hill V, McCrone JT, Ruis C, et al. A dynamic nomenclature proposal for SARS-CoV-2 lineages to assist genomic epidemiology. Nat Microbiol. 2020;5:1403–7. https://doi.org/10.1038/s41564-020-0770-5
7. Laiton-Donato K, Villabona-Arenas C, Usme-Ciro JA, Franco-Muñoz C, Álvarez-Díaz DA, Villabona-Arenas L, et al. Genomic epidemiology of severe acute respiratory syndrome coronavirus 2, Colombia. Emerg Infect Dis. 2020;26:2854–62. https://dx.doi.org/10.3201/eid2612.202969
8. Candido DS, Claro IM, de Jesus JG, Souza WM, Moreira FRR, Dellicour S, et al. Evolution and epidemic spread of SARS-CoV-2 in Brazil. Science. 2020;369:1255–60. https://doi.org/10.1126/science.abd2161
9. Korber B, Fischer WM, Gnanakaran S, Yoon H, Theiler J, Abfalterer W, et al.; Sheffield COVID-19 Genomics Group. Tracking changes in SARS-CoV-2 spike: evidence that D614G increases infectivity of the COVID-19 virus. Cell. 2020;182:812–827.e19. https://doi.org/10.1016/j.cell.2020.06.043
10. Ou X, Liu Y, Lei X, Li P, Mi D, Ren L, et al. Characterization of spike glycoprotein of SARS-CoV-2 on virus entry and its immune cross-reactivity with SARS-CoV. Nat Commun. 2020;11:1620. https://doi.org/10.1038/s41467-020-15562-9
11. Bartolini B, Rueca M, Gruber CEM, Messina F, Carletti F, Giombini E, et al. SARS-CoV-2 phylogenetic analysis, Lazio region, Italy, February–March 2020. Emerg Infect Dis J. 2020;26:1842–5. https://doi.org/10.3201/eid2608.201525
12. Lu J, du Plessis L, Liu Z, Hill V, Kang M, Lin H, et al. Genomic epidemiology of SARS-CoV-2 in Guangdong province, China. Cell. 2020;181:997–1003. https://doi.org/10.1016/j.cell.2020.04.023
13. de Souza WM, Buss LF, Candido DDS, Carrera J-P, Li S, Zarebski AE, et al. Epidemiological and clinical characteristics of the COVID-19 epidemic in Brazil. Nat Hum Behav. 2020;4:856–65. https://doi.org/10.1038/s41562-020-0928-4
14. Bedford T, Greninger AL, Roychoudhury P, Starita LM, Famulare M, Huang M-L, et al. Cryptic transmission of SARS-CoV-2 in Washington state. Science. 2020;370:571–5. https://doi.org/10.1126/science.abc0523
15. Deng X, Gu W, Federman S, du Plessis L, Pybus OG, Faria NR, et al. Genomic surveillance reveals multiple introductions of SARS-CoV-2 into northern California. Science. 2020;369:582–7. PubMed https://doi.org/10.1126/science.abb9263

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Appendix 2

Methods

Additional Details of COVID-19 Surveillance and Laboratory Diagnosis in Panama

The surveillance program for COVID-19 was implemented by the Panama Ministry of Health (MoH) on January 20, 2020. Suspected cases were actively sought at international airports using World Health Organization/Pan American Health Organization case definitions and recommendations (*1*). In this first stage, suspected cases were defined by symptoms and signs from influenza-like illness (ILI) and severe acute respiratory infections (SARI), as well as patients coming into Panama from China. On March 4, the list of countries from which travellers were monitored was expanded to include Italy, Iran, South Korea, and Japan. Travelers from these countries, confirmed cases, and their contacts were isolated in home or hotel quarantine for 14 days. Clinical evaluation and temperature measurement were done every day; if symptoms developed, nasopharyngeal or oropharyngeal swabs were taken by MoH and sent for laboratory diagnosis. For confirmed cases, contact tracing was performed by MoH.

The Gorgas Memorial Institute for Health Studies (GMI) is the national reference laboratory of Panama and is recognized as a World Health Organization National Influenza Center (*2*). The National Laboratory Network for Surveillance of Respiratory Viruses collects data from 16 sentinel sites through the national territory and 3 laboratories (Obaldia Hospital in Chiriqui province for eastern Panama, Chicho Fabrega Hospital in Veraguas province for Central Panama, and GMI in Panama City). The National COVID-19 Laboratory Network was built from the National Laboratory Network for Surveillance of Respiratory Viruses, but after increasing equipment capacity and training laboratory personnel intended to perform the molecular diagnosis of SARS-CoV-2, this network was extended to include more public health laboratories (from MoH as well as from the social security system and private hospitals).

Through April 16, 12 laboratories were part of the network; this was expanded to ≥20 laboratories for molecular diagnosis around the country.

Nasopharyngeal and oropharyngeal samples were collected in 503CS01 nasopharyngeal nylon swabs (Copan Diagnostics, https://www.fishersci.com) in 305C viral transport medium (Copan Diagnostics) to preserve the integrity of the viral particles. The collected samples were sent to GMI for laboratory confirmation beginning January 23 and to additional laboratories from the National COVID-19 Laboratory network beginning March 16. Samples were sent with a surveillance form with demographic, clinical, and contact tracing information (date of onset of symptoms, description of symptoms, age, sex, district of residence, district of employment, travel in or outside the country ≤15 days before symptom onset; if the person had contact with a positive patient: name and phone number of that person were also recorded).

The processing of SARS-CoV-2 suspected samples was performed in a BSL-2 facility with negative pressure. After viral inactivation, viral RNA was obtained by using QIAamp Viral Mini kit (QIAGEN, https://www.qiagen.com) according to the manufacturer's recommendations. During January 23–February 16, for SARS-CoV-2 suspected cases, the presence of viral RNA from coronavirus was detected using a generic reverse transcription PCR (RT-PCR) (*3*) and Sanger sequencing of the fragment as confirmation. Charité Institute's SARS-CoV-2–specific real time RT-PCR was implemented, using the E gene as screening and the RdRp gene of SARS-CoV-2 as confirmation (*4*), by using the One-Step RT-PCR kit AgPath-ID (Applied Biosystems, https://www.thermofisher.com) or the Invitrogen SuperScript III One-Step RT-qPCR (ThermoFisher, https://www.thermofisher.com) and the ABI 7500 Fast computer platform v1.4.0 System (Applied Biosystems). The fluorescence was read at the annealing/extension step and the threshold cycle (C_t) value for each PCR reaction was recorded. Samples with Ct values ≤40 were considered positive.

Additional Information of Epidemiologic Investigation and Epidemic Parameters Estimation

Epidemiologic data on suspected cases and their contacts were recorded by physicians, using a standardized epidemiologic form for surveillance of respiratory viruses, at the airport, health facilities, or at home or hotel during quarantine, when nasopharyngeal and oropharyngeal swabs were taken. Data entry was independently undertaken by GMI and the laboratories from the National COVID-19 Laboratory network, and then checked by the National Department of

Epidemiology of MoH to confirm the accuracy of the information. A dataset of daily incidence based on the date of symptom onset was created, for samples reported through April 16 with the dates of first onset of symptoms during February 15–April 14. Data on delay in notification of patients was corrected by using the median of delay between onset of symptoms and report of confirmed cases. After the epidemic curve correction was done, the first 61 days of COVID-19 epidemic in Panama, February 15–April 13, were analyzed.

General Description

Data on the demographics (age, sex, region) and clinical condition (ambulatory, for asymptomatic, presymptomatic, or mildly symptomatic outpatient patients; hospitalized; or fatal) of suspected patients were collected from MoH's respiratory virus surveillance sheet through the COVID-19 surveillance laboratory network. Data were evaluated until April 13 to correct reporting delay. We undertook several epidemiologic analyses.

We estimated the basic reproductive number (R_0) using the time series of confirmed cases with likelihood-based estimation using a branching process, following Poisson likelihood standards (*5*). A serial interval mean of 4.7 days, SD 2.9 was used for the estimation (*6*). The time-variant effective reproductive number (R_t) was estimated in a Bayesian framework because the cumulative number of cases reached 25 as described elsewhere (*6*), serial interval with 95% confidence intervals (95% Cl), using the EpiEstim package (https://cran.r-project.org) implemented in R (*5*).

Epidemic Curve

The number of confirmed cases reported through April 15 reflects the number of cases per day using the date of symptom onset reported by the patient to the clinician or, when necessary, extrapolated from the date of sample receipt by GMI (*6*).

Transmission Dynamics

To analyze local transmission dynamics through April 13, imported cases were removed from the epidemic curve. In addition, to avoid giving a false impression of decreasing transmissibility by a potential delay in the appearance and detection of cases because of the artificial drop in the epidemic curve from removing imported cases, the curve was corrected by removing the last 4 days of observations in the epidemic curve.

Daily Growth Rate and Doubling Time

The daily growth rate was estimated using the formula $log(I) = r * t + b$, where r is the incidence based on dates of symptom onset, t is the length of time since onset, and b is the intercept. The doubling time was calculated using $Dt = \frac{log(2)}{r}$ in an interval of 7.7 days. The growth rate with 95% confidence intervals was visualized using the Incidence package.

Basic Reproductive Number

Daily reported incidence based on dates of symptom onset was used to estimate R_0 and R_t. To estimate R_0, several methods were explored, using serial intervals reported elsewhere (*6*), of mean 4.7 days, SD 2.9 days, according to gamma distribution (shape = 0.118, scale = 39.52). Early R_0 with likelihood-based estimation using a branching process follows Poisson likelihood standards described elsewhere (*5*). R_0 was estimated from data collected during February 28–March 24, 2020, to avoid variation due to implementation of control strategies.

Effective Reproductive Number

We undertook approaches to estimate the time-varying effective reproductive number R_t, with a serial interval distribution described elsewhere (*6*), using a Bayesian framework. For this, the R_t since the cumulative incidence reached 25 cases was obtained to reduce the coefficient of variation to 0.2. After 25 cases, the final time range analyzed included 31 days (March 13–April 13). R_t with 95% confidence intervals (95% Cl), was estimated every 7 days using the EpiEstim package implemented in R (*5*).

SARS-CoV-2 Genomic Characterization

To genetically characterize the SARS-CoV-2 strains introduced in Panama, as well as to analyze their distribution, samples were selected from areas where new cases were confirmed by laboratory during March 8–April 16, taking into account the cumulative number of cases for regions, as described elsewhere (*7*). In total, we selected 421 confirmed cases. Besides the clinical, epidemiologic, and demographic data, the C_t values of the diagnostic RT-qPCR were also recorded (Appendix 2 Table 2).

Viral RNA extraction was performed and the RNA was transcribed to cDNA using the reverse transcription protocol by using Invitrogen SuperScript III First-Strand Synthesis System (ThermoFisher) with random hexamers and a pool of ARTIC reverse primers (https://artic.network) set to 50 μm. To amplify SARS-CoV-2–specific cDNA, a PCR reaction

was done by using Invitrogen Platinum Taq HiFi (ThermoFisher) with ARTIC Network protocol (*8*). PCR products were confirmed by agarose gel electrophoresis with evidence of a band of ≈450bp.

Amplicons generated were pooled and prepared for Illumina sequencing with the Nextera XT (https://www.illumina.com) library, according to the manufacturer's standard protocol. All samples were sequenced with MiSeq V2 (https://www.illumina.com) reagent kits for 500 cycles.

Bioinformatics Analysis

The reads obtained were filtered with a minimum quality score of Q30 and 120 bp length, with Quasitools-hydra pipeline (https://github.com) (*9*) using the SARS-CoV-2 reference sequence MN908947.3. Variants were determined using a consensus based on a predetermined error rate of 0.0021, a minimum read depth of 10×, an allele count of 5, and a variant quality score of Q30. The average coverage obtained was 92.9%, IQR 0.05.

Quality Control of Genome Consensus Sequences

A total of 365 PCR fragments were sequenced. To verify their quality for downstream analysis a quality control step was included; briefly, consensus sequences were filtered according to a genome coverage >75% and region-spanning nucleotide positions were masked with a python script (https://github.com) used elsewhere (*10*). After these steps, a total of 313 sequences were included in the phylogenetic analysis (Appendix 2 Figure 7). To maximize phylogenetic signal and reduce masked regions for Bayesian analysis (Figure 2, panel A), only sequences with >29,000 bp (~97% of coverage compared with MN908947.3 reference strain) were included (133 sequences).

