Vargas *et al. International Journal for Equity in Health* (2025) 24:201
https://doi.org/10.1186/s12939-025-02575-3

International Journal for Equity in Health

RESEARCH **Open Access**

Inequities in mortality and potential years of life lost (PYLL) in greater Santiago, Chile, during and after the COVID-19 pandemic

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Abstract

Introduction In Chile and worldwide, disparities in age-adjusted mortality rates and Potential Years of Life Lost (PYLL) intensified during the initial two years of the COVID-19 pandemic, with low- and middle-income countries experiencing a disproportionate burden. However, the post-pandemic landscape in Chile has yet to be comprehensively characterized.

Objective To evaluate the evolution of inequities in mortality rates and PYLL during the post-pandemic years (2022 and 2023) in Greater Santiago, comparing these with pandemic years (2020 and 2021) and the pre-pandemic period (2002–2019).

Methods This study uses publicly available data from the 34 urban municipalities of the Greater Santiago Metropolitan Region provided by the Department of Statistics and Health Information (DEIS) of the Chilean Ministry of Health. Inequality indices, such as the Concentration Index (CI) and the Relative Index of Inequality (RII), were estimated using the average per capita income of each municipality as the ranking variable.

Results Age-adjusted mortality rates and PYLL have re-established their pre-pandemic declining trajectory, although at different magnitudes. Concurrently, levels of inequity, although reduced from the peaks observed during the pandemic, have reverted to their prior upward trend. During the pandemic, between 2019 and 2020, mortality and PYLL increased by 31% and 32%, respectively, in the lowest-income municipalities, reaching levels comparable to those observed in 2002. In contrast, wealthier municipalities experienced substantially smaller impacts. These patterns were consistently observed across multiple inequality assessment methodologies, including municipal income quintile comparisons, the Concentration Index (CI), and the Relative Index of Inequality (RII).

Conclusions In Greater Santiago, although mortality rates and PYLL in 2023 declined below pre-pandemic levels, health inequities exhibited only a temporary decline. Subsequently, these disparities have resumed the upward trajectory characteristic of the pre-pandemic period.

Keywords Social determinants of health, COVID-19, Years of life lost, Health status disparities, Concentration index

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Introduction

The COVID-19 pandemic resulted in nearly 13 million deaths globally and contributed to a decline in life expectancy of 1.8 years between 2019 and 2021. These impacts disproportionately affected vulnerable populations, exacerbating pre-existing health inequities [1, 2]. According to the World Health Organization (WHO), such inequities are defined as systematic differences in health status between population groups that are both unjust and avoidable [3]. These disparities are closely linked to the social determinants of health, which shape individuals' access to opportunities and resources across the life course [3]. Socioeconomic inequalities, in particular, are strongly associated with a greater burden of disease and an elevated risk of premature mortality among disadvantaged groups—an issue quantifiable through the indicator of Potential Years of Life Lost (PYLL), which emphasizes deaths that occur at younger, preventable ages [4, 5]. This underscores the urgent need for targeted interventions and structural public policies aimed at reducing health inequities and mitigating risk exposures.

Globally, as documented by Pifarré et al. [6], the COVID-19 pandemic accounted for 20.5 million years of life lost across 81 countries in 2020, with a disproportionate burden of PYLL observed among younger individuals (55 years or younger) in low- and middle-income countries.

Among high-income countries, Chile—and particularly Greater Santiago—represents a compelling case study due to its pronounced socioeconomic inequalities [7] and the severe impact of the COVID-19 pandemic. In 2020, a total of 18,680 deaths attributable to COVID-19 were reported nationwide [8], resulting in an estimated 409,086 potential years of life lost (PYLL), of which approximately one-fifth was directly associated with COVID-19-related mortality [6]. Furthermore, municipalities with lower income levels faced significantly higher inequities, particularly in association with premature deaths [9].

Traditional evaluations of excess mortality often overlook variations in the age distribution of deaths across social groups, potentially underestimating the true extent of pandemic-related inequities. PYLL serves as a valuable metric for examining health inequities, as it captures both direct and indirect excess mortality—including deaths resulting from delayed access to healthcare and the broader consequences of containment measures—which often disproportionately impact vulnerable populations. This study focuses on analyzing PYLL attributable to COVID-19—both directly and indirectly—by examining mortality data across geographic areas with pronounced socioeconomic disparities. The aim is to quantify the unequal impact of the pandemic and post-pandemic periods among the municipalities of Greater Santiago, categorized by per capita household income, to inform policies that promote equity.

Despite ongoing efforts in Chile to advance health equity, updated analyses are essential to assess progress in mitigating pandemic-related excess mortality and PYLL. A comprehensive understanding of post-pandemic inequities is critical to identifying priority areas for intervention, developing targeted policies, and ensuring that gains in health equity are achieved and sustained over time.

