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ORIGINAL PAPER

Business cycles and mortality in Italy

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Abstract
Our study examines the relationship between business cycles and mortality rates in Italy over the period 2004–2019. Using the unemployment rate as a proxy for macroeconomic conditions, we investigate how economic fluctuations affect mortality rates across causes of death, age groups, genders, and educational levels. The analysis relies on data from the National Institute of Statistics (ISTAT) and applies panel data methods to control for province-specific heterogeneity and time effects. The findings reveal a procyclical pattern, with higher unemployment rates associated with lower mortality. Substantial heterogeneity emerges across demographic groups and causes of death. To test robustness, the analysis is extended to include the COVID-19 pandemic years (2020–2021), thereby assessing its impact on the previously identified relationships. Results suggest that the pandemic disrupted established unemployment–mortality dynamics, particularly for transport accidents and respiratory diseases. Overall, the findings highlight the importance of targeted public policies to mitigate health risks during economic expansions and provide insights into how macroeconomic conditions shape public health outcomes in Italy.

Keywords Business Cycles · Mortality Rates · Unemployment · Public Health · Italy · COVID-19 Impact

JEL Classification E32 · I10 · I12 · I14 · J14 · J16

Introduction

The relationship between macroeconomic conditions and health outcomes has long attracted the attention of researchers and policymakers, as it lies at the intersection of economic performance, social conditions, and individual well-being. Early contributions emphasized the detrimental effects of economic downturns on health, particularly among socioeconomically vulnerable populations [6–8]. More recent evidence, however, has challenged this view, documenting a procyclical pattern in which mortality increases during periods of economic expansion, especially in developed countries with well-functioning social safety nets [17, 29]. Subsequent studies suggest that this relationship is not uniform but varies across countries, time periods, population groups, and causes of death, reflecting differences in institutional settings, health behaviors, and demographic structures [30].

A central mechanism linking macroeconomic fluctuations to health outcomes operates through the labor market, with unemployment serving as a key indicator of business cycle conditions. At the individual level, job loss has been consistently associated with adverse health outcomes and higher mortality risks, both in the short and long run [9, 32]. At the aggregate level, however, increases in unemployment rates have often been found to coincide with reductions in overall mortality, giving rise to an apparent paradox between individual and contextual effects. This tension underscores the importance of distinguishing between micro- and macro-level mechanisms and motivates analyses that explicitly account for heterogeneity across demographic groups and causes of death.

While much of the empirical literature focuses on contemporaneous (short-run) associations between economic

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conditions and mortality, other contributions highlight that the sign and magnitude of business-cycle effects may differ over longer horizons and across the life course. In particular, procyclical relationships have been documented for early-life and childhood health outcomes (e.g., [2, 14]), whereas adverse long-run health consequences of exposure to economic downturns have been emphasized in studies focusing on scarring and cumulative disadvantage (e.g., [1]). This distinction provides an important conceptual framework for interpreting differences across studies.

Despite the extensive international literature on the macroeconomic–mortality association, evidence for Italy remains relatively limited, particularly at the sub-national level and for the most recent decades. This gap is noteworthy given Italy's distinctive demographic and economic characteristics. Italy is one of the most rapidly aging countries in Europe, with a mortality profile dominated by chronic and degenerative diseases that primarily affect older individuals. At the same time, the Italian economy is characterized by pronounced regional disparities, persistently high unemployment rates in certain areas, and a marked North–South divide. Over the period under study, Italy experienced several major macroeconomic shocks, including the global financial crisis and the subsequent sovereign debt crisis, which had profound effects on labor market conditions. These features make Italy a particularly informative setting in which to examine how business cycle fluctuations are associated with mortality in an aging society marked by structural economic heterogeneity.

This paper contributes to the literature by providing a comprehensive descriptive analysis of the association between business cycle fluctuations and mortality in Italy using provincial-level data over the period 2004–2019. We use the unemployment rate as our baseline indicator of macroeconomic conditions and examine how variations in labor market conditions are associated with mortality across different causes of death. In line with existing evidence for other Southern European countries, including Spain [12], we document a predominantly procyclical association between unemployment and overall mortality, while highlighting substantial heterogeneity across causes of death. We further explore this heterogeneity by examining differences in the unemployment–mortality association across age groups, sex, and educational attainment. These dimensions are particularly relevant in the Italian context, given the country's aging population, gender differences in labor market participation, and persistent educational gradients in health.

To assess the robustness of our findings, we implement several additional analyses. First, we extend the baseline sample to include the years 2020 and 2021, thereby incorporating the COVID-19 period into the full panel. Second, we use GDP growth as an alternative indicator of macroeconomic conditions and compare the resulting estimates with our baseline results based on unemployment rates. Throughout the paper, the analysis remains descriptive in nature and is intended to facilitate cross-country comparisons rather than to establish causal effects.

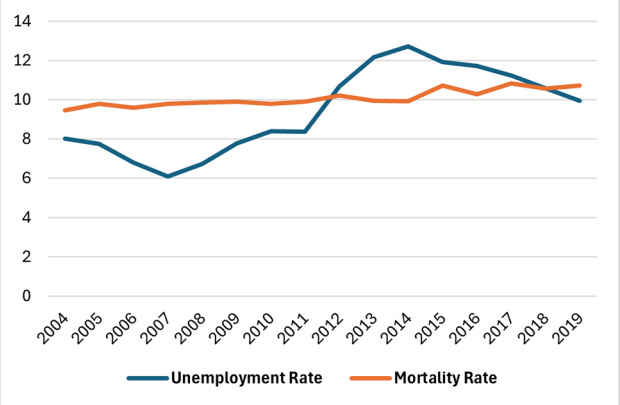

Fig. 1 Mortality Rate and Unemployment Rate - Source: Eurostat

The remainder of the paper is organized as follows. Section 2 describes the data and presents descriptive statistics. Section 3 outlines the empirical methodology. Section 4 presents the main results. Section 5 explores heterogeneity by age, sex, and educational attainment. Section 6 provides robustness checks, including alternative macroeconomic indicators and the analysis for the COVID-19 period, and Section 7 concludes.

Data and descriptive statistics

We use data from the National Institute of Statistics (ISTAT), Italy's official agency for collecting and disseminating economic, demographic, social, and health statistics. The dataset contains detailed information on mortality and unemployment rates.

