

## Evaluation of neonatal mortality in Buenos Aires City by place of residence and use of a health system subsector

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### ABSTRACT

Neonatal mortality is the most important component of infant mortality. Analyzing neonatal mortality is complex and does not depend exclusively on the health system.

In Buenos Aires City (CABA), between 2000 and 2012, neonatal mortality rate was lower than the national mean rate but no changes were recorded. Besides, the difference is narrowing: in 2000, it was 46% lower but in 2012, it was 21% lower.

**Objective:** To assess the relationship among the place of maternal residence, the use of a health system subsector, and mortality rate among newborn infants younger than 28 days old in CABA.

**Methods:** Cross-sectional, population-based study conducted in 2011 and 2012 using data from the Office of Vital Records and the Department of Statistics and Surveys of CABA.

**Results:** A total of 164 837 births were recorded. The ratio of births in public and private facilities has remained stable; the private subsector accounts for 57% of births. The ratio between both subsectors was also similar in terms of gender, birth weight, and average gestational age. Neonatal mortality was higher among mothers who lived outside CABA (6.55% versus 5.42%, odds ratio: 1.21, 95% confidence interval: 1.07-1.37,  $p$  0.0039). Among mothers living in CABA, neonatal mortality was higher in the public health subsector (7.8% versus 4.4%, odds ratio: 1.77, 95% confidence interval: 1.48-2.11,  $p$  < 0.001).

**Conclusion:** Unlike any other district in Argentina, CABA has a very high rate of births and deaths from other jurisdictions, especially from Greater Buenos Aires, which is not reflected in official statistics that only consider the place of parental residence.

**Key words:** neonatal mortality, health systems, regionalization, epidemiological factors.

<http://dx.doi.org/10.5546/aap.2016.eng.405>

### INTRODUCTION

Neonatal mortality is the most important component of infant mortality; its analysis is complex and does not depend exclusively on the health system.

Since 1980, in Argentina, infant mortality rate (IMR) has tended to reduce, with mild fluctuations. Over

the past 31 years, IMR reduced 64.8%, from 33.2‰ in 1980 to 11.7‰ in 2011, and neonatal mortality rate (NMR) was 7.6‰.<sup>1</sup>

NMR accounts for two-thirds of IMR and is proportionally higher when IMR is lower, as observed in developed countries or in populations with good socioeconomic and cultural conditions.

There is a global consensus regarding the fact that the reduction in infant mortality rates that occurred in the past decades in developed countries is the result of the increase in survival rate of extremely preterm infants.<sup>2,3</sup> Neonatal networks allow for improved survival and enhanced good clinical practice. The infant's birthplace plays a major role in its survival.<sup>4</sup>

The circumstances in which people are born, develop, live, work, and grow old, including the health system, are social determinants of health; these are the cause of the greatest health inequalities among and within countries.<sup>5</sup> Such determinants are the subject of public policies and may be modified through effective interventions.

Over the 22-year period between 1990 and 2011, IMR tended to reduce in Buenos Aires City (CABA), which implies a 47% reduction (from 16‰ to 8.5‰). However, important disparities in IMR have been recorded in each municipality.<sup>6,7</sup>

In CABA, NMR has not improved as expected. In the 13-year period between 2000 and 2012, in spite of being lower than the national mean rate, no changes have been observed, and the difference is becoming smaller: while it was 46% lower in

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Funding: None.

Conflict of interest: None.

Received: 11-20-2015  
Accepted: 04-21-2016

2000, it was 21% lower in 2012, based on official data (Table 1).<sup>1</sup>

Several descriptions have been made regarding this problem but no associations have been established. This would be relevant for an assessment and future intervention aimed at achieving a greater effectiveness and efficiency in health systems regarding this issue.

The goal of this study is to assess the relationship among the place of maternal residence, the use of a health system subsector, and mortality rate among newborn infants younger than 28 days old in CABA, in 2011 and 2012.