SARS-CoV-2 Global Dataset

The dataset used for Bayesian analysis was made up of 433 genomes from Brazil previously described (*7*), and genomes retrieved from gisaid.org; of these, 41 genomes were from the United States, 7 from Chile, 6 from Mexico, 3 from Argentina, 1 from Peru, 1 from Canada, and 636 from countries outside of the Americas (Appendix 2 Table 3), corresponding to a global subsampling of sequences including 1 genome per country per day (based on sampled collection day). This global dataset was retrieved on April 24, 2020. We sequenced genomes from Panama, Brazil, and from other parts of the world in the dataset used for this analysis.

Phylogenetic Analysis of Panamanian SARS-CoV-2 Sequences

To perform the phylogenetic analysis, we adopted nomenclature described elsewhere (*11*), which was based on the dynamics of propagation of the virus according to the country of origin of the strain, with the objective of evaluating the lineage distribution in the country over time (*11*). The pangoLEARN pipeline, version 2020–08–29_3 (https://github.com) was used to assign lineage. To review the phylogenetic structure of SARS-CoV-2 virus in Panama, sequences were aligned using mafft v7.445 (https://mafft.cbrc.jp) (*12*), a high speed multiple sequence alignment program, and the maximum likelihood tree was inferred with IQTREE (http://www.iqtree.org) (*13*) using a substitution model (HKY + ⌈4 gamma variation) suggested previously (*7*,*14*–*16*) and visualized in FigTree 1.14 (http://tree.bio.ed.ac.uk) (Appendix 2 Figure 7).

Temporal Signal of SARS-CoV-2 in Panama

To explore the temporal signal of SARS-CoV-2 in Panama, a Bayesian coalescent phylogeny was calculated using BEAST v.1.10.4 (https://beast.community) (*17*), using the same substitution model as in the maximum likelihood analysis, under an uncorrelated lognormal molecular clock, with a noninformative continuous-time Markov chain reference prior distribution (*18*). The exponential population growth tree model was implemented as in previous studies (*14*,*15*). The analysis was run for 250 million chains using BEAGLE v3 (https://github.com) (*19*) to enhance computational speed, writing to log every 25,000 chains. Convergence of the MCMC chains was inspected using Tracer v.1.7.1 (https://beast.community) (*20*). After removal of 10% burn-in, tree files were resampled using LogCombiner v.1.10.4 (https://beast.community) (*17*) to obtain a posterior sample of 1,000 dated phylogenetic trees. Maximum clade credibility summary trees were generated using TreeAnnotator v.1.10.4 (https://beast.community) (65). Time of the most recent common ancestor was calculated for each monophyletic lineage formed by sequenced with confirmed only local transmission from the same posterior tree distribution. Sequence mutations were annotated using the pipeline implemented in (*16*) and plotted with ggplot2 suite (https://rstudio.com) (*21*).

Data and Materials Availability

Control Measures in Latin America

Reports from the World Health Organization and the Organisation for Economic Co-operation and Development, and official communications from ministries of health were used to obtain data on control and mitigation strategies at the country level to reconstruct a timeline representing the strategies adopted by Latin American countries. Only if no official information was found, were press articles from local newspapers consulted.

References

1. World Health Organization. Coronavirus disease (COVID-19) pandemic [cited 2020 August 26] https://www.who.int/emergencies/diseases/novel-coronavirus-2019

2. World Health Organization. National influenza centres. [cited 2020 Jun 9]. https://www.who.int/influenza/gisrs_laboratory/national_influenza_centres/list/en/index1.html

3. de Souza Luna LK, Heiser V, Regamey N, Panning M, Drexler JF, Mulangu S, et al. Generic detection of coronaviruses and differentiation at the prototype strain level by reverse transcription-PCR and nonfluorescent low-density microarray. J Clin Microbiol. 2007;45:1049–52. PubMed https://doi.org/10.1128/JCM.02426-06

4. Corman VM, Landt O, Kaiser M, Molenkamp R, Meijer A, Chu DK, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Euro Surveill. 2020;25:2000045. PubMed https://doi.org/10.2807/1560-7917.ES.2020.25.3.2000045

5. Cori A, Ferguson NM, Fraser C, Cauchemez S. A new framework and software to estimate time-varying reproduction numbers during epidemics. Am J Epidemiol. 2013;178:1505–12. PubMed https://doi.org/10.1093/aje/kwt133

6. Nishiura H, Linton NM, Akhmetzhanov AR. Serial interval of novel coronavirus (COVID-19) infections. Int J Infect Dis. 2020;93:284–6. PubMed https://doi.org/10.1016/j.ijid.2020.02.060

7. Candido DS, Claro IM, de Jesus JG, Souza WM, Moreira FRR, Dellicour S, et al. Evolution and epidemic spread of SARS-CoV-2 in Brazil. Science. 2020;369:1255–60. PubMed https://doi.org/10.1126/science.abd2161

8. Quick J. nCoV-2019 sequencing protocol. 2020 [Cited 2020 November 22] https://dx.doi.org/10.17504/protocols.io.bibtkann

9. Taylor T, Lee ER, Nykoluk M, Enns E, Liang B, Capina R, et al. A MiSeq-HyDRA platform for enhanced HIV drug resistance genotyping and surveillance. Sci Rep. 2019;9:8970. PubMed https://doi.org/10.1038/s41598-019-45328-3

10. Hadfield J, Megill C, Bell SM, Huddleston J, Potter B, Callender C, et al. Nextstrain: real-time tracking of pathogen evolution. Bioinformatics. 2018;34:4121–3. PubMed https://doi.org/10.1093/bioinformatics/bty407

11. Rambaut A, Holmes EC, O'Toole Á, Hill V, McCrone JT, Ruis C, et al. A dynamic nomenclature proposal for SARS-CoV-2 lineages to assist genomic epidemiology. Nat Microbiol. 2020;5:1403–7. PubMed https://doi.org/10.1038/s41564-020-0770-5

12. Katoh K, Standley DM. MAFFT multiple sequence alignment software version 7: improvements in performance and usability. Mol Biol Evol. 2013;30:772–80. PubMed https://doi.org/10.1093/molbev/mst010

13. Nguyen LT, Schmidt HA, von Haeseler A, Minh BQ. IQ-TREE: a fast and effective stochastic algorithm for estimating maximum-likelihood phylogenies. Mol Biol Evol. 2015;32:268–74. PubMed https://doi.org/10.1093/molbev/msu300

14. Oude Munnink BB, Nieuwenhuijse DF, Stein M, O'Toole Á, Haverkate M, Mollers M, et al.; Dutch-Covid-19 response team. Rapid SARS-CoV-2 whole-genome sequencing and analysis for informed public health decision-making in the Netherlands. Nat Med. 2020;26:1405–10. Corrected and republished from: Nat Med. 2020;26:1802. PubMed https://doi.org/10.1038/s41591-020-0997-y

15. Nie Q, Li X, Chen W, Liu D, Chen Y, Li H, et al. Phylogenetic and phylodynamic analyses of SARS-CoV-2. Virus Res. 2020;287:198098. PubMed https://doi.org/10.1016/j.virusres.2020.198098

16. Lu J, du Plessis L, Liu Z, Hill V, Kang M, Lin H, et al. Genomic epidemiology of SARS-CoV-2 in Guangdong province, China. Cell. 2020;181:997–1003. PubMed https://doi.org/10.1016/j.cell.2020.04.023

17. Suchard MA, Lemey P, Baele G, Ayres DL, Drummond AJ, Rambaut A. Bayesian phylogenetic and phylodynamic data integration using BEAST 1.10. Virus Evol. 2018;4:vey016. PubMed https://doi.org/10.1093/ve/vey016

18. Ferreira MAR, Suchard MA. Bayesian analysis of elapsed times in continuous-time Markov chains. Can J Stat. 2008;36:355–68. https://doi.org/10.1002/cjs.5550360302

19. Ayres DL, Cummings MP, Baele G, Darling AE, Lewis PO, Swofford DL, et al. BEAGLE 3: improved performance, scaling, and usability for a high-performance computing library for statistical phylogenetics. Syst Biol. 2019;68:1052–61. PubMed https://doi.org/10.1093/sysbio/syz020

20. Rambaut A, Drummond AJ, Xie D, Baele G, Suchard MA. Posterior summarization in Bayesian phylogenetics using Tracer 1.7. Syst Biol. 2018;67:901–4. PubMed https://doi.org/10.1093/sysbio/syy032

21. Wickham H. ggplot2: elegant graphics for data analysis. 2nd ed. New York: Springer; 2016.

Appendix 2 Table 1. Estimates of the reproductive number (R_t) over time.

Observations	t_start	t_end	Mean(R)	Std(R)	Quantile 0.025 (R)	Quantile 0.975 (R)	Dates
1	2	9	3.01	0.25	2.54	3.52	3/13/2020
2	3	10	2.59	0.20	2.22	2.99	3/14/2020
3	4	11	2.35	0.16	2.04	2.68	3/15/2020
4	5	12	2.24	0.14	1.97	2.53	3/16/2020
5	6	13	2.06	0.12	1.82	2.30	3/17/2020
6	7	14	1.84	0.11	1.64	2.05	3/18/2020
7	8	15	1.82	0.10	1.64	2.02	3/19/2020
8	9	16	1.84	0.09	1.67	2.02	3/20/2020
9	10	17	1.78	0.08	1.62	1.94	3/21/2020
10	11	18	1.61	0.07	1.47	1.76	3/22/2020
11	12	19	1.60	0.07	1.47	1.73	3/23/2020
12	13	20	1.49	0.06	1.37	1.62	3/24/2020
13	14	21	1.43	0.06	1.32	1.55	3/25/2020
14	15	22	1.32	0.05	1.22	1.43	3/26/2020
15	16	23	1.23	0.05	1.14	1.33	3/27/2020
16	17	24	1.11	0.05	1.02	1.20	3/28/2020
17	18	25	1.09	0.04	1.01	1.18	3/29/2020
18	19	26	1.14	0.04	1.05	1.23	3/30/2020
19	20	27	1.05	0.04	0.97	1.14	3/31/2020
20	21	28	1.08	0.04	1.00	1.17	4/1/2020

Appendix 2 Table 2. Characteristic and demographic information of sequenced samples in the study.