The dependent variable is the mortality rate between 2004 and 2019 at the provincial level, computed on the total resident population. Individual-level records include causes of death and demographic characteristics such as sex, age, and education, which we aggregated by province and year. The sample covers 103 of Italy's 107 provinces, excluding four created after 2009.[1]

Figure 1 illustrates trends in unemployment and mortality rates from 2004 to 2019. From 2004 to 2011, both rates remain relatively stable. However, beginning around 2011–2012, the unemployment rate rises sharply, coinciding with the sovereign debt crisis. This increase peaks between 2013 and 2014 before gradually declining. In contrast, the

[1] Barletta-Andria-Trani, Fermo, and Monza and Brianza were established in 2009, and South Sardinia in 2016.

mortality rate remains largely flat for most of the period, showing a slight upward trend from approximately 2015 onward. Notably, during the peak unemployment years (2013–2014), the mortality rate does not exhibit a corresponding spike, suggesting a potential decoupling between economic downturns and immediate changes in mortality.

Similarly, Table 8 in the appendix supports the analysis of potential relationships between unemployment and mortality. During periods of elevated unemployment (2008–2011), no immediate or clear increase in mortality is observed, indicating that the unemployment–mortality relationship is complex and not straightforward.

We aggregated individual-level data by province and year to calculate the number of deaths in each province during the study period. Additionally, we collapse the data by cause of death. The selection of these causes was based on their significance as primary statistical indicators for assessing a population's health status and addressing the healthcare planning needs of the country. Specifically, we included the following categories: *Transport accidents*, *Suicide*, *Homicide*, *Cancer*, *Diabetes*, *Alzheimer's disease*, *Circulatory system diseases*, *Digestive diseases*, *Respiratory diseases*, and *Other accidents* (including drowning, poisoning, events of undetermined intent, and other external causes of trauma and poisoning). We also included *Other diseases*, encompassing certain infectious and parasitic diseases, diseases of the blood and hematopoietic organs, immune system disorders, endocrine, nutritional, and metabolic diseases, mental and behavioral disorders, diseases of the nervous system and sense organs, among others.

Figure 2 shows mortality trends by cause between 2004 and 2019. The left panel shows a relatively stable trend in cancer-related deaths, a slight increase in respiratory disease mortality, and a consistent number of deaths from other accidents. There is also a modest upward trend in deaths from circulatory system diseases and a notable rise in deaths from other diseases, particularly after 2015. In the right panel, a continuous decline in deaths from transport accidents is evident throughout the period. Suicide-related deaths show a slight decrease over time, while homicide-related deaths remain relatively low and stable. Mortality from digestive diseases remains constant, whereas deaths from Alzheimer's disease exhibit an increasing trend, particularly after 2010, reflecting the impact of an aging population. Lastly, deaths due to diabetes show a slight upward trend.

The unemployment rate is used as a macroeconomic indicator to capture business cycle fluctuations, and it is measured for individuals aged 15–74, the only age group for which consistent provincial-level unemployment data are available in the source database. Figure 5 plots provincial unemployment rates over time, illustrating their evolution and cross-province dispersion. The use of sub-national unemployment rates is common in the health-economics literature, where spatial and time variation in unemployment is exploited to identify the health effects of business-cycle conditions (e.g., [1]). The choice for using this variable is also based on evidence that other economic indicators, as highlighted by Granados [19], are highly correlated. Such correlations can lead to unreliable results in multiple regressions when modeling mortality using two or more economic indicators simultaneously. Notably, when mortality is regressed on multiple economic variables, unemployment is the only variable that consistently remains statistically significant. Furthermore, previous research has shown that the effects of regional GDP or income are more sensitive to model specifications compared to the effects of regional unemployment, reinforcing the robustness of unemployment as an indicator of health fluctuations [19, 29]. Finally, the choice of the unemployment rate is also motivated by its practicality for provincial-level analysis, given the challenges associated with obtaining GDP data at such a granular level.

Figure 3 illustrates unemployment trends in Italy relative to the EU average. Until 2013, Italy's unemployment rate remained below the European average. The sovereign debt crisis of 2011–2012 triggered a sharp increase, from 8.4% in

