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Overview of mortality in Mexico through four indicators from 1990 to 2012

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Abstract

Objective: *To describe the behavior of mortality in Mexico through four indicators from 1990 to 2012.* **Material and methods:** *The official mortality and population records of Mexico were used.* **Results:** *An advance was achieved for children under five years of age, with a decrease in mortality, although there was an increase in the years of potential life lost (YPLL) from 2008 for this age group. For children under one year of age, there was no advance since 2002 in the index of YPLL and in the productive years of life lost (PYLL). Since 2008 there has been an increase in the rates of mortality, YPLL, and PYLL in the group from 10 to 29 years of age. There has been a sustained increase in YPLL in the age group from 40 to 69.* **Conclusions:** *It is relevant to evaluate the health policies in Mexico for the different age groups; even though there have been positive results in some of them, these are not across all the age groups, which could put some sectors of the population at risk, such as children and young people from 10 to 29 years of age.* (Gac Med Mex. 2017;153:13-22)

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Introduction

A country's mortality of is one of the most important indicators to assess a population's health. In addition, it allows for decision-making to be addressed at the local and national levels in order to prioritize health expenditure and to develop and implement health policies. In a country like Mexico, knowing and monitoring the behavior of mortality in all age groups in a given time period is necessary.

Mortality rates, years of potential life lost (YPLL), years of potential life lost index (YPLLI) and productive years of life lost according to the investment-production-consumption model ($PYLL_{ipc}$) are four of the main mortality indicators. However, their use and interpretation has been shown in many studies to confer different prioritization when the causes of mortality are analyzed in the same population[1-6].

All four above-mentioned indicators require different elements, based on the number of deaths for a particular period of time. Mortality rates take into account the number of deaths and total population. YPLL are constituted as a measure of absolute impact and indicate the time average a person should have lived according to life expectancy; therefore, a loss of potential life is

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generated and, thus, the more premature the death, the greater the loss of life will be. YPLLI is a relative impact measure that allows for comparisons with other populations to be made[7]. $PYLL_{ipc}$ take age at the moment of death and potential future productivity into account, which can result in gains or losses for society[1,8].

The official source of information on mortality in Mexico is based on the death certificate, which is an official legal medical document. However, this document may have limitations related to its filling and capture.

The present work illustrates the behavior of mortality in Mexico between the years 1990 and 2012 by age groups through four indicators, out of which three (YPLL, YPLLI and $PYLL_{ipc}$) give more weight to those deaths occurring in younger age groups, which are groups that acquire vital importance because the achievements obtained on them will reflect on long-term greater impacts.

Material and methods

Four mortality indicators were calculated: 1) overall mortality rate, 2) YPLL, 3) YPLLI, and 4) $PYLL_{ipc}$; all of them for the following age groups: subjects younger than 1 year, from 1 to 4 years, 5 to 9 years and 10 years old and older with cutoff points by decades, from 1990 through 2012 in Mexico. The calculated indicators included total deaths per age group.

The number of deaths per age group was obtained from the official databases of the National Institute of Statistics and Geography (INEGI – *Instituto Nacional de Estadística y Geografía*). Total population for each year and per age group was obtained from the Health Ministry of Mexico databases, through its General Direction of Information on Health, which are based on the 2005-2030 Population Projections of Mexico by the National Population Council (CONAPO – *Consejo Nacional de Población*).

For the calculation of YPLL and YPLLI, the methodology established by the Pan-American Health Organization was used[7], and life expectancy corresponding to the specific year was taken into account, according to CONAPO's data[9]. YPLLI was calculated as a relative indicator, unlike YPLL, which is an absolute indicator.

In addition, $PYLL_{ipc}$, which is an indicator that takes age at the moment of death and potential future productivity into account, was also calculated. For that, the investment-production-consumption model proposed by Bustamante-Montes et al. was used[1]. Since the age of 45 years, there is a potential loss in negative numbers, which means an indication of potential earnings according to the model. Therefore, before the age of 45 years, the balance is indicated in positive numbers, due to potential loss.

This project was reviewed and authorized by the Committee of Bioethics and Research of the Autonomous University of San Luis Potosí.

For more clarity in the presentation of results (in figures), mortality rates are presented in decreasing order. For YPLL, YPLLI and PYLL, there are two cutoff points: age younger than 30 years and older than 30 years. The statistical analysis was made using the Microsoft Excel v2010 spreadsheet.

Results

Age-adjusted mortality rates

The highest mortality rates occur in subjects older than 80 years, followed by the groups of 70-79 and 60-69 years of age. Throughout the years, these specific groups show an increasing trend in the mortality rate (Fig. 1 A).