Case	Epi week	Sex	Age, y	Region	ID	GISAID Accession #	Date symptom onset	Date results received	Epi cluster	Epiclusterlink	Type of exposition	Epi link	Exposition description	Lineage autocolor
1	10	F	40	Panamá Metro	328677	EPI_ISL_415152	2020-03-06	2020-03-09	1	travel	imported	travel	Spain	B.1.5
3	10	F	29	Panamá Metro	328688	EPI_ISL_496603	2020-03-04	2020-03-09	2	travel	imported	travel	USA	A.3
4	10	F	43	Panamá Metro	328706	EPI_ISL_496604	2020-03-05	2020-03-09	4	travel	imported	travel	Spain	A.2
5	9	M	64	Panamá Norte	328709	EPI_ISL_496605	2020-02-28	2020-03-09	3	school	local	school	NA	A.2
6	8	M	49	Panamá Metro	328710	EPI_ISL_496606	2020-02-20	2020-03-09	3	school	local	unknown	NA	A.2.1
7	8	F	58	Panamá Metro	328719	EPI_ISL_496607	2020-02-22	2020-03-10	3	school	local	unknown	NA	A.2
8	10	F	35	Panamá Metro	328721	EPI_ISL_496608	2020-03-09	2020-03-10	5	travel	imported	travel	USA	A.1
9	8	F	57	Panamá Norte	328723	EPI_ISL_496609	2020-02-17	2020-03-10	3	school	local	school	NA	A.2
11	11	M	60	San Miguelito	328726	EPI_ISL_496610	2020-03-08	2020-03-10	6	travel	imported	travel	USA	A.3
12	10	M	61	Panamá Metro	328733	EPI_ISL_496611	2020-03-07	2020-03-10	NA	unknown	imported	travel	USA	A.1
14	11	M	38	Panamá Metro	328774	EPI_ISL_496612	2020-03-10	2020-03-10	4	travel	local	contact	Travel	A.2.1
15	10	M	31	Panamá Metro	328844	EPI_ISL_496613	2020-03-07	2020-03-11	NA	unknown	imported	travel	Spain	B.1.5
16	11	F	28	Panamá Metro	328848	EPI_ISL_496614	2020-03-08	2020-03-11	NA	unknown	imported	travel	Europe	B.1
17	11	M	34	Panamá Metro	328927	EPI_ISL_496615	2020-02-15	2020-03-11	1	travel	imported	travel	Spain	B.1
18	11	F	44	Panamá Metro	328933	EPI_ISL_496616	2020-03-09	2020-03-11	6	travel	imported	travel	Puerto Rico	A.3
19	9	F	37	San Miguelito	328941	EPI_ISL_496617	2020-02-27	2020-03-11	5	travel	imported	travel	USA	A.1
20	10	M	43	San Miguelito	328944	EPI_ISL_496618	2020-03-04	2020-03-11	5	travel	imported	travel	USA	A.1
23	11	F	70	Panamá Metro	328971	EPI_ISL_496619	2020-03-09	2020-03-11	15	travel	imported	travel	USA	A.1
24	11	M	41	Panamá Norte	328972	EPI_ISL_496620	2020-03-08	2020-03-11	3	school	local	contact	School	A.1
26	10	M	40	Panamá Norte	328980	EPI_ISL_496621	2020-03-07	2020-03-11	3	school	local	contact	School	A.2
27	11	F	10	Panamá Norte	328981	EPI_ISL_496622	2020-03-10	2020-03-11	7	travel	imported	travel	France, Italy	A.2.1
30	11	M	42	Panamá Este	329064	EPI_ISL_496623	2020-03-09	2020-03-12	8	police	local	police	NA	A.2
32	11	M	42	Panamá Metro	329108	EPI_ISL_496624	2020-03-10	2020-03-12		unknown	imported	travel	Spain	B.1.5
33	11	F	48	Panamá Oeste	329117	EPI_ISL_496625	2020-03-08	2020-03-12	1	travel	imported	travel	Spain, Switzerland	B.1
35	11	F	38	Panamá Metro	329198	EPI_ISL_496626	2020-03-08	2020-03-12	9	travel	imported	travel	Germany	B.1
36	10	F	13	Panamá Metro	329230	EPI_ISL_496627	2020-03-05	2020-03-12	10	travel	imported	travel	USA	A.1
40	11	F	44	Panamá Metro	329377	EPI_ISL_496628	2020-03-13	2020-03-13	NA	unknown	local	unknown	NA	B
42	11	F	45	Panamá Oeste	329388	EPI_ISL_496629	2020-03-11	2020-03-13	1	travel	local	contact	Travel	B.1
44	11	F	60	Panamá Norte	329446	EPI_ISL_496630	2020-03-12	2020-03-13	1	travel	local	contact	Health	A.2.1
45	11	F	43	Colón	329536	EPI_ISL_496631	2020-03-09	2020-03-14	26	local	local	contact	Health	A.3
52	11	F	50	Panamá Oeste	329546	EPI_ISL_496632	2020-03-12	2020-03-14	25	local	local	contact	Health	A.2
53	11	F	40	Panamá Oeste	329547	EPI_ISL_496633	2020-03-13	2020-03-14	5	travel	local	contact	Travel	A.1
55	11	M	63	Panamá Metro	329560	EPI_ISL_496634	2020-03-12	2020-03-14	10	travel	imported	travel	USA	A.1
59	11	F	48	Panamá Metro	329576	EPI_ISL_496635	2020-03-09	2020-03-15	NA	unknown	local	school	NA	A.2
61	11	M	49	Panamá Oeste	329593	EPI_ISL_496636	2020-03-13	2020-03-15	8	police	local	police	NA	A.2
62	11	M	54	Panamá Oeste	329628	EPI_ISL_496637	2020-03-11	2020-03-15	8	police	local	police	NA	A.2
68	11	M	41	Panamá Oeste	329653	EPI_ISL_496638	2020-03-10	2020-03-15	17	local	local	unknown	NA	A.2.1
69	11	F	41	Panamá Metro	329655	EPI_ISL_496639	2020-03-11	2020-03-15	NA	unknown	local	school	NA	A.2.1
70	11	M	48	Panamá Metro	329667	EPI_ISL_496640	2020-03-14	2020-03-16	8	police	local	police	NA	A.2
71	11	F	51	San Miguelito	329676	EPI_ISL_496641	2020-03-12	2020-03-16	8	police	local	police	NA	A.2
73	10	F	34	Veraguas	329682	EPI_ISL_496642	2020-03-06	2020-03-16	14	local	local	unknown	NA	A.2
74	11	M	36	Panamá Oeste	329694	EPI_ISL_496643	2020-03-10	2020-03-16	20	local	local	unknown	NA	A.1
75	12	M	48	Panamá Metro	329700	EPI_ISL_496644	2020-03-16	2020-03-16	8	police	local	police	NA	A.2
77	12	F	30	Panamá Oeste	329718	EPI_ISL_496645	2020-03-15	2020-03-16	8	police	local	police	NA	A.2
78	11	M	62	Panamá Metro	329728	EPI_ISL_496646	2020-03-14	2020-03-16	NA	unknown	local	unknown	NA	A.1
80	11	M	54	Panamá Metro	329734	EPI_ISL_496648	2020-03-14	2020-03-16	NA	unknown	imported	travel	USA	B.1

Case	Epi week	Sex	Age, y	Region	ID	GISAID Accession #	Date symptom onset	Date results received	Epi cluster	Epiclusterlink	Type of exposition	Epi link	Exposition description	Lineage autocolor
82	11	M	45	Panamá Metro	329752	EPI_ISL_496649	2020-03-14	2020-03-16	NA	unknown	local	contact	Health	A.2.1
88	11	F	28	San Miguelito	329844	EPI_ISL_496650	2020-03-12	2020-03-16	NA	unknown	local	unknown	NA	A.2
91	11	M	57	Panamá Metro	329862	EPI_ISL_496651	2020-03-14	2020-03-16	23	travel	local	contact	Travel	B.1
92	11	F	29	Panamá Norte	329868	EPI_ISL_496652	2020-03-13	2020-03-16	NA	unknown	local	unknown	NA	A.2
93	10	M	45	Veraguas	329877	EPI_ISL_496653	2020-03-06	2020-03-16	18	local	local	unknown	NA	B.1
94	11	F	61	Veraguas	329879	EPI_ISL_496654	2020-03-14	2020-03-16	14	local	local	unknown	NA	A.2
95	10	M	34	Panamá Metro	329893	EPI_ISL_496655	2020-03-09	2020-03-17	NA	unknown	local	unknown	NA	A.2.1
97	11	F	70	Panamá Metro	329916	EPI_ISL_496656	2020-03-13	2020-03-17	NA	unknown	local	unknown	NA	A.2.1
112	12	M	66	Panamá Oeste	330057	EPI_ISL_496657	2020-03-15	2020-03-17	NA	unknown	local	unknown	NA	A.2.1
116	11	M	55	Panamá Metro	330089	EPI_ISL_496658	2020-03-13	2020-03-17	8	police	local	police	NA	A.2
121	12	M	53	Panamá Metro	330130	EPI_ISL_496659	2020-03-15	2020-03-17	2	travel	local	contact	Health	A.2.1
129	11	M	42	Panamá Oeste	330208	EPI_ISL_496660	2020-03-10	2020-03-18	NA	unknown	local	unknown	NA	A.2.1
134	11	M	52	Panamá Metro	330286	EPI_ISL_496661	2020-03-09	2020-03-18	18	local	local	contact	MP	B.1
138	11	M	40	Panamá Norte	330339	EPI_ISL_496662	2020-03-09	2020-03-18	8	police	local	police	NA	B.1
157	11	M	30	Panamá Oeste	330413	EPI_ISL_496663	2020-03-13	2020-03-18	NA	unknown	local	police	NA	A.2
163	11	M	40	Panamá Oeste	330449	EPI_ISL_496664	2020-03-13	2020-03-18	NA	unknown	local	unknown	NA	A.2
170	11	F	37	Panamá Este	330490	EPI_ISL_496665	2020-03-19	2020-03-19	NA	unknown	local	unknown	NA	A.2
175	11	M	46	Coclé	330547	EPI_ISL_496666	2020-03-14	2020-03-19	NA	unknown	local	police	NA	A.2
176	11	M	37	Panamá Oeste	330553	EPI_ISL_496667	2020-03-11	2020-03-19	20	local	local	unknown	NA	A.2.1
177	12	M	14	Panamá Metro	330558	EPI_ISL_496668	2020-03-18	2020-03-19	11	travel	local	contact	Travel	B.1
194	12	F	46	Colón	330671	EPI_ISL_496669	2020-03-18	2020-03-19	26	local	local	contact	Health	A.3
197	11	M	63	Panamá Metro	330722	EPI_ISL_496670	2020-03-13	2020-03-19	NA	unknown	local	police	NA	A.2
202	11	M	46	Panamá Oeste	330754	EPI_ISL_496671	2020-03-12	2020-03-19	NA	unknown	local	unknown	NA	A.2.1
207	11	F	53	Colón	330771	EPI_ISL_496672	2020-03-12	2020-03-19	NA	unknown	local	unknown	NA	A.2.1
208	10	M	54	Panamá Metro	330775	EPI_ISL_496673	2020-03-01	2020-03-19	NA	unknown	local	unknown	NA	A.3
211	12	F	49	Panamá Norte	330779	EPI_ISL_496674	2020-03-18	2020-03-19	19	local	local	contact	Health	B.1
217	11	M	46	Panamá Oeste	330795	EPI_ISL_496675	2020-03-14	2020-03-19	NA	unknown	local	unknown	NA	B.1
223	11	M	41	Panamá Metro	330817	EPI_ISL_496676	2020-03-10	2020-03-20	NA	unknown	local	contact	MP	B.1
239	12	F	49	Panamá Norte	330961	EPI_ISL_496677	2020-03-19	2020-03-20	NA	unknown	local	unknown	NA	A.2.1
243	12	F	38	Panamá Norte	331025	EPI_ISL_496678	2020-03-18	2020-03-20	NA	unknown	local	unknown	NA	A.2
245	12	F	59	Panamá Metro	331050	EPI_ISL_496679	2020-03-19	2020-03-20	28	local	local	contact	Health	A.2.1
251	12	M	46	Panamá Oeste	331074	EPI_ISL_496680	2020-03-18	2020-03-20	NA	unknown	local	contact	Health	A.2.1
259	10	F	42	Panamá Oeste	331186	EPI_ISL_496681	2020-03-06	2020-03-20	NA	unknown	local	unknown	NA	A.2.1
262	11	M	43	Panamá Norte	331254	EPI_ISL_496682	2020-03-11	2020-03-20	NA	unknown	local	unknown	NA	A.2.1
270	12	F	10	Panamá Metro	331336	EPI_ISL_496683	2020-03-20	2020-03-21	30	local	local	contact	Travel	B.1
291	12	F	2	Panamá Este	331499	EPI_ISL_496684	2020-03-17	2020-03-21	NA	unknown	local	contact	Police	A.2.1
297	10	M	49	Panamá Este	331516	EPI_ISL_496685	2020-03-21	2020-03-21	NA	unknown	local	unknown	NA	A.2.1
303	12	F	13	Panamá Metro	331540	EPI_ISL_496686	2020-03-19	2020-03-22	NA	unknown	local	unknown	NA	A.2
311	12	M	34	Chiriqui	331578	EPI_ISL_496687	2020-03-19	2020-03-22	NA	unknown	local	contact	MP	B.1
312	12	M	46	Chiriqui	331580	EPI_ISL_496688	2020-03-19	2020-03-22	NA	unknown	local	contact	MP	B.1
314	12	F	64	Panamá Metro	331596	EPI_ISL_496689	2020-03-17	2020-03-22	NA	unknown	local	unknown	NA	B.1
340	12	F	45	Panamá Metro	331701	EPI_ISL_496690	2020-03-18	2020-03-22	NA	unknown	local	unknown	NA	A.2.1
344	12	F	95	Panamá Metro	331715	EPI_ISL_496691	2020-03-20	2020-03-22	NA	unknown	local	unknown	NA	A.2
366	12	F	15	Panamá Metro	331789	EPI_ISL_496692	2020-03-21	2020-03-23	NA	unknown	local	unknown	NA	A.2.1
371	10	M	48	Panamá Este	331797	EPI_ISL_496693	2020-03-20	2020-03-23	NA	unknown	local	unknown	NA	A.2
379	12	M	49	Panamá Norte	331836	EPI_ISL_496694	2020-03-18	2020-03-23	NA	unknown	local	unknown	NA	A.2.1
380	12	M	30	Panamá Oeste	331837	EPI_ISL_496695	2020-03-19	2020-03-23	NA	unknown	local	contact	MP	B.1
387	12	M	55	San Miguelito	331872	EPI_ISL_496696	2020-03-16	2020-03-23	NA	unknown	local	unknown	NA	A.3

