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Excess Mortality in Türkiye during 2020-2022: Regional and Time-Based Analysis

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Background: The coronavirus disease-2019 (COVID-19) pandemic significantly impacted global mortality, albeit Türkiye has been largely excluded from mortality studies owing to delayed data release and a lack of nationwide analyses.

Aims: To identify the excess mortality rates in Türkiye between 2020 and 2022, analyze the temporal trends and regional differences, and determine factors associated with excess deaths at the regional level.

Study Design: A cross-sectional ecological analysis.

Methods: We analyzed all-cause mortality data from the Turkish Statistical Institute from January 2015 to December 2022. The projected deaths during 2020-2022 were derived from Quasi-Poisson Regression models applied to the 2015-2019 provincial mortality data, adjusting for seasonal trends, population offsets, and overdispersion. The results were aggregated to national and socioeconomic levels for comparative analyses. Excess deaths were calculated as the difference between observed and projected deaths. P-scores and excess mortality per 100,000 inhabitants were utilized as standardized metrics. Socioeconomic disparities were examined using the Socioeconomic Development Ranking of Provinces and Regions (SEGE-2017). We assessed the associations between excess mortality and vaccination coverage, elderly population ratio, intensive care unit beds per 100,000 population, and population per family physician.

Results: Türkiye experienced 247,640 excess deaths [95% confidence interval (CI): 176,405-315,204] from 2020 to 2022. Excess mortality peaked in 2021 with 121,426 excess deaths (27.2% P-score, 143.5 per 100,000 population). Lower vaccination coverage [estimate: -0.51, 95% CI: (-0.81, -0.20), $p = 0.001$] and higher population per family physician [estimate: 0.01, 95% CI: (0.00, 0.02), $p = 0.005$] were significantly associated with higher excess mortality. A higher elderly population ratio was positively associated with excess deaths [estimate: 1.41, 95% CI: (0.50, 2.32), $p = 0.003$]. Socioeconomically less developed regions (SEGE 5 and SEGE 6) exhibited higher P-scores (21.3% and 20.2%, respectively), indicating greater relative increases in mortality when compared with the relatively more developed regions.

Conclusion: Excess mortality in Türkiye during the COVID-19 pandemic was substantial, particularly in 2021, and was influenced by regional socioeconomic disparities, vaccination coverage, and healthcare access. These findings underscore the importance of addressing sociodemographic factors and strengthening primary healthcare services in pandemic responses.

INTRODUCTION

The coronavirus disease-2019 (COVID-19) pandemic has significantly impacted global mortality, both through direct deaths induced by the virus and indirect effects such as the overwhelmed healthcare systems and socioeconomic disruptions.[1,2] Excess mortality-the number of deaths exceeding the expected levels based on historical trends-is a critical metric for assessing the pandemic's total impact, encompassing deaths directly attributable to COVID-19 and those resulting from factors such as delayed medical care and exacerbated chronic conditions.[3,4]

The Turkish Statistical Institute (TURKSTAT) delayed the release of death data for 2020 and 2021 until February 2023 and for 2022 until June 2023.[5-7] Therefore, Türkiye has been excluded from most of the excess mortality calculation studies. In addition, excess mortality studies conducted by organizations such as Our World in Data and the Economist lack the required in-depth analyses necessary to capture the unique dynamics of the Turkish population. Previous studies in Türkiye have estimated excess mortality using only local data, with a focus on provinces such as İstanbul, Bursa, and Malatya.[8-12] Although these studies provide valuable insights, they do not offer a nationwide perspective on excess mortality nor adequately account for key demographics and healthcare-related factors or regional

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disparities. Furthermore, attributing all of the excess deaths solely to undiagnosed COVID-19 oversimplifies the complex factors contributing to increased mortality rates.[13]

International analyses emphasize that excess deaths arise from both direct COVID-19 infections and indirect effects such as healthcare disruptions and socioeconomic stress.[14,15] Factors influencing excess mortality include healthcare capacity, demographic characteristics, socioeconomic status, comorbidities, urbanization, and access to primary care services.[16] A comprehensive understanding of regional and country-specific determinants is therefore essential for formulating effective public health strategies.

In this study, we attempted to identify the excess mortality rates in Türkiye between 2020 and 2022, analyze the temporal trends and regional differences, and determine the factors associated with excess deaths at the regional level.

MATERIALS AND METHODS

Study design and data sources

This cross-sectional ecological study analyzed mortality data from Türkiye from January 2015 to December 2022. Mortality data were obtained from TURKSTAT, which provides monthly death counts for each province.[5-7] This analysis assessed excess mortality during the first 3 years of the COVID-19 pandemic (i.e., 2020-2022) by comparing the observed deaths with projected deaths based on historical trends from 2015 to 2019.

Considering the limitations in the cause-of-death data and the potential under-reporting of COVID-19 deaths, we analyzed all-cause mortality to capture the pandemic's total impact, including the direct and indirect effects. The application of all-cause mortality is a widely recognized methodological approach in epidemiological studies, particularly in contexts where specific cause-of-death information is either unreliable or incomplete.[17] All data are publicly available and aggregated at the provincial level, thereby ensuring that no individual-level data are involved.