## MATERIALS AND METHODS

Population-based, cross-sectional study. Birth rate data were provided by the Office of Vital Records of the City of Buenos Aires, and mortality data, by the Department of Statistics and Surveys.

## POPULATION

### Inclusion criteria

All records of infants younger than 28 days old born and deceased in CABA corresponding to either CABA or the province of Buenos Aires. The population was selected consecutively in 2011 and 2012.

### Exclusion criteria

Any incomplete record or showing incompatibilities with birth weight, maternal age, gender, birth date, and facility code records.

To establish IMR in this study, all newborn infants born in CABA during the above-indicated period (numerator) were analyzed; the denominator was built based on all newborn infants born in CABA and deceased. To this end, databases were cross-referenced using birth weight, maternal age, gender, birth date, and facility code records.

TABLE 1. Comparison of neonatal mortality between Argentina and Buenos Aires City

YEAR	Live births Argentina	Live births CABA	NMR ‰ Argentina	NMR ‰ CABA	Difference
2000	701 878	43 587	10.9	5.9	46%
2001	683 495	42 171	10.6	6.2	42%
2002	694 684	40 825	11.3	6.3	44%
2003	697 952	42 136	10.5	6.4	39%
2004	736 261	44 019	9.7	5.7	41%
2005	712 220	43 064	8.9	5.2	42%
2006	696 451	43 582	8.5	4.9	42%
2007	700 792	42 183	8.5	5	41%
2008	746 460	45 122	8.3	4.9	41%
2009	745 336	43 584	8	5.8	28%
2010	756 176	44 347	7.9	4.5	43%
2011	758 042	45 280	7.6	5.5	29%
2012	738 318	43 733	7.5	5.9	21%
Reduction in NMR 2000-2012			31%	0%	

Source: Department of Health Statistics and Information. Ministry of Health of Argentina. CABA: Buenos Aires City; NMR: neonatal mortality rate.

TABLE 2. Study outcome measures by category

<b>Output variable</b>
1. Death (dichotomous)
<b>Predictive outcome measures</b>
1. Place of maternal residence (in CABA versus outside CABA, dichotomous)
2. Use of a health system subsector (public health care provider versus SSP health care provider, dichotomous)
<b>Control outcome measures</b>
1. Sex (male, female)
2. Gestational age (in weeks)
3. Age at time of death (dichotomous, early NMR up to 6 days old, late NMR from 7 to 27 days old, overall NMR younger than 28 days old)
4. Birth weight (in grams)
5. Maternal age (in years)

CABA: Buenos Aires City, SSP: social security/private subsector; NMR: neonatal mortality rate.

### Outcome measures

Outcome measures are described in *Table 2* by category.

### Ethical considerations

The study is associated with a grant awarded by the Government of CABA and has been approved by the corresponding Research Ethics Committee.

### Analysis

Results are presented in two different sections: birth rate analysis and mortality rate analysis; in addition, mortality data in the sub-population with a birth weight between 500 g and 1499 g are also presented.

The incidence of outcome measures was described as mean and percentages with their corresponding 95% confidence interval (CI) or standard deviation, as applicable. The association among dichotomous outcome measures was assessed using the  $\chi^2$  test, and odds ratios (ORs) with their corresponding 95% CIs were estimated.

For a total of approximately 80 000 newborn infants born per year in the studied territory, the population was enough to identify a difference of at least 0.04% in predictive outcome measures for the output variable, with a 95% confidence level and an 80% power.

Analysis was performed using the EpiInfo™ statistical software, version 3.5.1 for Windows. A value of  $p < 0.05$  was considered significant.

## RESULTS

### Statistical analysis: Birth rate

A total of 164 691 newborn infants were born between 2011 and 2012. The number of births remained stable in both years. The ratio of births in public and social security/private (SSP) facilities also remained stable; the latter subsector accounts for most births.