Case	Epi week	Sex	Age, y	Region	ID	GISAID Accession #	Date symptom onset	Date results received	Epi cluster	Epiclusterlink	Type of exposition	Epi link	Exposition description	Lineage autocolor
391	12	F	29	Panamá Este	331920	EPI_ISL_496697	2020-03-21	2020-03-23	NA	unknown	local	unknown	NA	A.2.1
395	12	F	58	Panamá Oeste	331943	EPI_ISL_496698	2020-03-20	2020-03-23	NA	unknown	local	unknown	NA	A.2.1
397	12	M	53	Panamá Metro	331954	EPI_ISL_496699	2020-03-20	2020-03-23	NA	unknown	local	unknown	NA	A.2
405	13	F	17	Panamá Metro	331997	EPI_ISL_496700	2020-03-22	2020-03-23	NA	unknown	local	unknown	NA	A.2.1
407	12	M	86	San Miguelito	332013	EPI_ISL_496701	2020-03-19	2020-03-23	NA	unknown	local	unknown	NA	A.2.1
410	12	M	40	Panamá Metro	332033	EPI_ISL_496702	2020-03-20	2020-03-23	NA	unknown	local	unknown	NA	B.1.5
422	13	M	52	Panamá Metro	332089	EPI_ISL_496703	2020-03-22	2020-03-23	NA	unknown	local	unknown	NA	A.2.1
438	12	M	15	Panamá Norte	332231	EPI_ISL_496704	2020-03-18	2020-03-23	NA	unknown	local	unknown	NA	A.2.1
442	11	M	31	Coclé	332238	EPI_ISL_496705	2020-03-14	2020-03-23	NA	unknown	local	unknown	NA	A.2.1
445	13	M	49	Guna Yala	332252	EPI_ISL_496706	2020-03-23	2020-03-24	NA	unknown	local	unknown	NA	A.3
446	12	M	73	Panamá Metro	332254	EPI_ISL_496707	2020-03-16	2020-03-24	NA	unknown	local	unknown	NA	B.1
456	12	F	46	Panamá Norte	332298	EPI_ISL_496708	2020-03-20	2020-03-24	NA	unknown	local	unknown	NA	A.2.1
459	13	M	46	Panamá Oeste	332311	EPI_ISL_496709	2020-03-22	2020-03-24	NA	unknown	local	unknown	NA	A.2.1
472	13	F	60	Panamá Metro	332352	EPI_ISL_496710	2020-03-23	2020-03-24	NA	unknown	local	unknown	NA	A.2.1
481	12	M	40	Panamá Metro	332389	EPI_ISL_496711	2020-03-19	2020-03-24	NA	unknown	local	unknown	NA	A.2.1
500	12	M	60	Panamá Metro	332469	EPI_ISL_496712	2020-03-22	2020-03-24	NA	unknown	local	unknown	NA	A.2.1
511	13	M	55	Panamá Oeste	332513	EPI_ISL_496713	2020-03-23	2020-03-24	NA	unknown	local	unknown	NA	A.2.1
524	12	F	60	Panamá Metro	332575	EPI_ISL_496714	2020-03-17	2020-03-24	NA	unknown	local	unknown	NA	A.2.1
534	13	M	25	Chiriqui	332629	EPI_ISL_496715	2020-03-24	2020-03-24	NA	unknown	local	police	NA	B.1
549	13	M	39	Panamá Metro	332688	EPI_ISL_496716	2020-03-23	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
551	13	F	70	Panamá Metro	332692	EPI_ISL_496717	2020-03-23	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
554	12	F	39	Panamá Este	332702	EPI_ISL_496718	2020-03-15	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
559	13	M	26	Veraguas	332718	EPI_ISL_496719	2020-03-23	2020-03-25	NA	unknown	local	police	NA	A.2.1
567	12	F	48	Coclé	332759	EPI_ISL_496720	2020-03-20	2020-03-25	NA	unknown	imported	travel	USA	A.2
568	A	F	22	San Miguelito	332762	EPI_ISL_496721	2020-03-20	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
572	13	F	73	Panamá Metro	332791	EPI_ISL_496722	2020-03-22	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
575	12	M	31	Panamá Este	332800	EPI_ISL_496723	2020-03-20	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
577	13	F	35	Panamá Metro	332810	EPI_ISL_496724	2020-03-23	2020-03-25	NA	unknown	local	unknown	NA	A.2
582	13	F	59	Panamá Metro	332822	EPI_ISL_496725	2020-03-25	2020-03-25	NA	unknown	local	unknown	NA	A.2
583	12	F	44	Panamá Metro	332833	EPI_ISL_496726	2020-03-25	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
587	13	M	52	San Miguelito	332856	EPI_ISL_496727	2020-03-22	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
588	13	F	69	San Miguelito	332857	EPI_ISL_496728	2020-03-24	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
596	13	M	54	Panamá Metro	332875	EPI_ISL_496729	2020-03-22	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
623	13	F	7	San Miguelito	333048	EPI_ISL_496730	2020-03-24	2020-03-25	NA	unknown	local	unknown	NA	A.2
627	12	F	49	San Miguelito	333063	EPI_ISL_496731	2020-03-21	2020-03-25	NA	unknown	local	unknown	NA	A.2.1
657	13	M	25	San Miguelito	333156	EPI_ISL_496732	2020-03-24	2020-03-26	NA	unknown	local	unknown	NA	A.2
664	13	M	49	Panamá Metro	333177	EPI_ISL_496733	2020-03-23	2020-03-26	NA	unknown	local	unknown	NA	A.2.1
666	12	F	47	Colón	333181	EPI_ISL_496734	2020-03-19	2020-03-26	NA	unknown	local	unknown	NA	A.2.1
678	13	F	30	Panamá Este	333242	EPI_ISL_496735	2020-03-25	2020-03-26	NA	unknown	local	unknown	NA	A.2.1
687	12	F	71	Panamá Metro	333271	EPI_ISL_496736	2020-02-23	2020-03-26	NA	unknown	local	unknown	NA	A.2.1
714	13	F	24	San Miguelito	333338	EPI_ISL_496737	2020-03-25	2020-03-26	NA	unknown	local	unknown	NA	A.2.1
725	12	M	66	Guna Yala	333376	EPI_ISL_496738	2020-03-16	2020-03-26	NA	unknown	local	unknown	NA	A.2.1
734	12	M	45	Coclé	333393	EPI_ISL_496739	2020-03-18	2020-03-26	NA	unknown	local	unknown	NA	A.2
735	13	F	40	San Miguelito	333400	EPI_ISL_496740	2020-03-23	2020-03-26	NA	unknown	local	unknown	NA	A.2.1
740	13	M	66	Panamá Oeste	333427	EPI_ISL_496741	2020-03-25	2020-03-26	NA	unknown	local	contact	Health	A.2.1
742	13	M	36	Panamá Oeste	333430	EPI_ISL_496742	2020-03-23	2020-03-26	NA	unknown	local	contact	Health	A.2.1
753	13	M	77	Panamá Metro	333467	EPI_ISL_496743	2020-03-23	2020-03-26	NA	unknown	local	unknown	NA	B.1
758	13	M	65	San Miguelito	333487	EPI_ISL_496744	2020-03-23	2020-03-26	NA	unknown	local	contact	Family	B.1

Case	Epi week	Sex	Age, y	Region	ID	GISAID Accession #	Date symptom onset	Date results received	Epi cluster	Epiclusterlink	Type of exposition	Epi link	Exposition description	Lineage autocolor
765	13	M	29	San Miguelito	333517	EPI_ISL_496745	2020-03-27	2020-03-27	NA	unknown	local	unknown	NA	A.2.1
775	13	M	28	Chiriqui	333564	EPI_ISL_496746	2020-03-26	2020-03-27	NA	unknown	local	police	NA	B.1
777	12	M	45	Coclé	333567	EPI_ISL_496747	2020-03-18	2020-03-27	NA	unknown	local	contact	Police	B.1
778	12	M	42	Coclé	333568	EPI_ISL_496748	2020-03-16	2020-03-27	NA	unknown	local	contact	Police	B.1
809	13	M	48	Guna Yala	333668	EPI_ISL_496749	2020-03-26	2020-03-27	NA	unknown	local	unknown	NA	A.2.1
815	13	F	33	Panamá Este	333679	EPI_ISL_496750	2020-03-24	2020-03-27	NA	unknown	local	unknown	NA	A.2.1
817	13	F	58	Panamá Metro	333681	EPI_ISL_496751	2020-03-23	2020-03-27	NA	unknown	local	unknown	NA	A.2.1
818	13	F	49	Barco Anclado en Amador	333685	EPI_ISL_496752	2020-03-24	2020-03-27	NA	unknown	local	unknown	NA	A.2.1
821	13	M	19	Colón	333694	EPI_ISL_496753	2020-03-23	2020-03-27	NA	unknown	local	unknown	NA	A.3
827	12	M	29	Colón	333706	EPI_ISL_496754	2020-03-20	2020-03-27	NA	unknown	local	unknown	NA	A.2.1
853	13	F	86	Panamá Metro	333825	EPI_ISL_496755	2020-03-26	2020-03-27	NA	unknown	local	unknown	NA	A.2.1
881	12	F	29	Colón	333937	EPI_ISL_496756	1900-01-00	2020-03-28	NA	unknown	local	unknown	NA	A.3
883	12	M	39	Colón	333949	EPI_ISL_496757	2020-03-27	2020-03-28	NA	unknown	local	unknown	NA	A.2.1
894	13	M	49	Panamá Metro	334000	EPI_ISL_496758	2020-03-23	2020-03-28	NA	unknown	local	unknown	NA	B.1
903	13	M	48	Chiriqui	334032	EPI_ISL_496759	2020-03-22	2020-03-28	NA	unknown	local	police	NA	B.1
904	13	M	41	Panamá Oeste	334034	EPI_ISL_496760	2020-03-26	2020-03-28	NA	unknown	local	police	NA	B.1
905	13	M	40	Bocas Del Toro	334035	EPI_ISL_496761	2020-03-24	2020-03-28	NA	unknown	local	contact	MP	B.1
906	12	M	37	Coclé	334036	EPI_ISL_496762	2020-03-25	2020-03-28	NA	unknown	local	police	NA	B.1
907	13	M	22	Panamá Este	334038	EPI_ISL_496763	2020-03-24	2020-03-28	NA	unknown	local	police	NA	B.1
922	A	M	61	Guna Yala	334102	EPI_ISL_496764	2020-03-21	2020-03-29	NA	unknown	local	unknown	NA	A.2.1
930	13	F	35	Panamá Oeste	334115	EPI_ISL_496765	2020-03-26	2020-03-29	NA	unknown	local	unknown	NA	A.2.1
932	13	F	99	Panamá Oeste	334117	EPI_ISL_496766	2020-03-19	2020-03-29	NA	unknown	local	unknown	NA	B.1.5
937	13	F	40	Colón	334144	EPI_ISL_496767	2020-03-24	2020-03-29	NA	unknown	local	contact	Family	A.3
960	-	F	79	Panamá Metro	334239	EPI_ISL_496768	2020-03-29	2020-03-29	NA	unknown	local	unknown	NA	A.2.1
962	-	M	45	Panamá Norte	334245	EPI_ISL_496769	2020-03-23	2020-03-29	NA	unknown	local	unknown	NA	A.2
964	14	M	65	Guna Yala	334256	EPI_ISL_496770	2020-03-26	2020-03-29	NA	unknown	local	unknown	NA	A.2.1
969	13	M	26	Panamá Oeste	334277	EPI_ISL_496771	2020-03-29	2020-03-30	NA	unknown	local	unknown	NA	A.2.1
970	13	M	19	Herrera	334280	EPI_ISL_496772	2020-03-28	2020-03-30	NA	unknown	local	unknown	NA	A.2.1
973	13	M	27	San Miguelito	334283	EPI_ISL_496773	2020-03-27	2020-03-30	NA	unknown	local	unknown	NA	A.2.1
986		F	47	Panamá Oeste	334333	EPI_ISL_496774	2020-03-25	2020-03-30	NA	unknown	local	unknown	NA	A.2
1006	13	F	37	San Miguelito	334389	EPI_ISL_496775	2020-03-29	2020-03-30	NA	unknown	local	unknown	NA	A.2
1007	13	M		San Miguelito	334390	EPI_ISL_496776	2020-03-30	2020-03-30	NA	unknown	local	unknown	NA	A.2
1010	A	M	27	Panamá Metro	334396	EPI_ISL_496777	2020-03-27	2020-03-30	NA	unknown	local	unknown	NA	A.2.1
1013	13	F	60	Panamá Oeste	334400	EPI_ISL_496778	2020-03-30	2020-03-30	NA	unknown	local	unknown	NA	A.2.1
1031		M	29	Panamá Oeste	334440	EPI_ISL_496779	2020-03-30	2020-03-30	NA	unknown	local	contact	Health	A.2.1
1040	14	F	41	Colón	334456	EPI_ISL_496780	2020-03-20	2020-03-30	NA	unknown	local	unknown	NA	B.1
1041	13	M	46	Panamá Metro	334468	EPI_ISL_496781	2020-03-30	2020-03-30	NA	unknown	local	unknown	NA	A.2.1
1043	14	M	36	Panamá Metro	334475	EPI_ISL_496782	2020-03-27	2020-03-30	NA	unknown	local	unknown	NA	A.2.1
1068	14	F	33	Coclé	334554	EPI_ISL_496783	2020-03-25	2020-03-30	NA	unknown	local	unknown	NA	A.2.1
1069	14	M	43	Colón	334559	EPI_ISL_496784	2020-03-22	2020-03-30	NA	unknown	local	unknown	NA	A.2
1078	13	F	34	San Miguelito	334598	EPI_ISL_496785	2020-03-22	2020-03-30	NA	unknown	local	unknown	NA	A.2.1
1083	14	F	55	San Miguelito	334610	EPI_ISL_496786	2020-03-29	2020-03-31	NA	unknown	local	unknown	NA	A.2
1084	14	M	23	Panamá Metro	334611	EPI_ISL_496787	2020-03-29	2020-03-31	NA	unknown	local	unknown	NA	A.2.1
1087	13	M	34	Panamá Norte	334618	EPI_ISL_496788	2020-03-27	2020-03-31	NA	unknown	local	unknown	NA	A.2.1
1092	14	M	33	Coclé	334647	EPI_ISL_496789	2020-03-29	2020-03-31	NA	unknown	local	contact	MP	B.1
1095	14	M	41	Coclé	334655	EPI_ISL_496790	2020-03-30	2020-03-31	NA	unknown	local	unknown	NA	A.2.1
1098	14	M	4m	Panamá Oeste	334658	EPI_ISL_496791	2020-03-31	2020-03-31	NA	unknown	local	unknown	NA	A.2.1

