

# The Chilean infant mortality decline: improvement for whom? Socioeconomic and geographic inequalities in infant mortality, 1990–2005

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**Objective** To measure socioeconomic inequalities and differential risk in infant mortality on national and regional levels in Chile from 1990 to 2005, and propose new policy targets.

**Methods** The study analysed Chilean vital events registries from 1990 to 2005 for infant mortality by maternal education, head of household occupational status, cause, age and location of death. Annual infant mortality rates and relative risk were calculated by maternal education and head of household occupational status for each cause and age of death. Socioeconomic inequalities were then mapped to 29 regional health services.

**Findings** Reductions in the national infant mortality rate were driven by reductions among highly educated mothers, while recent stagnation in the national rate is caused by high levels of infant mortality among uneducated mothers. These vulnerable households are particularly prone to infant mortality risk due to infectious disease and trauma. We also identify clustering of high socioeconomic inequalities in infant mortality throughout the poorer north, indigenous south and densely populated metropolitan centre of Santiago. Finally, we report large inequities in vital statistics coverage, with infant deaths among vulnerable households much more likely to be inadequately defined than in the remaining population.

**Conclusion** These results indicate that the socioeconomically disadvantaged in Chile are at a significantly higher risk for infant mortality by infectious diseases and trauma during the first month of life. Efforts to reduce national infant mortality in Chile and other countries must involve policies that target child survival for at-risk populations for specific diseases, ages and locations.

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Une traduction en français de ce résumé figure à la fin de l'article. Al final del artículo se facilita una traducción al español. الترجمة العربية لهذه الخلاصة في نهاية النص الكامل لهذه المقالة.

## Introduction

Latin America remains one of the most extraordinarily unequal regions in the world. Despite its recent economic growth and development, Chile is plagued by the same profound disparities in the distribution of wealth, income and opportunity. Intrinsically related to these socioeconomic inequalities is a persistent stratification of access to health services and outcomes, with a significant portion of morbidity and mortality borne by the poorest segments of society.<sup>1–3</sup> It is these types of inequities in health outcomes that inform the increasing emphasis on equity-based analysis in public health and development literature and policy.<sup>4</sup> There is a growing consensus that development should be conceived in a broader context than simple economic growth, taking into account social concerns such as health. In turn, recent work has empha-

sized the importance of the basic social, economic, political, and environmental processes and structures for health. While genetic susceptibilities are the proximate causes of individual disease, social determinants of health are essential to the formation of well-being for populations, especially those at risk.

Child and infant mortality, often resulting from preventable failures in the provision of basic necessities, are important indicators of inequities in a country's infrastructure, services and development.<sup>5,6</sup> Furthermore, many previous studies have demonstrated a significant causal relationship between socioeconomic status and infant mortality rates at both sub-national and national levels.

Prior work has documented and analysed the impressive decline of average infant mortality in Chile throughout the past century,<sup>7–12</sup> which has decreased by 93% since 1955, and examined the

relationship between maternal education and child survival from 1985 to 1995.<sup>13</sup> Unfortunately, infant mortality reduction in Chile appears to have stagnated, and we hypothesize that this stagnation is the result of inequalities in the distribution of mortality burden, a subject unaddressed by prior studies. This study aims to examine the trends in infant mortality by cause, location, age of death and household socioeconomic status from 1990 to 2005 in Chile with an equity-based perspective and a view towards the identification of new targets for policy intervention and promotion of social and human development.