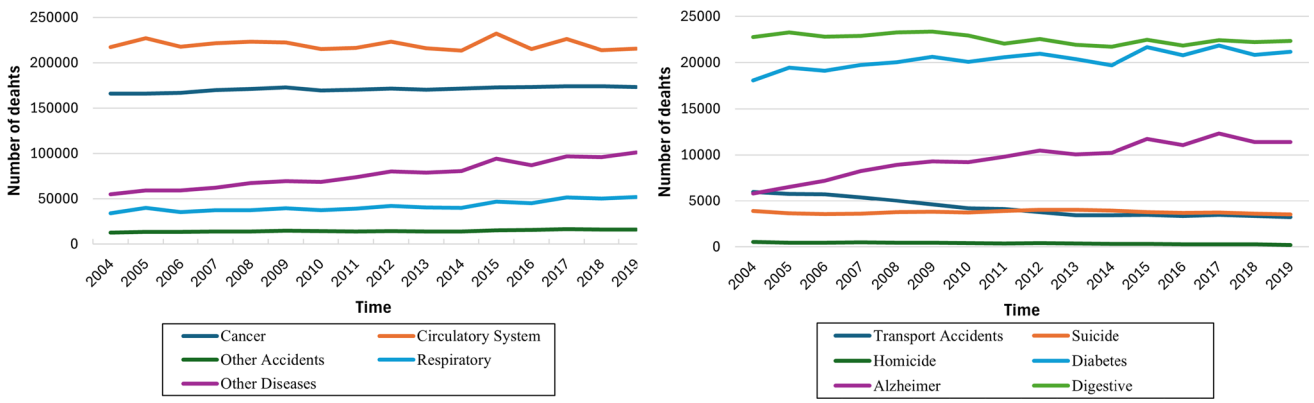

Fig. 2 Evolution of mortality by cause in the period 2004-2019 - Source: ISTAT

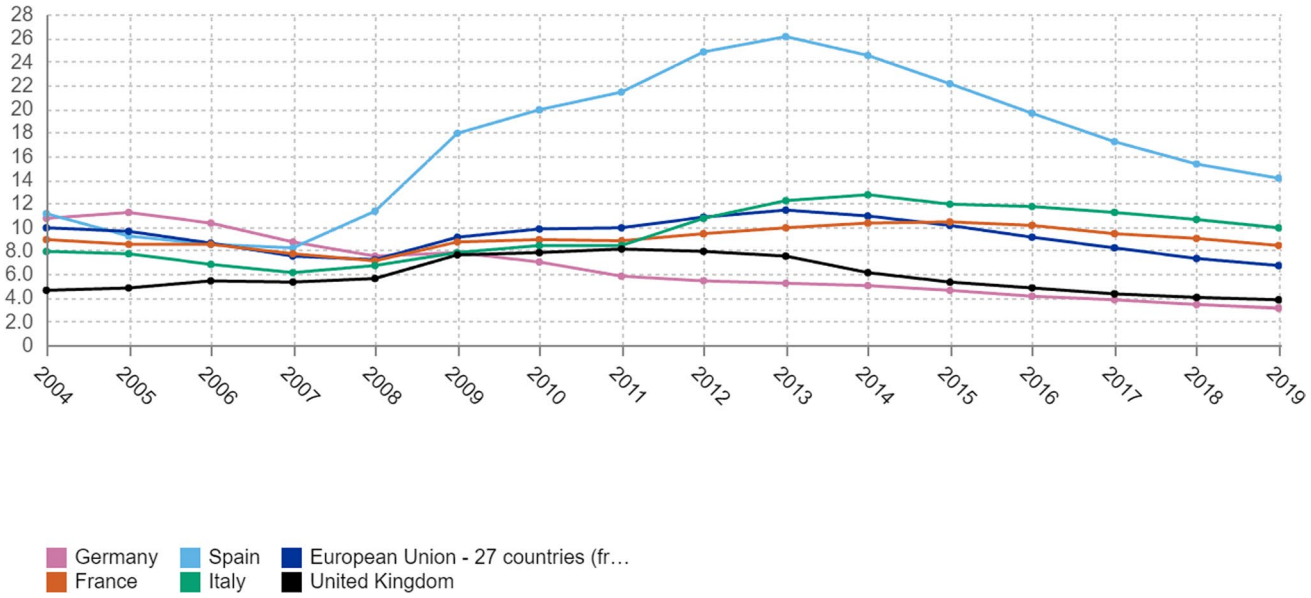

Fig. 3 Unemployment Rate (2004-2021) - Source: Eurostat

2011 to 10.7% in 2012, peaking at 12.7% in 2014. As noted by Petrelli [28], the rise was most pronounced in southern Italy, where unemployment reached 20.7% in 2014.

To capture heterogeneity in the relationship between economic conditions and mortality, we disaggregate by gender, age, cause of death, and education. Table 9 reports descriptive statistics. Men accounted for 48.54% of deaths (4,657,266) and women for 51.46% (4,937,313). Circulatory diseases were the leading cause of death (37.48%; 3,596,104), followed by cancer (29.19%; 2,800,617) and respiratory diseases (7.15%; 685,677).

By age, 72.84% of deaths (6,933,782) occurred among individuals aged 75 and older, and 14.74% (1,407,276) among those aged 65–74. Regarding education, 73.92% (7,050,636) of the deceased had only an elementary school certificate, 12.34% (1,176,601) a high school diploma, 11.68% (1,114,512) a middle school diploma, and just 2.64% (252,293) held a university degree.

Methodology

To examine the relationship between mortality and unemployment, we estimate the following specification, adapted from Cervini-Plá and Vall-Castelló [12] and Ruhm [30]:

$$ln(M_{kjt}) = \alpha_{kj} + \gamma_k U_{jt} + \lambda_{kt} + H_j * T + \delta A15_{jt} + \theta A65_{jt} + \epsilon_{kjt} \quad (1)$$

where M_{kjt} denotes the mortality rate from cause k in province j at time t, and U_{jt} is the provincial unemployment rate at that time, used as a proxy for macroeconomic conditions. Mortality is defined as the number of deaths from a specific cause (or from all causes) relative to the provincial population, expressed per 1,000 inhabitants. In other words, the mortality rate measures the frequency of deaths within a population, adjusted for population size, and is calculated using the following formula:

$$M_{kjt} = \frac{\text{Number of deaths}_{kjt}}{Population_{jt}/1000}$$

The term α_{kj} captures province fixed effects that are specific to cause k, λ_{kt} accounts for cause-specific year effects, and ϵ_{kjt} is the error term. The parameter of interest, γ_k, measures the association between unemployment and mortality from cause k.

A log-linear form is employed so that coefficients γ can be interpreted as semi-elasticity, i.e., the percentage change in mortality associated with one-unit increase in the unemployment rate (measured in percentage points). Year effects (λ_{kt}) absorb factors evolving uniformly across provinces for each cause of death, such as medical advances or changes in social behavior, while province fixed effects (α_{kj}) capture time-invariant local characteristics, such as lifestyle or environmental conditions. Thus, identification comes from within-province variation in unemployment over time, relative to other provinces.

The specification also includes province-specific linear trends ($H_j T$), where T is normalized between zero (2004) and one (2019), following Ruhm [30]. This generates 103 province-specific time trends.Province and year fixed effects, together with these province-specific trends, absorb common shocks and slow-moving components in unemployment, so that identification relies on within-province

deviations around province-specific trends net of common time shocks. Hence, pre-filtering the unemployment series is not required.

Demographic structure is controlled for using the share of the population aged under 15 ($A_{15,jt}$) and over 65 ($A_{65,jt}$), which account for variations in age composition and its potential effect on labor supply and health outcomes.

The empirical analysis proceeds in two steps. We first estimate a baseline specification using all-cause mortality. We then extend the baseline framework to a cause-specific setting, where mortality is disaggregated by cause of death *k* and the corresponding specification is given by Equation 1. For each specific cause of death, we estimate a separate regression, keeping the provincial unemployment rate as the main explanatory variable. This extension allows us to assess whether the association between unemployment and mortality differs across causes of death (through γ_k), thereby shedding light on the mechanisms underlying the aggregate relationship. We also explore heterogeneous effects by sex, five age groups (0–24, 25–44, 45–64, 65–74, 75+), and four educational levels (primary, secondary, high school, and university).

Finally, to quantify effect sizes, we follow Ruhm [30] and Cervini-Plá and Vall-Castelló [12]. The relative effect of a one percentage point increase in unemployment on mortality from cause *k* is:

$$(e^{\gamma_k} - 1) * 100\%$$

This formula provides the expected percentage change in mortality from cause *k* resulting from a one percentage point increase in the unemployment rate. These relative effects are then translated into absolute numbers using the formula:

$$(e^{\gamma_k} - 1) * \pi_k D$$

where π_k represents the share of deaths attributable to cause *k* and *D* is the average annual number of deaths (599,661).

Results

We begin by analyzing the relationship between unemployment and total mortality, with attention to differences across causes of death.