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1105	13	F	55	Panamá Metro	334687	EPI_ISL_496792	2020-03-26	2020-03-31	NA	unknown	local	unknown	NA	A.2.1
1128	14	M	49	Panamá Este	334779	EPI_ISL_496793	2020-03-29	2020-03-31	NA	unknown	local	unknown	NA	A.2.1
1145		F		Coclé	334835	EPI_ISL_496794	2020-03-31	2020-03-31	NA	unknown	local	unknown	NA	B.1
1148	14	M	48	Panamá Oeste	334845	EPI_ISL_496795	2020-03-30	2020-03-31	NA	unknown	local	unknown	NA	A.2.1
1155	13	M	48	Panamá Norte	334868	EPI_ISL_496796	2020-03-24	2020-03-31	NA	unknown	local	unknown	NA	A.2.1
1159		F	67	Panamá Metro	334898	EPI_ISL_496797	2020-03-31	2020-03-31	NA	unknown	local	unknown	NA	A.2.1
1161		M	38	Panamá Norte	334913	EPI_ISL_496798	2020-03-31	2020-03-31	NA	unknown	local	unknown	NA	A.2.1
1167	13	M	28	San Miguelito	334998	EPI_ISL_496799	2020-04-01	2020-04-01	NA	unknown	local	unknown	NA	A.2.1
1169	14	F	25	Panamá Oeste	335002	EPI_ISL_496800	2020-04-01	2020-04-01	NA	unknown	local	unknown	NA	A.2.1
1171	14	M	30	Coclé	335013	EPI_ISL_496801	2020-04-01	2020-04-01	NA	unknown	local	unknown	NA	A.2
1184	14	M	37	Panamá Norte	335067	EPI_ISL_496802	2020-03-31	2020-04-01	NA	unknown	local	unknown	NA	B.1
1188	14	F	23	Panamá Metro	335090	EPI_ISL_496803	2020-03-30	2020-04-01	NA	unknown	local	unknown	NA	A.2
1190	13	M	18	Panamá Este	335097	EPI_ISL_496804	2020-03-28	2020-04-01	NA	unknown	local	unknown	NA	A.2.1
1191	14	F	18	Panamá Este	335099	EPI_ISL_496805	2020-03-29	2020-04-01	NA	unknown	local	unknown	NA	A.2.1
1197	14	M	28	Panamá Oeste	335119	EPI_ISL_496806	2020-03-31	2020-04-01	NA	unknown	local	unknown	NA	A.2.1
1208		F	41	Panamá Metro	335156	EPI_ISL_496807	2020-03-30	2020-04-01	NA	unknown	local	unknown	NA	A.2.1
1216	14	F	9	Panamá Metro	335166	EPI_ISL_496808	2020-03-31	2020-04-01	NA	unknown	local	unknown	NA	A.2.1
1219	14	F	29	Panamá Norte	335182	EPI_ISL_496809	2020-03-28	2020-04-01	NA	unknown	local	unknown	NA	A.2
1255	14	M	41	Veraguas	335382	EPI_ISL_496810	31-03-2020	2020-04-02	NA	unknown	local	unknown	NA	A.2.1
1262	14	F	42	Panamá Oeste	335403	EPI_ISL_496811	NA	2020-04-02	NA	unknown	local	unknown	NA	A.2.1
1263	13	M	44	Colón	335406	EPI_ISL_496812	NA	2020-04-02	NA	unknown	local	unknown	NA	A.2.1
1267	13	M	27	Panamá Este	335473	EPI_ISL_496813	2020-03-26	2020-04-02	NA	unknown	local	unknown	NA	A.2.1
1268	14	M	89	Panamá Metro	335488	EPI_ISL_496814	2020-03-30	2020-04-02	NA	unknown	local	unknown	NA	B.1
1279	14	M	40	Panamá Oeste	335546	EPI_ISL_496815	NA	2020-04-02	8	police	local	unknown	NA	A.2
1284	14	M	33	Coclé	335568	EPI_ISL_496816	2020-04-02	2020-04-02	NA	unknown	local	unknown	NA	A.2.1
1285	14	M	45	Panamá Oeste	335572	EPI_ISL_496817	2020-03-29	2020-04-02	NA	unknown	local	unknown	NA	A.2.1
1302	13	F	19	Panamá Norte	335631	EPI_ISL_496818	NA	2020-04-02	NA	unknown	local	unknown	NA	A.2.1
1320	14	M	25	Panamá Metro	335723	EPI_ISL_496819	2020-04-02	2020-04-03	NA	unknown	local	unknown	NA	A.2.1
1342	13	F	61	Panamá Metro	335800	EPI_ISL_496820	2020-03-28	2020-04-03	NA	unknown	local	contact	Family	A.2.1
1348	14	M	16	Panamá Oeste	335859	EPI_ISL_496821	2020-03-30	2020-04-03	NA	unknown	local	unknown	NA	A.2.1
1349	14	F	44	Panamá Oeste	335862	EPI_ISL_496822	2020-04-02	2020-04-03	NA	unknown	local	contact	Family	A.2.1
1356	14	M	20	Chiriqui	335877	EPI_ISL_496823	2020-04-01	2020-04-03	NA	unknown	local	unknown	NA	A.2.1
1360	14	M	23	Herrera	335885	EPI_ISL_496824	2020-04-01	2020-04-03	NA	unknown	local	unknown	NA	A.2.1
1364	14	M	30	Coclé	335903	EPI_ISL_496825	2020-04-01	2020-04-03	NA	unknown	local	contact	Family	A.2.1
1367	14	M	24	Panamá Este	335922	EPI_ISL_496826	NA	2020-04-03	NA	unknown	local	contact	Family	A.2.1
1368	14	F	38	Panamá Metro	335925	EPI_ISL_496827	2020-03-31	2020-04-03	NA	unknown	local	unknown	NA	A.2
1370	14	M	61	Guna Yala	335931	EPI_ISL_496828	2020-04-02	2020-04-03	NA	unknown	local	unknown	NA	A.2.1
1375	14	F	54	Panamá Oeste	335941	EPI_ISL_496829	01/04/2020	2020-04-03	NA	unknown	local	unknown	NA	A.2
1378	14	F	31	Panamá Metro	335944	EPI_ISL_496830	2020-04-01	2020-04-03	NA	unknown	local	unknown	NA	A.2.1
1379	14	M	43	Panamá Metro	335945	EPI_ISL_496831	2020-03-29	2020-04-03	NA	unknown	local	unknown	NA	A.2.1
1385	14	F	36	Panamá Norte	335967	EPI_ISL_496832	2020-04-03	2020-04-03	NA	unknown	local	unknown	NA	A.2.1
1395	14	F	26	Panamá Oeste	336008	EPI_ISL_496833	2020-03-30	2020-04-03	NA	unknown	local	contact	Family	A.2.1
1402	14	M	74	San Miguelito	336023	EPI_ISL_496834	2020-04-01	2020-04-03	NA	unknown	local	contact	Family	A.2.1
1407	14	F	61	Colón	336044	EPI_ISL_496835	2020-04-01	2020-04-03	NA	unknown	local	contact	Family	A.3
1409	14	M	56	Colón	336047	EPI_ISL_496836	2020-04-03	2020-04-03	NA	unknown	local	unknown	NA	A.3
1418	A	F	25	Panamá Metro	336085	EPI_ISL_496837	2020-04-03	2020-04-03	NA	unknown	local	unknown	NA	A.2.1
1437	13	F	38	Panamá Metro	336231	EPI_ISL_496838	2020-03-28	2020-04-04	NA	unknown	local	contact	Family	A.2.1
1441	13	M	28	Panamá Este	336247	EPI_ISL_496839	2020-03-25	2020-04-04	NA	unknown	local	unknown	NA	A.2.1

