

Impact of the Covid-19 pandemic on the epidemiological weekly report surveillance system of Mexico

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Abstract

Objective. To quantify the impact of the Covid-19 pandemic on the reporting rate of notifiable diseases in Mexico between 2020-2022. **Materials and methods.** Data were obtained from the Weekly Epidemiological Bulletin of the Ministry of Health of the Government of Mexico for the period 2014-2022. One hundred thirty-two endemic channels were created by calculating the weekly percentiles 25th, 50th, and 75th for the period 2014-2019. Subsequently, data recorded between 2020-2022 were compared, determining if more or fewer cases were reported than expected. Pre-pandemic data tendency was considered. **Results.** The study included 132 diseases from 2014 to 2019, reporting an annual median of 49 947 420 cases. In comparison with the data reported between 2014-2019, there was a decrease in the reported cases of 39.9% in 2020, 19.7% in 2021, and 25.7% in 2022. Thirty-one diseases increased their reporting, while 101 decreased. Of the diseases that increased, seven were sexually transmitted, 13 were infectious, and five were chronic-metabolic. **Conclusions.** The pandemic has significantly impacted the landscape of mandatory notifiable diseases in Mexico. The pandemic has led to modifications in the epidemiological trends of disease reporting.

Keywords: epidemiological surveillance; Covid-19 pandemic; impact; report excess; report deficit

Resumen

Objetivo. Cuantificar el efecto de la pandemia de Covid-19 en la tasa de reporte de las enfermedades de notificación obligatoria en México entre 2020-2022. **Material y métodos.** Los datos se obtuvieron del Boletín Epidemiológico Semanal de la Secretaría de Salud del Gobierno de México para el periodo 2014-2022. Se crearon ciento treinta y dos canales endémicos calculando los percentiles semanales 25, 50 y 75 para el periodo 2014-2019. Posteriormente, se compararon los datos registrados entre 2020-2022 y se determinó si se reportaron más o menos casos de lo esperado. Se consideraron las tendencias prepandémicas de los datos. **Resultados.** El estudio incluyó 132 enfermedades desde 2014-2019, informando una mediana anual de 49 947 420 casos. En comparación con los datos reportados entre 2014-2019, hubo una disminución en los casos reportados de 39.9% en 2020, 19.7% en 2021 y 25.7% en 2022. Treinta y una enfermedades aumentaron sus informes y 101 disminuyeron. De las enfermedades que aumentaron, siete fueron de transmisión sexual, 13 infecciosas y cinco crónico-metabólicas. **Conclusiones.** La pandemia impactó en el panorama de las enfermedades de notificación obligatoria en México, con lo que se modificaron las tendencias epidemiológicas en la notificación de enfermedades.

Palabras clave: vigilancia epidemiológica; pandemia de Covid-19; impacto; exceso de reporte; déficit de reporte

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The Covid-19 pandemic is considered the worst global public health crisis in the past hundred years. In response, most governments implemented several strategies to diminish the spread of SARS-CoV-2 and prevent the collapse of their health systems, including anti-Covid-19 non-pharmaceutical interventions (NPIs). As is well known, the pandemic disrupted routine medical services, depleted supplies and drugs, impacted human resources, affected the health infrastructure, modified social behavior, and altered the global ecosystem.¹⁻³

The Covid-19 pandemic has not only affected individual health but has also had significant repercussions on the healthcare system. In China, it has been reported a reduction between 42.6-70.8% in the incidence of infectious diseases.^{4,5}

By the end of the first year of the pandemic, a global increase in sexual transmitted diseases (STDs) was detected in countries such as China, Cuba, Hungary, and Spain.⁶⁻⁸ Furthermore, there is evidence suggesting that the Covid-19 pandemic has adversely affected mental health and nutrition in the population.⁹

In Mexico, data from the *Instituto Mexicano del Seguro Social* (IMSS in Spanish) highlights the disruption of essential health services, with notable declines in critical areas. The services most profoundly impacted by this disarticulation include breast cancer screening (-79%), cervical cancer screening (-68%), childhood illness visits (-66%), contraceptive services (-54%), children's vaccination (-36%), diabetes and hypertension care (-32%), and prenatal care (-27%). Given that the IMSS serves as the primary public health provider in Mexico, these reductions in key health indicators serve as a gauge for the broader impact of the Covid-19 pandemic on healthcare in the country.¹⁰

According to the latest data published by the Ministry of Health of the Government of Mexico, the first cases of SARS-CoV-2 infection were reported on February 27th of 2020.¹¹ From this moment onward and gradually, the Mexican Government began implementing various NPIs for managing the pandemic. These strategies could alter the functioning of healthcare systems and bring changes in lifestyle.

In Mexico, one of the principal functions of the Ministry of Health is epidemiological surveillance. The actual data provided by the *Sistema Nacional de Vigilancia Epidemiológica* (Sinave in Spanish) has been reported weekly since 1880. Online weekly, monthly, and yearly information in raw data format has been accessible since 1981. However, there is currently no routine public assessment of the data trends on a weekly basis. The information reported by this system is collected from all public and private healthcare providers. Epidemiological surveillance in Mexico is regulated

by NOM-017-SSA2-2012. This standard establishes the criteria and specifications for epidemiological surveillance and reporting.¹²

This global health emergency not only contributed to an increase in morbidity and mortality, but also had a profound impact on the performance of health systems. It is important to consider that the pandemic and NPIs implemented to combat Covid-19 also modified our social behavior. Therefore, we suppose that Covid-19 pandemic could alter the tendency on diseases reports. The objective of this study was to evaluate the influence of pandemic on data collection and reporting by Sinave, comparing with the pre-pandemic period (2014-2019).

Materials and methods

Data source

Data were obtained from the Weekly Epidemiological Bulletin of the Ministry of Health of the Mexican Government (MoH), which reports the information recorded in the Sinave.¹³ The Weekly Epidemiological Bulletin (WEB) has been published since 1880 and serves as the official document for communicating epidemiological data. It provides weekly reports on new cases of 147 disease of mandatory notification.¹²

Between January 2023 and March 2023, we collected all the data of WEB from the Sinave. The period analyzed was between 2014 to 2022. Data collected covered all reported cases of 147 disease of mandatory notification, including communicable, non-communicable, zoonotic conditions, and some health risks (such as scorpion stings and deaths from automobile accidents). Fifteen diseases for which no cases have been reported were excluded, and for each of the remaining 132 diseases, we elaborated the endemic channel. The data source consisted of weekly epidemiological bulletins reported in PDF format. Consequently, a weekly database for all diseases had to be manually generated. After creating the database, it underwent independent review for errors and inconsistencies by three of the authors. All diseases were graphed to identify temporal inconsistencies in the data. For each disease, the minimum, maximum and percentiles (25th, 50th, and 75th) values were determined weekly and annually to identify any alterations in their reporting. In case of inconsistencies or alterations were identified, we proceed to correct the data comparing with the PDF files.

