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RESEARCH ARTICLE

Economic instability, income, and unemployment effects on mortality: using SUR panel data in Iran

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Abstract
This study aims to investigate the effects of socioeconomic factors on mortality in Iran. To this end, this research examines how economic instability, income, and unemployment affect mortality using a seemingly unrelated regression (SUR) with panel data for 30 provinces in Iran from 2004 to 2019. The results indicate that unemployment and mortality have a countercyclical relationship among the working age-groups 20–59 but a procyclical pattern among old-age (60+), except for rural mortality. This result is harmonious between employment and age-group mortality. This finding implies that unemployment increases mortality in working age-groups due to psychological stress and poverty risk. In addition, the income level decreases mortality in all ages over 40 years due to the provision of higher access to health and medical services and social welfare. However, it increases mortality in rural areas and age-group 20–39 because of their hazardous, unsafe, and stressful work conditions. Therefore, policymakers should plan for an inclusive economic growth to reduce poverty and out-of-pocket payments and increase the quality and accessibility of public health services, especially for beneficiaries of lower social groups. Moreover, they should adopt strategies to alleviate the burden of premature, preventable, and treatable deaths.

Keywords Economic instability · Income · Unemployment · Mortality · Public health

JEL Classification I15 · I18

Introduction

Economic development plays an important role in health status. Many researchers examine the impact of economic instability on mortality rates during the economic crises of 1997–1998 and 2007–2008 (McInerney & Mellor, 2012; Miller et al., 2009; Palència et al., 2020; Tapia Granados, 2005; Williams et al., 2016). Recent studies examine whether the relationship between mortality and economic status strengthens, weakens, or reverses during times of crisis. Many studies consider economic indicators, including unemployment

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rates, employment-to-population ratios, and GDP, as the main drivers of health inequalities (Clemens et al., 2015; Ruhm, 2012; Tapia Granados & Ionides, 2017; Vagerö & Garcy, 2016). These studies try to investigate whether the relationship between employment and GDP with mortality is positive, negative, or neutral, i.e., whether it follows procyclical, countercyclical, and acyclical patterns, respectively.

Many researchers conclude that there is a procyclical relationship between economic status and mortality. In the last two decades, Ruhm pioneered alternative methods to study the relationship between economic variables and health outcomes (Ruhm, 2000). Numerous studies confirm the procyclical pattern of mortality (Ariizumi & Schirle, 2012; Cervini-Plá & Vall-Castelló, 2021; Greenaway-McGrevy, 2021; Ruhm, 2005, 2015; Sameem & Sylwester, 2017; van den Berg et al., 2017; Zilidis & Hadjichristodoulou, 2020). Tapia Granados (2005) also confirms this procyclical pattern between mortality rates and economic conditions—the debate that an economic boom increases mortality rates because employment increases. Some studies show that morbidity from smoking and obesity increases during economic prosperity, while physical activity and doctor visits decrease (Ásgeirsdóttir et al., 2014, 2016; Fukuda et al., 2004; Jofre-Bonet et al., 2018; Urbanos-Garrido & Lopez-Valcarcel, 2015). In addition, health outcomes deteriorate due to pollution, accidents, and work pressure during economic booms (Heutel & Ruhm, 2016; Mohamad Taghvaee et al., 2021).

However, some researchers believe there is a countercyclical relationship between economic status and mortality. Mcinerney & Mellor (2012) concluded that adult mortality exhibited a countercyclical pattern from 1994 to 2008 (McInerney & Mellor, 2012). Lam & Pierard (2017) confirmed that the relationship between mortality and business cycles was countercyclical for some age-groups in the United States (Lam & Piérard, 2017). According to countercyclical theories, an economic downturn leads to unemployment and financial stress, which is detrimental to mental health. In addition, the recession reduces the money available to households, which prevents them from obtaining adequate health and medical items. Also, Gordon and Sommers (2016) claim that studies should consider other economic factors, such as median income and poverty rates, in investigating the relationship between unemployment and mortality (Gordon & Sommers, 2016). Bruning and Thuilliez (2019) show a significantly countercyclical relationship between unemployment and mortality in sample countries with a low level of education, high population, and large migrants. According to Bruning and Thuilliez (2019), this relationship depends on the sample and time conditions, as it changed from slightly procyclical to slightly countercyclical in the United States over time (Brüning & Thuilliez, 2019).

Iranian household wealth indicators deteriorated during 2004–2017 (Azizkhani, 2018). Since 2005, the consumption of essential goods and food calories has no longer been desirable, and the decline in per capita income has increased the poverty rate (Einian & Souri, 2018). In Iran, the poor account for about 59% of workers and 30% of unemployed and pensioners. Iran has also recorded more than 350,000 deaths per annum and is subject to severe economic fluctuations. Neshat Ghojagh et al. (2023) findings show that economic cycles play a critical role in the mortality rate in Iran as a developing country due to decades of chronic stagflation.

