

# Economic and Financial Crisis in Argentina: A Novel Risk Factor for Cardiovascular Mortality?

MARÍA I. SOSA LIPRANDI<sup>MTSAC, FACC</sup>, MARIO RACKI<sup>†</sup>, MARINA KHOURY, RICARDO VILLARREAL<sup>†</sup>, GERMÁN CESTARI, EDUARDO MELE<sup>MTSAC, FACC</sup>, ÁLVARO SOSA LIPRANDI<sup>MTSAC, FACC</sup>

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## Address for reprints:

Dra. María Inés Sosa Liprandi  
Investigación Cardiovascular.  
Sanatorio Güemes  
Francisco Acuña de Figueroa 1228  
- Piso 4º  
(C1180AAX) CABA  
Phone (011) 4959-8200  
extension 8652  
Fax number: (011) 4959-8392  
e-mail: misosaliprandi@fsg.org.ar

## SUMMARY

### Background

The relationship between the impact generated by diverse traumatic situations as wars, terrorist attacks and natural disasters with mortality in different regions of the world has been documented in clinical and experimental studies. A recent study showed that, in the absence of natural disasters or wars, financial crises might have a negative impact on cardiovascular mortality. The current experience suggests that financial crises could have a significant influence on health.

### Objective

To describe the trends in cardiovascular mortality rates (CVMR) in Argentina between 1995 and 2005, and to explore if there is a close temporal relationship with the changes in trends of the Gross Domestic Product (GDP) as indicator of economic and financial crisis.

### Material and Methods

The annual CVMR per 100,000 persons was calculated using the information obtained from the database of the Ministry of Health (9th and 10th International Classification of Diseases). The following causes of death were considered: heart failure (HF), acute myocardial infarction (AMI), chronic ischemic heart disease (IHD) and stroke (CVA). The population estimates used as the denominator were obtained from the National Institute of Statistics and Censuses. Two economic crises were identified: the Southeast Asia crisis (1998-1999) and the end of the convertibility system (2001-2002). Joinpoint models were used to evaluate changes in trends.

### Results

GDP showed an increasing trend (slope = 17.18) from 1995 to 1998, which decreased in the period 1998-2002 (slope = 12.90) and increased from 2002 to 2005 (slope = 19.88); CVMR decreased by 24.72% (from 474.9 to 357.5 per 100,000). The joinpoint model identified three slopes in CVMR: from 1995 to 1997 (17.94), a descending slope until 2002 (6.8) and an increasing slope until 2005 (slope 16.73). Mortality rates due to HF, MI and CVA had a similar trend, decreasing by 22.95%, 16.89% and 38.06%, respectively.

### Conclusions

The close temporal relationship between the relative increase in cardiovascular mortality and the reduction of GDP might consider economic and financial crises as a novel psychosocial risk factor.

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## Key words >

Cardiovascular Diseases - Mortality Rate - Vital Statistics - Epidemiology

## Abbreviations >

CCVA	Stroke	GDP	Gross domestic product
ICD	International Classification of Diseases	CVAMR	Stroke mortality rate
IHD	Ischemic heart disease	CVMR	Cardiovascular mortality rate
CVD	Cerebrovascular disease	IHDMMR	Ischemic heart disease mortality rate
AMI	Acute myocardial infarction	AMIMR	Acute myocardial infarction mortality rate
INDEC	Instituto Nacional de Estadística y Censos (National Institute of Statistics and Censuses)	HFMR	Heart failure mortality rate
		HF	Heart failure

Department of Cardiology, Sanatorio Güemes

<sup>MTSAC</sup> Full Member of the Argentine Society of Cardiology

<sup>†</sup> To apply as full member of the Argentine Society of Cardiology

<sup>FACC</sup> Fellow of the American College of Cardiology

## BACKGROUND

The relationship between the impact generated by diverse traumatic situations as wars, terrorist attacks, natural disasters and Christmas/New Year's holidays with mortality in different regions of the world has been documented in clinical and experimental studies. (1-4) In a recent study, Gurfinkel et al. have suggested that, in the absence of a major natural disaster or war, financial collapse might have a negative impact on cardiovascular mortality during hospitalization due to acute coronary syndrome and higher incidence of medical complications. (5)