Currently, there is a lack of available information on the behavior of PYLL in the post-pandemic period and its potential association with health inequities. Therefore, this study examines the evolution of mortality rates and PYLL in the municipalities of Greater Santiago across three distinct periods: pre-pandemic, pandemic, and post-pandemic. The analysis seeks to identify enduring disparities, highlight areas for enhancement in public policies, and advocate for targeted interventions to address the needs of the most affected populations.

Materials and methods

This study was conducted across the 34 urban municipalities of the Greater Santiago Metropolitan Region in Chile. This area was selected due to its high population density—encompassing nearly half of the country's population—and its pronounced structural inequalities. Prior research has demonstrated a significant association between economic segregation and mortality within this region [10, 11]. Two mortality indicators were calculated for each municipality: age-adjusted mortality rates and PYLL.

Mortality rates were calculated annually and adjusted for age using the direct method, with the 2015 population standard defined by the Organization for Economic Co-operation and Development (OECD) [12]. Five-year age groups were used, with an upper age limit of 75 years, for comparison purposes. In this context, d_{at} and P_{at} represent the number of deaths and the population at age a in municipality i during period t, respectively; Pr_a denotes the proportion of individuals of age a in the OECD 2015 standard population; and K corresponds to the maximum age at death (set at 75 years). The age-adjusted mortality rate (SMR) per 100,000 inhabitants is calculated as:

$$SMR_{it} = 100{,}000 \sum_{a=0}^{K} Pr_a \left(\frac{d_{at}}{P_{at}}\right)$$

Potential Years of Life Lost (PYLL) are calculated with an upper age limit $L = 75$, as defined by the OECD [12]. In this case, each death contributes $L - a$ years of life lost, and the PYLL per 100,000 inhabitants is given by:

$$PYLL_{it} = 100{,}000 \sum_{a=0}^{L-1} (L-a) Pr_a \left(\frac{d_{at}}{P_{at}} \right)$$

Analysis of health inequities

To assess health disparities, several inequity indices were estimated: the Concentration Index (CI), the Relative Index of Inequality (RII, as described by Kunst-Mackenbach and Pamuk), and the Slope Index of Inequality (SII). These indices quantify the magnitude of inequities in PYLL and mortality rates based on a socioeconomic variable.

The socioeconomic variable used for this analysis was the average per capita household income at the municipal level, obtained from the National Socioeconomic Characterization Survey (CASEN).

CASEN data were utilized for specific periods as follows: CASEN 2003 for the years 2002–2005, CASEN 2006 for 2006–2007, CASEN 2009 for 2009–2010, CASEN 2011 for 2011–2012, CASEN 2013 for 2013–2014, CASEN 2015 for 2015–2016, CASEN 2017 for 2017–2018, CASEN 2020 for 2019–2021, and CASEN 2022 for the post-pandemic period. Municipalities were classified into five quintiles based on the average per capita household income derived from the 2017 CASEN survey. Quintile 1 represented municipalities with the lowest income levels, while Quintile 5 encompassed those with the highest income levels [13].

The **Concentration Index (CI)** [14–17] was calculated based on the concentration curve L(p), which represents the cumulative percentage of a health variable plotted against the cumulative percentage of a socioeconomic variable. In a hypothetical scenario where the health variable is evenly distributed, a 45° line—known as the "line of equality"—is plotted. If the distribution is unequal, the curve will deviate above or below the line, depending on the direction of the inequality. The degree of inequality is represented by the distance between the curve and the line [18]:

$$CI = 1 - 2\int_0^1 L\left(p\right)\delta p$$

The CI ranges from −1 to 1, where 0 indicates perfect equality, negative values signify that the health burden is concentrated among the economically disadvantaged, and positive values indicate a concentration among the economically advantaged. The CI was estimated using Stata 18,, applying a formula that approximates the integral based on a discrete summation method [15].

This index takes into account the full socioeconomic distribution, offering an advantage over measures that only compare extreme groups (e.g., richest vs. poorest quintiles). Thus, the CI provides a more comprehensive assessment of inequality. Additionally, its ability to indicate the direction of the disparity—whether a health burden is concentrated among the poor or the rich—makes it particularly valuable for epidemiological analysis.

The Relative Indices of Inequality by Kunst-Mackenbach (KM) and Pamuk [19–21] are calculated using a linear regression model:

$$y_i = \alpha + \beta x_i + \varepsilon_i \quad (1)$$

.

Here, y_i represents the mortality or PYLL rate for the municipality i, α the intercept of the model, β the slope and x_i is the log-transformed, normalized per capita household income in the range between 0 and 1.

From this model, the **Pamuk RII** is derived as:

$$RII\left(Pamuk\right) = \frac{\beta}{\underset{-}{\rightarrow} y}$$

And the **Kunst-Mackenbach RII** as:

$$RII\left(KM\right) = \frac{\alpha + \beta}{\alpha}$$

Finally, the Slope Index of Inequality (SII) corresponds to the β coefficient from Eq. (1) and represents the absolute difference in the outcome between the highest and lowest positions in the normalized per capita household income.