This study investigates the nexus between socioeconomic factors and health status. The health status is proxied by the mortality rate. Hence, this study estimates the relationship between major socioeconomic factors and mortality rates among 30 provinces of Iran.

Figure 1 depicts the unemployment rate (UEM) and employment-to-population ratio (EPR) during 2004–2019. UEM varies between 10% and 15%, indicating 2-digit and chronic unemployment in Iran. EPR changes from above 40% in 2004 to a minimum rate of 35.5% in 2011 and reaches 39.36% in 2019, oscillating around 40% during the study period.

The remainder of this paper is organized as follows. Section 2 explains the method and data. Section 3 provides the results, and Section 4 discusses the research findings. Finally, Section 5 concludes.

Method and data

The economic activity affects health status in various ways. For instance, improper and hazardous work conditions can deteriorate laborers' physical and mental abilities. These induce multiple diseases and accelerate mortality. In addition, low wages may hinder buying sufficient insurance policies, which in turn makes workers vulnerable to catastrophic diseases.

Recessionary periods decrease workers' purchasing power and lower their demand for health. This condition may occur due to consuming inferior and unhealthy foods, low physician visits, parsimonious lifestyle, and lack of health-enhancing efforts.

On the other hand, when the economy enters a flourishing period, the income and demand for different goods and services increase. Some empirical studies confirm the health-endangering behaviors in the cycle of economic growth. Alcohol intake, hazardous driving, consumption of fast foods, addiction to drugs, and low physical activity are among these behaviors that lead to premature mortality.

However, mortality is a multifactorial issue that depends on socioeconomic conditions. As a result, modeling this phenomenon should account for intrinsic inequalities of people's health in terms of age, gender, geography, degree of economic development, participation in the labor market, and factors that affect healthcare utilization.

Following Hone et al. (2019), Lee and Kim (2017), Lindo (2015), and Ruhm (2000), this study employs Model 1 to investigate the relationship between the mortality rate and its components and socioeconomic indicators in 30 provinces of Iran during 2004–2019.

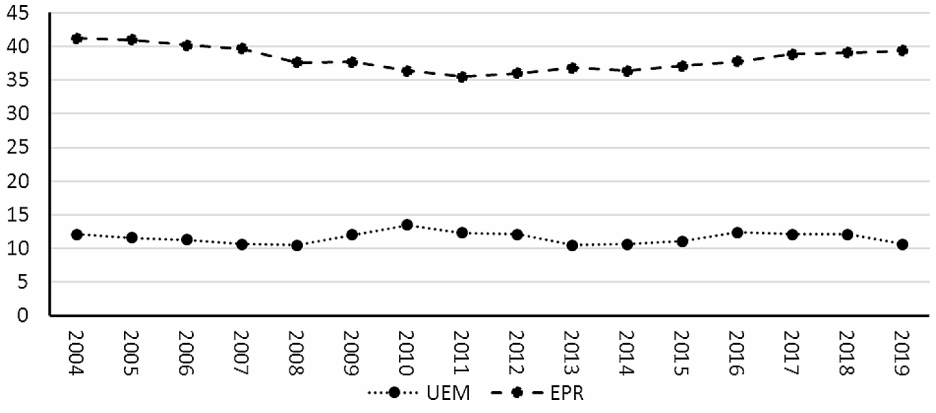

Fig. 1 Unemployment rate (UEM) and employment-to-population ratio (EPR). Source of data: Statistical Centre of Iran (SCI)

$$M_{it} = E_{it}\beta + X_{it}\delta + \alpha_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where M_{it} is a measure of mortality in province *i* in year *t*, E_{it} is a measure of economic conditions, X_{it} is a vector of control variables, α_i is provincial fixed effects, γ_t is time fixed effects, β is the coefficient of the economic conditions variable, δ is the coefficient of control variables, and ϵ_{it} shows error term. All dependent variables are in natural logarithm.

The dependent variables include the total, female and male, rural and urban mortality rates per 100,000 people for 20–39, 40–59, 60–74, and over 75 years old, denoted by TM, FM, MM, RM, and UM, respectively. The dependent variable is the mortality rate in a single regression.

Economic conditions, including alternative business cycle indicators, are the unemployment rate, employment-to-population ratio, and real GDP per capita (constant 2016 Rial of Iran), denoted by UER, EPR, and GDP, respectively.

