Effect of Mexico's vaccination program on Covid-19 cases, hospitalizations, and deaths among older adults in Mexico City

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Abstract

Objective. To characterize the impact of Mexico's Covid-19 vaccination campaign of older adults. **Materials and methods.** We estimated the absolute change in symptomatic cases, hospitalizations and deaths for vaccine-eligible adults (aged >60 years) and the relative change compared to vaccine-ineligible groups since the campaign started. **Results.** By May 3, 2021, the odds of Covid-19 cases among adults over 60 compared to 50-59 year olds decreased by 60.3% (95%CI: 53.1, 66.9), and 2 003 cases (95%CI: 1 156, 3 130) were avoided. Hospitalizations and deaths showed similar trends. **Conclusions.** Covid-19 events decreased after vaccine rollout among those eligible for vaccination.

Keywords: Coronavirus infections; mass vaccination; impacts on health; Mexico

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Resumen

Objetivo. Caracterizar el impacto de la campaña de vacunación contra Covid-19 de México en adultos mayores. **Material y métodos.** Se estimó el cambio absoluto de casos sintomáticos, hospitalizaciones y muertes en personas elegibles (>60 años) para la vacunación y el cambio relativo comparado con grupos no elegibles. **Resultados.** El momio de casos en adultos mayores de 60 comparado con los de 50-59 disminuyó en 60.3% (IC95%: 53.1, 66.9) el 3 de mayo de 2021. Adicionalmente, 2 003 infecciones (IC95%: 1 156, 3 130) fueron evitadas. Hospitalizaciones y muertes muestran resultados similares. **Conclusiones.** Los eventos por Covid-19 disminuyeron después del inicio de la vacunación.

Palabras clave: Infecciones por coronavirus; vacunación masiva; impactos en la salud; México

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The Covid-19 pandemic has severely affected the wellbeing of many people worldwide. As of October 08, 2021, Mexico reported over 3.7 million infections and 282 227 deaths.[1] The Mexican vaccination campaign began for all citizens over 60 on February 15, 2021.[2] The multi-stage approach of the vaccination campaign by age groups allowed for comparisons with a pseudo-control sample, as vaccination eligibility expanded over time. However, the real-world effect of the vaccination campaign has yet to be formally quantified.

In this study, we researched the impact of the vaccination campaign in Mexico by comparing the trends in Covid-related symptomatic cases, hospitalizations, and deaths between the population over 60 to those of younger groups residing in Mexico City. We report the relative reduction in the proportion of cases among older adults and other age groups, which is a proxy for the effectiveness of the campaign, and the estimated absolute number of cases, hospitalizations**,** and deaths that were avoided after the campaign started. This study could provide evidence to help public health officials determine whether a similar vaccine campaign—multi-staged by age groups—can be effective.

Materials and methods

We conducted a retrospective study using public data from Mexico's Ministry of Health. The database contained de-identified daily confirmed cases of SARS-CoV-2 from all approved laboratories in the country since February 2020.[3] We studied the trends of confirmed cases, hospitalizations and deaths among the patients with a positive antigen or PCR test in Mexico City (June 1, 2020 to June 1, 2021). This allowed for a complete year of evidence and gave us sufficient time to observe the effect of vaccination on people over 60. We chose Mexico City because of its large healthcare network, which facilitates corroboration of suspected cases.

In order to estimate the relative impact of the vaccination campaign among different age groups, we compared proportional incidences from February 15, 2021 (start of the campaign for adults over 60) to May 3, 2021 (start of the campaign for 50-59 year olds). If the campaign had an effect, we would expect there to be a large reduction in the proportional incidence at a later point in time (until May 3, 2021) for adults over 60. We therefore compared the proportional incidences over time for adults over 60 to all other age groups, expecting a greater decrease (below 0) in the older adults. Finally, as there can be delays in reporting cases, we used a 7-day moving average of observed counts per day (listed by symptom onset date).