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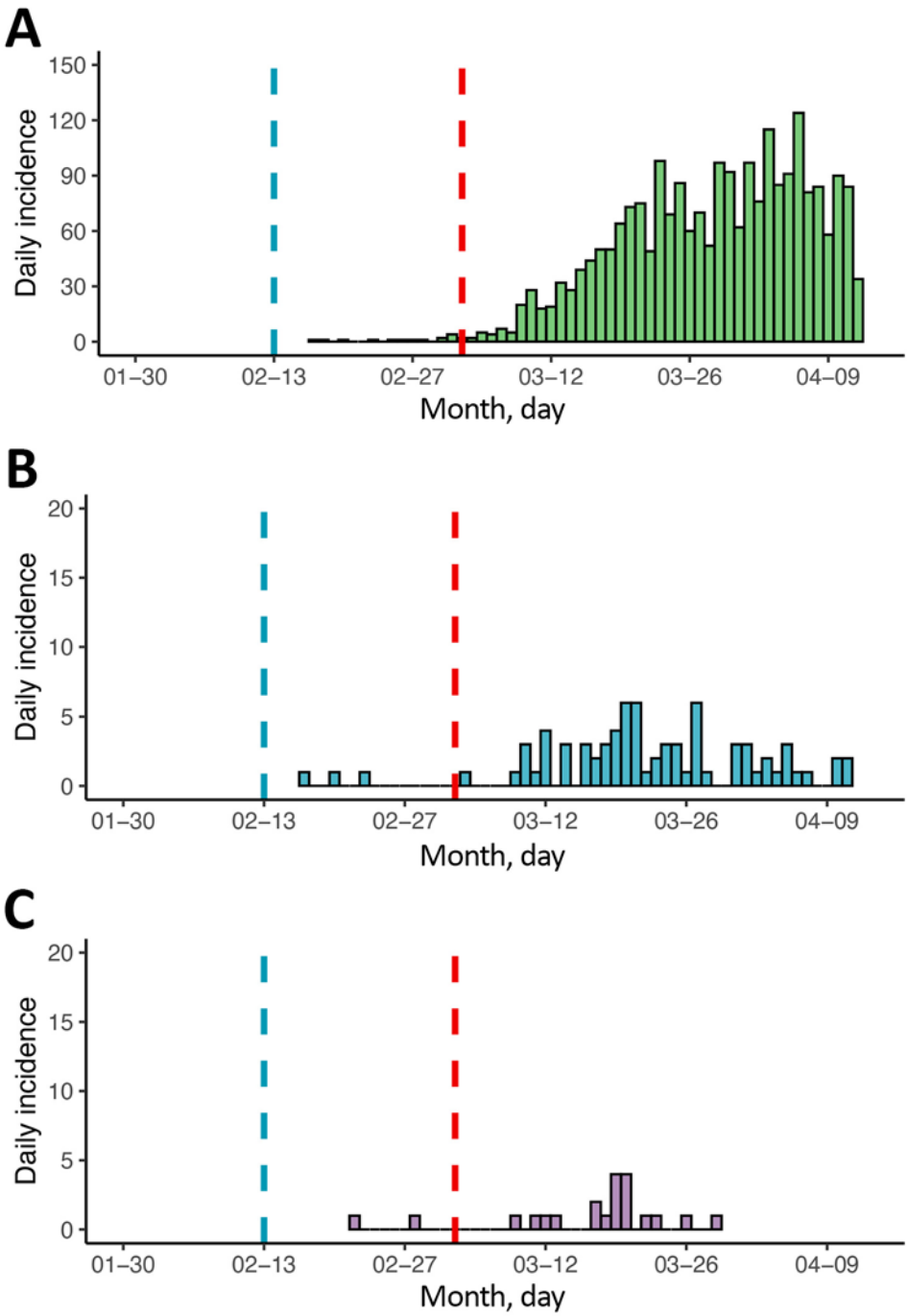
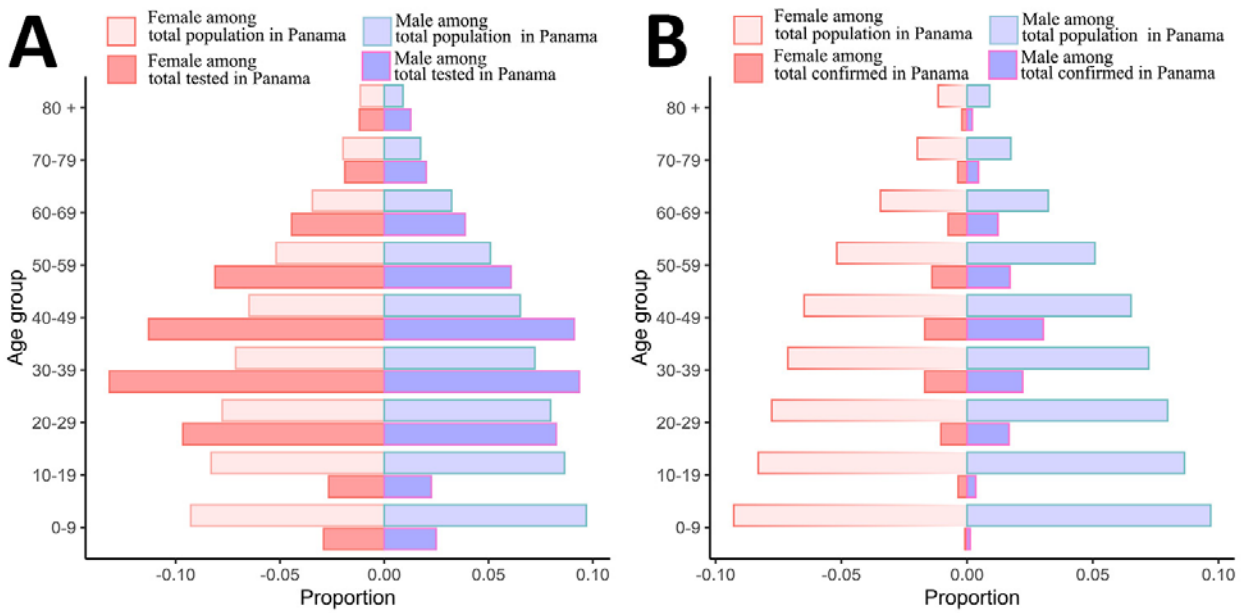
1445	14	F	42	Panamá Metro	336264	EPI_ISL_496840	2020-04-04	2020-04-04	NA	unknown	local	contact	Family	B.1
1452	14	M	60	San Miguelito	336320	EPI_ISL_496841	2020-03-31	2020-04-04	NA	unknown	local	unknown	NA	A.2.1
1458	14	M	45	Panamá Metro	336341	EPI_ISL_496842	2020-04-02	2020-04-04	NA	unknown	local	unknown	NA	A.2.1
1460	14	F	40	Panamá Norte	336344	EPI_ISL_496843	2020-04-02	2020-04-04	NA	unknown	local	contact	Family	A.2
1466	14	F	15	Panamá Oeste	336377	EPI_ISL_496844	2020-04-03	2020-04-04	NA	unknown	local	contact	Family	A.2
1469	14	M	61	San Miguelito	336388	EPI_ISL_496845	NA	2020-04-04	NA	unknown	local	unknown	NA	A.2.1
1475	14	F	52	Panamá Metro	336416	EPI_ISL_496846	2020-04-03	2020-04-04	NA	unknown	local	contact	Family	A.2.1
1476	14	M	34	San Miguelito	336417	EPI_ISL_496847	2020-04-04	2020-04-04	NA	unknown	local	unknown	NA	A.2.1
1477	14	F	41	Panamá Metro	336418	EPI_ISL_496848	2020-04-02	2020-04-04	NA	unknown	local	unknown	NA	A.2.1
1480	14	M	48	San Miguelito	336432	EPI_ISL_496849	2020-03-29	2020-04-04	NA	unknown	local	unknown	NA	A.2.1
1481		F	42	Panamá Metro	336440	EPI_ISL_496850	2020-04-03	2020-04-05	NA	unknown	local	unknown	NA	A.2.1
1484	13	M	32	Panamá Este	336491	EPI_ISL_496851	2020-03-26	2020-04-05	NA	unknown	local	unknown	NA	A.2.1
1490	14	M	33	Panamá Metro	336523	EPI_ISL_496852	2020-04-04	2020-04-05	NA	unknown	local	unknown	NA	A.2.1
1497	14	F	44	Panamá Oeste	336567	EPI_ISL_496853	2020-04-03	2020-04-05	NA	unknown	local	unknown	NA	A.2
1606	14	F	56	San Miguelito	336897	EPI_ISL_496854	2020-04-01	2020-06-04	NA	unknown	local	unknown	NA	A.2.1
1650	14	M	50	Guna Yala	337097	EPI_ISL_496855	2020-04-04	2020-04-06	NA	unknown	local	unknown	NA	A.2.1
1651	15	M	38	Guna Yala	337099	EPI_ISL_496856	2020-04-05	2020-04-06	NA	unknown	local	unknown	NA	A.2.1
1681	15	M	39	Colón	337250	EPI_ISL_496857	2020-04-05	2020-04-07	NA	unknown	local	unknown	NA	A.2.1
1689	14	F	26	Los Santos	337306	EPI_ISL_496858	2020-04-04	2020-04-07	NA	unknown	local	police	NA	A.2.1
1705	14	F	26	Panamá Metro	337358	EPI_ISL_496859	NA	2020-04-07	NA	unknown	local	contact	Family	A.2.1
1725	14	M	28	Chiriqui	337442	EPI_ISL_496860	2020-04-04	2020-07-04	NA	unknown	local	unknown	NA	A.2.1
1731	14	M	28	Panamá Oeste	337467	EPI_ISL_496861	2020-04-05	2020-07-04	NA	unknown	local	contact	Family	A.2.1
1775	14	M	27	Chiriqui	337640	EPI_ISL_496862	2020-04-03	2020-07-04	NA	unknown	local	unknown	NA	B.1.5
1778	15	M	43	Panamá Oeste	337660	EPI_ISL_496863	2020-04-06	2020-07-04	NA	unknown	local	unknown	NA	A.2.1
1781	14	F	55	Panamá Oeste	337668	EPI_ISL_496864	2020-04-01	2020-07-04	NA	unknown	local	unknown	NA	A.2
1834	15	M	36	Panamá Oeste	337884	EPI_ISL_496865	2020-04-05	2020-04-08	NA	unknown	local	unknown	NA	A.2.1
1895	14	F	46	San Miguelito	338258	EPI_ISL_496866	2020-04-01	2020-04-08	NA	unknown	local	unknown	NA	A.2.1
1904	15	M	23	San Miguelito	338362	EPI_ISL_496867	2020-04-07	2020-04-09	NA	unknown	local	police	NA	A.2.1
1910	15	F	25	Panamá Metro	338393	EPI_ISL_496868	2020-04-05	2020-04-09	NA	unknown	local	unknown	NA	A.2
1918	14	M	51	Panamá Oeste	338477	EPI_ISL_496869	2020-04-02	2020-04-09	NA	unknown	local	unknown	NA	A.2.1
1952	15	F	48	Guna Yala	338634	EPI_ISL_496870	2020-04-06	2020-09-04	NA	unknown	local	unknown	NA	A.2.1
1954	15	M	53	Guna Yala	338639	EPI_ISL_496871	2020-04-06	2020-09-04	NA	unknown	local	unknown	NA	A.2.1
1955	15	F	33	Guna Yala	338640	EPI_ISL_496872	2020-04-06	2020-09-04	NA	unknown	local	unknown	NA	A.2.1
1956	15	F	21	Guna Yala	338641	EPI_ISL_496873	2020-04-06	2020-09-04	NA	unknown	local	unknown	NA	A.2.1
1957	15	M	60	Guna Yala	338642	EPI_ISL_496874	2020-04-06	2020-09-04	NA	unknown	local	unknown	NA	A.2.1
1959	14	M	48	Coclé	338657	EPI_ISL_496875	2020-04-02	2020-09-04	NA	unknown	local	unknown	NA	B.1
1960	14	M	36	Coclé	338658	EPI_ISL_496876	2020-03-29	2020-09-04	NA	unknown	local	unknown	NA	B.1
1964	A	M	54	Colón	338674	EPI_ISL_496877	NA	2020-09-04	NA	unknown	local	contact	MP	B.1
1965	A	M	31	Colón	338677	EPI_ISL_496878	2020-04-06	2020-09-04	NA	unknown	local	unknown	NA	B.1
1966	15	F	30	Coclé	338681	EPI_ISL_496879	2020-04-05	2020-09-04	NA	unknown	local	contact	Family	A.2.1
1967	15	M	30	Colón	338687	EPI_ISL_496880	2020-04-07	2020-09-04	NA	unknown	local	contact	MP	B.1
1968	15	M	46	Colón	338689	EPI_ISL_496881	2020-04-08	2020-09-04	NA	unknown	local	contact	MP	B.1
1970	15	F	32	Panamá Oeste	338698	EPI_ISL_496882	NA	2020-09-04	NA	unknown	local	contact	Family	A.2.1
1972	15	M	32	Coclé	338706	EPI_ISL_496883	NA	2020-09-04	NA	unknown	local	police	NA	B.1
1981	15	F	25	Colón	338744	EPI_ISL_496884	2020-04-08	2020-09-04	NA	unknown	local	contact	Family	A.3
1984	14	M	70	Panamá Metro	338777	EPI_ISL_496885	NA	2020-09-04	NA	unknown	local	contact	Health	A.2.1
1993	15	M	47	Panamá Metro	338832	EPI_ISL_496886	NA	2020-09-04	NA	unknown	local	unknown	NA	A.2.1
2000	14	M	34	Panamá Metro	338859	EPI_ISL_496887	2020-04-01	2020-10-04	NA	unknown	local	unknown	NA	A.2.1