Control variables are the number of physicians per 100,000 people, percentage of insurance coverage, and demand for health services denoted by NPH, INS, and DEM, respectively.

This model applies multiple seemingly unrelated regression (SUR) using the xtsur command in Stata 17, which is based on a multistep (stepwise) algorithm, Generalized Least Squares (GLS), and the Maximum Likelihood (ML) procedures, first proposed by Biorn (2004) and Nguyen (2010).

In this paper, our dataset covers 30 provinces during 2004–2019.[1] The mortality at the provincial level is gathered from the National Organization of Civil Registration (NOCR, 2021). Annual mortality data are provided as the number of deaths per 100,000 people for gender, urban, and rural regions separately.[2]

All data of explanatory variables are extracted from the Statistical Center of Iran (SCI, 2021). The sample is a macro panel data, where T=16, N=30, T<N, which can produce valid results irrespective of testing cross-sectional dependence, contemporaneous correlation, serial correlation, and unit root (Torres-Reyna, 2007).

Table 1 presents the descriptive statistics of the mortality rates. The mortality rate of men is higher than that of women. This difference is also visible between rural and urban areas. Therefore, more deaths occur in cities, especially for people aged below 75. The difference between mortality rates might be related to differences in socioeconomic status in rural and urban regions.

Table 1 reports the descriptive statistics of explanatory variables. These variables include unemployment rate, employment to population ratio, real GDP per capita, number of physicians per 100,000 people, percentage of insurance coverage, and demand for health services—data collected from the Statistical Center of Iran (SCI) website.

[1] Iran has 31 provinces, but the mortality data are available only for 30 provinces.

[2] According to the official Iranian law, mortality data are recorded ten days after death.

Table 1 Descriptive statistics of variables

Variable	Age	Notation		Mean	Std. dev.	Min	Max	Observations
Rural mortality rate	20–39	RM 20–39	Overall	42.70	22.50	1	224	$N = 480$
			Between		16.21	5.94	74.88	$n = 30$
			Within		15.87	5.83	198.01	T = 16
	40–59	RM 40–59	Overall	53.96	18.84	4	102	$N = 480$
			Between		16.31	14.31	89.06	$n = 30$
			Within		9.86	25.34	109.15	T = 16
	60–74	RM 60–74	Overall	96.22	38.17	8	208	$N = 480$
			Between		34.39	24.00	174.06	$n = 30$
			Within		17.63	45.78	166.09	T = 16
	Over 75	RM≥75	Overall	205.54	87.89	16	557	$N = 480$
			Between		80.09	41.50	420.06	$n = 30$
			Within		38.87	48.48	389.29	T = 16
Urban mortality rate	20–39	UM 20–39	Overall	48.84	17.18	2	145	$N = 480$
			Between		14.32	10.69	89.69	$n = 30$
			Within		9.82	6.16	104.16	T = 16
	40–59	UM 40–59	Overall	68.86	15.80	9	108	$N = 480$
			Between		13.93	23.13	90.50	$n = 30$
			Within		7.86	46.04	118.73	T = 16
	60–74	UM 60–74	Overall	96.44	23.18	22	187	$N = 480$
			Between		20.17	49.81	137.81	$n = 30$
			Within		11.97	61.44	173.62	T = 16
	Over 75	UM≥75	Overall	170.67	40.64	68	281	$N = 480$
			Between		32.40	97.38	228.38	$n = 30$
			Within		25.20	59.92	280.48	T = 16
Female mortality rate	20–39	FM 20–39	Overall	29.67	18.20	4	196	$N = 480$
			Between		12.56	10.50	71.38	$n = 30$
			Within		13.36	-14.70	171.49	T = 16
	40–59	MM 40–59	Overall	44.95	9.87	13	77	$N = 480$
			Between		8.53	25.31	63.13	$n = 30$
			Within		5.19	19.89	73.26	T = 16
	60–74	MM 60–74	Overall	84.90	20.85	35	169	$N = 480$
			Between		18.83	48.94	130.69	$n = 30$
			Within		9.56	48.03	140.34	T = 16
	Over 75	MM≥75	Overall	174.49	48.02	51	360	$N = 480$
			Between		40.75	72.13	275.31	$n = 30$
			Within		26.39	44.93	269.68	T = 16

Table 1 (continued)