The absolute impact of the vaccination campaign on the daily counts of those over 60 was estimated by comparing their observed events with a prediction of their expected number of events had the vaccination intervention not occurred. Specifically, we predicted these Covid-19 events with a Bayesian structural time-series[4] using data prior to the vaccination campaign (with the 50-59 and 40-49 year-old groups as prediction covariates). More details regarding our analyses can be found in the supplementary material.[5]

Results

After the vaccination campaign started, the proportion of symptomatic cases, hospitalizations and deaths among adults over 60 visibly decreased (figure 1).[3] On May 3, 2021, when 83% of the eligible adults had been vaccinated with at least one dose,[6] the odds of confirmed cases, hospitalizations and deaths in adults over 60 with respect to those of 50-59 year olds had decreased by 60.3% (95%CI: 53.1, 66.9), 66.8% (95%CI: 52.0, 77.8) and 74.7% (95%CI: 56.7, 86.8), respectively. These proportions increased by June 1st, coinciding with the beginning of the vaccination campaign for 50-59 year olds.[5]

Among adults over 60, we also estimated a significant reduction in the absolute daily number of cases, hospitalizations and deaths, compared with the counterfactual expected counts if the intervention had not occurred (figure 2).[3] The Bayesian structural time-series model estimated that 2003 Covid-19 cases (95%CI: 1 157, 3 130), 519 hospitalizations (95%CI: 265, 1 668), and 374 deaths (95%CI: 110, 1 117) were avoided in Mexico City's adults over 60 between February 15 and May 3, 2021.[5]

Discussion

Our findings suggest that the Mexican vaccination campaign is associated with a strong reduction in Covid-19's burden among age groups that were eligible for vaccines. These findings represent indirect evidence of the effectiveness of Mexico City's vaccination campaign. Our results complement those observed in other countries that also followed a multi-stage vaccination campaign prioritizing older adults.[7,8]

Our estimates rely on Mexico's publicly-available dataset of Covid-19 cases, and as such, our study is limited to its quality, timeliness, completeness, and availability. To date, no study has formally evaluated the quality of the data in Mexico, although underreporting of cases is evident based on observed disparities between excess and reported deaths.[9] Nonetheless, this does not pose a significant threat to our study, as suggested by the constant proportion of Covid-19 cases across age groups before the vaccination campaign,

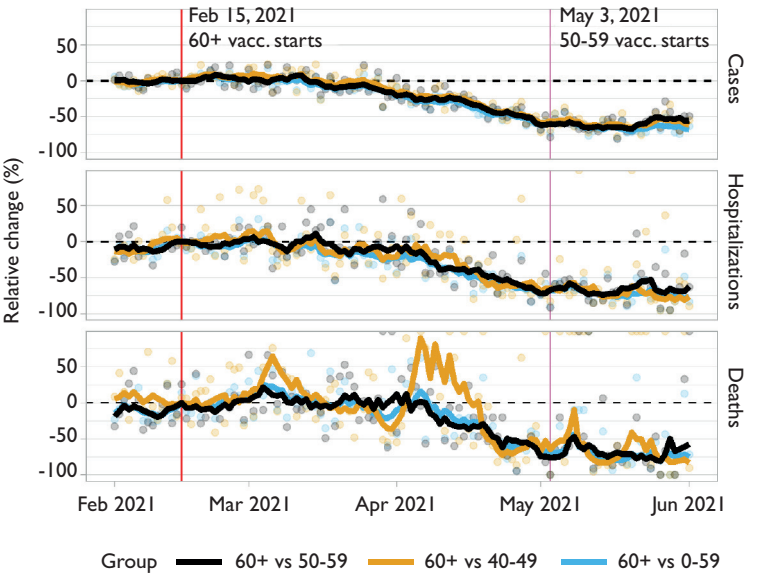

Figure 1. Estimated daily relative change in the proportion of symptomatic cases, hospitalizations and deaths in adults over 60 in Mexico City compared to other age groups, using February 15, 2021 (start of the vaccination campaign) as a baseline. Mexico, February-June 2021[3]

though it does lead to more variability in our Bayesian model. Additionally, these data rely on the country's diagnostic capabilities, which is why we selected Mexico City: so that we could focus on a population with considerable access to testing, in order to eliminate potential differences in case reporting.

Our analysis is also sensitive to the choices of comparison groups, reference dates, and modeling assumptions. We selected 50-59 year olds as an unvaccinated comparison group for adults over 60 because of their similarity in health status and risk behaviors during the pandemic, compared to other populations.[10-12] In order to select a reference date, we avoided times near the Christmas and New Year's festivities, as they were likely to reflect higher exposure rates and riskier behaviors than a typical week. Instead, we chose February 15, 2021, though the results did not change significantly when we used other February dates. Next, we defined our time period to be three months after vaccination rollout in order to allow ample time for a substantial portion of the eligible population to be vaccinated. Lastly, our analyses assume that, in absence of the vaccination campaign, the proportion of events across different age groups would be constant over time, which probably is a simplification. However, the model predictions for the pre-campaign period (figure 2) suggest that these proportions do not vary too much.