Endemic channels

To construct the endemic channels, we gathered all weekly reports of diseases documented by Sinave

between 2014-2019 (prepandemic period). Using this data, we computed the 25th, 50th, and 75th percentiles for each week and for each disease. The acquisition of weekly percentiles during the period 2014-2019 enables us to determine the seasonality pattern of each disease. To ascertain the weekly excess or deficit of cases, we deducted the weekly number of cases reported during 2020-2022 from the corresponding weekly values of the endemic channel's (p25th, p50th, and p75th values). At the conclusion of each year, we aggregated the weekly excess or deficit of cases for each percentile.

The annual percentage change for the pandemic period was calculated by dividing the weekly p50th values of each year by the p50th value of the endemic channel. This calculation enabled us to evaluate the relative change during pandemic period compared to the expected value based on the endemic channel. Microsoft Excel and IBM SPSS Statistics (version 28.0) programs were used.

Prepandemic and pandemic comparison

To compare the pandemic with the prepandemic period, we analyze trends in pre-Covid-19 pandemic disease reporting. We compared the total number of cases of each disease during 2019 with the expected total number of cases of the endemic channels. If the 2019 total cases were below p25th, we considered a tendency to reduction; if the 2019 data were between p25th and p75th, we considered it not-changed tendency; and, if the 2019 data were above p75th, we considered a tendency to increased. In order to be confirmed the tendency, we also consider the yearly data trend previous pandemic. We classified whether the trend indicated an increase, decrease, or no change (supplementary table I, supplementary figures 1-3).¹⁴

We adjusted the number of cases reported according to population size (rate per 100 000 inhabitants = "annual reporting rate index"). Population size adjustment was performed using mid-year population projections provided by the *Consejo Nacional de Población* (Conapo in Spanish).

Finally, we compared the weekly number of cases between the periods of 2014-2019 and 2020-2022 using the Mann-Whitney U test. A *p*-value <0.05 was considered statistically significant.

The 132 diseases evaluate using the endemic channel methodology were classified into one of two groups: i) Diseases for which NPIs could reduce reporting, transmission, and/or incidence, and ii) Diseases for which NPIs could not reduce reporting, transmission, and/or incidence. This classification was based on various criteria, including whether the diseases are

communicable or non-communicable, mode of transmission, susceptibility to social mobility, association with nutrition, association with social or psychological stress, and its association with social factors (such as drug abuse, sun exposure, sexual transmission, etc.). This classification was not based on a pre-existing methodology and was developed freely by the authors, according to the physiopathology of each disease and if were communicable or not diseases. The measures taken into consideration encompassed the use of face masks, school closures, reduction of capacity in public places, isolation of cases, increased hand hygiene, etc. (supplementary table I).¹⁴

The purpose of this study was to assess if the Covid-19 pandemic had any significant effect on the data collected and reported by Sinave in the pandemic period (2020-2022) comparing to prepandemic period (2014-2019). Supplementary data can be with the following ODI: <https://doi.org/10.6084/m9.figshare.25213550.v1>.¹⁴

Results

We analyzed the weekly trends of cases reported for 132 diseases under monitoring by the MoH, as reported in the WEB between 2014-2019, and compared them against the weekly reporting trends during the first three years of the Covid-19 pandemic.

From 2014-2019, the MoH reported an annual median of 49 947 420 cases for the 132 diseases (p25th-p75th, 47 698 379-51 938 633). This information was taken as a baseline, and it was compared with the reported data in 2020 (30 038 042 reported cases), in 2021 (40 124 009 reported cases), and finally with the information reported in 2022 (37 130 249 reported cases). This comparison showed a decrease in the number of reported cases by 39.9, 19.7, and 25.7%, respectively.

To conduct the data analysis, we calculated the annual reporting rate index, which represents the number of cases reported per 100 000 inhabitants. The annual reporting rate index for the baseline period was 39 842 cases per 100 000 inhabitants, ranging from 38 936-42 933 (p25th-p75th). When comparing the annual reporting rate index for 2020-2022 against the baseline, we observed a decrease of 41.0, 21.9, and 29.6%, respectively (table I). During the first year of the pandemic, we calculated a decrease of approximately 18 361 706 (p25th-p75th, -20 954 789 to -14 269 361) cases reported. In 2021 a deficit of 18 594 029 cases (p25th-p75th, -20 154 399 to -14 559 610) was calculated. At the end of 2022, the deficit was smaller, with a decrease of 11 463 127 cases (p25th-p75th, -14 033 765 to -2 282 631). Globally, during the three years of the Covid-19 pandemic, we calculated a reporting deficit of -48 818 862 cases (p25th-p75th, -55 142 953 to -31 411 602).

Out of the 132 diseases analyzed, we considered that the anti-Covid NPIs could affect the transmission of 50 of them. Additionally, due to the pathogenesis and natural history of the diseases, there were 82 diseases for which the NPIs could not affect their reporting or transmission (figure 1).