An international analysis has reported the concern about the negative impact the economic crises have on public health as a consequence of unemployment and reduced real wages, suggesting alternative approaches to attenuate this impact. (6)

The current experience suggests that financial crises could have a significant influence on health, as economic uncertainty produces panic and stress, particularly in elder and vulnerable populations. Stress produces significant increase in heart rate, blood pressure and myocardial oxygen demands, leading to rupture of vulnerable plaques. In patients with atherosclerotic disease endothelial dysfunction occurs with failure in the mechanisms of vasodilatation and vasoconstriction of the coronary vessels, leading to a reduction in myocardial oxygen supply. (7-11)

The lack of data from our country encouraged us to perform the present study to describe the trends in cardiovascular mortality rates (CVMR) in Argentina between 1995 and 2005. We also wanted to explore if there is a close temporal relationship with changes in gross domestic product (GDP) trends as an indicator of economic and financial crisis.

## MATERIAL AND METHODS

The information was retrieved from the database of the Office of Statistics and Health Information of the Ministry of Health which has coded all deaths mentioned on the death certificates using the 9th and 10th Revision of International Classification of Diseases (ICD). The following basic causes of death in > 35 years were considered: acute myocardial infarction (AMI) (ICD-9 410, ICD-10 I21-I22), chronic ischemic heart disease (IHD) (ICD-9 410-414; ICD-10 I21-I25), heart failure (HF) (ICD-9 428; ICD-10 I50) and cerebrovascular disease (CVD) (ICD-9 436; ICD-10 I64).

The population projections (denominators) for each year of those > 35 years were obtained from the 2001 Census of the National Institute of Statistics and Censuses (INDEC).

Annual cardiovascular mortality rates (CVMR) was calculated per 100,000 population. In addition, mortality rates due to specific causes were also estimated: heart failure (HFMR), acute myocardial infarction (AMIR), stroke (CVAMR) and chronic ischemic heart disease (IHDMR).

The specific rates were adjusted for gender and age considering the economically active population (between 35 and 64 years) and older adults (aged 65 years or above).

The GDP expressed in thousand million pesos and annual percent change of GDP estimated by the INDEC were used as economic indicators. (12)

The economic crises during the period 1995-2005 were

identified using the report by Jim Saxton based on GDP, inflation, unemployment, poverty rate, wages and the exchange rate for one peso in terms of one dollar. (13) Two economic crises were identified in Argentina for the period 1995-2005: the Southeast Asia crisis (1998- 1999) and the end of the convertibility system (2001-2002).

The most significant economic changes during those periods were: 1) the real GDP fell 28% from peak (1998) to trough (2002); 2) Argentina's currency, the peso, equal to US\$1 since April 1991, was devalued in January 2002 and depreciated to nearly 4 per dollar before partly recovering; 3) inflation, low or negative since the early 1990s, was 41% in 2002; 4) unemployment, excluding people working in emergency government relief programs, rose from 12.4% in 1998 to 18.3% in 2001 and 23.6% in 2002; and 5) the poverty rate rose from 25.9% in 1998 to 38.3% in 2001 and 57.5% in 2002. 6) In real terms (that is, adjusted for inflation), wages fell 23.7% in 2002.

The annual percent changes in mortality rates and GDP were calculated by subtracting the value of the first year from the last year of the period, then dividing by the value of the reference year (the first year of the period) and multiplying by 100.

Analysis of trends was performed with a Joinpoint statistical software. This program uses joinpoint models, a method used by the National Cancer Institute to report trends in cancer rates. (14) We used the Joinpoint Regression Program version 3.5.0. The significant model for GDP was chosen. Mortality rates were modeled with a fixed number of joinpoints.

## RESULTS

### Gross domestic product

Table 1 and Figure 1 A describe the values corresponding to GDP. The joinpoint models identified two points with changes in GDP trends that were statistically significant (Figure 1 B): in 1998 (95% CI = 1997-2000) and 2002 (95% CI = 2001-2003). Three slopes were identified: a first ascending slope of 17.18 ( $p = 0.004$ ) from 1995 to 1998, a second descending slope of 12.89 ( $p = 0.01$ ) between 1998 and 2002 and a third ascending slope of 19.87 ( $p = 0.003$ ) in the period 2002-2005. The difference between slopes 1 and 2 ( $p = 0.002$ ) and slopes 2 and 3 ( $p = 0.001$ ) were statistically significant.