The next group in decreasing order corresponds to subjects younger than 1 year, where a trend towards a decrease in their mortality rate of 10.77 points per year was observed to occur from 1990 to 2004; however, in 2005, the rate increased by 0.77 until 2012. The population aged from 30 to 59 years shows a trend towards a decrease of its mortality rates (Fig. 1 B).

In the group of 1 to 29 years of age, the lowest mortality rates were observed to be found between the years 1999 and 2007 (Fig. 1 C). In the 1 to 4-year group, a trend towards a decrease in mortality of 3.5 points per year was found from 1990 to 2001, with a substantial decrease from 1990 to 1992. The 10 to 29 years age-group showed an increase in the mortality rate after the year 2007 (Fig. 1 C).

YPLL

With regard to YPLL, the fact that the age group of subjects younger than 1 year produced more YPLL during both these decades stands out. However, although there is a trend towards a decrease in the number of YPLL of 7.5 per year, in 2004 there was a trend towards an increase of 0.9 for this same group (Fig. 2 A).

The second group with the highest number of YPLL in Mexico was the 20 to 29 years age-group since

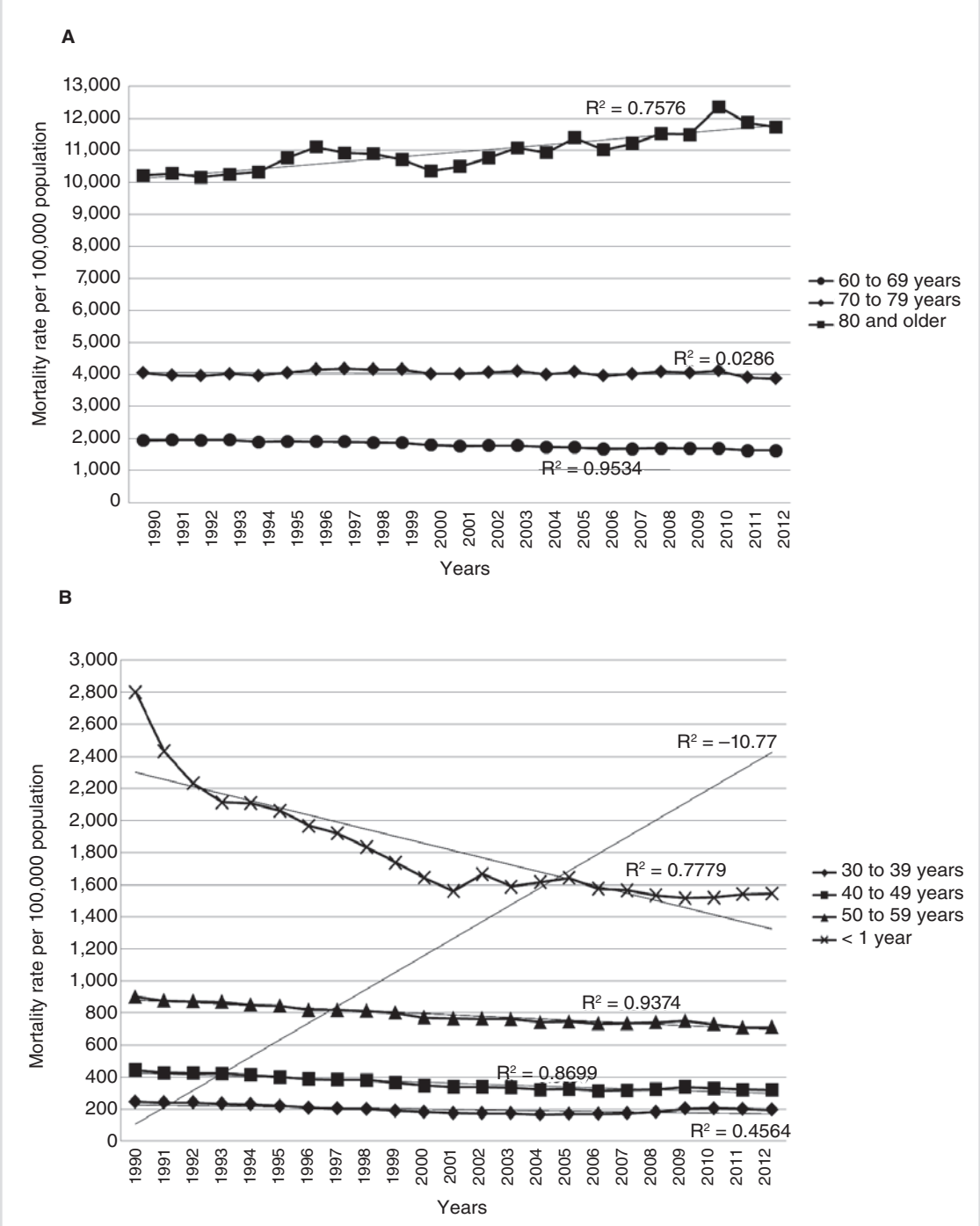

Figure 1. *Age-adjusted mortality rates in Mexico from 1990 to 2012.* **A:** *60-year old and older population.* **B:** *populations younger than 1 year and from 30 to 59 years of age.*