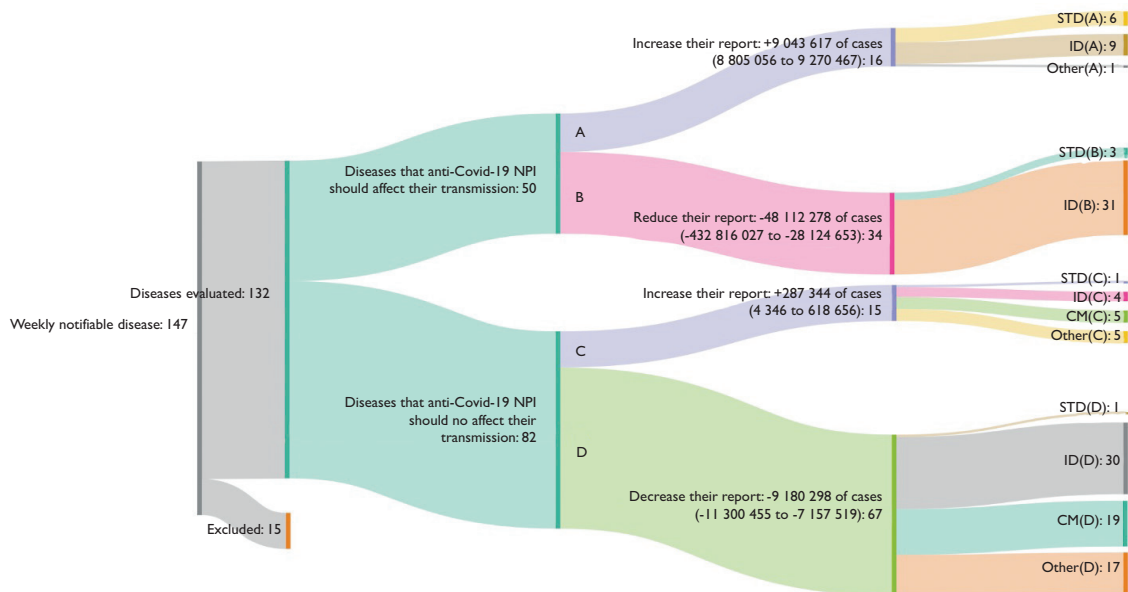
Among the 50 diseases that should have been affected by the NPIs, 16 showed an increase in their

reporting (infectious diseases, sexually transmitted diseases, and car accidents) (figure 1A), and 34 exhibited a decrease (infectious diseases and sexually transmitted diseases) (figure 1B). During the first three years of the pandemic, the diseases that increased by more than 100% were genitourinary gonorrhea, congenital syphilis, venereal syphilis, and tuberculous meningitis. It is necessary to mention that these diseases had al-

Table I
IMPACT OF THE COVID-19 ON THE CASES REPORTED BY THE WEEKLY EPIDEMIOLOGICAL BULLETIN IN MEXICO DURING COVID-19 PANDEMIC (2020-2022). JANUARY 2014-DECEMBER 2022

	2014-2019	2020	2021	2022	2020-2022
Cases reported, median (p25-p75)	49 947 420 (47 698 379 to 51 938 633)	30 038 042	40 124 009	37 130 249	NC
Percentage of cases reported reduction	Baseline	-39.9	-19.7	-25.7	NC
Annual reporting rate index (cases/100 000 inhabitants)	39 842 (38 936 to 42 933)	23 505.4	31 110.5	28 051.3	NC
Percentage of reporting rate reduction	Baseline	-41.0	-21.9	-29.6	NC
Estimated deficit of the number of cases reported, median (p25 th -p75 th)	Baseline	-18 361 706 (-20 954 789 to -14 269 361)	-18 594 029 (-20 154 399 to -14 559 610)	-11 463 127 (-14 033 765 to -2 582 631)	-48 418 862 (-55 142 953 to -31 411 602)

NC: not calculated



A) Direct consequence of social behavior changes due to Covid-19 pandemic; a slow but sustained increase could be expected in the next years (except Covid-19). B) Direct beneficial effect of NPI against Covid-19 > under-registration report rate + hospital conversion + hospital saturation; a slow but sustained increase could be expected in the next years. C) Direct consequence of social behavior changes due to Covid-19 pandemic; quick and abrupt increase could be expected in the next years. D) Under-registration report rate + hospital conversion + hospital saturation < direct beneficial effect of NPI against Covid-19; a quick and abrupt increase could be expected in the next years. NPI: non-pharmaceutical interventions STD: sexual transmitted disease; ID: infectious disease; CM: chronic-metabolic disease.

FIGURE 1. SANKEY PLOT OF THE DISEASE EVALUATED IN MEXICO 2020-2022

ready been on the rise since 2016. However, during the pandemic, the reporting of these diseases exacerbated their growth. There were diseases that during the first year of the pandemic showed a statistically significant reduction, but in the subsequent years, they increased. At the end of these three years, the increase in these diseases (rickettsiosis, HCV infection, stroke, leprosy, car accidents, hypertension, and type 2 diabetes) ranged from 4.1 to 33.5%.

Regarding the diseases for which NPIs were not expected to impact their transmission, 15 had an increase in their reporting (chronic metabolic diseases, infectious diseases, sexually transmitted diseases, and others) (figure 1C), and 67 showed a decrease (infectious

diseases, chronic metabolic diseases, sexually transmitted diseases, and others) (figure 1D).

Table II shows diseases that exhibited a statistically significant increase during the pandemic. Genitourinary gonorrhea, congenital syphilis, syphilis, venereal lymphogranuloma, genital herpes, and respiratory tuberculosis all demonstrated an excess of cases between 2020-2022. On the other hand, rickettsiosis, HCV infection, stroke, leprosy, car accidents, arterial systemic hypertension, and type 2 diabetes mellitus showed a decrease in cases in 2020 but subsequently displayed an excess of recorded cases.

Table III displays the major diseases that showed a decreasing trend before the Covid-19 pandemic. Among