### Cardiovascular mortality

Tables 1 and Figure 1 A show CVMR in the population > 35 years in the period 1995-2005.

A model with two joinpoints (Figure 1 C) was constructed. Changes in trends in 1997 and 2002 were identified with three slopes: 17,74 between 1995 and 1997; 6,80 between 1997 and 2002 and 16,73 between 2002 and 2005. These results were not statistically significant.

Between 1995 and 2005, CVMR decreased by 24,72% (from 474.9 to 357.5 per 100,000). Yet, this descending trend was not constant. Initially, from 1995 to 1997, CVMR decreased by 9.52%, in coincidence with a real GDP increase of 14.06%. Then, from 1997 to 2002, CVMR increased by 5.38% and real GDP decreased by 15.21%. From that moment,

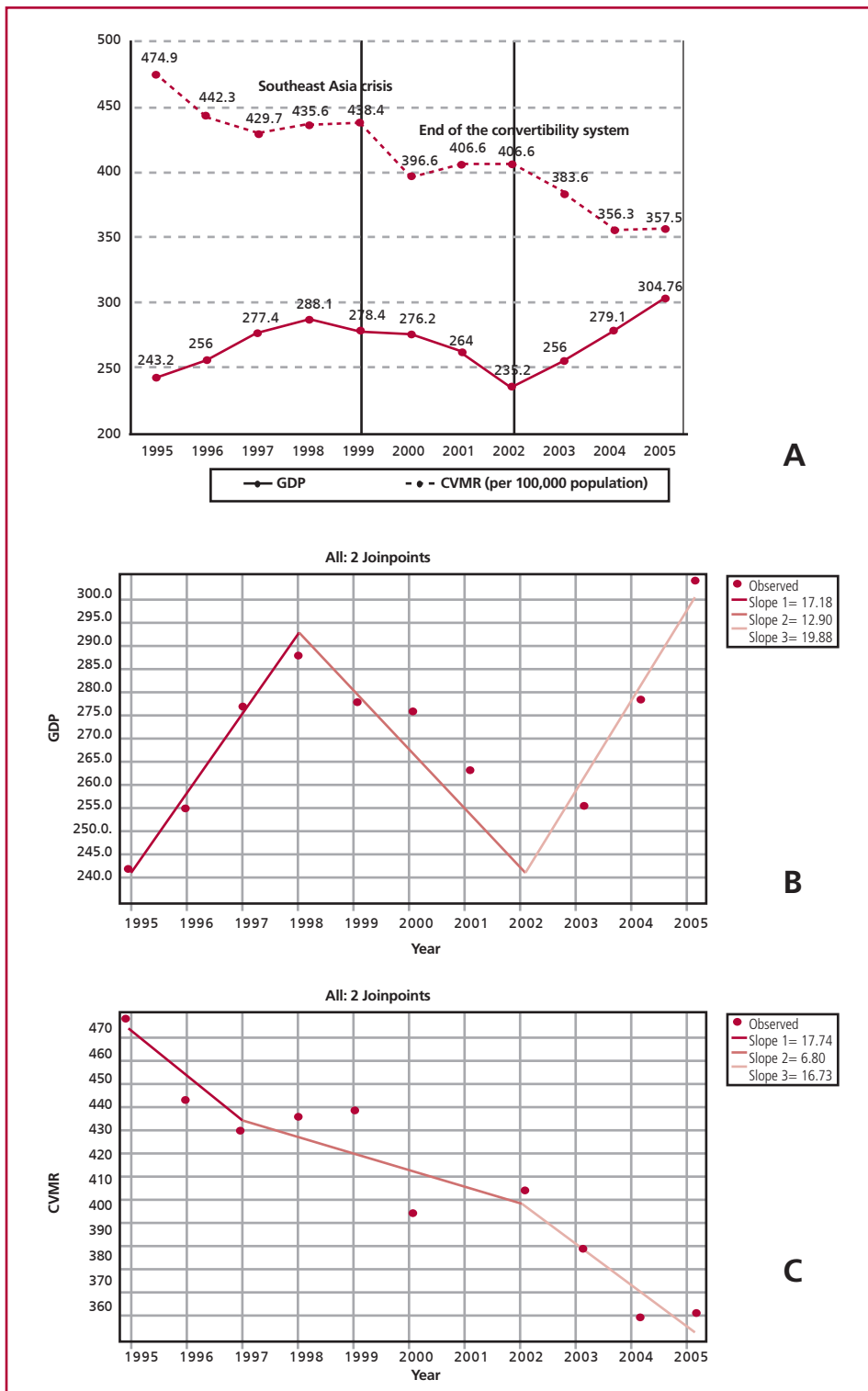
GDP increased by 29.57% in the period 2002-2005 and CVMR decreased by 7.65%.