## Methods

Electronic records of vital events were obtained from the national registry maintained by the Ministry of Health, National Statistical Institute, and Civil Registry and Identification Service.<sup>14</sup>

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These data were subsequently aggregated by cause, age of death, maternal education and head of household occupational status. Coverage of vital events statistics during the period since 1990 is considered to be quite robust, reaching 98% of the population by 1999.<sup>15</sup> Of important note, however, is the regional variation in quality of statistics, with poorly defined deaths ranging from 1.5% to 13.7% in 2003.<sup>15</sup>

To confirm previous findings and further validate the coverage of the Chilean vital registration system, three sources of infant mortality data were analysed and compared against the data used in this paper: indirect estimates from census surveys of birth histories from 1982 and 1992, estimates from survey data underpinning the World Bank's World Development Indicators and estimates from national life table cohorts. This analysis found near convergence of all methods with the vital registry data from 1990 onwards. In addition, it is important to note that computation of infant mortality using the national life table method with cohorts, rather than the annual rate-ratio method, also demonstrates the stagnation discussed in this paper. This indicates that the structure of infant mortality events is relatively consistent between birth cohorts. Given the high national coverage of vital events reporting and concordance with alternative methods of mortality computation, the authors did not apply correctional methods.

Secondary information, such as maternal education and occupation, had coverage rates slightly lower but nevertheless statistically reliable over the period of interest, ranging from 86 to 94% for educational attainment coverage and 91%–97% for head of household occupational status inclusion in recorded vital events. The remaining data that was missing values for maternal education or other categories was analysed but not included; however, infant mortality data for these poorly coded groups was nearly identical to the uneducated/unemployed household cohorts, indicating that these poorly registered deaths belong to the disadvantaged strata of society. This suggests that most statistical underreporting occurs for low socioeconomic status groups.

The data were processed by age, International Classification of Disease (ICD-9 and ICD-10) causes of death,

maternal education and head of household occupational status. Full implementation of the ICD-10 in Chile was achieved in 1999; thus data from 1990 to 1998 were analysed with ICD-9 codes and data from 1999 onwards with ICD-10 codes. Occupational status was determined for the head of household, and was derived from coding of either “employed” or “unemployed”. Maternal education was measured in years of approved education, a standardized indicator computed by adding the variable “level of instruction” to “last completed course” using an algorithm designed by the National Statistical Institute. Years of approved education were further divided into six categories: no maternal education, 1 to 3, 4 to 6, 7 to 9, 10 to 12, and 13 or more years. We then computed and analysed infant mortality for each variable during the period 1990–2005 by dividing deaths by births and multiplying this ratio by 1000. Throughout the study, relative risk (or risk ratio) is used as the primary method of comparing relative incidence of infant mortality between the two extremes of the educational groups: uneducated versus 13 years or more of education, calculated by dividing mortality rates in the former by the latter.

In addition, we conducted spatial analysis of the distribution of socioeconomic inequalities in infant mortality, calculating relative risk of “no maternal education” against “13 years or more” for each regional health service. There are 29 Chilean regional authorities responsible for implementing and evaluating national and local health policy.

## Results

### Socioeconomic composition

Fig. 1 shows historical trends in the distribution of infant mortality rates by maternal education and in the nation as a whole. The general decline in mortality rates for these two cohorts is also indicative of the other cohorts (not shown in the figure). Within this trend, however, infant mortality rates are sharply stratified by maternal education level. The “no education” cohort exhibits a considerable degree of volatility, as demonstrated by the sudden increase in 1997 followed by a decrease in 2000. The national rate reflects these sudden variations, expressing slight increases in 1996, 1998, 2001 and 2003, and

sharp decreases in 1991 and 2000. This volatility cannot be accounted for by variations in the birth or death rates, as these are relatively consistent throughout the period of analysis. We posit that the recent stagnation in the rate at which the aggregate infant mortality rate has fallen could be attributed to relatively high levels of mortality among disadvantaged populations, which now dominate the mean.

Fig. 2 examines this hypothesis, presenting the contribution of each maternal education cohort to the national average changes in the infant mortality rate. The plot indicates that the aggregate decrease of 8.5% experienced from 1990 to 1995 was mainly driven by a reduction in mortality among the groups with “3 to 9 years of education” (contributing a share of 35%) and “9 and more years of education” (contributing a share of 41%); the “no education” cohort contributed only modestly, with a share of 24% to the overall decline. In contrast, the increases in the aggregate rate from 2000 to 2005 were driven by the “no education” cohort, which accounted for 94% of the change. This confirms the hypothesis that the households with low educational attainment are the main contributors to the recent stagnation in aggregate infant mortality decline.