Table II
PRINCIPAL DISEASES WITH AN INCREASE DURING COVID-19 PANDEMIC IN MEXICO (2020-2022).
JANUARY 2014-DECEMBER 2022

Disease	Estimated excess or deficit during 2020	% of change	Estimated excess or deficit during 2021	% of change	Estimated excess or deficit during 2022	% of change	Cumulative estimated excess or deficit during 2020-2022	% of change
Genitourinary gonorrhea	4 679.0* (4 100 to 6 865.0)	220.2	7 716* (7 137.0 to 9 902.0)	363.1	8 933* (8 354.0 to 11 119.0)	420.4	21 328.0* (19 591.0 to 27 886)	298.9
Congenital syphilis	297.5* (260.8 to 449.3)	185.4	323.5* (286.8 to 465.3)	201.6	673.5* (636.8 to 825.3)	419.6	1 294.5* (1 184.3 to 1 749.8)	233.3
Syphilis	1 193.0‡ (955.0 to 2 876)	34.4	6 044.0* (5 806.5 to 7 727.0)	173.7	11 026.0§ (10 788.5 to 12 709.0)	317.9	18 263.0* (17 550.5 to 23 312.0)	132.2
Meningeal tuberculosis	14.0 (-15.5 to 98.5)	6.6	249.0§ (219.5 to 333.5)	118.0	352.0* (322.5 to 436.5)	166.8	615.0* (526.5 to 868.5)	100.0
Venereus lymphogranuloma	61.5‡ (-2.3 to 115.8)	22.4	133.5* (69.8 to 187.8)	48.6	113.5* (49.8 to 167.8)	41.3	308.5* (117.3 to 471.3)	75.0
Genital herpes	920.5* (45.0 to 2 196.0)	18.7	2 416.5* (1 451.0 to 3 692.0)	49.1	4 132.5§ (3 167 to 5 408.0)	83.9	7 469.5* (4 573.0 to 11 296.0)	57.5
Gestational diabetes	1 745 (-689.0 to 6 176.0)	13.9	6 773.0* (4 339.0 to 11 204.0)	54.0	10 777.0* (8 343.9 to 15 208.0)	85.9	19 295.0* (11 993.0 to 32 588.0)	55.6
Other rickettsiosis	-96.0* (-213.3 to 1 163.3)	-62.7	32.0§ (-85.3 to 1 291.3)	20.9	438.0‡ (320.8 to 1 697.3)	286.3	374.0‡ (22.3 to 4 151.8)	33.5
Respiratory tuberculosis	12 168.5* (11 577.0 to 13 277.8)	87.1	2 088.5* (1 497.0 to 3 197.8)	14.9	5 670.5* (5 079.0 to 6 778.8)	40.6	19 927.5* (18 153.0 to 23 255.3)	31.2
HCV infection	-738.0* (-840.5 to -542.5)	-37.1	356‡ (253 to 551.5)	17.9	1 542* (1 439.0 to 1 737.5)	77.4	1 160§ (852.5 to 1 746.5)	17.2
Stroke	-6129.0 (-7 602.3 to -3 727.0)	-15.2	1 099.0 (-374.3 to 3 501.0)	2.7	10 913.0 (9 439.8 to 13 315.0)	27.1	5 883.0 (1 463 to 13 089.0)	9.0
Leprosy	-14.5§ (-88.8 to 25.5)	-15.0	28.5 (-45.8 to 68.5)	29.5	33.5 (-40.8 to 73.5)	34.7	47.5 (-175.3 to 167.5)	8.0
Car accidents	-34 135.5* (-45 219.5 to -29 920)	-28.2	2 862.5‡ (-8 221.5 to 7 078.0)	2.4	47 295.5* (36 211.5 to 51 511.0)	39.1	16 022.5§ (-17 229.5 to 28 669.9)	7.3
Arterial systemic hypertension	-48 129* (-90 954.5 to 1 698.0)	-10.2	17 668 (-25.157.5 to 67 495.0)	3.8	107 525* (65 699.5 to 157352.0)	22.9	77 064.0§ (-51 412.5 to 226.545.9)	5.0
Diabetes mellitus type 2	-75 945.0* (-102 859.8 to -42 809.8)	-19.7	9 732 (-17 182.8 to 42 867.3)	2.5	85 040.0* (58 125.3 to 118 175.3)	22.1	18 827.0 (-61 917.3 to 118 232.8)	4.1

Note: Weekly cases average of each year compared with the 2014-2019 endemic channel. Mann-Whitney U test * p < 0.0001, ‡ p < 0.05, § p < 0.005. Except venereus lymphogranuloma and leprosy that had a stable report during the last 10 years, all the other disease had a previous increased tendency, and the pandemic enhanced it. Data reported: p50th (p25th-p75th); HCV: hepatitis C virus

Table III
PRINCIPAL DISEASES WITH AN ENHANCED REDUCTION DURING COVID-19 PANDEMIC IN MEXICO
(2020-2022). JANUARY 2014-DECEMBER 2022