Between 1997 and 1999, CVMR increased by 5.40% in men > 65 years (annual mortality rates 1630 and 1718 per 100,000 respectively). In men < 65 years, CVMR increased by 4.26% between 2001 and 2002 (from 141 to 147 per 100,000).

**Heart failure**

Mortality due to HF is shown in Table 2. A reduction of 22.95% in HFMR was observed from 1995 to 2005. A model with two joinpoints was constructed and identified three slopes of changes in trends in 1997 and 2002: -11,95 until 1997; 1,04 until 2002 and 8,81 thereafter. A descending trend was noted in HFMR

**Fig. 1.** Trends in cardiovascular mortality rates (CVMR) and gross domestic product (GDP). Argentina, 1995-2005. A. CVMR and GDP values per year. B. Model with two joinpoints in GDP trends. C. Model with two joinpoints in CVMR trends.



**Table 1.** Annual gross domestic product and cardiovascular mortality rates in the population > 35 years. Argentina, period 1995-2005

Year	GDP	Total CVMR	CVMR 35-54	CVMR > 65	CVMR women	CVMR women 35-64	CVMR women >65	CVMR men	CVMR men 35-64	CVMR men >65
1995	243.2	474.9	128.1	1586.5	416.0	67.6	1397.1	530.2	189.4	1810.6
1996	256.0	442.3	121.6	1471.4	384.5	64.2	1287.7	498.7	179.7	1697.9
1997	277.4	429.7	113.5	1429.5	376.4	59.9	1252.2	475.9	166.1	1630.3
1998	288.1	435.6	111.1	1459.9	341.3	50.3	1302.0	486.6	164.9	1685.3
1999	278.4	438.4	107.0	1479.5	396.2	57.9	1323.9	486.3	158.9	1702.1
2000	276.2	396.6	98.6	1328.3	355.2	52.8	1179.7	443.7	147.1	1541.9
2001	264.0	406.6	96.7	1376.8	371.9	54.1	1239.4	445.9	141.7	1573.1
2002	235.2	406.6	98.9	1371.0	369.1	53.3	1232.2	449.2	147.2	1569.8
2003	256.0	383.6	88.0	1294.8	348.5	46.3	1156.0	423.6	132.0	1496.4
2004	279.1	356.3	82.0	1201.3	326.3	43.6	1080.5	390.3	122.6	1377.0
2005	304.7	357.5	79.6	1213.5	330.8	42.2	1099.5	387.9	119.1	1379.3

GDP: Gross domestic product, in thousand million pesos. CVMR: Cardiovascular mortality rate.

in the period 1997-2002; yet these results were not statistically significant.

#### Acute myocardial infarction and ischemic heart disease

Table 3 shows AMIMR and IHDMR. During the period 1995-2005, AMIMR decreased by 16.89% (from 109.5 to 91 per 100,000). From 1995 and 1997 a 4.5% decrease was observed, while AMIMR increased by 11.36% between 1997 and 1999. Yet, mortality decreased in the period 2000-2002 and this reduction continued until 2004.

The model identified two joinpoints: one in 1999 and another in 2003 with three slopes: 2.23, 6.35 and 0.08. These results were not statistically significant.

Mortality rate due to HF decreased by 21.68% between 1995 and 2005. The model identified changes in the trends in 2000 and 2003, with three slopes which had no statistical significance: -0.73 in 2000, 0.03 between 2000 and 2003 and -1.70 after 2003.