### Trends in age and cause of death

We also examined the trends in cause and age of death, observing a general decrease in mortality rates for all diseases and all educational levels. The diseases most likely to claim infants of uneducated mothers have shifted from congenital defects, perinatal conditions and respiratory illness in 1990 to infectious diseases and trauma in the more recent period. We noted similar tendencies in the incidence of infant mortality by head of household occupational status and cause of death. During 2000–2005, infant mortality due to trauma and respiratory distress among the group with unemployed heads of household was 10 times as prevalent as for the employed group, and five times as prevalent in the case of infectious diseases.

However, relative mortality risks for infants of mothers with no education rose from 1995 to 2005 for deaths on the first day through 5 months, and maintained a similar level for deaths between 6 and 11 months. The largest

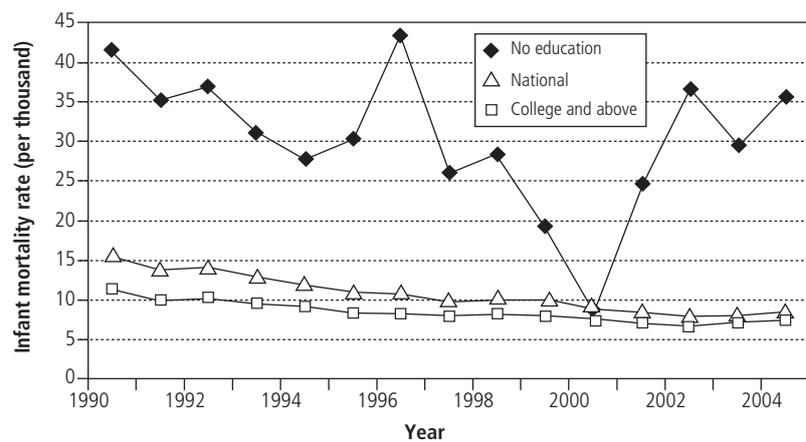
inequity was found in deaths between 6 and 11 months of life, where relative risk rose from 3.35 to 7.19. The same trends were found in the infant mortality rates for unemployed heads of household, where infant mortality rates increased at all ages of death from 1990 to 2005, while the same rates for employed heads of household decreased by nearly half. The largest inequity among unemployed heads of household relative to their employed counterparts was found in the infant mortality rate between 7 and 27 days, which also represented the greatest increase from 1990 levels for unemployed households.

### Geographic inequalities

Fig. 3 illustrates the geographic distribution of infant mortality inequality by health service region in 2005. Clustering of high levels of inequality occurs in the traditionally poorer northern regions (Antofagasta, Iquique), the southern traditionally indigenous regions (Araucanía Norte y Sur), and the densely populated Santiago metropolis. We also examined the relationship between the general infant mortality rate and inequality in infant mortality (as measured by relative risk between the no-education and 13+ years cohorts) by health service between 1990 and 2005. We highlight two trends:

1. Regions that have decreased their aggregate infant mortality rates but increased their inequality (most notably Concepción, Iquique, Araucanía Norte, Araucanía Sur, Metropolitano Central, Ñuble, Antofagasta and Metropolitano Occidental);

Fig. 1. Trends in infant mortality by maternal education, 1990–2005



2. Regions that have decreased their aggregate infant mortality rates and decreased their inequality (most notably Talcahuano, Metropolitano Sur Oriente and Metropolitano Oriente).