The first row of Table 1 shows that overall mortality ("All Causes") exhibits a procyclical pattern. The coefficient (-0.00161) is negative and statistically significant, indicating that a one–percentage point increase in the local unemployment rate is associated with a modest decline (-0.16%) in mortality. This result reflects a contemporaneous correlation between unemployment and mortality and is consistent with the evidence reported by Ruhm [30], who documents a weakening of the procyclical relationship over time.

Table 1 Association between unemployment rate increase and mortality rate by cause of death

Mortality Rate	Unemployment Rate
All Causes	-0.00161*
	(0.000923)
Transport Accidents	-0.00853*
	(0.00471)
Suicide	-0.00916*
	(0.00503)
Homicide	0.00282
	(0.0116)
Cancer	-0.00139
	(0.00102)
Diabetes	-0.000960
	(0.00227)
Alzheimer	-0.00258
	(0.00335)
Circulatory System Diseases	-0.00192*
	(0.00111)
Digestive	-0.000923
	(0.00192)
Other Accidents	-0.000761
	(0.00264)
Respiratory	-0.00270
	(0.00169)
Other Diseases	-0.00122
	(0.00147)
Observations	1,648
Year fixed effects	YES
Province fixed effects	YES
Province specific linear trends	YES

All estimations include Year FE, Province FE, Province-specific linear trends and Demographic control

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Focusing on cause-specific mortality, the analysis reveals a more nuanced pattern of associations across causes of death. Among the statistically significant coefficients, a one–percentage point increase in the unemployment rate is associated with a 0.853% decrease in mortality from transport accidents, significant at the 90% confidence level. Similarly, a one–percentage point increase in unemployment corresponds to a 0.916% decrease in suicide mortality, also significant at the 90% level. In addition, mortality from circulatory system diseases is associated with a 0.192% decline following a one–percentage point increase in unemployment, again significant at the 90% confidence level.

The decline in mortality from transport accidents is consistent with descriptive mechanisms discussed in the literature, whereby economic downturns reduce mobility and

traffic volumes and therefore lower exposure to accident-related risks. This interpretation aligns with the correlations documented by Ruhm [29] and, more recently, by Cervini-Plá and Vall-Castelló [12] for the Spanish context.

For other causes of death, the estimated coefficients are not statistically different from zero. In particular, cancer and diabetes display negative but insignificant associations with unemployment, while homicide exhibits a positive but insignificant coefficient. The remaining categories ("Respiratory," "Digestive," "Other Accidents," "Alzheimer's," and "Other Diseases") also yield negative yet statistically insignificant estimates.

Taken together, these results indicate predominantly procyclical associations for specific causes of death, particularly those related to external and cardiovascular factors. Mortality from transport accidents declines markedly during economic downturns, consistent with reduced exposure to mobility-related risks. The estimated association for suicide is comparatively modest and only significant at the 10% level and should therefore be interpreted with caution.

While our findings partially align with the evidence reported by Cervini-Plá and Vall-Castelló [12] for Spain, the absence of a strong statistically significant associations across all causes mirrors the patterns highlighted by Ruhm [30]. In particular, Ruhm documents a substantial shift over time, whereby total mortality evolved from being strongly procyclical in earlier decades to becoming weakly related or uncorrelated with macroeconomic fluctuations in more recent periods.

Importantly, the absence of a strong aggregate association between unemployment and mortality should not be interpreted as evidence that job loss improves health outcomes. A large body of micro-level evidence shows that unemployment is causally associated with higher individual mortality risk through mechanisms such as stress, income loss, and employment instability [32].

This apparent paradox between individual-level causal effects and aggregate-level correlations is discussed in detail by Tapia Granados et al. [33], who show that while individual unemployment raises mortality risk, higher contextual (state-level) unemployment rates are correlated with lower mortality at the aggregate level. As our analysis is conducted at the macro level using provincial data, our estimates should be interpreted as capturing these contextual correlations rather than causal effects of unemployment on mortality.

The results presented above are therefore best interpreted as short-run, contemporaneous associations between macroeconomic conditions and adult mortality. Consistent with the literature following Ruhm [29], we document a predominantly procyclical relationship driven primarily by causes of death that respond rapidly to changes in economic activity, most notably traffic accidents.

These associations do not contradict evidence showing that adverse economic conditions may generate negative health consequences over longer horizons or across the life course. A growing literature documents that exposure to economic downturns early in life can causally impair infant and childhood health outcomes [2, 14] and generate persistent scarring effects that increase mortality risks later in adulthood [1]. The mechanisms emphasized in this literature–such as in utero conditions, parental investments, or cumulative disadvantage–differ fundamentally from those driving short-run correlations in adult mortality related to mobility or accident risk.

Taken together, this body of evidence points to a coherent framework in which economic downturns may simultaneously reduce certain contemporaneous mortality risks while increasing long-term health risks through early-life and life-cycle channels. While identifying these long-run causal pathways lies beyond the scope of the present analysis, our descriptive results for Italy are fully consistent with this interpretation and highlight the importance of distinguishing between short-run correlations and long-run causal effects when assessing the health consequences of macroeconomic fluctuations.

Heterogeneous analysis

In this section, we explore heterogeneities by examining the association between unemployment and mortality across age groups, gender, and educational levels. All specifications include year and province fixed effects as well as demographic controls, thereby accounting for unobserved variations specific to a given year or province and reducing the risk of omitted-variable bias.

Table 2 reports the relationship between fluctuations in unemployment and mortality across different age groups. The results highlight substantial heterogeneity by age.

Only the 0–24 age group exhibits a statistically significant association: a 1% increase in the unemployment rate corresponds to a 0.39% decline in mortality. This procyclical pattern appears specific to younger cohorts; for the other age groups, coefficients remain negative (procyclical) but are not statistically significant. This analysis indicates that the procyclical association is concentrated among young individuals (0-24). While our provincial panel provides age-specific *all-cause* mortality only (and does not report cause-specific mortality by age at the provincial level), external evidence supports a transport-related interpretation. First, official Italian road-safety statistics show that accident-involvement risk (relative to the number of active driving licences) is highest

Table 2 Changes in age-specific mortality rates relative to unemployment rate fluctuations

Mortality Rate	0-24	25-44	45-64	65-74	75+
Unemployment rate	-0.0039**	-0.0003	-0.000	0.0013	-0.0005
	(0.0017)	(0.0014)	(0.0013)	(0.0013)	(0.0013)
Observations	8,240	8,240	8,240	8,240	8,240
R^2	0.994	0.994	0.994	0.994	0.994
Year fixed effects	YES	YES	YES	YES	YES
Province fixed effects	YES	YES	YES	YES	YES
Province specific linear trends	YES	YES	YES	YES	YES

All estimations include Year FE and Province FE

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

among young drivers and declines after age 25, before rising again at older ages [22, 23]. The same sources document that road-traffic fatalities peak around ages 20-24 for men. Finally, Biondi and Mazzocchi [4] provide evidence for Italy that links road-traffic accidents to economic activity and mobility conditions using comprehensive police-record data for 2014–2020, and note that road traffic accidents disproportionately affect younger age groups.