Variable	Age	Notation		Mean	Std. dev.	Min	Max	Observations
Male mortality rate	20–39	MM 20–39	Overall	63.82	18.29	4	124	$N = 480$
			Between		15.52	15.56	94.19	$n = 30$
			Within		10.05	31.25	104.82	T = 16
	40–59	MM 40–59	Overall	83.26	18.55	14	136	$N = 480$
			Between		17.15	32.38	116.88	$n = 30$
			Within		7.69	54.26	140.89	T = 16
	60–74	MM 60–74	Overall	109.10	27.46	35	220	$N = 480$
			Between		24.62	68.19	174.25	$n = 30$
			Within		12.92	75.78	190.78	T = 16
	Over 75	MM≥75	Overall	189.32	43.58	84	338	$N = 480$
			Between		38.69	105.19	271.69	$n = 30$
			Within		21.19	116.63	273.07	T = 16
Total mortality rate	20–39	TM 20–39	Overall	47.02	16.19	4	145	$N = 480$
			Between		12.79	13.06	81.63	$n = 30$
			Within		10.18	8.39	125.02	T = 16
	40–59	TM 40–59	Overall	64.31	13.35	14	106	$N = 480$
			Between		12.21	29.06	89.38	$n = 30$
			Within		5.81	44.88	106.25	T = 16
	60–74	TM 60–74	Overall	97.13	23.34	35	194	$N = 480$
			Between		21.20	59.44	152.31	$n = 30$
			Within		10.46	65.88	165.88	T = 16
	Over 75	TM≥75	Overall	181.91	44.64	69	349	$N = 480$
			Between		38.87	89.63	273.19	$n = 30$
			Within		23.01	87.16	271.10	T = 16
Independent variables								
Unemployment rate		UER	Overall	11.52	2.85	5.3	22.2	$N = 480$
			Between		2.01	8.80	16.10	$n = 30$
			Within		2.06	6.13	18.70	T = 16
Employment to population ratio		EPR	Overall	38.02	3.80	27.7	50.2	$N = 480$
			Between		2.87	32.21	42.82	$n = 30$
			Within		2.54	32.20	48.56	T = 16
Real GDP per capita		GDP	Overall	185.00	145.23	48.1	909.1	$N = 480$
			Between		135.23	67.39	583.50	$n = 30$
			Within		58.10	121.32	521.28	T = 16
Control variables								
Number of physicians per 100,000 people		NPH	Overall	54.12	18.23	5.25	132.13	$N = 470$
			Between		11.01	37.92	85.69	$n = 30$
			Within		14.65	6.12	100.56	T = 16
Percentage of insurance coverage		INS	Overall	44.20	14.96	2.81	83.95	$N = 480$
			Between		13.25	20.96	77.56	$n = 30$
			Within		7.33	7.62	55.32	T = 16
Demand for health service		DEM	Overall	16.01	8.29	0.9231	47.244	$N = 442$
			Between		5.55	7.67	27.75	$n = 30$
			Within		6.12	0.20	41.68	T = 16

Source Research findings

Results

This section represents the relationships between the mortality rate and economic conditions in Iran by estimating panel data models. These conditions include business cycle indicators such as the unemployment rate (UER), employment-to-population ratio (EPR), and real GDP per capita (GDP).

The results are presented in Tables 2, 3, 4 and 5, in which Table 2 contains the estimation results of the models without control variables, and the following Tables 3, 4 and 5 denote estimations with the control variables including number of physicians, percentage of insurance coverage, and demand for health services denoted by NPH, INS, and DEM, respectively. Also, the intra-group correlation (rho) represents the time variation of the independent variables in each province, which was added to the last column of Tables 3, 4 and 5.

Table 2 shows the results of the regression of mortality rates on UER, EPR, and GDP. In most cases, unemployment has no significant effect on mortality rates, but there is a positive relationship between UER and mortality rates for people aged 75 years and over in rural and urban areas. Unemployment in the elderly group is meaningless because they are in retirement age. EPR is of significant coefficients in most samples, but it has a positive sign for rural mortality rates in the age-groups 20–74. The predominant adverse effects of EPR on urban, female, male, and total mortality rates mean that employment can reduce mortality. In other words, employment can increase personal earnings and provide proper lifestyles, which results in good health and delay in death. Per capita GDP has a mostly insignificant

Table 2 Results of regressions of mortality rate by age-groups on **UER, EPR, and GDP** without control variables, conducted at the provincial level, 2004–2019