The socioeconomic development indicator

To examine the impact of regional socioeconomic disparities on excess mortality, Türkiye's 81 provinces were classified with reference to the Socioeconomic Development Ranking of Provinces and Regions (SEGE-2017);[18] the relevant geographic distribution is illustrated in Figure 1. Developed by the Ministry of Industry and Technology, SEGE-2017-the latest available classification-employs Principal Component Analysis to assign provinces to six development grades, with grade 1 indicating the highest and grade 6 indicating the lowest level of development. The index encompasses 52 variables across demographics, education, health, employment, and economic domains, including per capita income, unemployment and literacy rates, hospital bed availability, and access to essential services. Detailed methodologies and indicators are provided in the SEGE-2017 report.[18]

Vaccination data

COVID-19 vaccination data were obtained from the TURCOVID-19 website, which archives data initially published by the Turkish Ministry of Health.[19] The data included the number of individuals vaccinated at the provincial level from January 25, 2021, to September 13, 2021, after which the provincial-level vaccination data were no longer made publicly available. We analyzed the coverage of at least two vaccine doses as of September 13, 2021, to assess its potential association with excess mortality across regions.

Other health metrics

Data for the elderly population ratio, intensive care unit (ICU) beds per 100,000 population, and population per family physician were

FIG. 1. Geographic distribution of the SEGE categories.
SEGE, Socioeconomic Development Ranking of Provinces and Regions.

obtained from the Health Statistics Yearbook 2021, as published by the Turkish Ministry of Health.[20] Although newer data are now available for these variables, 2021 data were used because the latest vaccination data were from September 13, 2021. This alignment is essential for accurately assessing the pandemic's impact, considering that vaccination rates significantly affect mortality and healthcare strain. We assumed that these variables remained relatively stable throughout 2021, based on national trends indicating minimal annual fluctuations. Wherever feasible, interim estimates and reports were consulted to corroborate the stability of these variables during the study period. The elderly population ratio represents the proportion of residents aged ≥ 65 years in each of Türkiye's 81 provinces. ICU beds per 100,000 population indicate the number of ICU beds available per 100,000 inhabitants for each province in 2021. Population per family physician denotes the number of individuals assigned to each family physician in every province as of 2021.

Ethical considerations

No ethical approval was required as this study utilized publicly available, aggregated data. We adhered to ethical data handling and reporting principles, thereby ensuring transparency and accuracy in our analyses.

Statistical analysis

- Projected death estimation

To estimate the projected number of deaths for 2020-2022, we applied the mortality data from January 2015 to December 2019, aligning with methodologies commonly employed in the literature.[2,21-25] We conducted separate Quasi-Poisson Regression analyses for each of Türkiye's 81 provinces using the R package "excessmort" to account for the overdispersion in mortality counts (i.e., when the variance exceeds the mean).[26,27] Each provincial model incorporated seasonal variations and adjusted for the annual population figures via an offset term. The detailed model formulation and parameter estimates for each province are provided in the Supplementary Tables 1, 2, and the confidence interval (CI) was computed using robust standard errors. The monthly projected death counts derived from these analyses were aggregated to produce national-level estimates and the estimates were stratified by SEGE categories for monthly and yearly comparative analysis. This approach facilitated the prediction of projected deaths from 2020 to 2022.

- Excess mortality calculation

Excess deaths were calculated by subtracting the number of projected deaths from the number of observed deaths for each month and province, as follows:

$$Number\ of\ Excess\ Deaths = Observed\ Deaths - Projected\ Deaths$$

Our analysis involved positive and negative excess deaths to capture the full spectrum of mortality changes. We believe that specific public health measures during the pandemic may have led to reductions in specific types of mortality (e.g., decreased traffic accidents due to lockdowns) and that negative excess deaths provide a comprehensive understanding of mortality trends.[28]

- P-score calculation

The P-score, representing the percentage difference between observed and projected deaths in a specific period, was calculated as follows:

$$P-score\ (\%) = \left(\frac{Number\ of\ Excess\ Deaths}{Projected\ Deaths}\right) \times 100$$

TABLE 1. National-Level Summary of Mortality Statistics (2020-2022).

Year	Observed deaths	Projected deaths	Excess deaths (95% CI)	P-score (%), (95% CI)	Excess deaths per 100,000
2020	509,048	439,074	69,973 (50,108; 88,977)	15.9 (11.4; 20.2)	83.9
2021	566,485	445,058	121,426 (97,797; 143,862)	27.2 (21.9; 32.3)	143.5
2022	504,839	448,598	56,241 (28,500; 82,365)	12.5 (6.3; 18.3)	65.9

CI, confidence interval.

TABLE 2. Summary of Mortality Statistics Categorized by SEGE-2017 (2020-2022).