We note with concern that while all health services except Arica and O'Higgins have experienced reductions in infant mortality for the 13+ years educational group, only a slight majority have experienced reductions for the no maternal education group. Two specific examples illustrate these trends at the regional level. Concepción experienced a nearly fourfold increase in relative risk from 1990 to 2005; this increase was driven by a simultaneous increase in infant mortality rates for the no maternal education group from 76.09 to 131.54 and a decrease in rates for the 13+ years group from 12.61 to 9.04. Metropolitano Sur conversely

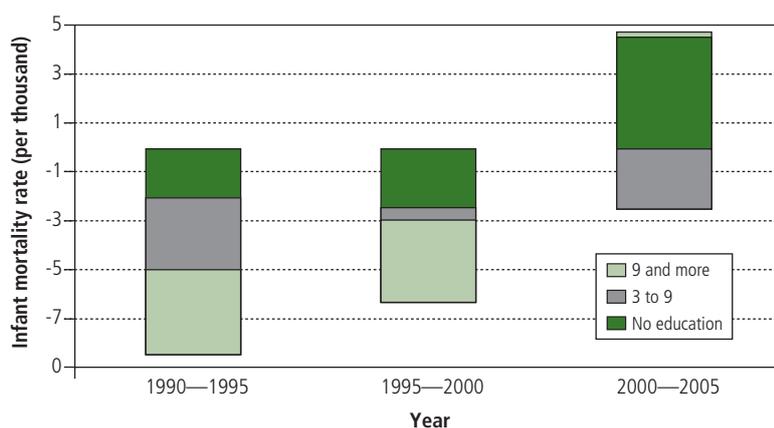
experienced a twofold reduction in relative risk from 1990 to 2005, driven by a marked decrease in infant mortality for the no education group from 57.03 to 31.98 and a decrease in the 13+ years group from 11.93 to 6.92.

### Discussion

This paper has identified and tracked several important inequalities in the burden of infant mortality by socioeconomic level in Chile. We found strong relationships between maternal education and head of household employment status and infant mortality rates, a conclusion borne out by previous studies, including one conducted from 1985 to 1995 in Chile,<sup>13</sup> as well as studies in Iran<sup>16</sup> and Norway<sup>17</sup> and a cross-national study of nine developing countries.<sup>18</sup> Further studies in Chile are necessary to elucidate the mechanism by which maternal education influences child survival, how this pathway has shifted with the dramatic reduction in aggregate rates, and any interaction that may exist with broader social and economic processes.

A recent study has conceptualized the impressive Chilean infant mortality decline as a two-step success and a model that should be considered by other developing countries.<sup>12</sup> We argue that the historical reduction has indeed been a considerable success, but that inequities persist and are even increasing in some regions of Chile. These findings give cause for concern and for policy intervention. This work sought to provide a broad overview of socioeconomic inequalities in infant mortality and to offer new directions and targets for policy

Fig. 2. Socioeconomic composition of trends in infant mortality: weighted share of maternal education on change in aggregate infant mortality rate, 1990–2005



interventions. The results suggest that apparent stagnation in the reduction of national infant mortality is caused by increasing mortality in the low maternal education groups. Therefore, the key to further reductions in the aggregate infant mortality rate, as well as to elimination of related inequities, is to target specific disadvantaged and at-risk populations, as these account for the majority of variation in the national rate.

This study also identifies specific geographic regions, ages and causes of death that are particularly susceptible to inequality. We identify the most vulnerable periods for the disadvantaged to be the first day after birth and the period from the seventh day to the fifth month after birth, and the most prevalent causes of death to be infectious diseases, respiratory distress and trauma. These patterns of disease are unique to vulnerable households, indicating the need for targeted public health policy interventions. Because many of these disadvantaged households are underutilizing health-care services (due to social or economic exclusion), we advocate the creation of more family-community care and outreach efforts. These two interventions are complementary: family-community care mobilizes and empowers individuals, families and communities to demand services from specialized providers sensitive to the community's specific needs, and outreach efforts are required to provide these services. Such services may include the adoption of behaviour-changing public health campaigns, increased attention to symptoms and corresponding care-seeking, and care provision through trained community health workers.<sup>19</sup> We highlight a panel of interventions that have proven effective and cost-efficient, as reported in prior public health and policy literature, that can be implemented within a family-community and outreach care framework:<sup>19,20</sup>

- Antenatal: nutritional supplements and counselling on breastfeeding and child care;
- Neonatal: resuscitation of newborn babies and hypothermia/hypoglycaemia prevention;
- Postnatal: early and exclusive breastfeeding, kangaroo maternal-child care for low-birth-weight infants, community-based pneumonia and infection management, and awareness campaigns to reduce trauma-based deaths.