Case	Epi week	Sex	Age, y	Region	ID	GISAID Accession #	Date symptom onset	Date results received	Epi cluster	Epiclusterlink	Type of exposition	Epi link	Exposition description	Lineage autocolor
2004	14	M	55	Panamá Metro	338872	EPI_ISL_496888	2020-04-03	2020-10-04	NA	unknown	local	contact	Family	A.2.1
2024	15	M	21	Panamá Norte	338939	EPI_ISL_496889	05/04/2020	2020-10-04	NA	unknown	local	unknown	NA	A.2.1
2061	14	F	8	Panamá Norte	339064	EPI_ISL_496890	NA	2020-04-10	NA	unknown	local	unknown	NA	A.2.1
2074	15	M	27	Coclé	339125	EPI_ISL_496891	NA	2020-04-10	NA	unknown	local	unknown	NA	A.2.1
2083	15	M	28	Colón	339160	EPI_ISL_496892	NA	2020-04-10	NA	unknown	local	unknown	NA	A.3
2147	A	M	43	Colón	339459	EPI_ISL_496893	NA	2020-04-11	NA	unknown	local	unknown	NA	B.1
2148	A	F	57	Panamá Oeste	339467	EPI_ISL_496894	NA	2020-04-11	NA	unknown	local	unknown	NA	A.2.1
2152	15	M	22	Colón	339494	EPI_ISL_496895	NA	2020-04-11	NA	unknown	local	unknown	NA	A.3
2155	15	M	26	Colón	339499	EPI_ISL_496896	NA	2020-04-11	NA	unknown	local	unknown	NA	A.3
2165		M	35	Coclé	339631	EPI_ISL_496897	NA	2020-04-12	NA	unknown	local	unknown	NA	A.2.1
2166	15	M	40	Colón	339644	EPI_ISL_496898	NA	2020-04-12	NA	unknown	local	unknown	NA	A.3
2181	15	M	36	Colón	339755	EPI_ISL_496899	NA	2020-04-12	NA	unknown	local	unknown	NA	B.1
2182	14	M	38	Colón	339756	EPI_ISL_496900	NA	2020-04-12	NA	unknown	local	unknown	NA	B.1
2220	16	M	28	Chiriqui	340006	EPI_ISL_496901	2020-04-12	2020-04-13	NA	unknown	local	unknown	NA	A.2.1
2244	15	F	47	Panamá Oeste	340172	EPI_ISL_496902	2020-04-08	2020-04-13	NA	unknown	local	unknown	NA	A.2
2266	15	F	23	Guna Yala	340229	EPI_ISL_496903	2020-04-09	2020-04-13	NA	unknown	local	unknown	NA	A.2.1
2267	15	M	68	Guna Yala	340232	EPI_ISL_496904	2020-04-09	2020-04-13	NA	unknown	local	unknown	NA	A.2.1
2269	15	F	22	Guna Yala	340239	EPI_ISL_496905	2020-04-10	2020-04-13	NA	unknown	local	unknown	NA	A.2.1
2367	16	M	31	Panamá Oeste	340836	EPI_ISL_496906	NA	2020-04-14	NA	unknown	local	unknown	NA	A.2.1
2368	15	F	41	Panamá Oeste	340837	EPI_ISL_496907	2020-04-10	2020-04-14	NA	unknown	local	unknown	NA	B.1
2414	A	M	46	Colón	341001	EPI_ISL_496908	NA	2020-04-14	NA	unknown	local	unknown	NA	B.1
2415	A	M	37	Colón	341003	EPI_ISL_496909	NA	2020-04-14	NA	unknown	local	unknown	NA	B.1
2418	15	M	34	Colón	341008	EPI_ISL_496910	2020-04-11	2020-04-14	NA	unknown	local	unknown	NA	B.1
2419	A	M	42	Colón	341009	EPI_ISL_496911	NA	2020-04-14	NA	unknown	local	unknown	NA	B.1
2422	15	M	29	Bocas Del Toro	341042	EPI_ISL_496912	2020-04-11	2020-04-14	NA	unknown	local	unknown	NA	A.3
2463	16	M	21	San Miguelito	341259	EPI_ISL_496913	2020-04-12	2020-04-15	NA	unknown	local	unknown	NA	A.2.1
2466	16	M	26	Guna Yala	341269	EPI_ISL_496914	2020-04-13	2020-04-15	NA	unknown	local	unknown	NA	A.2.1
2481	16	M	22	Colón	341361	EPI_ISL_496915	NA	2020-04-15	NA	unknown	local	unknown	NA	A.2.1

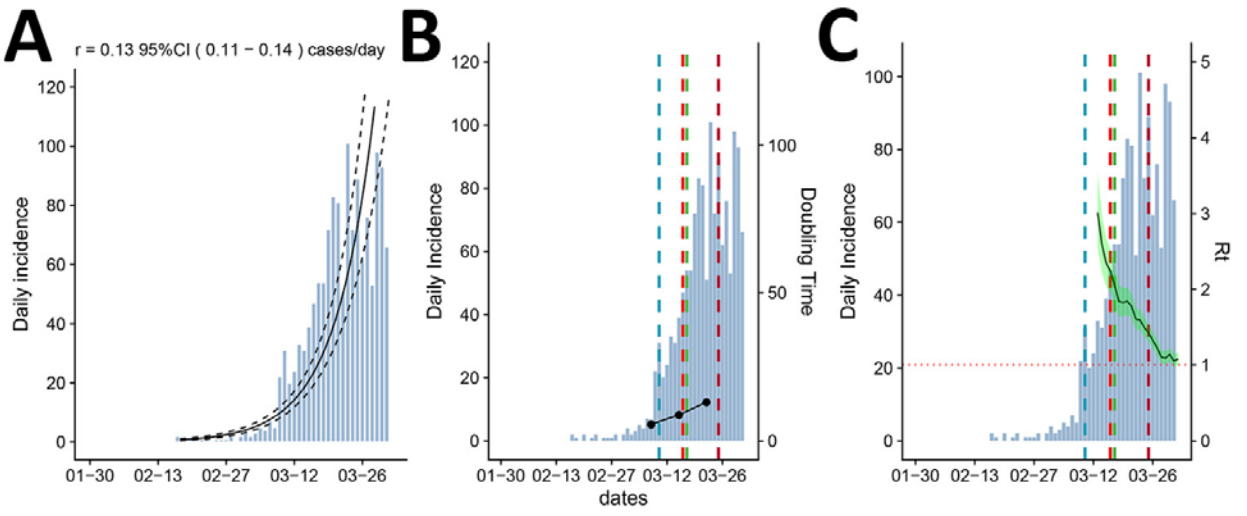
epi, epidemiological; NA, not available.



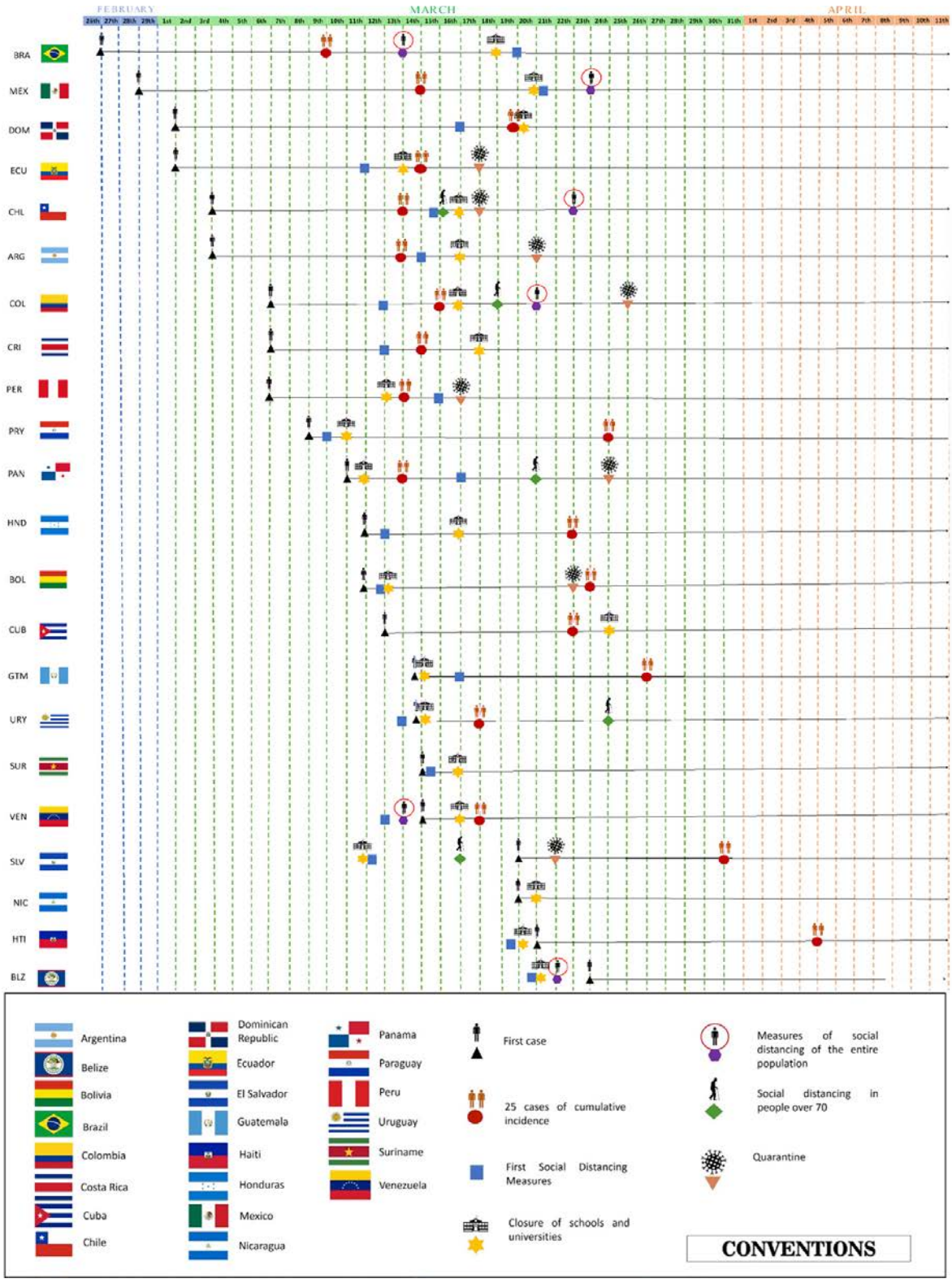
Appendix 2 Figure 1. Daily incidence of SARS-CoV-2 cases in Panama: A) ambulatory patients (asymptomatic, pre-symptomatic, mildly symptomatic outpatient), B) hospitalized patients, and C) patients who had died, detected through April 16, with symptom onset during February 15–April 13. In all 3 charts, the y-axis represents the daily incidence and the x-axis represents the date of symptom onset for each reported case. The blue dashed vertical lines represent the first recorded onset of symptoms and red dashed vertical lines the date of first case confirmed by the surveillance system.