Grade	Number of provinces	Median age*	Population	Observed deaths	Projected deaths	Excess deaths (95% CI)	P-score (%) (95% CI)	Excess deaths per 100,000
SEGE 1	9	34.0	36,138,533	627,741	531,790	95,951 (67,993;122,493)	18.0 (12.8;23.0)	87.1
SEGE 2	15	35.4	12,369,559	296,405	251,737	44,668 (30,528;58,046)	17.7 (12.1;23.1)	119.0
SEGE 3	13	32.9	11,474,689	235,597	199,548	36,049 (24,008;47,394)	18.1 (12.0;23.8)	103.9
SEGE 4	14	33.5	7,242,160	164,255	137,123	27,132 (19,202;34,621)	19.8 (14.0;25.2)	124.3
SEGE 5	14	33.2	5,922,881	135,641	111,813	23,828 (17,017;30,241)	21.3 (15.2;27.0)	133.6
SEGE 6	16	23.0	10,466,540	120,733	100,432	20,301 (14,317;25,943)	20.2 (14.3;25.8)	64.5

*Median age and population for 2020. CI, confidence interval.

This metric standardizes excess mortality, thereby facilitating comparisons across regions and periods.

- Excess mortality per 100,000 inhabitants

To provide a population-standardized measure, we calculated the excess mortality rates per 100,000 inhabitants using TURKSTAT's population data for each province and year:

$$Excess\ Mortality\ per\ 100{,}000\ Inhabitants = \frac{Number\ of\ Excess\ Deaths}{Population} \times 100000$$

- Univariate and multivariate regression analysis

To identify factors associated with P-scores, we initially conducted a correlation analysis and performed univariate linear regression for each predictor. Subsequently, a multivariate linear regression model was constructed, including the Elderly Population Ratio, Vaccination Coverage, Population per Family Physician, and ICU Beds per 100,000 population. These predictors were selected based on their relevance in the literature, correlation parameters, final model performance, and Variance Inflation Factor (VIF) assessments. In addition, alternative models incorporating the SEGE variables were evaluated. Multicollinearity was assessed using VIF scores, which all remained below the threshold of 5, as such confirming the absence of significant collinearity among the predictors.

Before the model fitting, diagnostic tests-including QQ-plots and the Shapiro-Wilk test (Supplementary Figure 1)-were conducted to assess the normality of the P-score residuals (considering the theoretical bounds of -100% and ∞). These results indicated that the residuals did not significantly deviate from normality, which justifies the application of a linear regression framework. Furthermore, sensitivity analyses employing both a log transformation and generalized linear modeling were performed to confirm the robustness of the findings; the corresponding results are provided in the Supplementary Tables 3-5.

All statistical analyses were conducted using R software (version 4.2.1).[29] Statistical significance was assessed at a significance level of 0.05, and CI was calculated wherever appropriate.

RESULTS

Table 1 presents the national-level annual calculations of excess mortality in Türkiye from 2020 to 2022 when compared to historical projections. From 2020 to 2022, Türkiye experienced significant excess mortality when compared to historical projections. In 2020, deaths exceeded projections by 69,973 (15.9% P-score, 83.9 per 100,000). This value peaked in 2021 with 121,426 excess deaths (27.2% P-score, 143.5 per 100,000). In 2022, excess deaths declined to 56,241 (12.5% P-score, 65.9 per 100,000).

The temporal analysis revealed that excess mortality peaked in 2021, marking a 73.5% increase compared with that in 2020. Subsequently, excess deaths and P-scores decreased by more than half in 2022 although the mortality rates remained elevated relative to the projections. Standardized excess deaths per 100,000 population followed a similar trend, increasing from 83.9 in 2020 to 143.5 in 2021 and decreasing to 65.9 in 2022. All excess death estimates and P-scores were statistically significant, as their 95% CI did not include zero.

The monthly mortality analysis (Figure 2) from January 2020 to December 2022 revealed significant fluctuations in excess deaths and P-scores. In 2020, excess mortality remained stable until August, peaking at 21,758 in November and December. In 2021, excess deaths declined, starting in February with intensive vaccination for healthcare workers and older adults, rose again in April and May, and decreased in June and July following the general population vaccination launch. Between August 2021 and February 2022, the monthly excess deaths ranged from 12,153 to 17,556, totaling 102,673. Despite a slight increase in July and August 2022, excess mortality stabilized for the remainder of the year.