Furthermore, Stevens et al. [31] document that increases in unemployment are associated with marked declines in traffic-related deaths among young adults, while He [21] finds that each percentage-point increase in unemployment reduced motor vehicle fatalities by 2.9% in the U.S. during the Great Recession. These reductions are not primarily driven by fewer miles traveled but by lower risk per mile, particularly in crashes involving heavy trucks, multi-vehicle collisions, and speeding. During downturns, reduced commercial activity lowers truck circulation and congestion, while risky behaviours such as speeding or alcohol-impaired driving decline due to reduced disposable income. Taken together, these facts make the stronger procyclical response among the youngest cohort consistent with differential exposure to mobility and transport-related risks over the business cycle, while we transparently acknowledge that we cannot directly decompose provincial mortality by cause within each age group.

Previous studies have shown that macroeconomic conditions, including unemployment, can influence mortality, but effects often differ substantially between men and women [16]. As a second dimension of heterogeneity, we examine the association by gender. Table 3 presents the results, highlighting important differences across causes of death.

For men, the coefficient for "All Causes" is negative and marginally significant ($\rho < 0.10$), suggesting modest procyclicality: a one–percentage-point increase in unemployment

Table 3 Relationship between unemployment rate changes and mortality for different causes of death by gender

Mortality Rate	Men	Women
All Causes	-0.00170*	-0.000357
	(0.00101)	(0.000644)
Transport Accidents	-0.00613	-0.0133**
	(0.00475)	(0.00660)
Suicide	-0.00969*	0.00158
	(0.00523)	(0.00698)
Homicide	-0.00161	-0.0203**
	(0.0123)	(0.00975)
Cancer	-0.00178	-0.000600
	(0.00117)	(0.000867)
Diabetes	0.00200	-0.000153
	(0.00307)	(0.00186)
Alzheimer	-0.00373	-0.0000843
	(0.00536)	(0.00267)
Circulatory System Diseases	-0.00110	-0.000531
	(0.00130)	(0.000768)
Digestive	-0.00170	0.00144
	(0.00240)	(0.00191)
Other Accidents	-0.00678**	0.00459**
	(0.00337)	(0.00225)
Respiratory	-0.00387*	-0.00101
	(0.00202)	(0.00160)
Other Diseases	-0.00230	-0.000141
	(0.00176)	(0.00114)
Observations	1,648	1,648
Year fixed effects	YES	YES
Province fixed effects	YES	YES
Province specific linear trends	YES	YES

All estimations include Year FE, Province FE and demographic control

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

is associated with a 0.17% decline in overall mortality. Cause-specific estimates reveal further procyclical effects. Mortality from suicide, other accidents, and respiratory diseases falls significantly when unemployment rises: a one–percentage-point increase in unemployment is associated with 0.97% fewer suicide deaths (significant at the 10% level), 0.68% fewer deaths from other accidents (significant at the 5% level), and 0.39% fewer respiratory deaths (significant at the 10% level). While the suicide result may appear counterintuitive, these patterns are consistent with reduced work- and traffic-related exposures during downturns and with more time available for health maintenance. In contrast, estimates for homicide, circulatory diseases, digestive diseases, Alzheimer's, transport accidents, cancer, and other causes are not statistically significant. Overall, men's mortality displays modest procyclicality, driven mainly by reductions in external and respiratory causes,

while most other outcomes show no systematic association with unemployment.

For women, the coefficient for "All Causes" is negative but not statistically significant, indicating no aggregate relationship between unemployment and mortality. At the cause-specific level, however, distinct patterns emerge. Transport accidents decline as unemployment rises (1.33% per one–percentage-point increase, 5% level), consistent with lower mobility and reduced exposure to traffic during recessions. Homicide also decreases (2.03% at 5% level), suggesting a procyclical pattern potentially linked to reduced public or contact-intensive activities in weaker labor markets. By contrast, deaths from other accidents increase (0.46% at 5% level), pointing to a countercyclical component that may reflect greater time spent at home and a higher incidence of domestic accidents. For suicide, cancer, diabetes, Alzheimer's, circulatory, digestive, respiratory, and other causes, no statistically significant effects are observed.

Table 4 presents the relationship between unemployment and mortality across education groups. The coefficients for individuals with high school and university education are negative and statistically significant, indicating procyclicality, consistent with the findings of Edwards [15]. For those with a high school degree, a one–percentage-point increase in unemployment is associated with a 0.694% reduction in mortality, while for university graduates the reduction is 0.628%. These results suggest that the relationship between unemployment and mortality is not uniform across education groups, with more educated individuals experiencing relatively stronger mortality reductions during economic downturns.

While these results should not be interpreted causally, they are consistent with several mechanisms emphasized in the labor and health economics literature. One potential mechanism relates to differences in baseline health and health-related behaviors across education groups. A large body of evidence shows that more educated individuals tend to have healthier lifestyles, including better diet, higher levels of physical activity, and healthier behaviors overall. Importantly, prior research suggests that these differences may become more salient during economic downturns, when reductions in working time allow individuals to reallocate time toward health-enhancing activities. In this sense, recessions may disproportionately benefit the health of higher-educated individuals who are better positioned to translate additional non-working time into healthier behaviors [24].

A second mechanism emphasized in the labor economics literature concerns financial resources and liquidity constraints during unemployment spells. Higher-educated individuals typically have higher lifetime earnings and greater accumulated wealth, which can buffer income losses during periods of joblessness. Reduced liquidity constraints may alleviate financial stress and allow for less pressured job search behavior, potentially mitigating adverse health effects associated with unemployment. By contrast, individuals with lower education levels often face tighter financial constraints, which may amplify stress and limit their ability to smooth consumption during unemployment spells, with possible negative implications for health [5, 13].

These findings partly align with Muller [26], who document that the share of individuals without a high school diploma is positively and linearly associated with age-adjusted mortality. In our case, having at least a high school diploma appears to be protective against mortality during economic downturns. Taken together, these results highlight the importance of socioeconomic heterogeneity in shaping the health effects of macroeconomic fluctuations. Nevertheless, the proposed mechanisms cannot be directly tested in our empirical framework and should therefore be interpreted as suggestive rather than causal.