1991, followed by the group of 10 to 19 years of age since 1997. The 1 to 4 years age-group showed a marked YPLL decrease from 1990 to 1992 and in the 1996 to 2001 period. From the year 2009 onwards, there is an increase in this indicator's value in the groups encompassed between 10 and 29 years of age (Fig. 2 A). The youngest age group that produces less YPLL in Mexico is the 5 to 9-year group, although there

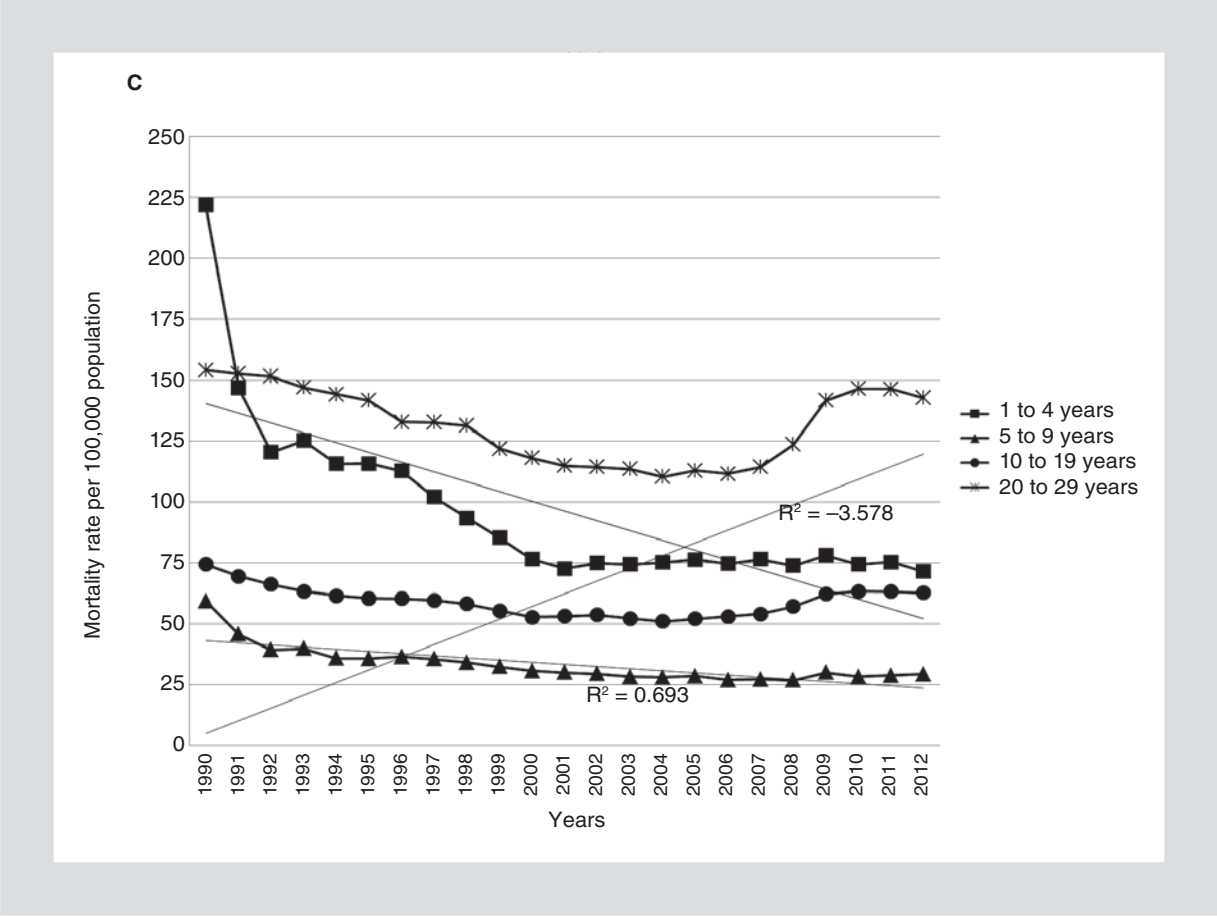

Figure 1. *Age-adjusted mortality rates in Mexico from 1990 to 2012.* **C:** *population aged 1 to 29 years.*

was a YPLL decrease in this group from 1990 to 1992 and, as of 1993, it shows a trend towards a YPLL increase of 0.74.