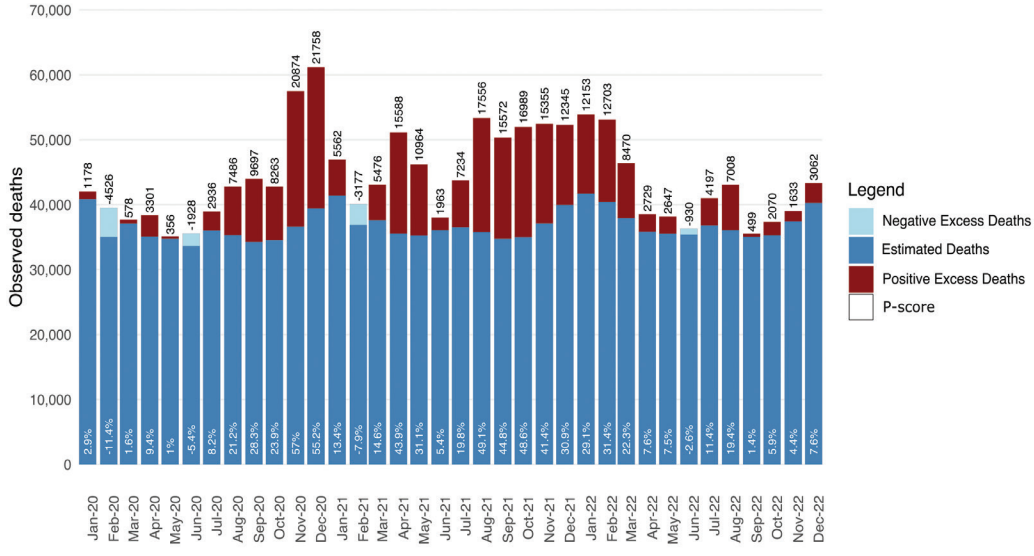

FIG. 2. Monthly observed and projected deaths in Türkiye (2020-2022).

Excess mortality varied across Türkiye's socioeconomic regions (Table 2). The increment was 18.0% (95,951 excess deaths) for SEGE 1, 17.7% (44,668) for SEGE 2, 18.1% (36,049) for SEGE 3, 19.8% (27,132) for SEGE 4, 21.3% (23,828) for SEGE 5, and 20.2% (20,301) for SEGE 6. While SEGE 1 had the highest absolute excess deaths, SEGE 5 and SEGE 6 had higher P-scores, indicating more significant relative increases. Excess deaths per 100,000 population were highest in SEGE 5 (133.6), followed by SEGE 4 (124.3), SEGE 2 (119.0), SEGE 3 (103.9), SEGE 1 (87.1), and SEGE 6 (64.5).

Figure 3 depicts the P-scores for Türkiye's six SEGE categories from 2020 to 2022. In 2020, SEGE 6 had the highest P-score (24.0%), followed by SEGE 4 (19.2%) and SEGE 5 (16.7%), while the score for the developed regions (SEGE 1-3) ranged from 10% to 15%. In 2021, the P-scores rose in all regions, peaking at SEGE 5 (32.1%) and SEGE 6 (29.6%). By 2022, the P-scores declined to 10-15% for SEGE 1-5 and 6.9% for SEGE 6. The relatively less developed regions (SEGE 4-6) consistently showed higher P-scores, especially in 2021.

Provincial univariate regression analyses identified factors associated with excess mortality (Figure 4). Vaccine coverage (%) was significantly negatively associated with P-scores ($p = 0.033$), indicating that the higher vaccination rates reduced excess mortality. Conversely, the population per family physician was positively associated ($p = 0.002$), indicating that more people per physician increased excess mortality. The elderly population ratio and ICU beds per 100,000 revealed no significant associations ($p = 0.225$ and $p = 0.206$). In addition, SEGE 6 had fewer elderly populations, vaccine coverage, and ICU beds per 100,000 population.

In the multivariate analysis (as detailed in Table 3), lower vaccination coverage was significantly associated with higher P-scores [estimate: -0.51, 95% CI: (-0.81, -0.20), $p = 0.001$]. Conversely, a higher elderly population ratio was positively linked [estimate: 1.41, 95% CI: (0.50, 2.32), $p = 0.003$]. Population per family physician showed a significant positive association [estimate: 0.01, 95% CI: (0.00, 0.02), $p = 0.005$]. ICU beds per 100,000 population were not significantly related [estimate: 0.90, 95% CI: (-0.08, 1.87), $p = 0.070$]. The model explained 17.6% of the variability in the P-scores ($R^2 = 0.176$, adjusted $R^2 = 0.133$) with an AIC of 555.2. All VIF values were < 5.

Incorporating the SEGE-2017 score resulted in high-VIFs or required the exclusion of correlated predictors, which diminished the model performance. Furthermore, the univariate analysis of the numeric SEGE-2017 with P-scores (2021) was not significant ($p = 0.355$). Consequently, the models integrating the SEGE-2017 score are provided in the (Supplementary Tables 6-8).

DISCUSSION

Our study provides valuable insight into excess deaths in Türkiye between 2020 and 2022. Over 3 years, 247,640 (95% CI: 176,405-315,204) excess deaths were identified. The year 2021 had the highest excess mortality, with a P-score of 27.2% and 121,426 (95% CI: 97,797-143,862) excess deaths, making it the year with the most significant excess mortality within the 3 years of COVID-19.