Disease	Estimated excess or deficit during 2020	% of change	Estimated excess or deficit during 2021	% of change	Estimated excess or deficit during 2022	% of change	Cumulative estimated excess or deficit during 2020-2022	% of change
Chickenpox	-124 816* (-155 114 to -65 513.0)	-76.9	-146 719* (-177 017.0 to -87 416.0)	-90.4	-127 623* (-147 921 to -68 320.0)	-78.6	-399 158* (-490 052.0 to -221 249.0)	-88.8
Scarlat fever	-2 087.0* (-2 488.5 to -1 409.8)	-61.0	-2 825.0* (-3 226.5 to -2 147.8)	-82.5	-2 308.0* (-2 709.5 to -1 630.8)	-67.4	-7 220.0* (-8 424.5 to -5 188.5)	-77.7
Hepatitis A	-5 144.0* (-6 752.8 to 2 003.3)	-57.6	-6 808.0* (-8 416.8 to 339.3)	-76.3	-4 926.0* (-6 534.8 to 2 221.3)	-55.2	-16 878.0* (-21 704.3 to 4 563.8)	-73.7
Typhoid fever	-28 708.5* (-39 027.8 to -21 943.0)	-64.0	-28 980.5* (-39 227.8 to -22 143.0)	-64.4	-30 975.5* (-41 222.8 to -24 138)	-68.8	-88 736.5* (-119 478.3 to -68 224)	-65.4
Brucellosis	-1 501.0* (-2 222.5 to -1 237.5)	-65.2	-1 623.0* (-2 344.5 to -1 359.5)	-70.5	-1 289.0* (-2 010.5 to -1 025.5)	-24.8	-4 413.0* (-6 577.5 to -3 622.5)	-64.3
Rotavirus	-933.0* (-988.0 to -388.3)	-75.5	-565.0* (-620.0 to -20.3)	-45.8	-460.0* (-515.0 to -84.8)	-37.3	-1 958.0* (-2 123.0 to -323.8)	-64.0
Asthma	-125 701.5* (-133 246.0 to -115 066.0)	-49.2	-161 632.5* (-169 177.0 to -150 997.0)	-63.3	-121 655.5* (-129 200.0 to -111 020.0)	-47.6	-408 989.5* (-431 623.0 to -377 083.0)	-63.7
<i>Haemophilus influenzae</i> invasive disease	1.0 (-24.3 to 24.8)	0.9	-113.0 (-138.2 to -89.3)	-100.0	-100.0 [‡] (-125.3 to -76.3)	-88.5	-212.0* (-287.8 to -149.8)	-62.3
Other helminthiasis	-93 928.0* (-115 343.5 to -48 213.5)	-62.3	-90 677.0* (-112 092.5 to -44 962.5)	-60.2	-85 152.0* (-106 567.6 to -39 437.5)	-56.5	-269 757.0* (-334 003.5 to -132 613.5)	-60.8
Shigellosis	-2 359.5* (-3 274.5 to -56.5)	-53.4	-2 809.5* (-3 723.5 to -505.5)	-63.5	-2 001.5* (-2 916.5 to 301.5)	-45.3	-7 169.5* (-9 914.5 to -260.5)	-59.1
Urogenital trichomoniasis	-24 014.0* (-31 436.3 to -5 519.8)	-51.4	-24 435.0* (-31 857.3 to -5490.8)	-52.3	-25 507.0* (-32 929.3 to -7 012.8)	-54.6	-73 956.0* (-96 222.8 to -18 473.3)	-54.7
Burns	-65 782.5* (-71 851.8 to -55 526.3)	-58.2	-63 604.5* (-69 673.8 to -53 348.3)	-56.3	-53 783.5* (-59 852.8 to -43 527.3)	-47.6	-183 170.5* (-201 378.3 to -152 401.8)	-54.2
Paratyphoid fever	-5 855.0* (-7 653.0 to -4 341.5)	-53.3	-5 634.0* (-7 432.0 to -4 120.5)	-51.3	-4 786* (-6 584.0 to -3 272.59)	-43.6	-16 275* (-21 669.0 to -11 734.5)	-53.7
Intestinal amebiasis	-107 038.0* (-129 614.3 to -64 016.3)	-49.5	-107 934.0* (-130 510.3 to -64 912.3)	-49.9	-103 725.0* (-126 301.3 to -60 703.3)	-48.0	-318 697.0* (-386 425.8 to -189 631.8)	-53.6
HPV	-12 862.5* (-14 663.3 to -6 549.3)	-64.1	-10 166.5* (-11 967.3 to -3 853.3)	-50.7	-6 790.5* (-8 591.3 to -477.3)	-33.8	-29 819.5* (-35 221.8 to -10 879.8)	-52.6
Ascaris	-20 335.5* (-23 255.5 to -15 360.0)	-47.0	-20 638.5* (-23 558.5 to -15 663.0)	-47.7	-20 619.5* (-23 539.5 to -15 664.0)	-47.6	-61 593.5* (-70 353.5 to -46 667.0)	-51.2
Mild malnutrition	-46 352.5* (-49 348.5 to -32 816.8)	-60.1	-38 147.5* (-41 143.5 to -24 611.8)	-49.5	-27 512.5* (-30 508.5 to -13 976.8)	-35.7	-112 012.5* (-121 000.5 to -71 405.3)	-50.1
Poisoning by animal contact	-23 318.5* (-31 397.8 to -19 869.0)	-53.1	-23 249.5* (-31 328.8 to -19 800.0)	-52.9	-18 141.5* (-26 220.8 to -14 692.0)	-41.3	-64 709.5* (-88 947.3 to -54 361.0)	-47.9
Infectious parotiditis	-796.0* (-1 493.0 to 2 157.5)	-18.2	-2 026.0* (-2 723.0 to 927.5)	-46.3	-1 587.0* (-2 284.0 to 1 366.5)	-36.3	-4 409* (-6 500 to 4 451.5)	-45.9
Urogenital candidiasis	-81 993.5* (-104 397.3 to -67 453.0)	-41.5	-82 187.5* (-104 591.3 to -67 647.0)	-41.6	-82 678.5* (-105 082.3 to -68 138.0)	-41.9	-246 859.5* (-314 070.8 to -203 238.0)	-39.9
Other protozoal infection	-23 695.5* (-26 556.3 to -17 690.3)	-34.5	-23 430.5* (-26 556.3 to -17 425.0)	-34.1	-22 442.5* (-25 303.3 to -16 437.0)	-32.7	-69 568.5* (-78 150.8 to -51 552.0)	-37.3
Pesticide poisoning	-1 806.0* (-2 651.3 to -1 429.3)	-47.1	-1 766.0* (-2 611.3 to -1 389.3)	-46.0	-1 472.0* (-2 318.3 to -1 096.3)	-38.4	-5 045.0* (-7 580.8 to -3 914.8)	-34.4
Hepatitis B	-325.5* (-386.8 to -273.0)	-49.0	-184.5* (-244.8 to -131.0)	-27.7	-30.5* (-90.8 to 23.0)	-4.6	-541.5* (-722.3 to -381.0)	-33.3
Cleft lip and palate	-332.0* (-473.3 to 207.5)	-37.7	-149.0* (-290.3 to 390.5)	-16.9	64.0* (77.3 to 603.5)	7.3	-417.0* (-840.8 to 1 201.5)	-17.6

Note: Weekly cases average of each year compared with the 2014-2019 endemic channel. Mann-Whitney U test * $p < 0.0001$, [‡] $p < 0.005$. Data reported: $p50^{th}$ ($p25^{th}$ - $p75^{th}$)
 HPV: human papillomavirus

the three years, the largest reduction in reports was observed in 2021. Among all the diseases that experienced an accelerated reduction during the pandemic, only the reports of invasive *Haemophilus influenzae* disease were not significantly reduced during the first two years. There were diseases whose frequency was already decreasing before the pandemic, but during the pandemic, their reduction intensified. Among these diseases, varicella, scarlet fever, asthma, urogenital trichomoniasis, and urogenital candidiasis stand out. In these diseases, although a reduction was recorded during these three years, the greatest decrease occurred during the second year of the pandemic. Subsequently, in 2022, their frequency showed a recovery, and therefore, the reduction of these diseases was less. In the case of hepatitis A, brucellosis, rotavirus, other helminthiases, shigellosis, burns, paratyphoid fever, HPV infection, mild malnutrition, poisoning by animal contact, other protozoal infections, pesticide poisoning, hepatitis B, and cleft lip and palate, a higher reduction in cases was reported during 2021, but the reduction in 2022 was similar to the rate in 2020.