The 40 to 69 years' age groups (Fig. 2 B) showed a continuous increase in the YPLL trend in the entire period. Since the YPLL indicator takes life expectancy into account, the 80-year and older group does not produce YPLL.

YPLLI

According to the YPLLI, it coincides that the group with the highest index was the group of subjects younger than 1 year, where a decrease in this indicator is observed from 1991 to 2001; after this year, it has remained without major fluctuations, unlike YPLL, which showed a decreased tendency until the year 2004 (Fig. 3 A).

The 1 to 4 years of age showed a marked decrease in YPLLI from 1990 to 1992 (Fig. 3 B). The remaining groups remained with YPLLI without major fluctuations over the entire assessed period, but there is a marked increase of this indicator in the 20 to 29 years age-group since the year 2009 (Fig. 3 B).

The 50 to 59-year old population had the highest YPLLI after the population younger than 1 year during the entire assessed period (Fig. 3 C).

$PYLL_{ipc}$

The age group with more $PYLL_{ipc}$ in Mexico was the younger than 1-year age-group from 1990 to 2007. From the year 2008 onwards, the group with more $PYLL_{ipc}$ in Mexico was the 20 to 29 years' age-group (Fig 4 A).

The 10 to 19-year age-group occupied the third place with more $PYLL_{ipc}$ during the assessed period; in addition, from 2007 onwards there was an increase of this indicator for this group. The 1 to 4-years' age-group had a greater $PYLL_{ipc}$ decrease, especially from 1990 to 1992 (Fig. 4 A).