Finally, we conclude this section by calculating the impact of these coefficients in terms of the number of deaths. Table 5 shows that a one percentage point increase in the unemployment rate leads to an average reduction of 965 deaths per year, with a 95% confidence interval ranging from -2407 to 119 deaths. When broken down by gender, the effect of a one percentage point increase in the unemployment rate is more pronounced for men, reducing deaths by 494, compared to a reduction of 110 deaths for women, the latter of which is not statistically significant.

We calculate death predictions for the causes of death that were statistically significant in the previous analysis, as shown in Table 1. Specifically, cardiovascular deaths show the largest decrease during a recession: a one percentage

Table 4 Relationship between unemployment rate changes and mortality for different cause of death by education level

Mortality Rate	Primary	Secondary	High School	University
Unemployment Rate	-0.00174	0.000380	-0.00694**	-0.00628**
	(0.00116)	(0.00287)	(0.00267)	(0.00299)
Observations	1648	1648	1648	1648
R^2	0.9175	0.8920	0.9162	0.8363
Year fixed effects	YES	YES	YES	YES
Province fixed effects	YES	YES	YES	YES
Province specific linear trends	YES	YES	YES	YES

All estimations include Year FE, Province FE and Demographic control

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5 Predictions of the number of deaths and confidence intervals at 95% for various causes of death.

Causes	Number of deaths	95% Conf. Interval	
Total Causes	-965	-2407	119
Transport accidents	-39	-81	3
Suicide	-36	-74	3
Circulatory System Diseases	-431	-919	57
Men	-494	-1069	81
Women	-110	-499	279

Note: In order to calculate the predicted number of death we use $(e^{\hat{\gamma}k} - 1)x\pi_k D$ where π_k is the share of deaths due to source k and D is the average annual number of deaths (599,661). 95% confidence intervals are estimated as $(e^{\hat{\gamma}k \pm 1.96xs_k} - 1)x\pi_k D$ for s_k standard error. *** p<0.01, ** p< 0.05

point increase in the unemployment rate leads to 431 fewer cardiovascular deaths annually. Additionally, a one percentage point rise in the unemployment rate is associated with a reduction of 39 deaths from transport accidents and 36 fewer deaths from suicide.

Robustness check

In this section, we assess the robustness of our baseline results to the use of an alternative macroeconomic proxy for business-cycle conditions. Specifically, we replace the provincial unemployment rate with *GDP per capita growth*, an output-based indicator that captures local fluctuations in economic activity. Since GDP growth is constructed using lagged values, the first year of each provincial time series is mechanically lost; accordingly, the number of observations in the GDP-growth specification (1,545) is smaller than in the baseline unemployment specification (1,648).

Table 6 reports the results of this robustness exercise and juxtaposes the coefficients obtained using unemployment (a countercyclical indicator) with those obtained using GDP per capita growth (a procyclical indicator). Because unemployment typically increases during downturns whereas GDP growth rises in expansions, a *procyclical* mortality pattern should manifest as a negative association with unemployment and a positive association with GDP growth. Consistent with this interpretation, the coefficient for *all-cause mortality* is negative and statistically significant when unemployment is used as the macroeconomic proxy, while it is positive and statistically significant when GDP per capita growth is used, means that a one–percentage point increase in the GDP per capita growth is associated with a modest increase (0.079%) in mortality.

The cause-specific results indicate that this pattern is not purely driven by aggregation, but is instead linked to specific mechanisms. In particular, *suicide mortality* exhibits a sign-consistent procyclical pattern across proxies: it increases

Table 6 Association between GDP per capita growth and unemployment rate increase with mortality rate by cause of death

Mortality Rate	GDP per capita growth	Unemployment Rate
All Causes	0.000785*	-0.00161*
	(0.000408)	(0.000923)
Transport Accidents	-0.00256	-0.00853*
	(0.00272)	(0.00471)
Suicide	0.00521*	-0.00916*
	(0.00308)	(0.00503)
Homicide	-0.00315	0.00282
	(0.00649)	(0.0116)
Cancer	0.000945*	-0.00139
	(0.000490)	(0.00102)
Diabetes	0.000846	-0.000960
	(0.00114)	(0.00227)
Alzheimer	0.00121	-0.00258
	(0.00163)	(0.00335)
Circulatory System Diseases	0.000953*	-0.00192*
	(0.000509)	(0.00111)
Digestive	-0.000344	-0.000923
	(0.00111)	(0.00192)
Other Accidents	0.00137	-0.000761
	(0.00153)	(0.00264)
Respiratory	0.000427	-0.00270
	(0.000860)	(0.00169)
Other Diseases	0.000327	-0.00122
	(0.000743)	(0.00147)
Men	0.0007684*	-0.00170*
	(0.0004599)	(0.00101)
Women	0.000773*	-0.000357
	(0.000445)	(0.000644)
Observations	1,545	1,648
Year fixed effects	YES	YES
Province fixed effects	YES	YES
Province specific linear trends	YES	YES

All estimations include Year FE, Province FE, Province-specific linear trends, and Demographic control

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

with GDP per capita growth (0.52%) and declines when unemployment rises (-0.92%). A similar pattern emerges for *circulatory system diseases*, with a positive and statistically significant association with GDP growth (0.095%) and a negative and statistically significant association with unemployment (-0.19%). These findings suggest that the all-cause procyclicality is partly driven by causes plausibly linked to changes in exposure, intensity of activity, and behavioral adjustments over the business cycle.

At the same time, the robustness exercise reveals heterogeneity across causes, which is expected given that unemployment and output growth capture different dimensions of local economic conditions. For *transport accidents*, the

unemployment coefficient is negative and statistically significant, whereas the GDP-growth coefficient is negative but not significant. This divergence is consistent with the view that labor-market slack may proxy traffic exposure and commuting intensity more directly than GDP growth at the provincial level. Conversely, *cancer mortality* shows a small but statistically significant positive association with GDP growth (0.095%), while the unemployment coefficient is negative but not significant.

Overall, Table 6 indicates that the qualitative implication of a procyclical mortality response is robust to replacing unemployment with an output-based macroeconomic proxy, especially for all-cause mortality and for key causes such as suicides and circulatory diseases. Using GDP-based indicators as an alternative proxy for macroeconomic conditions follows standard practice in the macro–health literature, which often relates mortality dynamics to output growth in addition to labor-market indicators [20].