Data Sources

Mortality data, categorized by cause and age group for each municipality, were obtained from publicly accessible datasets provided by the Department of Health Statistics and Information (DEIS) of the Chilean Ministry of Health [22]. This weekly registry includes all deaths occurring in Chile between 2016 and 2023 (with preliminary data for 2022 and 2023) and records the primary cause of death, classified according to the International Classification of Diseases (ICD-10), as well as information on age, sex, and municipality of residence of the deceased.

Population estimates for each municipality, disaggregated by age group, were obtained from the Chilean National Institute of Statistics, based on projections derived from the 2017 national census [23].

Results

The analysis of age-standardized all-cause mortality rates in Greater Santiago from 2002 to 2023 demonstrates a sustained downward trend until the onset of the COVID-19 pandemic in 2020. As illustrated in Fig. 1, mortality rates during 2020, 2021, and 2022 deviate significantly from this trend, with markedly higher values reflecting

Fig. 1 Age-Adjusted Mortality Rate Based on the OECD 2015 Population, Greater Santiago, 2002–2023. Predicted values from a generalized linear model with fractional polynomials terms (fp function in Stata 18): GM M1* for pre-COVID-19 trends and GM M2** for the entire study period (excluding pandemic years)

the substantial impact of the pandemic on mortality dynamics.

By 2023, mortality rates show a reversion to the expected pre-pandemic trajectory, indicating a recovery and a return to patterns observed prior to the pandemic. This finding suggests a stabilization of mortality rates following the acute disruptions caused by the pandemic, aligning with a broader normalization in public health trends.

Unlike all-cause mortality rates, the impact of the COVID-19 pandemic on PYLL was confined to a two-year period. As illustrated in Fig. 2, by 2022, the PYLL indicator had returned to levels consistent with the pre-pandemic period.

This more rapid recovery, compared to overall mortality rates, reflects the inherent characteristics of the PYLL metric, which places greater emphasis on deaths occurring at younger ages. During the pandemic, a substantial proportion of PYLL was concentrated in younger age groups. However, in the post-pandemic period, mortality rates within these cohorts stabilized more quickly, enabling the indicator to revert to its historical trajectory.

To analyze the disparities observed in these indicators, PYLL was disaggregated across the 34 municipalities of Greater Santiago, stratified by income quintiles as defined by the 2017 CASEN Survey. As depicted in Fig. 3, the overall trend in PYLL demonstrates a sustained decline across all quintiles. However, the increase observed in 2020 was disproportionately higher in municipalities with lower income levels.

Moreover, the magnitude of this increase diminishes progressively with rising income quintiles, underscoring the heightened vulnerability of lower-income municipalities to the pandemic's impact. In the post-pandemic period, while PYLL declined across all quintiles, lower-income municipalities continue to exhibit levels above those of higher-income quintiles, indicating a slower pace of recovery in these areas.

Figure 3 shows disparities in PYLL across municipalities, with consistently higher values in the lowest income quintile—i.e., the most socioeconomically disadvantaged areas (7,746 PYLL per 100,000 inhabitants in 2002 vs. 8,424 in 2020). In contrast, the wealthiest municipalities (fifth quintile) experienced a notable decrease over the same period (from 4,402 to 3,057 PYLL per 100,000 inhabitants). A similar pattern is observed in overall mortality rates (see Fig. 9 in the Supplementary material). In 2020, municipalities in the first income quintile registered higher mortality than in 2002 (10.40 vs. 11.74