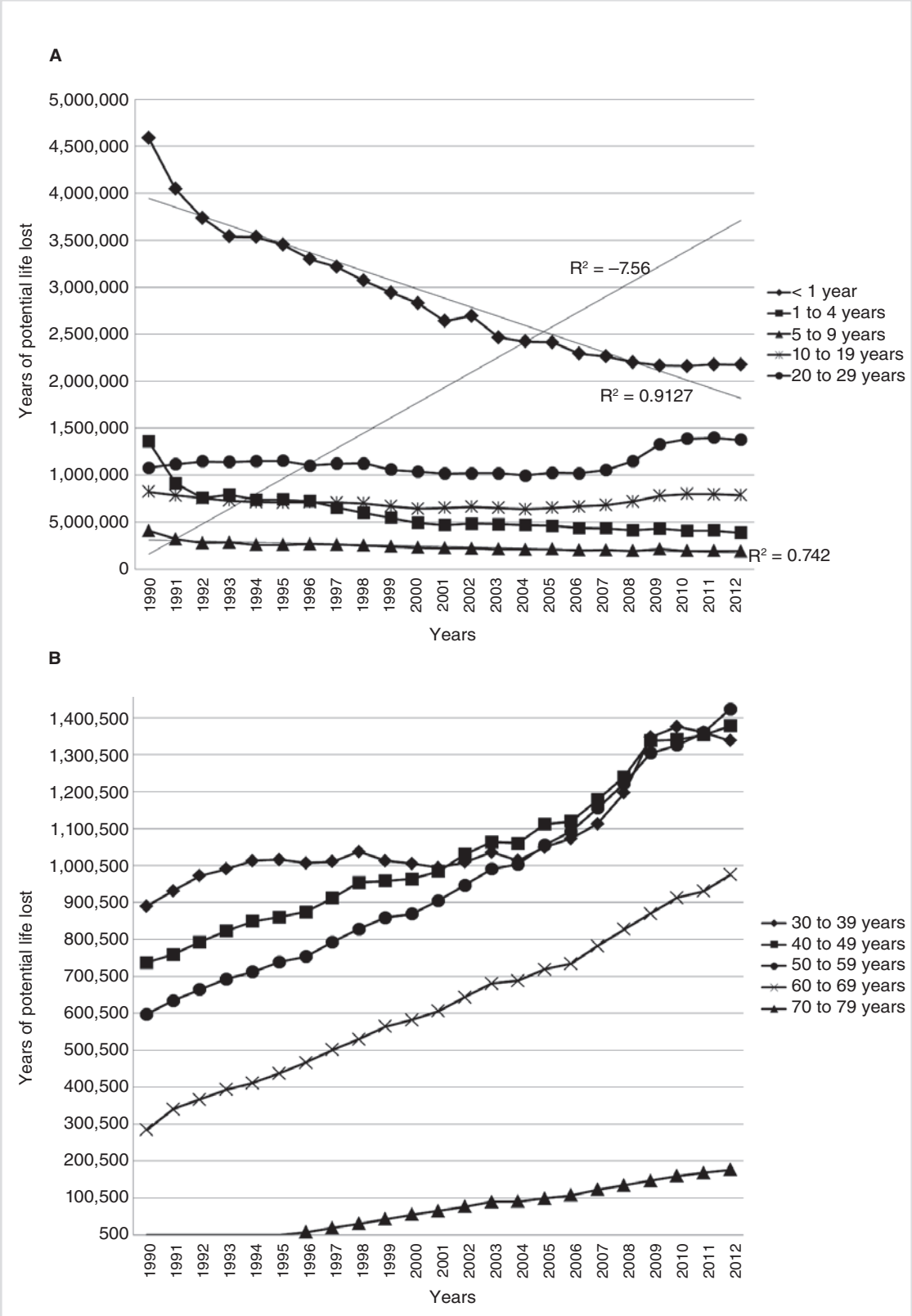

Figure 2. *YPLL in Mexico from 1990 to 2012.* **A:** *population of 29 years of age and younger.* **B:** *population of 30 years of age and older.*

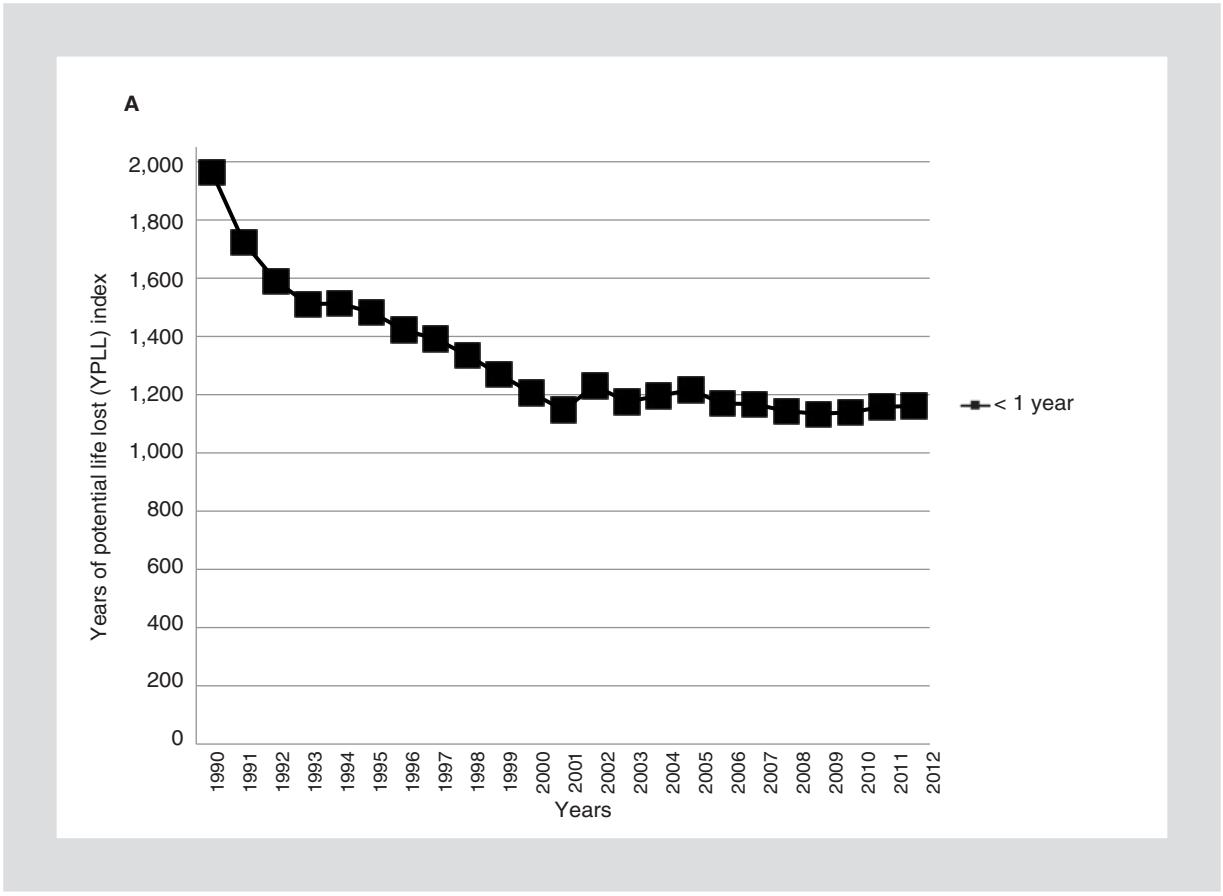

Figure 3. *YPLLI in Mexico from 1990 to 2012.* **A:** *population younger than 1 year.*

Although there is a horizontal trend in the 30 to 49 years' age groups, a slight increase in this indicator has occurred since 2009 (Fig. 4 B). In addition, the 50 to 59-year group had its $PYLL_{ipc}$ number decreased during the assessed period (Fig. 4 B).