Furthermore, we extend the analysis to 2020 and 2021 to examine the impact of the COVID-19 pandemic. Including these years allows us to assess whether the unemployment–mortality relationship changes significantly during this unprecedented crisis. The pandemic affected not only the healthcare system but also individual behaviors and lifestyles, influencing both direct and indirect causes of mortality. This extended timeframe therefore provides a more comprehensive perspective on the interplay between unemployment and mortality under extraordinary circumstances.

In the main analysis, we exclude the pandemic years because the pandemic represents an external factor that influences mortality (particularly by increasing deaths from respiratory causes) while simultaneously driving up unemployment due to the accompanying economic crisis. Consequently, during these years, both unemployment and mortality increase simultaneously, moving in the same direction. Therefore, our hypothesis is that when we include these years in the analysis, the relationship between unemployment and mortality will become less procyclical, as the dynamics observed during the pandemic are countercyclical in nature.

The data analysis in Table 7 indicates that the effect of unemployment on overall mortality is negative for both periods considered, suggesting that an increase in the unemployment rate generally corresponds to a decrease in mortality. However, the effect size is slightly smaller when the COVID-19 years are included, and the coefficient becomes statistically insignificant. This outcome can be explained by the contrasting effects observed across different causes of death. The pandemic caused a sharp rise in respiratory-related deaths, primarily due to COVID-19, as shown by the significant peak in respiratory mortality in 2020 (purple line in Fig. 4). This trend is reflected in the positive and

Table 7 Effect of a one point increase in the unemployment rate on the mortality rate due to different causes of death

Mortality Rate	2004-2019	2004-2021	2020-2021
All Causes	-0.00161*	-0.000618	0.000405
	(0.000923)	(0.000854)	(0.00318)
Transport Accidents	-0.00853*	-0.0107**	-0.00800
	(0.00471)	(0.00429)	(0.0199)
Suicide	-0.00916*	-0.00197	0.0381***
	(0.00503)	(0.00431)	(0.0138)
Homicide	0.00282	0.00893	0.0519
	(0.0116)	(0.0101)	(0.0688)
Cancer	-0.00139	-0.00165*	-0.00328
	(0.00102)	(0.000858)	(0.00244)
Diabetes	-0.000960	-0.000204	0.000456
	(0.00227)	(0.00197)	(0.00854)
Alzheimer	-0.00258	-0.00442	-0.0212**
	(0.00335)	(0.00310)	(0.0107)
Circulatory System Diseases	-0.00192*	-0.00140	0.00357
	(0.00111)	(0.000993)	(0.00250)
Digestive	-0.000923	-0.00209	-0.00599
	(0.00192)	(0.00169)	(0.00657)
Other Accidents	-0.000761	0.000608	0.00534
	(0.00264)	(0.00225)	(0.00668)
Respiratory	-0.00270	0.00388*	0.00394
	(0.00169)	(0.00210)	(0.0134)
Other Diseases	-0.00122	-0.00282**	-0.00251
	(0.00147)	(0.00130)	(0.00308)
Men	-0.00170*	-0.00061	0.0012
	(0.00101)	(0.00093)	(0.0047)
Women	-0.00036	-0.00006	-0.0014
	(0.00064)	(0.00063)	(0.002)
Observations	1,648	1,854	206
Year fixed effects	YES	YES	YES
Province fixed effects	YES	YES	YES
Province specific linear trends	YES	YES	NO

All estimations include Year FE, Province FE and Demographic control

Robust standard errors in parentheses

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

significant coefficient for respiratory diseases, highlighting the substantial impact of the pandemic on mortality specifically related to respiratory causes. In particular, with a one percentage point increase in the unemployment rate, respiratory disease mortality will increase by 0.39%. Furthermore, since the coefficient is positive and statistically significant at the 90% confidence level, it also indicates a countercyclical effect of the mortality rate with increasing unemployment.

At the same time, other causes of death remained stable or even declined. For example, deaths from transport accidents and cardiovascular diseases either decreased or did not increase significantly, likely due to mobility restrictions and lockdowns, which reduced incidents associated with

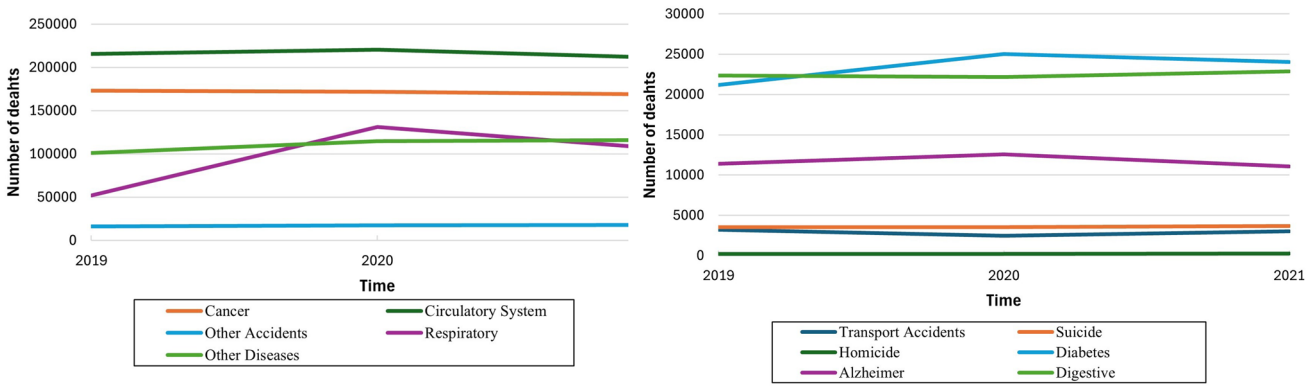

Fig. 4 Evolution of mortality by cause in the period 2019-2021 - Source: ISTAT

external risks. This offset between the rise in respiratory-related deaths and the decline or stability in other causes contributed to maintaining a relatively stable overall mortality rate. Consequently, while unemployment increased and respiratory-related deaths rose during the pandemic, the stability in other causes resulted in no significant change in the total mortality rate.

For "other diseases," the coefficient becomes negative and statistically significant at the 95% level once 2020–2021 are included. A one–percentage-point increase in unemployment is associated with a 0.28% reduction in mortality from these causes, consistent with procyclicality.

Overall, incorporating the pandemic years reduces the overall procyclical effect of unemployment on mortality. The most striking change concerns respiratory diseases, where the pandemic reversed the usual relationship, producing a countercyclical pattern. For other causes, procyclical effects persist, but they are overshadowed by the pandemic's direct impact on respiratory mortality.