	Variables	UER	EPR	GDP	Obs	N of id
(1)	RM 20–39	0.0072	0.007***	-0.0242	480	30
(2)	RM 40–59	0.0060	0.003*	-0.0107	480	30
(3)	RM 60–74	-0.0026	0.018***	-0.0172	480	30
(4)	RM ≥ 75	0.0092**	-0.004*	0.0171	480	30
(5)	UM 20–39	0.0134***	-0.032***	-0.0210	480	30
(6)	UM 40–59	0.0029	-0.012***	0.0097	480	30
(7)	UM 60–74	0.0038	0.010***	0.0207*	480	30
(8)	UM ≥ 75	-0.0079***	-0.006*	0.0327***	480	30
(9)	FM 20–39	0.0096***	-0.016***	-0.0113	480	30
(10)	FM 40–59	0.0032**	-0.010***	0.0143	480	30
(11)	FM 60–74	-0.0018	0.005***	0.0098	480	30
(12)	FM ≥ 75	0.0046***	-0.014***	0.0414***	480	30
(13)	MM 20–39	0.0100**	-0.010***	-0.0270*	480	30
(14)	MM 40–59	0.0042	-0.005***	-0.0022	480	30
(15)	MM 60–74	0.0024	0.014***	0.0086	480	30
(16)	MM ≥ 75	-0.0043*	-0.005***	0.0142*	480	30
(17)	TM 20–39	0.0081**	-0.011***	-0.0198	480	30
(18)	TM 40–59	0.0051**	-0.009***	0.0067	480	30
(19)	TM 60–74	0.0018	0.014***	0.0110	480	30
(20)	TM ≥ 75	-0.0010	-0.012***	0.0277***	480	30

Note *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source Research findings

effect on mortality rates. Thus, more evidence is needed to justify the different coefficients of GDP.

Table 3 shows the estimation results of the relationship between mortality rate and economic factors by age-group in Iran. According to Table 3, the unemployment rate has a significant effect on mortality rates of all age-groups. This effect is positive for the mortality of the working age-groups in rural regions (see UER coefficients for rural mortality, or RM). In rural areas, losing a job is highly beating and discouraging compared to urban areas, which may induce illness and hazardous behaviors such as suicide. As a result, mortality increases. In different age-groups, most coefficients UER for urban, female, male, and total mortality, denoted by UM, FM, MM, and TM, are negative and statistically significant. These indicate an indirect and general link between unemployment and mortality. Increasing unemployment provides some opportunities for leisure and recreation, social networking, physical activity, and self-care. These health-improving efforts might postpone sickness and mortality. The results confirm an indirect pattern between unemployment and mortality rate in working age-groups due to the psychological stress of poverty risk and chronic stagflation.

In general, the number of physicians per 100,000 people (NPH) has a significant effect on mortality rate. For the 20–39 age-group, irrespective of gender or region, the impact of NPH on mortality rate is negative. In this age-group, increasing physician density may result in effective treatment, which can decrease mortality rates. For ages over 60, the coefficients of NPH are positive and statistically significant. Due to multiple diseases among adults, increasing physician density cannot lower mortality rates. For the 40–59 age-group, NPH positively affects the rural mortality rate but negatively affects FM, UM, and TM. This contradictory result needs further study.

Health insurance has no direct effect on mortality. In the long run, all insured and non-insured people die. Insurance decreases out-of-pocket payments and guarantees patients financially when facing illnesses. The percentage of insurance coverage (INS) significantly affects the mortality rate. For the 20–39 and 40–59 age-groups, irrespective of gender or region, the effect of INS on mortality rate is negative. Increasing insurance coverage in these groups provides financial incentives to visit doctors and receive more medical services, reducing mortality rates. Except for urban mortality in 60–74 years older people, the coefficients of INS for ages over 60 are positive. As mentioned earlier, adults face various diseases, and the burden of diseases increases despite higher insurance coverage. This results in a direct relation between mortality rate and insurance coverage.

The demand for health care (DEM) is the third control variable under study. When an illness occurs, the demand for health care is realized. It depends mainly on patient purchasing power and health services fees. As Table 3 shows, DEM, in most cases, has a positive and significant impact on mortality rates. This effect can indicate two medical probabilities. First, health care may not be adequate for patient treatment. Second, most patients may visit doctors at the latest and critical stages of illness. Of course, this result seems strange and should be examined more precisely. The coefficient of DEM is negative for all age-groups in rural areas, which means demand for health care lowers mortality rates.

According to Table 3, the model's coefficients, including control variables, show a higher significance level compared with the corresponding coefficients of the model, excluding the control variables in Table 2. This difference can signal that including control variables improved the model's overall fit, reducing the residual variance. A better-fitting model can provide more precise estimates for all variables, including the main independent variables.