Fig. 3. Relative risk of infant mortality, no maternal education relative to 13 or more years of education, by health service in Chile, 2005



Another interesting result of this study was the observation of large socioeconomic inequalities in the coverage and quality of vital statistics registration. We observed a substantial incidence of poorly defined deaths among the socioeconomically disadvantaged relative to the remaining population, measured by both occupational status and maternal education. This suggests that the true infant mortality for these populations may be higher than the rates presented in this paper. Moreover, the areas identified as having very high relative incidence and inequalities of infant mortality were the same regions where underreporting and poor coding were previously identified as being most prevalent.<sup>15</sup> Although Chile currently has excellent aggregate coverage for vital events (nearly 99%), high-risk populations have lower rates of both quality and coverage, thus suggesting a double inequity. These groups are not only more likely to have higher levels of infant mortality, but the cases are less likely to be codified properly. Improvements in the life and death registries need to focus on these populations to rectify this inequity.

The geographic results of this study indicate that traditional aggregate measures of health need to be paired with equity-based indicators (such as differential risk by socioeconomic status) to be truly effective in guiding the improvements of health for all populations. The study identified regions within Chile that are particularly at risk for inequality and analysed their trends relative to aggregate mortality rates, noting with concern that while all regions reduced their mean mortality, socioeconomic inequalities increased considerably in

several regions. Most notably, Araucanía Norte increased nearly fourfold and Concepción and Talcahuano nearly threefold. These regions would do well to emphasize infant and child survival for at-risk, low-socioeconomic-status populations.

This investigation comes at an important time for Chile and many other countries, as concerns of equity, particularly in health and education, are receiving greater attention from social critics. Distributional concerns are becoming increasingly important and policy-makers face intense questioning about the underlying philosophies of social, economic and political institutions. Nations – their decision-makers and citizens alike – must reconcile their processes and institutions of governance with two important concepts: equity and a broader definition of development. In the realm of public health, both concepts are being integrated slowly into the policy arena. The work of Amartya Sen, in particular, has highlighted the need to view development as a broader expansion of the human condition rather than simply economic growth.<sup>21</sup> In this vision of development, health assumes a key role as both a means and an end. Child survival and health takes a central place in turn. Preventable infant mortality is an affront to society as a whole, a theft of its active contributors. The elimination of the inequities presented by child and infant mortality is essential for true national development.

## Conclusions

This work presents a robust analysis of socioeconomic inequality and its

impact on infant mortality in Chile. It does so by providing aggregated data by cause, age of death, geographic location, maternal education and head of household occupational status for the period 1990–2005, a task that prior to this work had not been addressed for Chile. These results indicate that the socioeconomically disadvantaged are at a significantly higher risk for infant mortality by infectious diseases and trauma during the first month of life. The identification of these specific trends in the burden of mortality provides a base for further analysis and generation of population-specific policy interventions. Chilean President Michelle Bachelet has made infant and child health a priority of her administration, and oversaw the creation and work of a special Commission on Infancy in 2006 to generate new policy recommendations. This commission has made equity and the social determinants of health central components of its recommendations; this is a laudable accomplishment. However, essential to the success of these policies will be the inclusion of the at-risk populations identified in this study. These groups have experienced a rise in their infant mortality rates and are at higher risk of certain diseases at certain ages; further progress in reducing infant mortality rates for these groups will require specific and targeted policy interventions. Beyond Chile, all countries that wish to promote child well-being would do well to emphasize the importance of equity in public health as they seek to advance social and economic development. ■

**Competing interests:** None declared.

## Résumé

### Baisse de la mortalité infantile au Chili : à qui bénéficie ce progrès ? Inégalités socioéconomiques et géographiques en matière de mortalité infantile de 1990 à 2005

**Objectif** Mesurer les inégalités socioéconomiques et les variations du risque de mortalité infantile aux niveaux national et régional au Chili entre 1990 et 2005 et proposer de nouveaux objectifs pour les politiques sanitaires.