The weight assigned by the $PYLL_{ipc}$ calculation method has a breaking point at 45 years; prior to this age (positive numeric value) there is potential loss. Conversely, after this age (negative numeric value) it indicates potential earnings according to the model (Fig. 4 B). This last behavior was observed from 40 years of age onwards.

Discussion

One of the purposes of health systems is to increase populations' life expectancy. It is important knowing and monitoring the mortality trends in all age groups[7]. This is why this study is based on information that provides a better approach to reality.

The weakness of measuring mortality with crude or adjusted rates is the weight attributed to all deaths, regardless of the age at which they occur. Since most deaths occur in elderly people, the rates show a dominance of deaths occurred at advanced ages, and hide mortality trends in other age groups, as in this study. For this reason, calculations for all 4 indicators were made by age group in the present study.

An increase in the mortality rate was found in the 80 years' and older age groups. However, further investigation should be made and assess the quality of life to verify if subjects remain functional or if they have some kind of impairment. It is relevant to highlight that, until the year 2009, the General Directorate of Epidemiology reported heart conditions, followed by diabetes mellitus, malignant tumors and stroke to be the main causes of mortality in the population older than 60 years[10].

The age groups younger than 1 year and from 1 to 4 years show a lower decrease in the mortality rate; however, for the rest of the groups there is no significant decrease, which may be due to the fact that priority health programs focus on vulnerable groups such as children younger than 5 years[11,12] and pregnant