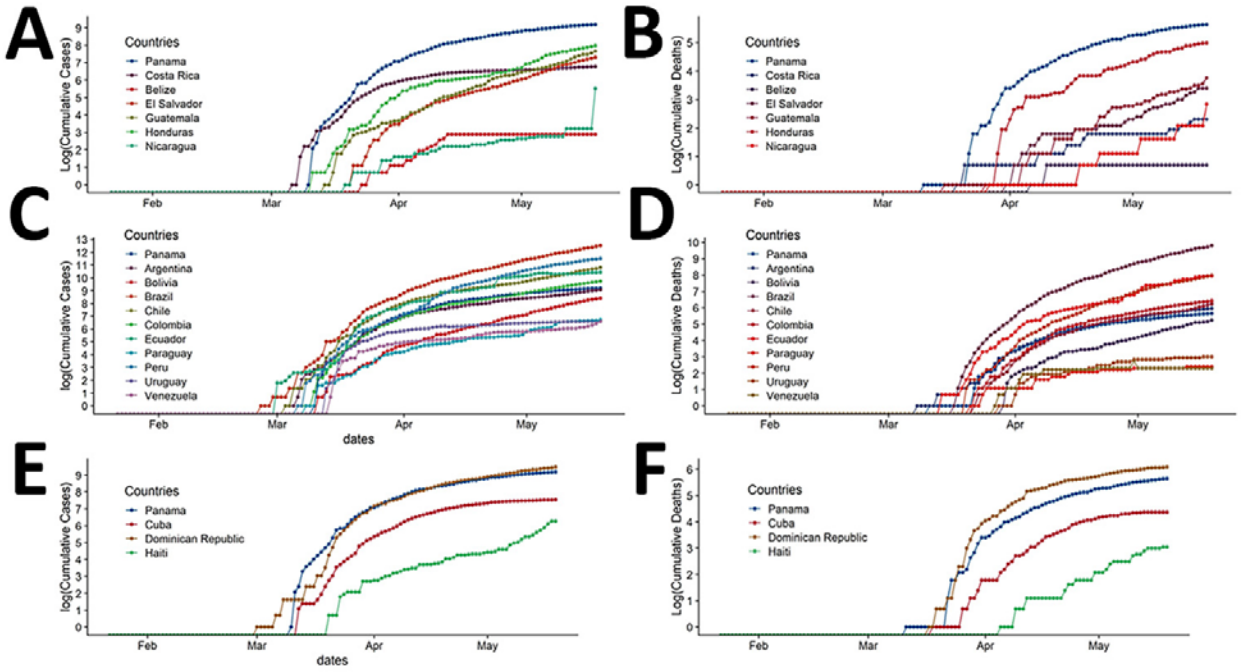
Appendix 2 Figure 2. Age and sex distribution of tested subjects in Panama. Proportion of subjects with age group distribution and sex proportion of A) tested and B) SARS-CoV-2–confirmed cases.



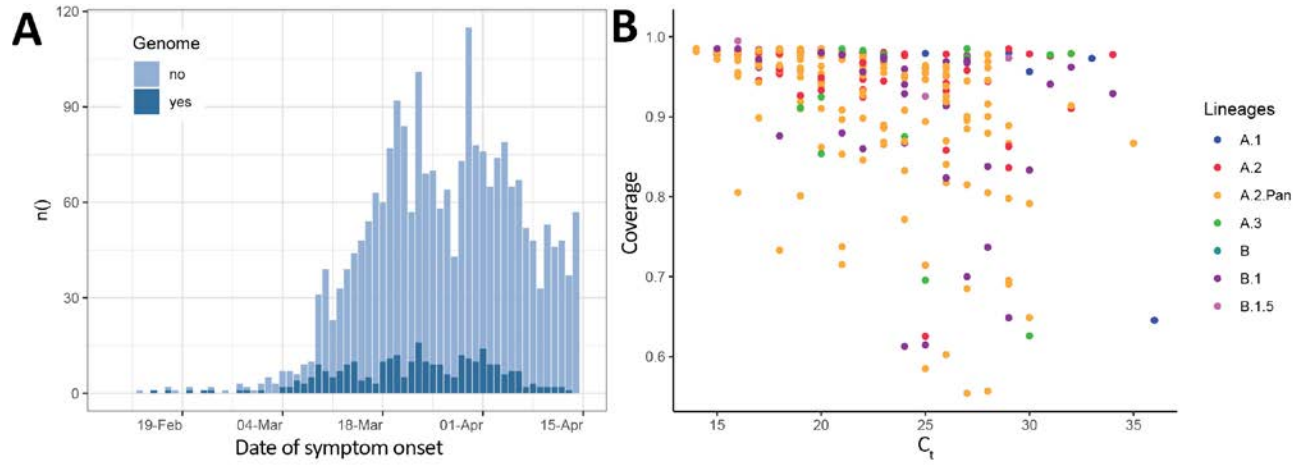
Appendix 2 Figure 3. Estimates of epidemiologic dynamics in Panama. Number of COVID-19 daily confirmed infections (left axes and bars) overlaid with estimates of A) fitted exponential growth in cases daily growth rate; B) doubling time; and C) time-varying effective reproduction number R_t, for a time frame of 45 days (x-axes). For C), green shaded areas show 95% confidence intervals around the median estimated R_t. The threshold value $R_t = 1$ is indicated by the red dashed horizontal line. For both B) and C), dashed vertical lines indicate the implementation dates of school closures (blue), night curfews (red), restrictions of movement (green), and the 24-hour curfew (purple).



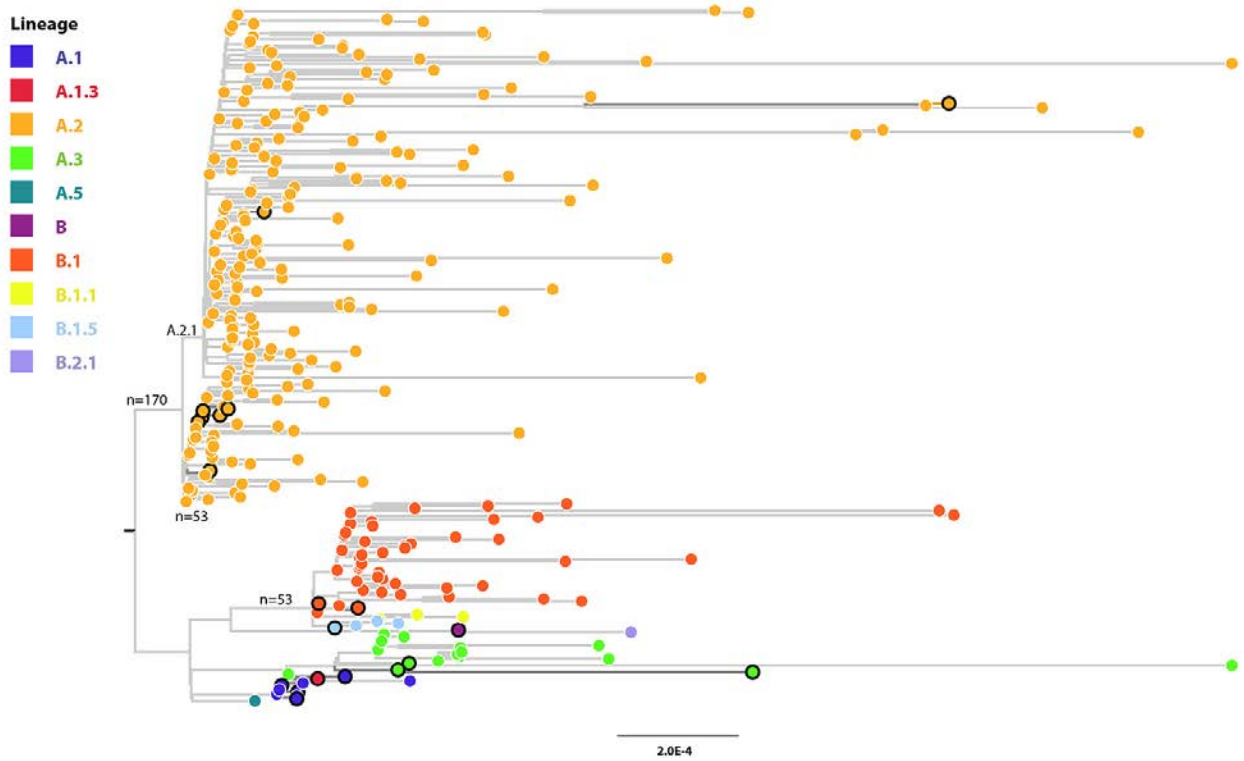
Appendix 2 Figure 4. SARS-CoV-2 timelime in Latin America. Timeline of the first reported SARS-CoV-2 infection and time frame to adopt control strategies for each Latin American country based on official report of Panama MoH and media reports.



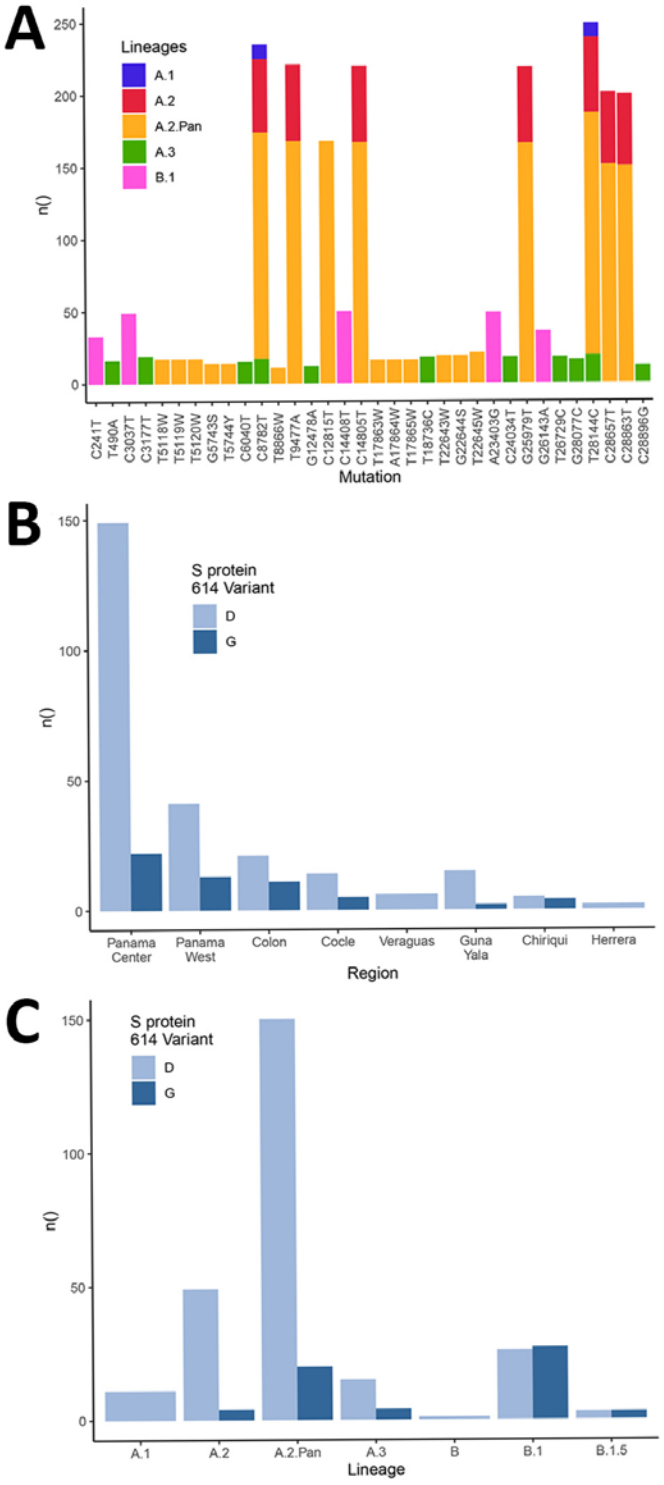
Appendix 2 Figure 5. Cumulative incidence and deaths over time in Panama compared with A) Central America (incidence), B) Central America (deaths), C) South America (incidence), D) South America (deaths), E) Caribbean countries (incidence), and F) Caribbean countries (deaths).



Appendix 2 Figure 6. Daily distribution and characteristics of SARS-CoV-2 genomes obtained in the study. A) COVID-19–confirmed cases and SARS-CoV-2 genomes distribution during the analyzed period in Panama, by date of symptom onset reported by the patient. B) Plot of proportion of genome coverage versus C_t value obtained in real-time PCR, dots are colored according to lineages.



Appendix 2 Figure 7. Maximum likelihood tree of the SARS-CoV-2 genomes obtained (n = 313) circulating in Panama. Tip shapes were colored according to the inferred lineage of the samples. Circles outlined in black indicate samples with travel-related epidemiologic link.



Appendix 2 Figure 8. Mutation profile of the sequences obtained in the study: A) frequency of single nucleotide polymorphism in the genome (position according to MN908947) for all analyzed sequences (n = 313) in the study. Distribution of S protein variants, D614 or G614, B) in different regions of the country or C) among lineages.