**Méthodes** L'étude a analysé les registres d'état civil chiliens entre 1990 et 2005 pour déterminer la mortalité infantile par niveau d'éducation de la mère, statut professionnel du chef de famille, cause, âge et lieu du décès. Pour chaque cause et âge de décès, les taux annuels de mortalité infantile et les risques relatifs ont été calculés par niveau d'éducation maternelle et par statut professionnel du chef de familles. On a ensuite dressé la carte des inégalités socioéconomiques en fonction des 29 services de santé régionaux.

**Résultats** Les baisses du taux de mortalité infantile national étaient liées à des baisses du taux de mortalité infantile chez les femmes bénéficiant d'un niveau d'éducation élevé, tandis que la stagnation récente du taux national était imputable à de forts niveaux de mortalité infantile chez les femmes non éduquées. Les foyers vulnérables concernés étaient plus exposés au risque de mortalité infantile par maladie infectieuse ou traumatisme. Nous avons aussi relevé une concentration de fortes inégalités socioéconomiques en matière de mortalité infantile dans le nord du pays plus pauvre, dans la partie sud du pays peuplée d'indigènes et dans la conurbation à forte densité de population de Santiago. Enfin, nous signalons d'importantes inégalités dans la couverture par les registres d'état-civil, le nombre de décès infantiles parmi

les foyers vulnérables ayant une probabilité nettement plus forte d'être mal défini que dans le reste de la population.

**Conclusion** Ces résultats indiquent que les habitants socioéconomiquement désavantagés du Chili sont exposés à un risque significativement plus élevé de mortalité par maladie infectieuse ou par traumatisme pendant leur premier mois de vie.

Les efforts pour réduire la mortalité infantile nationale dans des pays comme le Chili doivent comprendre des politiques visant la survie des enfants parmi les populations à risque exposées à des maladies et appartenant à des classes d'âge et à des lieux spécifiques.

## Resumen

### Disminución de la mortalidad infantil en Chile: ¿quiénes se benefician? Desigualdades socioeconómicas y geográficas en mortalidad infantil, 1990–2005

**Objetivo** Medir las desigualdades socioeconómicas y el riesgo diferencial en mortalidad infantil a nivel nacional y regional en Chile entre 1990 y 2005 y proponer nuevas metas de política.

**Métodos** A partir de registros de eventos vitales del país correspondientes al periodo de 1990 a 2005, se analizó la mortalidad infantil en función de la educación de la madre, la situación laboral del cabeza de familia, la causa, la edad y el lugar de la defunción. Se calcularon las tasas anuales y el riesgo relativo de mortalidad infantil en función de la educación de la madre y de la situación laboral para cada causa y edad de fallecimiento. Sobre esa base, se mapearon las desigualdades socioeconómicas en 29 servicios regionales de salud.

**Resultados** Las reducciones de la tasa nacional de mortalidad infantil se debieron a la disminución conseguida entre las madres con alto nivel de estudios, mientras que el estancamiento reciente de esa tasa se debe al elevado nivel de mortalidad infantil registrado entre las madres sin estudios. En estos hogares vulnerables se observa un riesgo especialmente elevado de

mortalidad infantil por enfermedades infecciosas y traumatismos. Detectamos además agrupamientos de gran desigualdad socioeconómica en las zonas más pobres del norte, las comunidades indígenas del sur y el centro metropolitano densamente poblado de Santiago. Por último, informamos de importantes inequidades en la cobertura de las estadísticas vitales, toda vez que las defunciones de lactantes que se producen en los hogares vulnerables suelen estar descritas con menos precisión que en el resto de la población.