#### Stroke

Mortality rates due to stroke (CVAMR) are shown in Table 4. A 38.06% decrease was noted between 1995 and 2005. From 1995 to 2000 CVAMR decreased by 27.82% (from 102.2 to 73.8 per 100,000).

The model identified two joinpoints: one in 2000 and the other in 2003 with three slopes, 5.28, 0.40 and 6.30. These differences were not statistically significant.

In the population < 65 years, CVAMR increased by 13.06% in 2002 compared to 2001 in both genders (from 17.6 to 19.9 per 100,000). In those > 65 years, the trend towards mortality reduction was interrupted, with a 2.60% increase in the year 2002 compared to 2001 (from 250.1 to 256.6 per 100,000).

#### DISCUSSION

Economic crisis might have an impact similar to that of natural disasters, bursting into the daily life of the population and producing negative consequences on cardiovascular health. The present study demonstrated a decrease in cardiovascular mortality, yet this trend was not linear. The descending slope changes coincide with the occurrence of the economic events identified. Joinpoint models were useful to make GDP the indicator of choice of economic crisis, as the significant changes in trends were observed between 1998 and 2002. These results support Jim Saxton's conclusions, who considered that both the Southeast Asia crisis and the end of the convertibility system behaved as a single phenomenon. The reduction in real GDP during economic crisis had a performance opposite to that of CVMR. The model of CVMR has almost a temporal coincidence with the changes in GDP, specially the second one, which occurred in 2002. The first change in trend was identified in 1997 for CVMR and in 1998 for GDP. Yet, this variation was expected considering the confidence intervals of the first joinpoint model of the GDP. However, the results for the models of mortality were not statistically significant.

Mortality rates due to specific causes showed a trend towards a temporal coincidence with the GDP joinpoints in the different clinical syndromes considered. In 1997 and 2002, HFMR had changes in trends with a plateau which included both economic crises identified. Interestingly, Southeast Asia crisis had a temporal coincidence with increase in AMIMR but not in CVAMR. The opposite was observed at the end of the convertibility system. The trend of AMIMR showed an increase until 1999 including higher rates

in 1998 and 1999. Then, AMIMR decreased until 2003. Until the year 2000, CVAMR has a descending trend followed by a plateau, which may be considered as a relative increase in mortality. After 2003, this rate decreased again with a slope that is similar to the first one. We did not find an explanation for this performance of mortality rates.

In a recent publication, David Stuckler et al. empirically tested whether banking crises were linked to increases in CVMR, using longitudinal data from 1960 to 2002 for high- and low-income countries. (7) They evaluated whether a banking system crisis increased short-term CVMR in men. A system-wide banking crisis increased CVMR by 6.4% in high income countries (GDP per capita > USD 25000 per year) For low-income countries (GDP per capita

< USD 2000), the estimated effect was roughly four times as large with a banking crisis corresponding to a 26.0% increase in CVMR.

In our study, CVMR increased by 5.40% between 1997 and 1999 in men > 65 years, an impact that is similar to that of developed countries. In men < 65 years the descending trend in cardiovascular mortality reached a plateau and then increased by 4.25% between 2001 and 2002.

In the United States, Mona Fiuzat et al. conducted an observational study with data from the Duke Databank for Cardiovascular Disease and examined the NASDAQ index to determine the period of severe economic decrease and time trends in AMI rates over the same period. (15) Time series analysis showed a significant increase in AMI rates during a period of

**Table 2.** Annual heart failure mortality rate by age and gender. Argentina. period 1995-2005

Year	HFMR >35	HFMR 35-64	HFMR >65	HFMR women	HFMR women 35-64	HFMR women >65	HFMR men	HFMR men 35-64	HFMR men >65
1995	229.2	47.8	810.8	218.3	28.2	753.7	235.1	67.1	865.9
1996	211.8	45.9	744.2	200.9	27.3	690.6	219.1	64.2	801.3
1997	204.1	42.8	714.3	196.1	24.9	669.5	205.3	59.5	748.8
1998	204.4	40.3	722.6	176.0	20.8	688.3	207.7	56.5	771.4
1999	208.2	38.4	741.3	208.0	24.2	712.1	208.3	53.5	783.0
2000	188.0	35.6	664.3	184.2	21.8	627.2	192.2	50.3	717.4
2001	201.7	36.4	719.2	202.5	23.4	691.3	200.6	50.2	758.4
2002	204.6	36.8	730.7	203.7	22.1	699.9	205.6	52.2	774.5
2003	186.3	31.0	664.9	186.6	18.5	635.8	185.7	44.0	707.0
2004	175.1	29.2	624.7	177.7	17.7	604.4	172.1	41.3	653.9
2005	176.6	28.3	633.5	180.8	17.3	616.3	171.7	39.9	658.0

HFMR: Heart failure mortality rate.