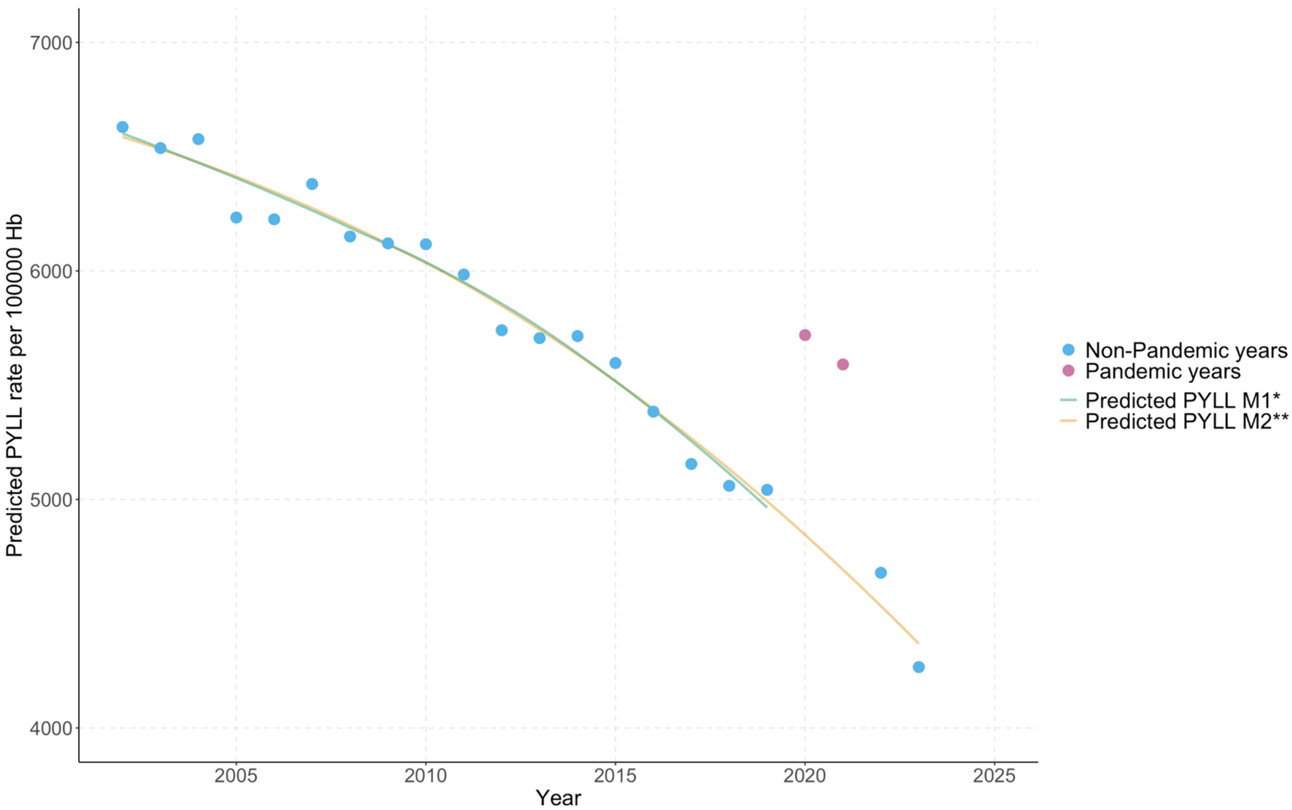

Fig. 2 Rate of Potential Years of Life Lost (PYLL) Based on the OECD 2015 Population, Greater Santiago, 2002–2023. Predicted values from a generalized linear model with fractional polynomials terms (fp function in Stata 18): PYLL M1* for pre-COVID-19 trends and PYLL M2** for the entire study period (excluding pandemic years)

per 1,000 inhabitants), whereas those in the fifth quintile showed a reduction (8.17 in 2002 vs. 6.98 in 2020).

To quantify these disparities, the Concentration Index (CI) and RII(KM) were calculated, with RII(Pamuk) results provided in the supplementary material. These indices were used to measure inequities in mortality rates and PYLL from 2002 to 2023, as illustrated in Fig. 4. The results demonstrate a consistent upward trend in inequity across both indicators over the years.

Both indices indicate that health inequities peaked in 2020, with lower-income municipalities disproportionately affected. While inequities have decreased in the subsequent years, the estimated concentration indices for PYLL and mortality rates remain above pre-pandemic levels. Nevertheless, they have realigned with the pre-pandemic trends observed before the onset of the COVID-19 pandemic.

Analyzing the relative inequity indices, RII(KM) and RII(Pamuk), reveals that in 2020, the estimated PYLL was 3.71 times higher in municipalities with lower average per capita income compared to those with higher income. Similarly, mortality rates exhibited a disparity of 1.81 times higher in the same range (see Tables 1 and 2 in the supplementary material). While these values declined during the post-pandemic period, they remain above pre-pandemic levels, aligning with the long-term increasing trend of relative inequity among municipalities throughout the study period.

Consistent results are observed when using the Concentration Index, which provides a similar interpretation. Both indices are concordant in identifying the trend and the peak levels reached in 2020. However, a divergence is noted for 2021: while the Concentration Index remains elevated, exceeding the trend, the RII returns to levels consistent with the pre-existing trajectory.

A detailed analysis of the Concentration Indices for PYLL, disaggregated by cause of death, reveals significant patterns in health inequities associated with the pandemic and their evolution. The indices, calculated for three key time points—pre-pandemic (2017), during the pandemic (2020), and the first post-pandemic year (2022)—are presented in the supplementary material's tables and figures.

In 2020, causes related to accidents and violence displayed the highest levels of inequity among the municipalities of Greater Santiago, surpassing even COVID-19. Conversely, cancer consistently remained the cause of death with the lowest level of inequity in PYLL across all three periods analyzed.