Table 3 Results of regressions of mortality rate by age-groups on UER and control variables (NPH, INS, DEM) at province level during 2004–2019

	Variables	UER	NPH	INS	DEM	rho
(1)	RM 20–39	0.0264***	-0.0048***	-0.0129***	-0.0087***	0.692
(2)	RM 40–59	0.0180***	0.0028***	-0.0032***	-0.0108***	0.675
(3)	RM 60–74	0.0374***	0.0034***	0.0023***	-0.0188***	0.762
(4)	RM ≥ 75	0.0264***	0.0051***	0.0076***	-0.0072***	0.824
(5)	UM 20–39	-0.0076***	-0.0045***	-0.0111***	-0.0039***	0.640
(6)	UM 40–59	-0.0156***	-0.0008**	-0.0036***	0.0068***	0.672
(7)	UM 60–74	-0.0044**	0.0006*	-0.0002	0.0049***	0.697
(8)	UM ≥ 75	-0.0014	0.0041***	0.0027***	0.0075***	0.743
(9)	FM 20–39	-0.0071***	-0.0112***	-0.0150***	0.0124***	0.374
(10)	FM 40–59	-0.0143***	-0.0005*	-0.0019***	0.0035***	0.637
(11)	FM 60–74	-0.0070***	0.0016***	0.0025***	0.0029***	0.774
(12)	FM ≥ 75	-0.0023**	0.0042***	0.0046***	0.0067***	0.820
(13)	MM 20–39	-0.0117***	-0.0038***	-0.0106***	-0.0050***	0.693
(14)	MM 40–59	-0.0098***	-0.0003	-0.0022***	0.0023***	0.746
(15)	MM 60–74	-0.0032*	0.0005	0.0008**	-0.0022***	0.775
(16)	MM ≥ 75	-0.0041***	0.0039***	0.0016***	0.0020***	0.879
(17)	TM 20–39	0.0058**	-0.0066***	-0.0162***	0.0005	0.553
(18)	TM 40–59	-0.0138***	-0.0007**	-0.0036***	0.0049***	0.734
(19)	TM 60–74	-0.0035**	0.0010***	0.0003	0.0006	0.798
(20)	TM ≥ 75	-0.0056***	0.0042***	0.0025***	0.0066***	0.871

Note *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Due to missing data, total observations is 432

Source Research findings

In this study, it seems that including demand for health service, insurance coverage, and number of physicians as controlling variables leads to a better specification of mortality pattern.

Table 4 is a new version of Table 3, the employment-to-population ratio (EPR) substituted with the unemployment rate (UER). The signs of NPH, INS, and DEM coefficients are generally similar to those of Table 2, confirming the previous results. In most cases, EPR coefficients are positive, which seems surprising. Hence, an increase in employment to population ratio raises the mortality rates. This relationship is because of the adverse effects of work conditions on health status.

While preserving NPH, INS, and DEM, Table 5 reports the estimation results by including gross domestic product (GDP). Similar results are observable for NPH, INS, and DEM again. The coefficients of GDP are mainly negative and statistically significant, although GDP coefficients are positive for rural mortality rates. The negativity of GDP coefficients means that increasing GDP can reduce mortality. This pattern is nearly countercyclical across all age-groups.

Table 4 Results of regressions of mortality rate by age-groups on EPR and control variables (NPH, INS, DEM) at province level during 2004–2019

	Variables	EPR	NPH	INS	DEM	rho
(1)	RM 20–39	-0.014***	-0.005***	-0.014***	-0.006***	0.693
(2)	RM 40–59	-0.021***	0.004***	-0.004***	-0.012***	0.648
(3)	RM 60–74	-0.009***	0.003***	-0.000	-0.018***	0.736
(4)	RM ≥ 75	-0.010***	0.006***	0.006***	-0.008***	0.808
(5)	UM 20–39	-0.004*	-0.004***	-0.009***	-0.003**	0.660
(6)	UM 40–59	-0.009***	-0.001	-0.001**	0.006***	0.680
(7)	UM 60–74	0.002	0.000	-0.000	0.005***	0.681
(8)	UM ≥ 75	0.004**	0.004***	0.003***	0.008***	0.739
(9)	FM 20–39	0.013***	-0.011***	-0.015***	0.011***	0.381
(10)	FM 40–59	-0.014***	-0.000	-0.003***	0.005***	0.631
(11)	FM 60–74	0.009***	0.001***	0.001***	0.005***	0.734
(12)	FM ≥ 75	0.009***	0.005***	0.007***	0.008***	0.799
(13)	MM 20–39	0.002	-0.003***	-0.009***	-0.004***	0.698
(14)	MM 40–59	0.000	0.000	-0.001**	0.002***	0.724
(15)	MM 60–74	0.008***	0.000	-0.000	-0.002***	0.682
(16)	MM ≥ 75	0.009***	0.004***	0.001***	0.003***	0.828
(17)	TM 20–39	0.015***	-0.006***	-0.015***	0.001	0.586
(18)	TM 40–59	0.002	-0.000	-0.001***	0.006***	0.723
(19)	TM 60–74	0.014***	0.000	0.001*	0.003***	0.715
(20)	TM ≥ 75	0.012***	0.004***	0.005***	0.009***	0.821

Note *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Due to missing data, the total observations is 432

Source Research findings

Discussion

This study shows that economic cycles significantly affect mortality in Iran via changes in the unemployment rate. Our findings show a countercyclical relationship between unemployment and mortality in working age-groups, including 20–39 and 40–59 years old, in both genders (male and female) and areas (rural and urban). Unemployment causes psychological stress due to increasing poverty risk and unsteady income, which in turn damages the health status, consistent with (Gordon & Sommers, 2016; Lam & Piérard, 2017; McInerney & Mellor, 2012), follows the corresponding changes observed in the United States.