Several potential explanations underlie the excess deaths identified in this study, including limited access to healthcare services, overcrowded emergency departments, and strained ICU capacities. A study conducted in Istanbul observed an increase in unmet healthcare needs from 9.2% in 2019 to 14.6% in 2021.[30] Nationwide, emergency department diagnoses significantly decreased from April to June 2020 and remained low until late 2021, although we noted a rise in emergency visits in late 2021 alongside high excess mortality.[31]

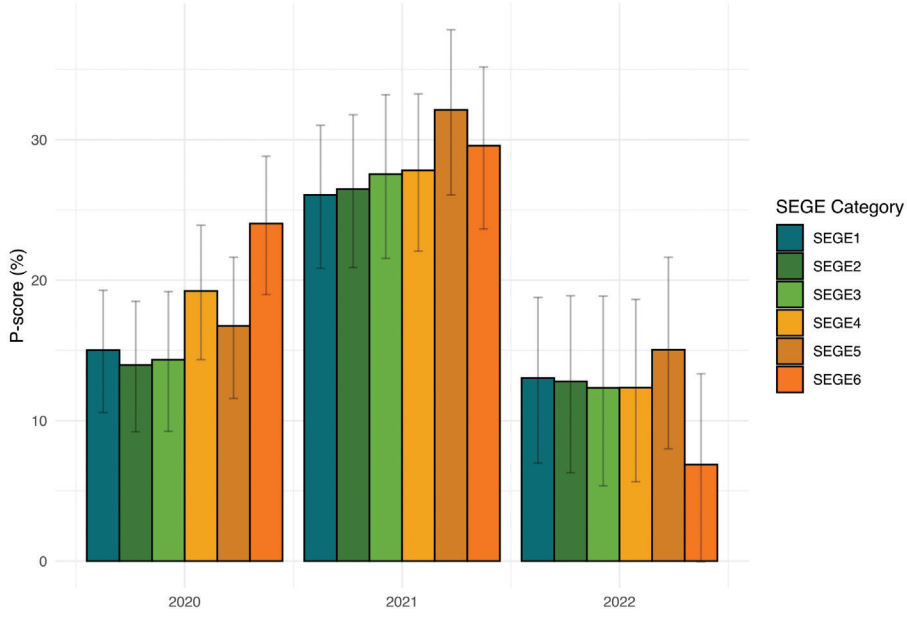

FIG. 3. P-scores categorized by year and SEGE-2017 (2020-2022).
SEGE, Socioeconomic Development Ranking of Provinces and Regions.

From October 2020 to June 2021, the ICU occupancy rates ranged between 60% and 70% every week.[32] During November and December 2020, when excess deaths peaked, monthly ICU occupancy reached 70%, whereas it decreased to approximately 60% in January and February 2021, correlating with reduced excess deaths. This pattern suggests a relationship between ICU strain and mortality, which aligns with Italy's observation that healthcare infrastructure "Beds Per Capita" influenced the regional outcomes during high-occupancy periods.[33]

According to TURKSTAT, COVID-19-related deaths were 22,274 in 2020, 65,366 in 2021, and 22,054 in 2022, indicating that excess deaths cannot be solely attributed to COVID-19. Post-pandemic deaths from septicemia, respiratory diseases, diabetes, and circulatory diseases increased by approximately 20%, 40%, 20%, and 12%, respectively. In addition, cases of deaths from unknown causes increased from 18,134 in 2019 to 28,935 in 2022.

Türkiye's digital death and cause-of-death reporting system, which is exclusively used by authorized physicians, may have omitted COVID-19 diagnoses during high hospital occupancy periods. The non-hospital deaths were reported by municipal or primary care physicians, who also handled high-demand tasks such as contact tracing and medication distribution, which could have potentially led to the omission of COVID-19 ICD codes. Although COVID-19 testing rates were adequate, with daily tests exceeding 100,000 in August 2020 and 300,000 by August 2021,[34] the lack of regional data limited our ability to examine disparities in testing and diagnosis.

Our monthly analysis revealed that excess deaths in Türkiye peaked in November and December 2020, which is later than the March-April peaks observed in most European countries. This delayed surge may be attributed to the initial lockdown measures, remote learning implementation, and gradual relaxation of restrictions starting in June 2020, which led to a peak when schools reopened in August. In early 2021, excess deaths decreased with ongoing preventive measures and the rollout of vaccines for those aged over 65 years. However, the emergence of the Delta variant in August 2021 caused a surge in excess deaths until February 2022. The introduction of the Omicron variant in December 2021 further impacted the mortality

TABLE 3. Multivariate Regression Analysis of Factors Associated with P-scores (2021).

Predictors	Univariate β (95% CI)	Multivariate β (95% CI)	*p* value	VIF
Elderly population ratio	–0.38 (–0.99-0.24)	1.41 (0.50-2.32)	**0.003**	4.91
Vaccination coverage	–0.33 (–0.62–-0.03)	–0.51 (–0.81–-0.20)	**0.001**	4.67
Population per family physician	0.02 (0.01-0.03)	0.01 (0.00-0.02)	**0.005**	1.18
ICU beds per 100,000 population	0.70 (–0.39-1.80)	0.90 (–0.08-1.87)	0.070	1.04

β, regression coefficient; CI, confidence interval; ICU, intensive care unit; Model Summary, $R^2 = 0.176$, Adjusted $R^2 = 0.133$, AIC, 555.2; VIF, Variance Inflation Factor.