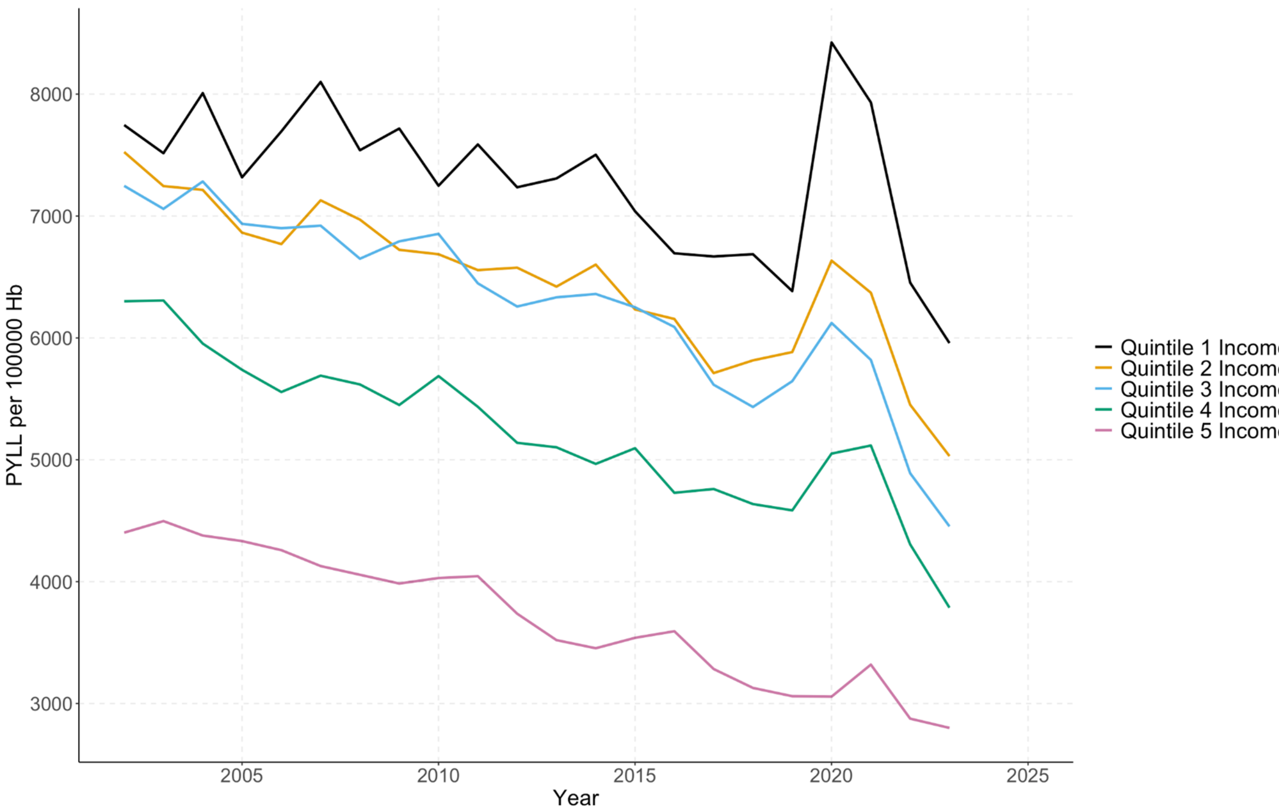

Fig. 3 Rate of Potential Years of Life Lost (PYLL) Grouped by Municipalities According to Income Quintiles

In terms of inequity trends, all causes showed an increase during the pandemic. However, by the first post-pandemic year (2022), inequity had decreased for most causes, returning to the pre-pandemic trend of gradual increases in inequity observed before the pandemic.

Discussion

Age-standardized mortality rates and Potential Years of Life Lost (PYLL) have resumed the declining trend observed prior to the COVID-19 pandemic. Simultaneously, levels of health inequity—after peaking during the pandemic—now appear to have returned to the pre-existing upward trajectory. However, this pattern may also be influenced by additional structural and contextual factors beyond the pandemic itself. During the pandemic period, the most socioeconomically disadvantaged municipalities experienced a marked increase in both overall mortality and PYLL, surpassing levels recorded at the beginning of the study period in 2002. Specifically, between 2019 and 2020, mortality and PYLL increased by 31% and 32%, respectively, in the lowest-income municipalities. In contrast, municipalities in the highest income quintile (quintile 5) experienced comparatively limited impacts, with an 11.2% increase in mortality and no change in PYLL over the same period. Notably, an increase in PYLL among these wealthier municipalities was observed only in the following year, rising by 8.5%. These disparities are consistently reflected across various inequality assessment methodologies, including trend comparisons by income quintile, estimation of the concentration index, and calculation of the Relative Index of Inequality (RII) using both the Pamuk and Kunst–Mackenbach (KM) approaches.

Our findings confirm that the highest general mortality rates in Greater Santiago occurred in 2020 and 2021, mirroring global trends where the COVID-19 pandemic reversed the increase in life expectancy at birth. COVID-19 became one of the five leading causes of death worldwide and the leading cause in the Americas during these years. According to the World Health Organization (WHO), the reduction in life expectancy was not evenly distributed globally, with decreases of nearly three years in the Americas and Southeast Asia (compared to a global average reduction of 1.6 to 1.8 years), while the Western Pacific experienced a minimal decline of only 0.1 years [24]. In Chile, life expectancy is estimated to have decreased by 1.89 years for men and 1.5 years for women, with the reductions concentrated among individuals aged 60–84 years for men and 60–89 years for women [25].