**Table 3.** Ischemic heart disease and acute myocardial infarction mortality rates in > 35 years. Argentina, period 1995-2005

Year	AMIMR >35	AMIMR 35-64	AMIMR >65	AMIMR women	AMIMR women 35-64	AMIMR women >65	AMIMR men	AMIMR men 35-64	MIMR men >65	IHDMR
1995	109.5	43.7	320.5	75.7	17.2	240.7	145.5	70.9	425.7	33.9
1996	105.1	41.8	308.2	72.3	15.7	231.9	140.2	68.8	408.7	31.6
1997	104.5	39.7	309.6	72.1	15.8	227.9	138.2	64.0	414.8	32.6
1998	116.5	42.1	351.1	74.9	14.8	273.1	151.3	67.8	462.4	30.3
1999	117.9	41.0	359.3	87.6	17.0	281.0	152.4	66.5	471.5	32.3
2000	105.4	38.4	314.9	77.2	15.7	244.8	137.5	62.4	415.6	29.5
2001	101.8	36.4	306.5	74.9	15.9	236.0	132.4	58.1	407.8	29.2
2002	95.8	35.6	284.4	68.5	14.5	216.0	126.9	58.0	382.4	29.1
2003	92.1	33.1	274.0	67.0	13.8	209.4	120.8	53.6	368.1	30.7
2004	85.9	30.9	255.3	62.3	13.0	193.8	112.8	49.8	345.1	27.9
2005	91.0	31.8	273.4	66.8	12.8	210.7	118.7	51.9	365.1	26.6

AMIMR: Myocardial infarction mortality rate. IHDMR: Ischemic heart disease mortality rate.

**Table 4.** Stroke mortality rate by age and gender. Argentina, period 1995-2005

Year	CVAMR >35	CVAMR 35-64	CVAMR >65	CVAMR women	CVAMR women 35-64	CVAMR women >65	CVAMR men	CVAMR men 35-64	CVAMR men >65
1995	102.2	29.4	335.7	93.8	19.4	303.4	109.7	39.5	373.2
1996	93.7	27.3	306.7	85.2	18.8	272.5	101.8	36.0	349.1
1997	88.4	23.5	293.7	81.6	16.0	263.1	93.7	30.6	328.9
1998	84.4	22.5	280.1	68.9	12.8	253.9	90.8	30.0	317.5
1999	80.0	20.5	267.0	74.1	14.2	238.4	86.8	27.2	308.0
2000	73.8	18.6	246.4	69.5	13.0	223.3	78.7	24.4	279.6
2001	73.9	17.6	250.1	70.3	12.6	227.8	78.0	22.9	282.1
2002	77.1	19.9	256.6	73.3	14.2	235.0	81.4	25.8	287.5
2003	74.5	17.4	250.5	69.8	11.7	225.0	80.0	23.6	287.5
2004	67.4	15.4	227.4	64.3	10.7	207.4	70.8	20.4	256.5
2005	63.3	13.5	216.5	62.1	9.8	201.3	64.6	17.5	238.5

CVAMR: Stroke mortality rate.

NASDAQ index decrease from July 2008 to January 2009 which decreased from January to July 2009 when the index recovered. The authors suggest that increased cardiovascular risk might be associated with mental stress. (16)

Changes in endothelial function (17), neurohormonal changes including increased levels of norepinephrine and cortisol (18,19), changes in platelet aggregation (20), increased inflammation (21), and autonomic dysfunction measured by reduced heart rate variability, (21) occur during periods of stress, and these are all plausible biological mechanisms for AMI. (22)

CVAMR showed a constant decrease that was more evident in the population < 65 years. This rate increased during the economic crisis that occurred at the end of the convertibility system. Between 2001 and 2002 CVAMR increased by 13.06% in < 35 years and by 2.60% in > 65 years in both genders. Then, CVAMR had a descending trend.