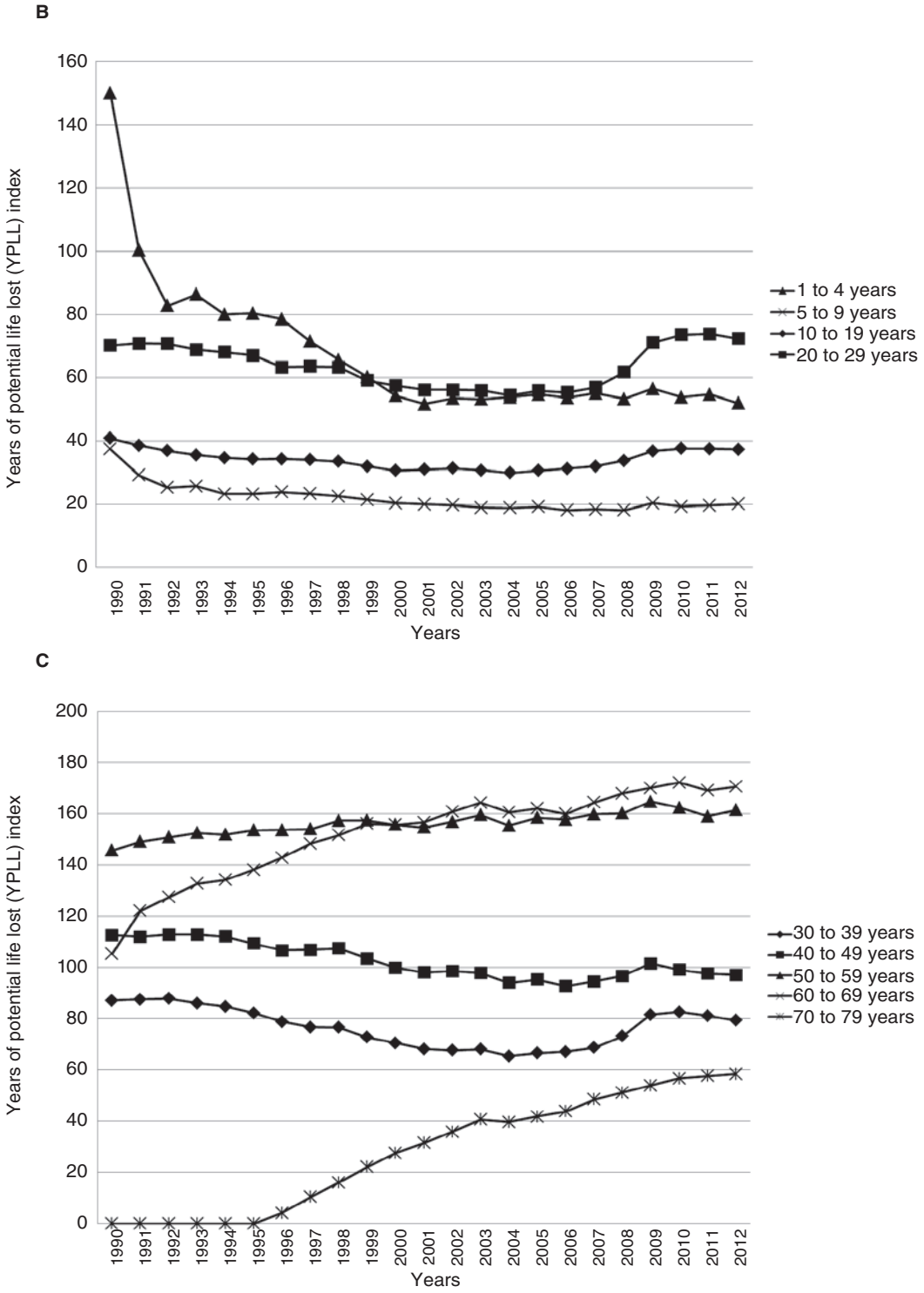

Figure 3. *YPLLI in Mexico from 1990 to 2012.* **B:** *population of 1 to 29 years of age.* **C:** *population of 30 years of age and older.*