At the onset of the pandemic, health inequalities were not recognized, and high-risk populations were not identified, limiting the ability to implement targeted

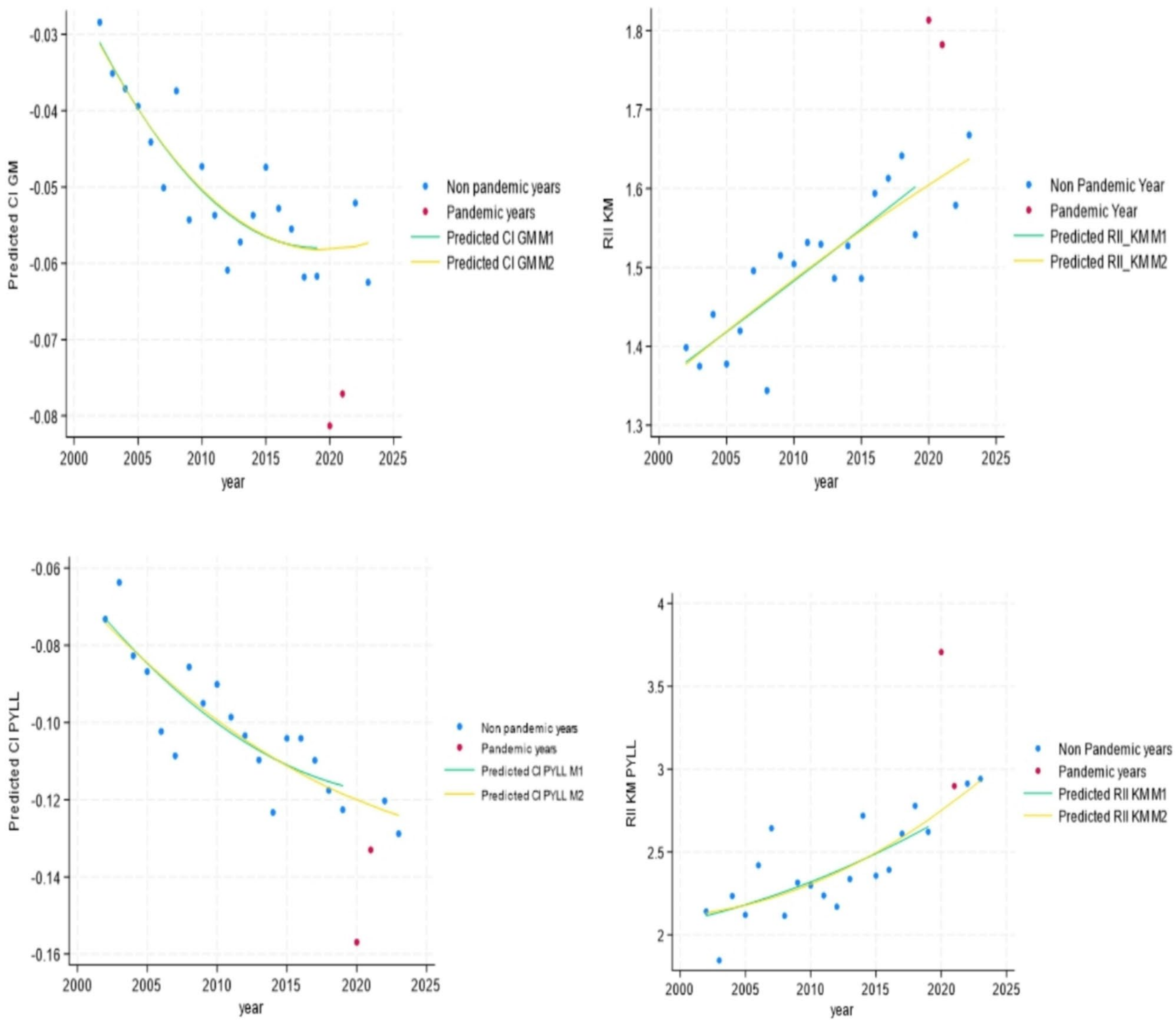

Fig. 4 Inequity Indicators for Potential Years of Life Lost (PYLL) and Mortality Rates in the Municipalities of Greater Santiago, 2002–2023
The figure includes the Concentration Index (CI) and the Relative Index of Inequality (RII(KM)). **Predicted M1** represents the model's predictions considering only pre-COVID-19 years. **Predicted M2** represents the model's predictions considering all years, both pre- and post-COVID-19

interventions. Studies have shown that inequalities affecting young people and racial/ethnic minorities in the United States were associated with poorer socioeconomic and environmental conditions [26, 27]. For instance, in terms of PYLL, the impact of premature mortality was 4.8 times greater in the most affected racial group, which consisted of Hispanic individuals [28]. Other research has reported higher PYLL rates among Indigenous women and pregnant women [29], all these disparities emerged during the pandemic.

In Greater Santiago, disparities between municipalities are consistently greater in PYLL rates compared to overall mortality rates across all three indicators studied. Prior research highlighted significant differences in PYLL between the poorest and wealthiest municipalities in Greater Santiago before the pandemic, as evidenced by both RII indicators, with these disparities intensifying significantly in 2020 [9]. However, this study found that inequalities have not fully reverted to pre-pandemic levels in the post-pandemic period, confirming that the effects of COVID-19 have exacerbated pre-existing inequities in the social determinants of health.