Our study was not focused on confirming the possible relation between economic crisis and cardiovascular mortality; the goal of this study was to explore whether the hypothesis had any support to justify further investigations. Despite the limitation of using a study design based on aggregated data and of analyzing a short period of time which reduced the power of the sample, the results suggest a temporal relation between the periods of crises and cardiovascular mortality. Other possible limitation is that the causes of death were based on the information provided by death certificates. The reliability of death certificates as a source of data may be questionable; yet there is no other database with the total number of deaths and of deaths due cardiovascular disease in Argentina. Over the past years, vital statistics have been used by several publications for monitoring

trends and determinants of cardiovascular mortality, reinforcing the usefulness of this method for the evaluation of the outcomes of large populations. (23-25) Therefore, this method makes it possible to obtain data that may be compared with other publications from different regions of the world.

## CONCLUSIONS

The results of this analysis might support the hypothesis that economic and financial crisis expressed through indicators as the GDP might have an impact on cardiovascular mortality in the Argentine population. The close temporal relationship between changes in cardiovascular mortality trends and the reduction of GDP might consider such crisis as a novel psychosocial risk factor. Further studies are necessary to evaluate the hypothesis of this association, as this study is only descriptive.

## RESUMEN

### Crisis económico-financieras en la Argentina: ¿un nuevo factor de riesgo de mortalidad cardiovascular?

#### Introducción

En estudios clínicos y experimentales se ha documentado la relación entre el impacto generado por diversas situaciones traumáticas, como guerras, ataques terroristas y desastres naturales, y la mortalidad en diferentes regiones del mundo y los resultados de un estudio reciente muestran que las crisis financieras, en ausencia de desastres naturales o guerras, podrían tener un impacto negativo sobre la mortalidad cardiovascular. La experiencia actual sugiere que las crisis del sistema financiero podrían tener una influencia importante sobre la salud.

#### Objetivos

Describir las tendencias de las tasas de mortalidad cardiovascular (TMCV) en la Argentina entre los años 1995 y 2005 y explorar si los cambios en ellas coinciden temporalmente con cambios en las tendencias del Producto

Bruto Interno (PBI) como indicador de crisis económico-financieras.

### Material y métodos

Se calculó la TMCV anual por 100.000 utilizando la base de datos del Ministerio de Salud de la Nación (Clasificación Internacional de Enfermedades 9.<sup>º</sup> y 10.<sup>º</sup>). Se consideraron las siguientes causas de defunción: insuficiencia cardíaca (IC), infarto agudo de miocardio (IAM), enfermedad coronaria (EC) crónica y accidente cerebrovascular (ACV). Para los denominadores se utilizaron las proyecciones de población del Instituto Nacional de Estadística y Censos. Se identificaron dos crisis económicas: la del sudeste asiático (1998-1999) y la caída de la convertibilidad (2001-2002). Se aplicaron modelos de joinpoint para evaluar los cambios en las tendencias.

### Resultados

El PBI presentó una tendencia ascendente (pendiente = 17,18) desde 1995 hasta 1998, luego una tendencia descendente (pendiente = 12,90) hasta 2002 y una tendencia ascendente (pendiente = 19,88) hasta 2005 y la TMCV descendió un 24,72% (de 474,9 a 357,5 por 100.000). El modelo de joinpoint identificó tres pendientes en la TMCV: la primera desde 1995 hasta 1997 de 17,94, la segunda hasta 2002 con una tendencia al descenso (pendiente = 6,8) y la tercera hasta 2005 con pendiente de 16,73. Las tasas de mortalidad por IC, IAM y ACV siguieron un comportamiento similar con un descenso del 22,95%, 16,89% y 38,06%, respectivamente.

### Conclusiones

La estrecha relación temporal entre el aumento relativo de la mortalidad cardiovascular y el descenso del PBI permitiría considerar a las crisis económico-financieras como un nuevo factor de riesgo psicosocial.

**Palabras clave** > Enfermedades cardiovasculares - Tasa de mortalidad - Estadísticas vitales- Epidemiología

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