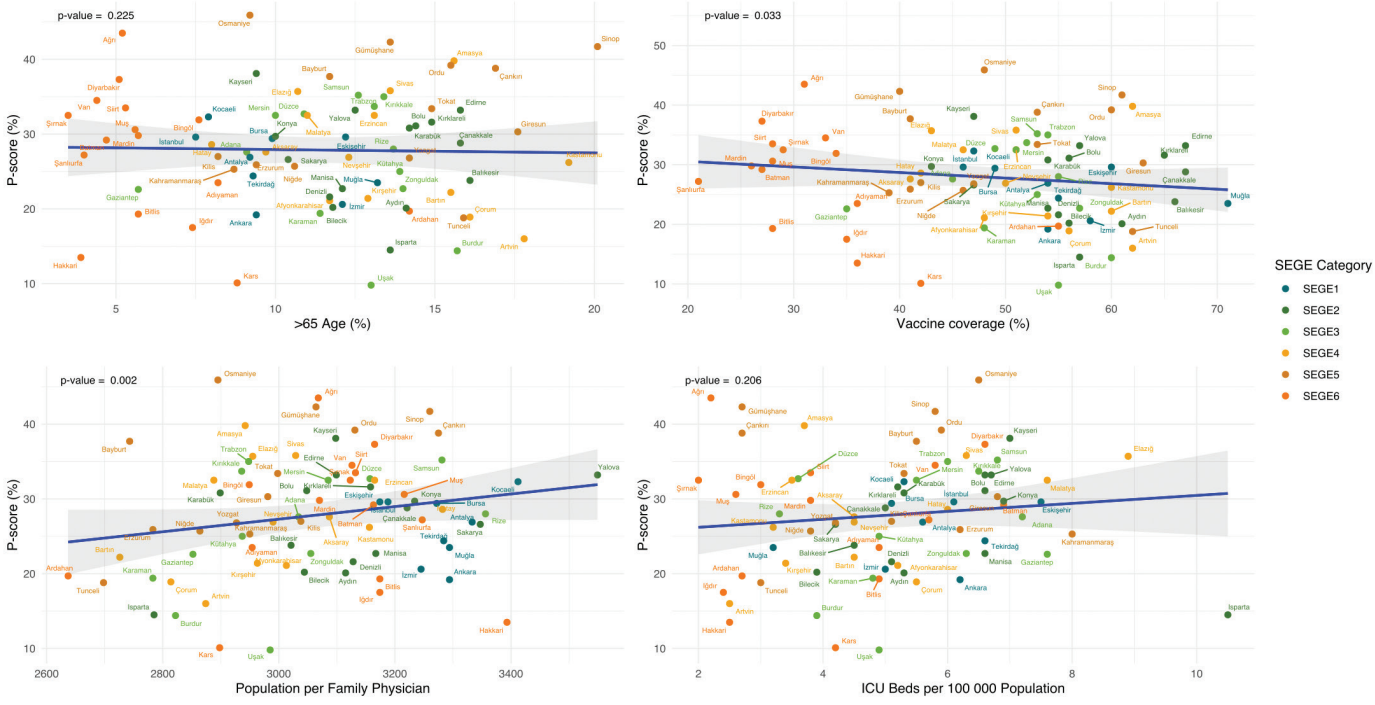

FIG. 4. Univariate regression analysis of factors associated with P-scores (2021).

trends.[35] Excess deaths declined after February 2022, possibly due to the milder variants, increased vaccination coverage, and improved treatment protocols.

Our study revealed significant variations in excess mortality across Türkiye's socioeconomic regions. SEGE 1 and SEGE 2, with the highest absolute excess deaths (95,951 and 44,668), had the lowest P-scores (18.0% and 17.7%). Conversely, the lower socioeconomic regions SEGE 5 and SEGE 6 exhibited higher P-scores (21.3% and 20.2%). Excess deaths per 100,000 aligned with SEGE categories and median age. Major cities (SEGE 1 and SEGE 2) implemented stricter lockdowns, potentially reducing the excess mortality rate. SEGE 6, overlapping with the Southeast, faced higher P-scores due to crowded households, economic challenges, limited healthcare access, and ineffective lockdown measures for the elderly.

In our multivariate analyses, the lower vaccination coverage, higher population per family physician, and higher elderly population ratio were significantly associated with higher P-scores. These findings align with the existing literature, emphasizing the importance of vaccination and primary healthcare services toward reducing excess mortality.[36-38] Higher population-to-physician ratios may reduce primary care effectiveness, contributing to increased mortality. Our study findings show that regions with more numbers of elderly people had higher excess mortality, which is significant in multivariate, but not univariate analyses. Although prior studies[33] report temporal variability-positive associations during the early pandemic phases and negative correlations in the later periods (context-dependent on vaccination prioritization and systemic factors)-our results align with findings emphasizing elderly-focused healthcare prioritization.[39,40] Spanning 2021, when the elderly populations were prioritized for vaccination, our analysis underscores the necessity of targeted resource allocation in high-risk regions during pandemics. The number of ICU beds per 100,000 population was not significantly associated with excess mortality, which is consistent with the findings from a similar study in Peru.[41] The clustering of ICU beds in major cities may have limited the effectiveness of the regional analyses. This study has several limitations. Excess mortality calculations depend heavily on the chosen methodology, and while various methods exist, the present approach may offer merits over alternatives such as time series analyses.[42] The absence of age-standardized data across provinces due to the incomplete TURKSTAT data is another limitation. SEGE categories, based on variables not directly linked to health or pandemic dynamics, may not reflect the regional shifts since the SEGE-2017 classification. Although Türkiye maintains rigorous death records, some late-presenting or untested cases (e.g., at-home deaths) may have led to under-reporting of COVID-19. Furthermore, our multivariate analyses may not fully capture the pandemic dynamics due to the partial vaccination data and missing variables like lockdown policies and healthcare strain. The model's low R^2 (0.176) reflects inherent heterogeneity in ecological analyses, although our aim focused on predictor relationships and not comprehensive prediction.