Thirty percent of reported diseases changed their trend during the pandemic (table IV). Among them, we expect some degree of change in the reporting rate for 11 diseases, while for 29, we do not expect any change. All of these changes were statistically significant except for HIV / AIDS and obesity. Among the diseases whose reporting changed during the Covid-19 pandemic, some have indeed shown a recovery in their reporting reduction. These diseases include giardiasis, heatstroke, gastrointestinal infections, gingivitis and periodontal disease, alcohol intoxication, moderate malnutrition, alcoholic liver disease, erysipelas, bacterial food poisoning, cirrhosis, cutaneous leishmaniasis, urinary tract infections, domestic violence, severe malnutrition, cervical dysplasia, venous insufficiency, ischemic heart disease, and dog bites. Considering the current trend, many of these diseases are expected to return to their pre-pandemic levels by 2023. In the case of cysticercosis, severe cervical dysplasia, *in situ* cervical cancer, HIV / AIDS, and hypertensive disorders of pregnancy, the reporting trend of these diseases changed towards reduction during the pandemic. However, all of these diseases showed an increase in 2022 compared to the comparison period.

Discussion

The disruption of health services during the pandemic was evaluated by IMSS. Doubova and colleagues estimated that 8.74 million patient visits were lost in the first eight months of the pandemic. This could be partially

explained by the IMSS and the Government of Mexico recommending limiting visits to health facilities to emergencies at the start of the pandemic. Another explanation could be that hospital reconversion decreased access to primary medical care attention.³

Similar phenomena were observed in other countries during the pandemic. The Pan American Health Organization (PAHO) reported that out of 28 countries, 11% had interrupted services, and 64% provided limited access to ambulatory services for non-communicable diseases.¹⁵

At the national level in Mexico, it has been reported that only 34% of the population that reported health-care needs during the pandemic received care in public healthcare facilities. It is estimated that only 64.4% of patients received care during the pandemic, and of these, 74.5% received care in the private sector.¹⁻²

Another factor related to disease transmission and / or reporting was the NPIs implemented by the Mexican Government during the pandemic. For example, the “stay-at-home” strategy, the reduction of social mobility, hospital reconversion, school closures, etc.¹⁶⁻¹⁸

All these factors could potentially be associated with a significant change in epidemiological reporting during the Covid-19 pandemic. In the first year of the pandemic, the distinction between Covid and non-Covid hospitals affected the effective levels of care provided to patients, leading to discontinuation or delay of services such as physical medicine and rehabilitation, prevention and health promotion programs, group psychological therapy, elective diagnostic studies, elective surgeries, and specialized ambulatory care.¹⁶

To varying degrees and at different points in time, all 132 weekly reported diseases monitored by MoH were affected by the pandemic. The primary significant result of our analysis is the observed decrease of nearly 48 million reported cases during the period 2020-2022. Due to the methodology employed, this result considers the trends of the data prior to the pandemic. Changes in the reporting of Non-Communicable Diseases (NCDs) were observed globally, including in China, where the reporting of respiratory, gastrointestinal, blood-borne, and vector-borne diseases, as well as sexually transmitted infections, decreased.¹⁸ It has also been reported during the early years of the pandemic, a reduction in the reporting of infectious diseases in countries such as China and Australia.^{4,5,19}

The reduction in reporting rates wasn't solely due to the Covid-19 NPIs. The pandemic not only impacted the functionality of healthcare systems worldwide but also brought about unprecedented changes in people's lives.¹⁸ These factors could influence disease development, transmission, diagnosis, and reporting. The impact

Table IV
PRINCIPAL DISEASES WITH CHANGES IN THEIR TREND DURING COVID-19 PANDEMIC (2020-2022) AND A REDUCTION WAS DETECTED IN MEXICO (2020-2022). JANUARY 2014-DECEMBER 2022