Furthermore, Table 7 reports, in addition to the baseline estimates for 2004–2019 and the extended sample 2004–2021, a separate specification for the COVID-19 years (2020–2021). Estimating this short window separately helps assess whether the unemployment–mortality rate relationship observed in normal times persists under crisis conditions. Due to the extremely limited time span (two years), we do not include province-specific linear trends in the COVID-only specification, as such trends would absorb most of the within-province variation and leave insufficient identifying variation. Focusing on the COVID-19 period, 2020–2021, the all-cause coefficient becomes close to zero, positive and statistically insignificant (0.0004), and most cause-specific coefficients are imprecisely estimated, reflecting both the exceptional nature of the shock and the limited sample size. Two noteworthy exceptions emerge: the coefficient for suicide turns positive and significant at the 99% confidence level (0.0381), while Alzheimer's-related mortality becomes more negative and significant at the 95% confidence level (−0.0212). Overall, these results support the hypothesis that the pandemic years behave differently and are more informative when analysed separately rather than mechanically pooled with the pre-pandemic period.

Conclusion

This study analyzes the relationship between economic cycles and mortality in Italy from 2004 to 2019, using unemployment as an indicator of macroeconomic conditions. The results reveal a procyclical pattern: higher unemployment is associated with lower mortality, with notable variations by gender and cause of death. Comparable evidence of procyclical mortality has been documented in Germany [27], Spain [12, 19], France [10], Mexico [18], Canada [3], OECD countries [17], and Pacific-Asian nations [25]. When the pandemic years (2020–2021) are included, the relationship weakens, with the effect of unemployment on mortality becoming negative but statistically insignificant.

The gender-specific analysis shows that unemployment significantly reduces mortality among men, but the effect is not significant for women. The impact also differs across causes of death: mortality from road accidents, suicides, and cardiovascular diseases declines when unemployment rises, while respiratory-related deaths increase during the pandemic, reflecting the influence of COVID-19. Across age groups, only the 0–24 cohort exhibits a statistically significant (procyclical) decline in mortality; estimates for other age groups are negative but not significant. Moreover, educational disparities are marked: the procyclical effect is strongest among individuals with higher education, such as high school and university graduates.

This study contributes to the literature by providing a provincial-level analysis for Italy, thereby emphasizing the importance of demographic characteristics in assessing the

health effects of economic conditions. This approach complements the national-level time series analysis of Cavicchioli and Pistoresi [11].

In sum, the evidence confirms a general procyclical relationship between mortality and recessions, consistently observed whether local business-cycle conditions are proxied by the unemployment rate or by GDP per capita growth, while the pandemic years illustrate how extraordinary crises can alter these dynamics. The findings underscore important policy implications: the health consequences of job loss extend beyond immediate economic hardship. Targeted interventions for unemployed individuals could therefore improve not only economic outcomes but also reduce health risks associated with labor market shocks. At the same time, periods of economic expansion and low unemployment also require careful monitoring, as they are associated with higher risks of traffic accidents and stress-related conditions. Policies aimed at promoting road safety and mitigating work-related stress could thus play a crucial role in reducing preventable mortality during economic upturns.

Appendix

Table 8 Yearly Data on Unemployment Rate, Total Causes (deaths), Population, and Mortality Rate

Year	Unemployment Rate	Deaths	Population	Mortality Rate
2004	8.015	541,908	55,907,407	9.693
2005	7.745	565,149	56,328,280	10.033
2006	6.790	551,597	56,564,801	9.752
2007	6.087	565,638	56,778,738	9.962
2008	6.737	574,313	57,257,169	10.030
2009	7.764	581,159	57,663,165	10.079
2010	8.381	565,654	57,925,411	9.765
2011	8.377	574,990	58,174,169	9.884
2012	10.678	593,664	58,323,892	10.179
2013	12.175	579,937	58,489,728	9.915
2014	12.717	579,004	58,557,238	9.888
2015	11.929	624,875	58,507,343	10.680
2016	11.725	597,577	58,379,655	10.236
2017	11.242	629,469	58,285,332	10.800
2018	10.639	612,186	58,159,212	10.526
2019	9.982	620,018	58,042,345	10.682

Table 9 Total and proportions of deaths in total mortality by cause of death - Source: National Institute of Statistics (ISTAT)

Charachteristics	Total of deaths	Percentage (%)
Gender		
Men	4,657,266	48.54
Women	4,937,313	51.46
Causes		
Transport accidents	73,832	0.77
Suicide	63,225	0.66
Homicide	7,120	0.07
Cancer	2,800,677	29.19
Diabetes	331,475	3.45
Alzheimer	157,917	1.65
Circulatory system diseases	3,596,104	37.48
Digestive	370,826	3.86
Other accidents	242,148	2.52
Respiratory	685,677	7.15
Other diseases	1,265,578	13.19
Age group		
0-24	67,186	0.70
25-44	168,521	1.77
45-64	948,814	9.95
65-74	1,420,677	14.89
75+	6,933,325	72.69
Education level		
Elementary school certificate	7,050,636	73.92
Middle school certificate	1,571,212	16.47
High school diploma	664,404	6.97
University degree or diploma	252,293	2.64

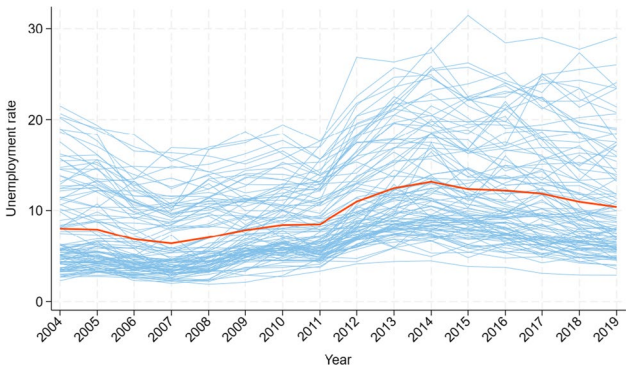

Fig. 5 Provincial unemployment trends (2004–2019). Note: The figure plots annual unemployment rates for each province over the sample period. Thin blue lines represent province-specific time series, while the red thicker line reports the cross-provincial (national) mean in each year. The graph highlights substantial heterogeneity in unemployment dynamics across provinces alongside common aggregate movements over time

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Data Availability The datasets analysed in this study are publicly available from ISTAT, Italian National Institute of Statistics, (https://esploradati.istat.it/databrowser/#/en) and Eurostat (https://ec.europa.eu/eurostat). Use of ISTAT and Eurostat data is subject to their respective terms of use.

Declarations

Competing interests All authors certify that they have no affiliations with, or involvement in, any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Ethical statement The study did not involve human participants, human data, human tissue, or animals.

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