In Türkiye, an additional 247,640 deaths were observed during the pandemic period, reflecting trends similar to the global patterns and potentially involving inaccuracies in the cause-of-death recording. Our study highlights the importance of considering sociodemographic disparities in pandemic responses and confirms the critical role of vaccinations and primary preventive healthcare services.

Ethics Committee Approval: Not applicable.

Informed Consent: Not applicable.

Data Sharing Statement: The datasets analyzed during the current study are available from the corresponding author upon reasonable request.

Authorship Contributions: Concept- S.K., G.E.; Design- S.K., G.E.; Supervision- G.E.; Materials- S.K.; Data Collection or Processing- S.K., G.E.; Analysis or Interpretation- S.K., G.E.; Literature Search- S.K.; Writing- S.K.; Critical Review- G.E.

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REFERENCES

1. Msemburi W, Karlinsky A, Knutson V, Aleshin-Guendel S, Chatterji S, Wakefield J. The WHO estimates of excess mortality associated with the COVID-19 pandemic. *Nature*. 2023;613:130-137. [CrossRef]
2. Weinberger DM, Chen J, Cohen T, et al. Estimation of excess deaths associated with the COVID-19 pandemic in the United States, March to May 2020. *JAMA Intern Med*. 2020;180:1336-1344. [CrossRef]
3. Islam N, Shkolnikov VM, Acosta RJ, et al. Excess deaths associated with covid-19 pandemic in 2020: age and sex disaggregated time series analysis in 29 high income countries. *BMJ*. 2021;373:n1137. [CrossRef]
4. Aburto JM, Schöley J, Kashnitsky I, et al. Quantifying impacts of the COVID-19 pandemic through life-expectancy losses: a population-level study of 29 countries. *Int J Epidemiol*. 2022;51:63-74. [CrossRef]
5. TURKSTAT. Death and Causes of Death Statistics 2020 [Internet]. Death and Causes of Death Statistics; 2023. [CrossRef]
6. TURKSTAT. Death and Causes of Death Statistics 2021 [Internet]. Death and Causes of Death Statistics; 2023. [CrossRef]
7. TURKSTAT. Death and Causes of Death Statistics 2022 [Internet]. Death and Causes of Death Statistics; 2023. [CrossRef]
8. Musellim B, Kul S, Ay P, et al. Excess mortality during COVID-19 pandemic in İstanbul. *Turk Thorac J*. 2021;22:137-141. [CrossRef]
9. Yardim M, Eser S. The COVID-19 pandemic and excess mortality: the İstanbul case study. *Turk J Public Health*. 2020;18:14-24. [CrossRef]
10. Ucar A, Arslan S. Estimation of excess deaths associated with the COVID-19 pandemic in İstanbul, Turkey. *Front Public Health*. 2022;10:888123. [CrossRef]
11. Pala K, Yürekli N, Çağaç NK, Türkkan A. All-cause excess mortality in 2020: the example of Bursa city in Turkey. *Infect Dis Clin Microbiol*. 2021;3:110-119. [CrossRef]
12. Aytemur ZA, Yalçınsoy M, Arslan AK, Hacıevliyagil SS. Excess deaths in Malatya in the COVID-19 pandemic. *Turk Thorac J*. 2021;22:473-476. [CrossRef]
13. Kelly G, Petti S, Noah N. COVID-19, non-COVID-19 and excess mortality rates not comparable across countries. *Epidemiol Infect*. 2021;149:e176. [CrossRef]
14. Kontis V, Bennett JE, Parks RM, et al. Lessons learned and lessons missed: impact of the coronavirus disease 2019 (COVID-19) pandemic on all-cause mortality in 40 industrialised countries and US states prior to mass vaccination. *Wellcome Open Res*. 2022;6:279. [CrossRef]
15. Woolf SH, Chapman DA, Sabo RT, Weinberger DM, Hill L. Excess deaths from COVID-19 and other causes, March-April 2020. *JAMA*. 2020;324:510-513. [CrossRef]
16. Baqui P, Bica I, Marra V, Ercole A, van der Schaar M. Ethnic and regional variations in hospital mortality from COVID-19 in Brazil: a cross-sectional observational study. *Lancet Glob Health*. 2020;8:e1018-1026. [CrossRef]
17. COVID-19 Excess Mortality Collaborators. Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020-21. *Lancet*. 2022;399:1513-1536. [CrossRef]