In 2020, lower-income municipalities experienced a disproportionately higher increase in PYLL compared to their higher-income counterparts, driven by disparities in access to healthcare services, riskier working conditions (including unequal adherence to quarantines due to occupational demands), and challenges in implementing preventive measures. This trend is consistent with international studies showing that vulnerable populations, including ethnic minorities and socioeconomically disadvantaged groups, experienced greater PYLL due to increased exposure to environmental hazards and long-standing barriers to healthcare access [30].

The COVID-19 pandemic not only exacerbated pre-existing health inequalities but also highlighted the structural vulnerabilities within Chile's healthcare system. Despite efforts to expand care through the public healthcare system and to integrate the private healthcare network in a universal and efficient manner during the pandemic, systemic challenges persisted. These included reduced access to routine medical care, delays in diagnosis, and extended waiting times for prioritized diseases, all of which deepened existing disparities. The full scope of these inequities remains unclear and is difficult to quantify due to the dilutional effect, as the time required for the occurrence of the outcomes of interest (mortality) complicates their precise measurement.

The disaggregated analysis of PYLL by cause of death indicates that during the pandemic years, PYLL attributable to cardiovascular diseases and cancer declined. Notably, cancer exhibited lower levels of inequity, despite its declining trends, reflecting a more uniform distribution of its impact across the population [31–34]. In contrast, cardiovascular and digestive diseases, after an initial reduction in PYLL during the pandemic—likely attributable to the displacement of healthcare resources toward COVID-19—displayed higher inequity indices in 2022 compared to pre-pandemic levels, likely due to delays in diagnosis and treatment [35, 36].

These findings align with international research, which also reports a significant reduction in PYLL for cardiovascular diseases, including ischemic heart disease and acute myocardial infarction, during the pandemic years. Conversely, PYLL related to Alzheimer's disease, dementia, and Parkinson's disease increased, with a pronounced impact among men [37].

Accidents and violence demonstrated the highest levels of inequity during the pandemic, likely due to the capacity of higher-income municipalities to implement and adhere to stricter confinement measures, thereby reducing the incidence of these events. In contrast, these causes disproportionately impacted younger populations in lower-income areas, where adherence to such measures was more challenging (see supplement).

One limitation of this study is that the Chilean mortality registry records only a single cause of death. During the pandemic, many patients with advanced cancer or cardiovascular disease, who might have otherwise been attributed to these conditions, were recorded as dying from "COVID-19" (U07.1 and U07.2) if they contracted the virus or developed pneumonia as a result. A study examining "other causes" of death highlighted persistent inequities, underscoring the importance of indirect effects such as restricted access to healthcare services during the pandemic. Additionally, a global study analyzing data from 49 countries between January 2020 and December 2021 estimated that approximately 85.6 million years of life were lost due to premature deaths from COVID-19 [38]. Countries such as Peru, Hungary, and Mexico had the highest PYLL rates, while nations like New Zealand and Australia reported lower rates. The global average PYLL rate was approximately 399 years lost per 10,000 inhabitants, reflecting both the large number of deaths and the younger age at which these losses occurred [39].

A second limitation of this study is its ecological design, as both socioeconomic indicators and health outcomes were assessed at the municipal level using aggregated data. This approach has significant implications, particularly regarding the generalizability of findings to individual-level outcomes, where results may not be directly applicable. Methodologically, the study is vulnerable to ecological fallacy, which occurs when group-level associations are erroneously inferred to apply at the individual level. For instance, if socioeconomic segregation between municipalities increased over time, this alone could explain the observed rise in relative inequality indices, even without an actual worsening of relative inequality at the individual level.

Another limitation of the models is the absence of controls for spatial autocorrelation, which is particularly relevant given the geographic clustering of municipalities with similar socioeconomic characteristics and the contagious nature of COVID-19—both of which likely contributed to the disproportionate impact observed in the most socioeconomically disadvantaged areas. Additionally, it is important to acknowledge that the Venezuelan migration occurring after 2017—the year of the most recent national census used to construct population projections—may not have been fully accounted for in the population estimates, potentially affecting the accuracy of the denominators used in rate calculations.

One of the key strengths of this research is its longitudinal approach, enabling the analysis of inequality trends across municipalities over a 22-year period. A preliminary analysis conducted during the preparation of this manuscript evaluated inequality over a shorter timeframe (2017–2023) to address the question: "Was inequality fully restored in the post-pandemic period?" The findings indicated that inequality did not fully return to pre-pandemic levels. However, adopting a broader temporal perspective, as presented in this final manuscript, revealed that inequalities have continued along a consistent upward trajectory, mirroring the trends observed in the years preceding the pandemic, as evidenced by the results of this study.