Disease	Estimated excess or deficit during 2020	% of change	Estimated excess or deficit during 2021	% of change	Estimated excess or deficit during 2022	% of change	Cumulative estimated excess or deficit during 2020-2022	% of change
Bordetella	-446.5* (-490.5 to -355.5)	-65.6	-664.5* (-708.5 to -573.5)	-97.6	-638.5* (-682.5 to -547.5)	-93.8	-1 794.5* (-1 881.5 to -1 476.5)	-85.9
Murine typhus	-87.5* (-183.3 to -39.3)	-75.8	-1 044.5* (200.3 to -56.3)	-90.5	-114.5* (-210.3 to -66.43)	-99.1	-306.5* (-593.8 to -161.8)	-74.4
Whooping cough	-1 292.5* (-1 469.5 to -450.0)	-59.6	-1 439.5* (-1 607.5 to -887.0)	-66.4	-1 140.5* (-1.308.5 to -588.0)	-52.6	-3 872.5* (-4 376.5 to -2 215.0)	-71.1
Acute respiratory tract infections	-10 170 229* (-10 773 944 to -7 967 113)	-45.8	-13 485 044* (-13 088 759 to -11.281 928)	-59.1	-7 850 265* (-8 453 980 to -5 647 149)	-36.4	-31 505 538* (-33 316 6784 to -24 896 190)	-56.0
<i>Plasmodium vivax</i>	-210.5* (-266.0 to 7.5)	-37.7	-326.5* (382.0 to -108.5)	-58.5	-397.5* (-453.0 to 179.5)	-71.2	-934.5* (-1 101.0 to -280.5)	-55.6
Scabies	-47 028* (-63 515.0 to -33 787)	-46.5	-58 366.0* (-74 854.0 to -45 125.8)	-57.7	-62 218.0* (-78 705.0 to -48 977.8)	-61.5	-7 612.0* (-217 073.0 to -127 891.3)	-55.5
Exanthematic febril illness	-1 889.0* (-2 255.3 to -1 251.3)	-42.8	-2 997.0* (-3 363.3 to -2 359.3)	-67.9	-1 868.0* (-2 234.3 to -1.230.3)	-42.3	-6 754.0* (-7 852.8 to -4.840.8)	-53.8
Giardiasis	-5 892.5* (-6 648.0 to -4 582.0)	-52.5	-5 647.5* (-6 403 to -4 337)	-50.3	-4 705.6* (-5 462.0 to -3 396.0)	-41.9	-16 246.5* (-18 513.0 to -12 315.0)	-52.7
Heath shock	-2 333.5* (-2 873.0 to -2 015.3)	-58.3	-1 746.5* (-2 284.0 to -1 426.3)	-43.6	-1 364.5* (-1 902.0 to -1 044.3)	-34.0	-5 446.5* (-7 059.0 to -4 485.8)	-51.6
Salmonellosis	-35 314.5* (-36 777.8 to -24 854.3)	-46.0	-35 693.5* (-37 102.8 to -25 179.3)	-46.5	-33 008.5* (-34 471.8 to -22 548.3)	-43.0	-103 962.5* (-108 352.3 to -72 581.8)	-49.0
Other gastrointestinal infections	-2 914 706* (-3 246 151 to -2 649 646)	-52.1	-2 619 658* (-2 941 103 to -2 344 598)	-46.7	-2 240 676* (-2 562 121 to -1 965 616)	-39.9	-7 785 040* (-8 749 377 to -6 959 862)	-48.9
Gastrointestinal infection	-2 760 755* (-3 211 473 to -2 724 360)	-53.0	-2 451 859* (-2 912 577 to -2 425 464)	-47.4	-2 093 654* (-2 554 372 to -2 057 259)	-40.2	-7 316 269* (-8 668 423 to -7 207 083)	-48.0
Acute haemorrhagic epidemic conjunctivitis	-209.0* (-534.0 to 626.3)	-53.6	-178.0* (-504.3 to 675.3)	-45.6	-192.0* (-517 to 643)	-49.2	-579.0* (-1 554.0 to 1 926.0)	-45.9
Gingivitis and periodontal disease	-715 611* (-738 086 to -690 186)	-64.3	-539 963* (-562 438 to -514 538)	-48.5	-220 570* (-243 045 to -195 145)	-19.8	-1 476 145* (-1 543 570 to -1 399 871)	-45.8
Alcohol intoxication	-19 734.0* (-20 903 to -17 256.3)	-49.2	-19 427* (-20 596 to -16 949.3)	-48.4	-14 852.0* (-17 021.0 to -13 374.3)	-39.5	-55 013.0* (-58 520 to -47 579.8)	-45.7
Moderate malnutrition	-6 473.5* (-6 772.3 to -5 303.3)	-54.2	-5 016.5* (-5 315.3 to -3 846.3)	-42.0	-3 037.5* (-3.336.3 to -1 867.3)	-25.4	-14 527.5* (-15 423.8 to -11 016.8)	-43.6
Gastric ulcer and duodenitis	-544 891.5* (-585 850 to -505 973.8)	-38.6	-555 613.5* (-595 572.0 to -516 695.8)	-39.3	-509 797.5* (-549 756 to -470 879.8)	-38.6	-1 610 302* (-1 730 178 to -1 493 549)	-40.5
Liver alcoholic disease	-3 024.0* (-3 878.8 to -1 500.0)	-44.5	-2 700.0* (-3 554.8 to -1 176.0)	-39.7	-2 309* (-3 163.8 to -785.0)	-34.0	-8 033.0* (-10 597.3 to -3 461.0)	-40.2
Enterobiasis	-4 229.0* (-4 908.8 to -1 432.3)	-42.0	-4 581* (-5 260.8 to -1 784.4)	-88.1	-4 043.0* (-4.772.8 to -1 246.3)	-40.2	-12 853.0* (-14 892.3 to -4 462.8)	-40.2
Acute median otitis	-202 405* (-295 439.8 to -101 450.3)	-29.7	-293 830* (-386 855.8 to -192 875.3)	-43.2	-223 765.0 (-316 790.8 to -122 810.3)	-32.9	-720 000.0* (-999 077.3 to -417 135.8)	-40.1
Erysipela	-5 144.5* (-6 871.8 to -4 089.8)	-41.3	-4 860.5* (-6 587.8 to -3 805.8)	-39.0	-4 762.5* (-6 489.8 to -3 707.8)	-38.2	-14 767.5* (-19 949.3 to -11 603.3)	-39.6
Bacterial food intoxication	-14 462.0 (-15 168.5 to -6 789.5)	-45.6	-10 439* (-11 145.5 to -2 757.5)	-37.2	-8 410* (-9 116.5 to -728.5)	-26.4	-33 311* (-35 430.5 to -10 266.5)	-38.3
Cirrhosis	-1 693.5* (-8150 to -1 358)	-47.8	-2 846* (-9 393 to -2 511)	-37.2	-1 695* (-8 150 to -1.358)	-22.1	-8 197* (-27 566 to -7 190.0)	-38.2
Endemic goiter	-254.0* (-335.3 to -61.8)	-21.3	-455.0* (-536.8 to -262.89)	-38.2	-244.0* (-325.3 to -51.8)	-20.5	-953.0* (-1 196.8 to -376.0)	-36.4
Pinta	-136.0* (-168.3 to -45.0)	-38.7	-93.0* (-125.3 to .2.0)	-26.5	-58.0* (-90.3 to 33.0)	-16.5	-287.0* (-383.8 to -14)	-35.7

(continues...)

(continuation)