Our results are promising, as they indicate that vaccination has slowed down the rate of Covid-19 infection. This is essential in settings such as Mexico, where direct evidence of the vaccine strategy's effectiveness is limited. When introducing a new vaccine campaign strategy, we must consider the structure and strength of the health system while monitoring for feedback to constantly improve the public policy. Ideally, to obtain a more accurate assessment of the relationship between Covid-19 cases and vaccine uptake, a more robust study with disaggregated data, individual-level covariates, and reliable diagnostics should be conducted. Further research should also focus on access to the vaccine and equity outside of urban areas in Mexico, especially for populations with limited access to healthcare. Nevertheless, the strength of our results provides promising evidence that vaccination has contributed to a reduction in the severity of the Covid-19 pandemic in Mexico City, and reflects the importance of prioritizing public health interventions when capacities are limited due to logistical or economic constraints.

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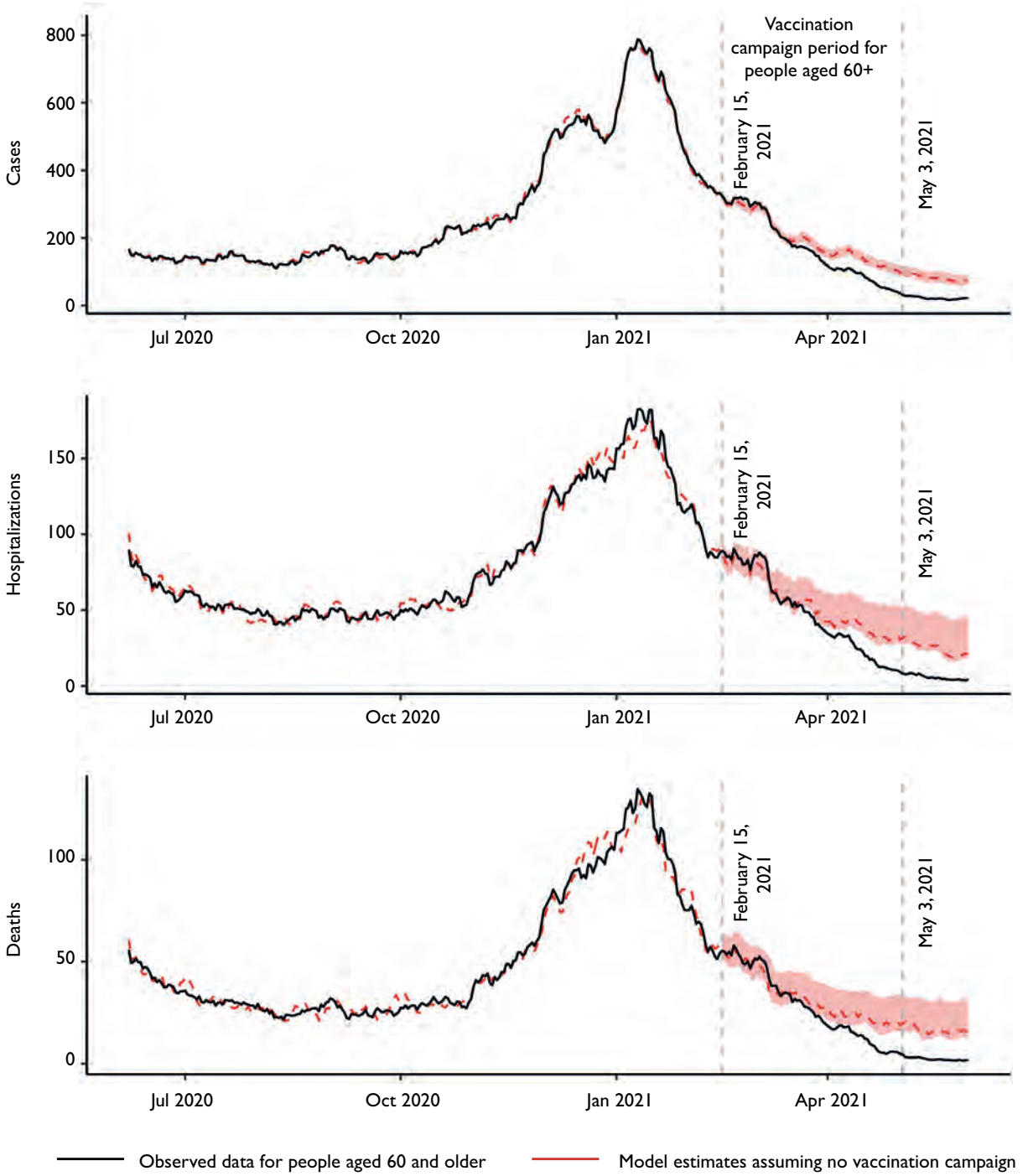