However, our results show a procyclical pattern between unemployment and mortality for ages over 60, described as old-age. An explanation is that economic fluctuations affect people's time allocation, stress levels, and related health investments via their impacts on work hours (Greenaway-McGrevy, 2021; Sameem & Sylwester, 2017; Stevens et al., 2015).

However, Gerdtham and Ruhm (2006), Miller et al. (2009), and Urbanos-Garrido and Lopez-Valcarcel (2015) disapprove of our results by investigating the relationship between unemployment and mortality rates in the United States, OECD countries, and Spain. One explanation for this conflict is the difference in economic structure between developed countries and Iran. Economic cycles are mostly short-term and low in developed countries, whereas Iran is a developing economy with long-term, high, and chronic stagflation (Ruhm, 2016; Tapia Granados & Ionides, 2017). In addition, the social insurance in Iran, compared with developed countries, is relatively weak which exacerbates the detrimental effect of

Table 5 Results of regressions of mortality rate by age-groups on GDP and control variables (NPH, INS, DEM) at province level during 2004–2019

	Variables	GDP	NPH	INS	DEM	rho
(1)	RM 20–39	0.1326***	-0.0047***	-0.0183***	-0.0101***	0.680
(2)	RM 40–59	0.0323***	0.0028***	-0.0056***	-0.0139***	0.681
(3)	RM 60–74	0.0632***	0.0041***	-0.0012	-0.0189***	0.787
(4)	RM≥75	-0.0092	0.0048***	0.0081***	-0.0093***	0.839
(5)	UM 20–39	0.0360***	-0.0044***	-0.0123***	-0.0036***	0.627
(6)	UM 40–59	-0.0474***	-0.0011***	-0.0015***	0.0064***	0.677
(7)	UM 60–74	-0.0429***	0.0005	0.0013***	0.0053***	0.687
(8)	UM≥75	-0.0693***	0.0037***	0.0055***	0.0077***	0.715
(9)	FM 20–39	0.0368***	-0.0112***	-0.0164***	0.0131***	0.328
(10)	FM 40–59	-0.0033	-0.0009***	-0.0035***	0.0041***	0.637
(11)	FM 60–74	0.0049	0.0016***	0.0013***	0.0045***	0.770
(12)	FM≥75	-0.0536***	0.0041***	0.0070***	0.0084***	0.787
(13)	MM 20–39	0.0399***	-0.0033***	-0.0115***	-0.0052***	0.696
(14)	MM 40–59	-0.0438***	-0.0004	-0.0010**	0.0019**	0.744
(15)	MM 60–74	-0.0324***	0.0003	0.0010**	-0.0019**	0.754
(16)	MM≥75	-0.0483***	0.0037***	0.0036***	0.0015**	0.854
(17)	TM 20–39	0.0734***	-0.0063***	-0.0164***	0.0007	0.571
(18)	TM 40–59	-0.0292***	-0.0008***	-0.0027***	0.0040***	0.734
(19)	TM 60–74	-0.0171***	0.0009***	0.0000	0.0010	0.782
(20)	TM≥75	-0.0655***	0.0042***	0.0044***	0.0057***	0.843

Note *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Due to missing data, the total observations is 432

Source Research findings

unemployment on public health and mortality. In addition to the economic condition, many socioeconomic determinants are effective in the mortality rate, including employment-to-population ratio (EPR), gross domestic product (GDP), the number of physicians per 100,000 people, Insurance coverage, and demand for health care.

EPR positively affects mortality rates. This correlation may relate to the adverse effects of work conditions on health status. This finding is consistent with Sorlie and Rogot (1990), who believe that employed persons aged 25–64 in the US have mortality ratios from 61 to 74% of the average.

Generally, GDP has a negative and significant effect on mortality rates. This effect means that increasing GDP can reduce mortality. This pattern is nearly countercyclical across all age-groups. Similarly, Khanzada et al. (2021) revealed that increased GDP leads to decreased deaths from cardiovascular disease. However, the effect of GDP on mortality is positive in rural regions, which confirms the upward section of the inverted U-shaped relationship between income and mortality rate (Spiteri & von Brockdorff, 2019).