Urinary tract infection	-1 428 201* (-1 518 438 to -1 328 958)	-34.4	-1 325 600* (-1 415 837 to -1 227 357)	-31.9	-988 501* (-1 078 738 to -890 258)	-23.8	-3 742 303* (-4 013 014 to -3 447 573)	-31.8
Domestic violence	-30 921* (-35 458.8 to -26 211.3)	-41.5	-18 708* (-23 246.8 to -13 999.3)	-25.1	-17 551.0 (-22 088.8 to -12 841.3)	-23.6	-67 181.0* (-80 794.3 to -53 051.8)	-29.0
Sever malnutrition	-2 334.5* (-2 440.5 to -1 837.3)	-42.5	-1 723.5* (-1 829.5 to 1 226.3)	-31.4	-934.5* (-1 040.5 to -437.3)	-17.0	-4 992.5* (-5 310.5 to -3 500.8)	-27.2
Mild and moderate cervical dysplasia	-17 775.5* (-20 284.3 to -12 071.5)	-55.8	-7 354.5* (-9 863.3 to -1 650.5)	-21.1	-2 098.5‡ (-4 607.3 to -3 605.5)	-6.6	-27 228.5* (-34 754.8 to -10 116.5)	-25.3
Mammal bite	-3 214.5* (-3 652.5 to -2 883.8)	-34.5	-2 386.5* (-2 824.5 to -2 055.8)	-25.6	-343.5 (-781.5 to -12.8)	-21.3	-5 955.5* (-7 258.3 to -4 952.3)	-25.1
Venous insufficiency	-79 382* (-113 399 to -48 007)	-39.2	-49 692* (-83 708 to -18 316)	-24.0	-19 829§ (-53 845 to -11 547.3)	-9.8	-14 993* (-250 952 to -54 775)	-23.1
Ischemic heart disease	-17 890* (-19 046 to -11 245)	-31.9	-13 011* (-14 175 to -6 365)	-23.2	-123.5§ (-1 287.5 to 6 522.3)	-0.2	-31 024.5* (-34 516.5 to -11 087.3)	-22.0
Cysticercosis	-108.0* (-127.3 to -92.5)	-39.7	-92.0* (-111.3 to -76.5)	-33.8	4.0 (-15.3 to 19.5)	1.5	-196.0* (-253.8 to -149.5)	-20.5
Dog bite	-35 808.0§ (-38 958.3 to 34 112.0)	-31.6	-22 961.0* (-26 111.3 to -21 265.0)	-20.2	-7 359.0* (-10 509.3 to -5 663.0)	-6.5	-66 128.0* (-75 578.8 to -61 040.0)	-18.9
Severe cervical dysplasia and in situ cancer	-1 976 (-2 410 to -1 757)	17.2	-424.5 (-858.8 to -206.0)	-10.6	612.5* (178.3 to 831.0)	15.3	-1 787.5‡ (-3 090.3 to -1 132.0)	-14.3
HIV/AIDS	-5 553‡ (-8 873.5 to -1 334.8)	30.6	-1 591.5 (-5 021.5 to 2 517.3)	-4.4	863.5‡ (-2 566 to 4 972.3)	12.3	-6 171.5 (-16 461.5 to 6 154.8)	-14.3
Dengue	-5 049.5 (-19 117.3 to 89.3)	17.2	-22 619.5* (-36 687.3 to -17 480.3)	-77.0	16 719.5* (-30 787.3 to -11 589.3)	-56.9	-44 388.5* (-86 591.8 to -28 979.8)	-13.0
Obesity	-233 508.5* (-418 130.5 to -163 043.3)	-38.9	-116 942.5‡ (-301 564.5 to -46 477.3)	-19.5	209 131.5* (24 509.5 to 279 596.8)	34.8	-141 319.5 (-695 185.5 to 70 076.3)	-11.0
Scorpion sting	-21 271.0* (-31 729.5 to -15 668.5)	-7.9	-27 912.0 (-38 370.5 to -22 209.5)	-10.4	-15 257.0 (-25 715.5 to -9 554.5)	-5.7	-64 440‡ (-95 815.5 to -47 33.5)	-9.4
Hypertensive pregnancy disease	-8 955.3* (-18 927.0 to -6 152.5)	-14.4	-153.5 (-10 125.0 to 2 648.5)	-0.2	5 997.5* (-3 974.0 to 8799.5)	9.7	-3 111.5‡ (-22 026 to 5 294.5)	-0.2

Note: Weekly cases average of each year compared with the 2014-2019 endemic channel. Mann-Whitney U test * $p < 0.0001$, † $p < 0.001$, ‡ $p < 0.01$.

Data reported: p50th (p25th-p75th)

HIV: human immunodeficiency virus; AIDS: acquired immunodeficiency syndrome

of reduced diagnoses of metabolic, oncologic, chronic, or STI conditions due to the pandemic might lead to the deterioration of patient healthcare, resulting in increased complications and associated healthcare costs in the upcoming years. The increase in the number of congenital syphilis cases during the pandemic could be explained, in part, by the reduction in antenatal care during the pandemic. For example, during the first nine months of the pandemic, antenatal care services at the IMSS declined by 27%, and the increase in congenital syphilis during the first year was 34.4%.³

Sexually transmitted infections had the highest number of excess cases and the highest percentage change. Contrary to what we expected when NPIs were established at the beginning of the pandemic, the detection of STIs increased during the pandemic. In our study, an increase in the reporting of STDs was found. This is consistent with what has been reported in Australia, Cuba, Hungary, and Spain. In China and the United States, there are reports that initially the report-

ing of these diseases increased, and after the first year of the pandemic, they began to rise.^{6-8,19,20} This information reinforces that the pandemic had a global effect on some disease's behavior or reports. Therefore, with the observed trend during 2020-2022, unless targeted strategies are implemented, we should expect the rise of STIs to continue.

Some diseases, such as stroke, arterial systemic hypertension, and type 2 diabetes mellitus, initially showed a decrease but were subsequently associated with an excess (table II). The increase in these diseases could be directly linked to the social changes (such as an increase in obesity, anxiety, depression, and a sedentary lifestyle) during the pandemic but also as a direct consequence of Covid-19 disease.²¹⁻²⁴

In fact, during 2022, it was estimated that the prevalence of pre-diabetes in Mexico was 22.1%, and diabetes was 18.3%. In the case of systemic arterial hypertension, the estimated prevalence in 2022 was 47.7%. Alarmingly, almost 44% of people with hypertension were unaware

that they had it. Therefore, we can also expect an increase in health costs after the Covid-19 pandemic.

The magnitude of epidemiological reporting in Mexico largely depends on the medical care provided in the public sector. During the first three years of the pandemic, it is estimated that 48.8% of medical care between 2020 and 2022 occurred in the private healthcare system. Significantly, 22.4% of care was provided through home consultations. Therefore, it is very likely that many of the diseases diagnosed in these consultations were not reported to the MoH. The main reasons for not seeking care within the social security healthcare system were access to services (71%), quality (21%), long wait times for appointments (19%), distance (18%), among others.²⁴

During the Covid-19 pandemic, the life expectancy declined at the global level.²⁵ This decline might not be entirely due to direct health impairments resulting from SARS-CoV-2 infection and/or long-lasting illness but also to lifestyle changes during the pandemic, disruption of healthcare systems, increases in metabolic and sexually transmitted diseases, and reduced or delayed diagnosis/treatment of nearly all diseases. The combination of delayed or missed diagnosis, reporting, and treatment may continue to further undermine life expectancy.

In summary, our results can be explained by several factors. The first is, in fact, a beneficial or positive outcome of the NPIs against Covid-19, in which the transmission of respiratory diseases and those with person-to-person transmission decreased or was cut off. A second explanation would be the decrease in primary healthcare consultations, laboratory tests, emergency room visits, and hospitalizations. A third could be the change in the epidemiological surveillance capacity generated by the massive effort in detecting SARS-CoV-2. Finally, we cannot exclude that changes in the epidemiological surveillance system may also be due to the lack of resilience and quality in the Mexican healthcare system, which failed at certain points during this health crisis.

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