During the COVID-19 pandemic, it has been proposed that some deaths may be attributable to the “harvesting effect,” as the virus disproportionately impacted individuals with preexisting conditions and older adults. This phenomenon suggests that, in certain contexts, the pandemic may have expedited the deaths of individuals in precarious health, leading to a concentration of deaths over a short period rather than their distribution over time. Although some studies indicate that the “harvesting effect” may have contributed to the concentration of deaths in 2020 and 2021, other factors, such as delayed diagnoses and persistent structural inequalities, remain significant contributors to these disparities [40–42].

The harvesting effect has critical implications for the interpretation of mortality statistics and the assessment of the true impact of the pandemic. This phenomenon can create a misleading impression of a reduction in mortality during the post-event period due to a decrease in the number of highly vulnerable individuals [43]. Recent studies have examined how COVID-19 amplified this effect, particularly among older populations and individuals with comorbidities, thereby intensifying its impact on mortality and PYLL. Comparisons of mortality rates before and after pandemic peaks illustrate how COVID-19 disproportionately concentrated deaths within these vulnerable groups, leading to a temporary reduction in mortality rates in certain contexts as infections declined.

In this study, the harvesting effect may have played a substantial role in the observed increase in inequity during the COVID-19 pandemic, given that lower-income municipalities tend to have a higher concentration of individuals in vulnerable circumstances. In the post-pandemic period, mortality rates and PYLL may have exhibited a smaller decline than observed and could have remained above historical trends if the harvesting effect had not occurred. While inequity has returned to preexisting trends, it is essential to highlight that, without a differential harvesting effect that disproportionately impacted the most vulnerable groups, inequity levels might have persisted above historical trajectories.

During the COVID-19 pandemic, Chile’s Human Development Index (HDI) experienced a significant setback in 2020, with a 15.6% decline when adjusted for inequality, emphasizing the urgent need for policies to address social and economic disparities [44]. To mitigate the impact of the pandemic, Chile implemented various measures, including early and free access to vaccination, educational and preventive support for families, employment subsidies, remote education, home isolation, and mobility restrictions. Despite these efforts, poverty increased from 8.6 to 10.8% between 2017 and 2020, and the Gini coefficient rose to 51.0, marking a return to levels observed between 2003 and 2006 [45, 46].

In the healthcare sector, routine primary care appointments and medical consultations, particularly emergency visits, declined significantly, limiting access to treatments [47, 48] and delaying diagnoses in other cases [49]. These reductions were attributed to mobility restrictions and public fear of contagion, phenomena observed globally [50–52]. Such factors likely contributed to the inequalities identified in this study.

While mortality and PYLL rates have shown signs of recovery toward pre-pandemic trends, persistent inequities highlight structural barriers, particularly in lower-income municipalities. Improvements in PYLL indicators remain uncertain and are expected to progress slowly in these areas, especially if disparities in HDI, ethnicity, gender, age, and geographic location persist [53]. Addressing these disparities necessitates interventions to improve social determinants of health, such as education and income, and to ensure universal access to high-quality healthcare, with a focus on the most vulnerable populations.

The research underscores the substantial burden of years of life lost due to premature deaths, particularly among vulnerable populations with preexisting inequalities in healthcare access. It is crucial to identify the causes of high PYLL rates. In Latin America, these rates are exacerbated by the younger age at which deaths occur and the limited capacity of healthcare systems, including unequal access to treatments and vaccines and the overburdening of public health infrastructure. These factors have significantly increased life years lost compared to other regions [54].

The persistence of elevated post-pandemic inequity levels, especially in PYLL, underscores the structural vulnerabilities of low-income municipalities, which face greater barriers to preventing and mitigating the health impacts of the pandemic.

The COVID-19 pandemic has offered critical insights into the importance of equity in health planning and response. Achieving sustainable recovery will require structural measures to reduce health disparities. Nevertheless, it is undeniable that vaccination programs and public health education played a significant role in reducing mortality across the Chilean population, which should inform the advancement of public health policies moving forward.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12939-025-02575-3.

Supplementary Material 1

Supplementary Material 2

Acknowledgements
The authors thank the support of DICYT Asociativo Grant 022191MH DAS to carry out the project "Understanding causes and consequences of COVID-19 and other diseases on population health: multicausality, time, and space for decision-making".

Author contributions
Conceptualization and methodology, C.V., F.E.; Validation, C.V., F.E., M.M.; Formal analysis, C.V., P.S.,V.M., E.V.; Data curation, C.V.; Writing—original draft preparation, C.V., P.S., V.M.; Writing—review and editing, F.E., M.M.; Visualization, C.V., E.V.; Supervision, F.E., M.M.; Funding acquisition, C.V., F.E., M.M.

Funding
This research was funded by Universidad de Santiago, DICYT Asociativo Grant 022191MH DAS.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethical approval and consent to participate
This study utilized secondary, aggregated, and anonymized data from publicly available databases provided by official Chilean institutions. Therefore, ethical committee approval was not required. The nature of the data ensures respect for privacy and confidentiality, adhering to ethical standards.

Competing interests
The authors declare no competing interests.

Received: 25 January 2025 / Accepted: 2 July 2025
Published online: 10 July 2025

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