**Conclusión** Los resultados indican que las clases desfavorecidas de Chile están expuestas a un riesgo significativamente mayor de mortalidad infantil por enfermedades infecciosas y traumatismos durante el primer mes de vida. Los esfuerzos orientados a reducir la mortalidad infantil en Chile y en otros países deben incluir políticas focalizadas en la supervivencia infantil en poblaciones de riesgo caracterizadas por enfermedades específicas, por la edad y por el lugar geográfico.

## ملخص

### انخفاض معدل وفيات الرضع في شيلي: هذا التحسن.. لمن؟ التفاوتات الاجتماعية والاقتصادية والجغرافية في وفيات الرضع، 1990 - 2005

الرضع فيها بسبب الأمراض المعدية أو التعرض للرضوح. وقد تمكّن الباحثون من تحديد مجموعات من التفاوتات الاجتماعية والاقتصادية ذات العلاقة بوفيات الرضع، وذلك في مناطق الشمال، الذي يعد الأكثر فقراً، وفي الجنوب المأهول بالسكان الأصليين، وفي مركز العاصمة سنتياغو، المكتظ بالسكان. كما أبلغ الباحثون عن وجود تفاوت كبير في التغطية بإحصائيات الولادات والوفيات بالمناطق المختلفة حيث يغلب أن يكون عدم التحديد الكافي لوفيات الرضع أكبر بين العائلات الأكثر عرضة لوقوع هذه الوفيات، منها بين بقية السكان.

**الاستنتاج:** تشير النتائج إلى أن الفئات المحرومة اجتماعياً واقتصادياً في شيلي، أكثر تعرّضاً بشكل يعتد به إحصائياً، لخطر وقوع وفيات الرضع بسبب الأمراض المعدية، والتعرّض للرضوح خلال الشهر الأول من عمر الرضيع. وينبغي أن تشمل الجهود الرامية إلى خفض المعدلات الوطنية لوفيات الرضع في شيلي وغيرها من البلدان، السياسات التي تستهدف بقاء الطفل على قيد الحياة وذلك بالنسبة للفئات السكانية المعرضة لمخاطر الإصابة بأمراض بعينها، أو الوفاة في أعمار أو أماكن معينة.

**الهدف:** قياس التفاوتات الاجتماعية والاقتصادية، والمخاطر التنافسية في وفيات الرضع على الصعيد الوطني والإقليمي في شيلي، في الفترة من 1990 إلى 2005، واقتراح تضمين أهداف جديدة في السياسات.

**الطريقة:** أجري في هذه الدراسة تحليل لبيانات سجلات المواليد والوفيات في شيلي، في الفترة من 1990 إلى 2005 من حيث وفيات الرضع، وفقاً لمستوى تعليم الأم، وعمل رب الأسرة، وسبب الوفاة، والعمر، ومكان حدوث الوفاة، حيث حُسبت المعدلات السنوية لوفيات الرضع والمخاطر النسبية، بحسب مستوى تعليم الأم وعمل رب الأسرة وذلك بالنسبة لسبب الوفاة وعمر الرضيع عند الوفاة. ثم جرى ترسيم للتفاوتات الاجتماعية والاقتصادية في 29 دائرة من دوائر الخدمات الصحية الإقليمية.

**الموجودات:** إن الانخفاض الذي حدث في المعدل الوطني لوفيات الرضع أوجده انخفاض المعدلات بين أطفال الأمهات من ذوات المستوى التعليمي المرتفع، بينما يرجع سبب مراوحة المعدل الوطني لمكانه، في الفترة الأخيرة، إلى ارتفاع معدلات وفيات الرضع بين أطفال الأمهات غير المتعلّقات، حيث تكون هذه العائلات السريعة التأثير معرضة، بصفة خاصة، لمخاطر وفيات

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