The number of physicians per 100,000 people (NPH) has varying effects on mortality rates in rural and urban areas, as well as between females and males. For the 20–39 age-group, the impact of NPH on mortality rate is negative since increasing physician density may result in access to treatment and decrease mortality rates. For ages over 60, NPH has a positive and significant effect on mortality. This positive association may imply that more older adults are becoming sick and need more physician services, which is due to their health status and increases the mortality rates. Therefore, increasing physician density can-

not lower mortality rates due to multiple diseases among adults. In similar work, Krakauer et al. (1996) find negligible effects of Physician supply levels on health status as measured by mortality rates. On the other hand, in the US, greater primary care physician supply was associated with lower mortality between 2005 and 2015 (Basu et al., 2019).

Health insurance decreases out-of-pocket payments and protects patients financially. Insurance coverage (INS) significantly affects the mortality rate. In younger ages, increasing insurance coverage facilitates visiting doctors and receiving medical services, which reduces mortality rates. In a similar study, Goldin et al. (2021) found that health insurance coverage can reduce mortality in the United States. Another research concludes that health insurance saves lives in the US (Woolhandler & Himmelstein, 2017). In older ages, the burden of diseases increases despite higher insurance coverage. In this context, a study by Chen et al. (2007) proved that Taiwan's National Health Insurance has increased the medical care utilization of older people but has not reduced their mortality.

The demand for health care (DEM), proxied by the number of hospital admissions per 100,000 people, depends on the severity of illness, the patient's income, and health services fees. In this study, the effect of DEM on mortality rates is positive. This direct link might be that as more people are sick, hospitalization rates increase, which in turn leads to worsened health status and increased mortality rates.

In this regard, Bodilsen et al. (2021) examined hospital admissions for all major non-covid-19 disease groups in Denmark during national lockdowns. They found that mortality rates were higher overall and for patients admitted to hospital with conditions such as respiratory diseases, cancer, pneumonia, and sepsis. Also, Filipovic et al. (2005) found a positive linkage between mortality rates and hospital admission rates for abdominal aortic aneurysms in England and Wales between 1979 and 1999. The coefficient of DEM is negative for all age-groups in rural areas, which means demand for health care lowers mortality rates. However, the impact of many socioeconomic factors on health status may differ in residential areas. Evidence shows that more people have limited access to adequate health care, especially in underdeveloped countries. Healthcare demand depends on the need for care, whether people know the need and want to obtain it, and whether care can be accessed. Furthermore, rural residents differ from urban residents in several characteristics that correlate with healthcare utilization. Rural residents have low incomes, sociodemographics, higher risk factors, utilization, and access, which cause lower health status and differentially affect population health (National Academies of Sciences, Engineering, and & Medicine, 2018).

Conclusion

Our research investigates how socioeconomic factors affect mortality rates in Iranian provinces using panel data between 2004 and 2019.

Our findings imply that unemployment and rural mortality have a positive relationship among working age-groups 20–59 due to the psychological stress and poverty risk but a negative nexus among old-age mortality (60+) by urban, female, male, and total. There is a harmonious relationship between employment-to-population ratio (EPR) and female, male, and total mortality.

These results are compatible with the prevalence of poverty, especially among the young workforce (20–39 years) and rural workers age-groups, who act in an economy with chronic

stagflation conditions. They suffer more due to hazardous working conditions. These conditions lead to health threats and increased mortality in this group. The relationship between GDP and old-age mortality (40+) is likely due to the spillover effects of higher income and wealth accumulation during economic stability. As a result, they have less pressure and stress than younger people. This relationship indirectly affects public health, such as food, housing, medical and public health services, leisure, and physical and human capital investments.

According to the findings, policymakers should implement integrated socioeconomic programs that increase health equity rather than conflicting plans that worsen health outcomes. In addition, the government should achieve inclusive economic growth to reduce poverty, improve public health, reduce out-of-pocket healthcare costs, and increase quality and access to it. Moreover, it should alleviate the burden of premature, preventable, and treatable deaths, especially for beneficiaries of lower social groups.

The limitation of this study is the ignorance of the effects of different variables on mortality in different age-groups. Socioeconomic factors may have different influences on mortality among age-groups. Therefore, a future study can investigate the impact of socioeconomic factors on the mortality of different age-groups. Also, our research about Iran as a developing country with chronic stagflation has different results than studies on developed countries with stable economic status. These findings propose a research gap for future studies to check if other economies with chronic stagflation confirm our results.

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Declarations

Conflict of interest No conflict of interest.

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