FIGURE 2. DAILY NUMBER OF COVID-19 CASES, HOSPITALIZATIONS AND DEATHS (7-DAY ROLLING MEAN). THE SYNTHETIC CONTROL SHOWS THE MODEL FIT PRIOR TO FEBRUARY 15, 2021 AND THE MODEL'S PREDICTION AFTERWARDS. THE SHADED REGION IS THE 95% CONFIDENCE INTERVAL FROM THE BOOTSTRAPPED MODEL PREDICTIONS. MEXICO, JUNE 2020-JUNE 2021[3]

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Declaration of conflict of interests. The authors declare that they have no conflict of interests.

References

1. Secretaría de Salud. Informe Técnico Diario COVID-19 MÉXICO. Mexico City: Secretaría de Salud, 2021 [cited October 15 2021]. Available from: https://www.gob.mx/cms/uploads/attachment/file/674505/Comunicado_Tecnico_Diario_COVID-19_2021.10.15.pdf
2. Barrientos-Gutiérrez T, Alpuche-Aranda CM, Bautista-Arredondo S. Preguntas y respuestas sobre la estrategia de vacunación contra Covid-19 en México. Salud Publica Mex. 2021;63(2):167-9 [cited October 15 2021]. Available from: https://saludpublica.mx/index.php/spm/article/view/12511/12064
3. Secretaría de Salud. Datos abiertos COVID-19. Mexico City: Secretaría de Salud [cited September 1 2021]. Available from: http://datosabiertos.salud.gob.mx/gobmx/salud/datos_abiertos/historicos/2021/09/datos_abiertos_covid19_01.09.2021.zip
4. Brodersen KH, Gallusser F, Koehler J, Remy N, Scott SL. Inferring causal impact using Bayesian structural time-series models. Annals of Applied Statistics. 2015;9(1):247-74. https://doi.org/10.1214/14-AOAS788
5. Gasca N, Reyes-Garza J, Lozano-Esparza S, Orozco del Pino P, Olivas-Martinez A, Ulloa-Pérez E, *et al*. Supplemental material: Quantifying the effect of Mexico's vaccination program on COVID-19 cases, hospitalizations, and deaths among older adults in Mexico City. Figshare 2022.. https://doi.org/10.6084/m9.figshare.19149575.v1
6. Secretaría de Salud. COVID-19 En La Ciudad de México. Mexico City: Secretaría de Salud [September 1 2021]. Available from: https://covid19.cdmx.gob.mx/
7. Haas EJ, Angulo FJ, McLaughlin JM, Anis E, Singer SH, Khan F, *et al*. Impact and effectiveness of mRNA BNT162b2 vaccine against SARS-CoV-2 infections and COVID-19 cases, hospitalizations, and deaths following a nationwide vaccination campaign in Israel: an observational study using national surveillance data. The Lancet. 2021;397(10287):1819-29. https://doi.org/10.1016/S0140-6736(21)00947-8
8. Ferres JML, Richardson BA, Weeks WB. Association of COVID-19 vaccination prioritization and hospitalization among older Washingtonians. J Am Geriatr Soc. 2021;69(10):2780-82. https://doi.org/10.1111/jgs.17315
9. Wang H. Estimation of total mortality due to COVID-19. Seattle: Institute for Health Metrics and Evaluation, 2021 [cited June 29 2021]. Available from: http://www.healthdata.org/special-analysis/estimation-excess-mortality-due-covid-19-and-scalars-reported-covid-19-deaths
10. Pasion R, Paiva TO, Fernandes C, Barbosa F. The AGE effect on protective behaviors during the COVID-19 outbreak: sociodemographic, perceptions and psychological accounts. Front Psychol. 2020;11:561785. https://doi.org/10.3389/fpsyg.2020.561785
11. Hutchins HJ, Wolff B, Leeb R, Ko JY, Odom E, Willey J, *et al.* COVID-19 Mitigation behaviors by age group — United States, April–June 2020. MMWR Morb Mortal Wkly Rep. 2020;69:1584-90. https://doi.org/10.15585/mmwr.mm6943e4
12. Kim JK, Crimmins EM. How does age affect personal and social reactions to COVID-19: Results from the national Understanding America Study. PLoS One. 2020;15(11): e0241950. https://doi.org/10.1371/journal.pone.0241950