18. Acar S, Bilen Kazancık L, Meydan MC, Işık M. Socio-economic development ranking research (SEGE) 2017 [Internet]. Ankara: T.C. Sanayi ve Teknoloji Bakanlığı; 2019 [cited 2023 Apr 9]. [CrossRef]
19. Uçar A, Arslan Ş, Manap H, et al. An interactive web based dashboard for Covid-19 pandemic in real-time monitorization in Turkey: TURCOVID19. *Anatol Clin J Med Sci.* 2020;25:154-155. [CrossRef]
20. Republic of Türkiye Ministry of Health. General Directorate of Health Information Systems. Health Statistics Yearbook 2021 [Internet]. Ankara; 2023. [CrossRef]
21. Alicandro G, Remuzzi G, La Vecchia C. Italy's first wave of the COVID-19 pandemic has ended: no excess mortality in May, 2020. *Lancet*. 2020;396:e27-e28. [CrossRef]
22. Michelozzi P, de'Donato F, Scortichini M, et al. Temporal dynamics in total excess mortality and COVID-19 deaths in Italian cities. *BMC Public Health.* 2020;20:1238. [CrossRef]
23. Karlinsky A, Kobak D. Tracking excess mortality across countries during the COVID-19 pandemic with the World Mortality Dataset. *eLife*. 2021;10:e69336. [CrossRef]
24. Morgan D, Ino J, Paolantonio GD, Murtin F. Excess mortality: measuring the direct and indirect impact of COVID-19 [Internet]. Paris: OECD; 2020 [cited 2023 Apr 9]. [CrossRef]
25. Scortichini M, Schneider dos Santos R, De' Donato F, et al. Excess mortality during the COVID-19 outbreak in Italy: a two-stage interrupted time-series analysis. *Int J Epidemiol*. 2020;49:1909-1917. [CrossRef]
26. Cameron AC, Trivedi PK. Regression Analysis of Count Data [Internet]. 2nd ed. Cambridge: Cambridge University Press; 2013 [cited 2024 Oct 4]. [CrossRef]
27. Irizarry RA, Acosta R. Excessmort: excess mortality [R package] CRAN [Internet]; 2021. [CrossRef]
28. Calderon-Anyosa RJC, Kaufman JS. Impact of COVID-19 lockdown policy on homicide, suicide, and motor vehicle deaths in Peru. *Prev Med.* 2021;143:106331. [CrossRef]
29. R Core Team. R: a language and environment for statistical computing [Internet]. Vienna: R Foundation for Statistical Computing; 2021. [CrossRef]
30. Tokatlioglu Y, Sulku SN. The impact of the Covid-19 outbreak on unmet health care needs in İstanbul. *Prev Med Rep*. 2023;36:102400. [CrossRef]
31. Çirakli Ü, Orhan M, Sayar B, Demiray EKD. Impact of COVID-19 on emergency service usage in Turkey: interrupted time series analysis. *Intern Emerg Med.* 2023;18:2105-2112. [CrossRef]
32. T.C. Sağlık Bakanlığı. COVID-19 bilgilendirme platformu [Internet]. 2020 [cited 2024 Nov 2]. [CrossRef]
33. Ceccarelli E, Minelli G, Egidi V, Jona Lasinio G. Assessment of excess mortality in Italy in 2020-2021 as a function of selected macro-factors. *Int J Environ Res Public Health*. 2023;20:2812. [CrossRef]
34. Ministry of Health of the Rebuplic of Turkey. COVID-19 information platform. 2024 [cited 2024 Nov 2]. [CrossRef]
35. Ministry of Health. Statement on the latest situation of the omicron variant in Turkey. 2021 [cited 2024 Nov 2]. [CrossRef]
36. Huang C, Yang L, Pan J, Xu X, Peng R. Correlation between vaccine coverage and the COVID-19 pandemic throughout the world: based on real-world data. *J Med Virol.* 2022;9:2181-2187. [CrossRef]
37. Mendoza-Cano O, Trujillo X, Huerta M, et al. Assessing the influence of COVID-19 vaccination coverage on excess mortality across 178 countries: a cross-sectional study. *Vaccines (Basel).* 2023;11:1294. [CrossRef]
38. Matveeva O, Shabalina SA. Comparison of vaccination and booster rates and their impact on excess mortality during the COVID-19 pandemic in European countries. *Front Immunol*. 2023;14:1151311. [CrossRef]
39. Shang W, Wang Y, Yuan J, Guo Z, Liu J, Liu M. Global excess mortality during COVID-19 pandemic: a systematic review and meta-analysis. *Vaccines*. 2022;10:1702. [CrossRef]
40. Oh J, Min J, Kang C, et al. Excess mortality and the COVID-19 pandemic: causes of death and social inequalities. *BMC Public Health*. 2022;22:2293. [CrossRef]
41. Ramírez-Soto MC, Ortega-Cáceres G. Analysis of excess all-cause mortality and COVID-19 mortality in Peru: observational study. *Trop Med Infect Dis*. 2022;7:44. [CrossRef]
42. Barbiellini Amidei C, Fedeli U, Gennaro N, et al. Estimating Overall and cause-specific excess mortality during the COVID-19 pandemic: methodological approaches compared. *Int J Environ Res Public Health.* 2023;20:5941. [CrossRef]