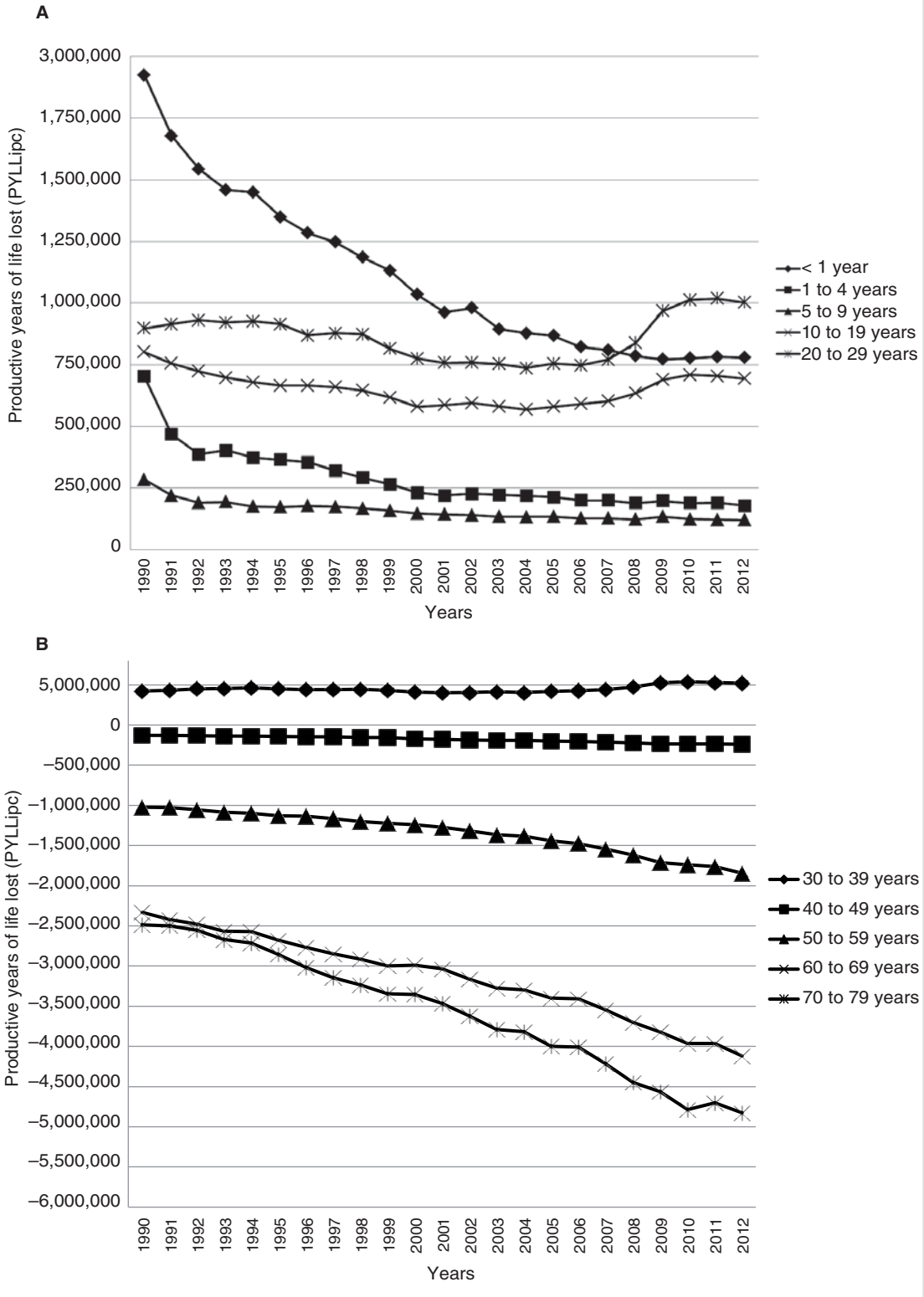

Figure 4. *PYLLipc in Mexico from 1990 to 2012.* **A:** *population younger than 30 years.* **B:** *population of 30 years and older.*

women, due to the social impact one death represents in these groups, which in turn is consistent with the Millennium Goals[13].

It is essential to continue emphasizing on the care of children younger than 5 years, since an increase in the number of YPLL was found since 2008. Furthermore, it is imperative to increase health expenditure for the 10 to 29-year age groups, since an increase in the number of YPLL and $PYLL_{ipc}$ was found since 2008. In view of this, it would be pertinent, as part of another study, to analyze these results in the light of changes in the implementation of programs that may have emerged or been eliminated from the public agenda in Mexico since that period for these specific age groups. On the other hand, implementation of multidisciplinary strategies is required based on the main causes of death in these groups, which are related to motor vehicle accidents, aggressions and intentionally self-inflicted lesions. It is imperative emphasizing on this aspect, since these groups are the productive force of any country.

If mortality rates and YPLL are taken into account, the group of children under 1 year of age is observed to have had the most marked decrease in these indicators. However, according to the YPLLI, public health policies for children younger than 1 year require to be reconsidered, since it has remained stable since 2001 and until the year 2012 in spite of new health programs and schemes implementation for this age group, in order for a decrease on this index to be generated for this specific population. The above-mentioned could not be appreciated in the YPLL calculation and, therefore, the importance of calculating the PYLLI as well is highlighted in order to allow for possible differences between the same and different age groups to be detected, since this is a relative impact indicator that is adjusted by a constant factor.

The group of children younger than 1 year was the age group that showed more $PYLL_{ipc}$ in Mexico over the assessed period; in addition, from the year 2007 onwards, no impact was observed of interventions made on this age group that would reflect on a decrease in this indicator, since the numbers of $PYLL_{ipc}$ have not shown fluctuations. Conversely, the benefits of $PYLL_{ipc}$ decrease in the 50 to 59 age group showed a marked decrease between 2000 and 2007.

Interestingly, since the year 2009, the indicators had their values increased in some age groups, in coincidence with social-natured phenomena, such as the wave of violence in Mexico caused by organized crime, or with health problems such as the influenza pandemic that occurred that same year[14,15].

In spite of the increased life expectancy, the 4 assessed indicators do not reflect a very favorable panorama. It should be noted that most values of all 4 assessed indicators show a downward trend, especially in the first evaluated decade, but after this period (second decade), there is an upward trend and, should this behavior persist, it might modify Mexican population epidemiological outlook. Checking these results against national or state programs or against social movements that overlap with the decreases and increases in the assessed indicators is necessary.

Assessing existing policies in Mexico is necessary, as well as creating public policies especially for adolescents[16] and young people of 10 to 29 years of age, which allow for the trend towards $PYLL_{ipc}$ increase to be modified. The need to review policies becomes unavoidable because the adolescent and young population, according to the investment-production-consumption model, is included in the production period of a country, which takes place from 15 to 64 years of age. In addition, also according to this model, the period of investment in health goes from 0 to 14 years of age. On the other hand, adverse experiences in childhood and adolescence, such as verbal, physical or sexual abuse, children of mothers who are victims of violence, substance abuse at home, mental problems at home, family members imprisoned, and parental separation or divorce, are associated with an increased risk of premature death during adulthood[17].

The indicators presented in this study are used to assess inequities in health, and we would therefore expect a decrease as equity is gained. However, the obtained results show a contrast, since an increase could be observed over the past few decades, which is contradictory and opens a range of possible explanations for the increase in these indicators[18].

Finally, the creation or restructuration of health public policies in Mexico is suggested to be based on the implementation of local, state or regional successful strategies, and to allow for these policies to be flexible at the moment of application in specific contexts. In addition, it would also be relevant learning the strategies that some countries have successfully used to decrease some specific causes of premature death, as well as non-transmittable chronic diseases associated with well-defined risk factors, such as traffic or occupational accidents and infectious diseases that can be controlled or treated[18]. In spite of the advances at different fields in health, there are groups where mortality continues to be high.

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