Most births from mothers living in CABA take place in the SSP subsector (64.7%) (*Table 3*).

The ratio of gender, birth weight, gestational age, and maternal age was similar between both subsectors and between those living in and

TABLE 3. CSociodemographic characteristics of infants born in Buenos Aires City by place of residence. Years 2011 and 2012

	CABA	Outside CABA
<b>Total, n (%)</b>	89 099 (54.1)	75 592 (45.9)
<b>a) Public sector, n (%)</b>	32 374 (34.8)	34 207 (45.2)
Male sex, n (%)	16 434 (50.8)	17 462 (51)
Mean birth weight in grams (SD)	3359 (580)	3290 (662)
Mean gestational age in weeks (SD)	38.97 (1.92)	40.12 (1.96)
Mean maternal age in years (SD)	26.2 (6.46)	25.85 (6.54)
<b>b) Social security/private sector, n (%)</b>	56 725 (64.7)	41 385 (54.6)
Male sex, n (%)	29 083 (51.3)	21 098 (51)
Mean birth weight in grams (SD)	3254 (554)	3225 (626)
Mean gestational age in weeks (SD)	38.51 (1.9)	38.95 (1.9)
Mean maternal age in years (SD)	31.79 (5.59)	30.72 (6.01)

CABA: Buenos Aires City, SD: standard deviation.

TABLE 4. Maternal population grouped by age range, place of residence, and use of a health system subsector. Years 2011 and 2012 (No data 2498)

Place of residence	CABA	
	Public	Social security/private
<b>Age range in years</b>		
10-17, n (%)	1773 (5.8)	486 (0.8)
18-45, n (%)	28 468 (94)	55 611 (98.7)
46-60, n (%)	17 (0.05)	199 (0.3)
<b>Residencia</b>		<b>Outside CABA</b>
<b>Age range in years</b>	<b>Public</b>	<b>Social security/private</b>
10-17, n (%)	2347 (6.9)	736 (1.8)
18-45, n (%)	31 797 (93)	40 522 (98)
46-60, n (%)	26 (0.07)	108 (0.2)

CABA: Buenos Aires City.

outside CABA (Table 3).

A distinctive feature of the public subsector is adolescent pregnancy, which is higher among those living outside CABA. When compared by age groups, a statistically significant difference was observed in the chance that adolescent mothers from CABA have of delivering their children in public hospitals (OR 7.15, 95% CI: 6.46-7.91,  $p < 0.001$ ). The result is similar in the population from outside CABA, but the association was weaker (OR 4.07, 95% CI: 3.74-4.43,  $p < 0.001$ ).

In contrast, the ratio of mothers older than 17 years old and older than 45 years old is significantly higher in the SSP health subsector of CABA; similar results were observed in the population from outside CABA, and a weaker association (Table 4).

No differences were observed in terms of gestational age; the number of extremely preterm newborn infants is similar across all populations.

No differences were observed either among populations in terms of birth weight. The number of preterm newborn infants with a birth weight of less than 1500 grams was similar across all subgroups (Table 3).

### Mortality analysis

To reduce the bias of deceased infants not living in CABA, birth and death databases were cross-referenced. Out of the 693 infants deceased between 2011 and 2012, it was confirmed that 491 (71%) had been born and died in CABA but their mother did not live in the city.

CABA has the lowest IMR in Argentina, and NMR is the greatest component of IMR. Among

CABA residents, mortality is twice as high in the public subsector than in the SSP subsector (7.8‰ versus 4.4‰).

NMR among residents from outside CABA is significantly higher than among CABA residents (6.55‰ versus 5.42‰, OR 1.21, 95% CI: 1.07-1.37,  $p < 0.003$ ); in turn, mortality is higher among residents from outside CABA in the public subsector (Table 5).

Among CABA residents, the different NMR categories are higher and statistically significant in the public subsector compared to the SSP subsector. For early NMR, OR was 1.72, 95% CI was 1.4-2.12, and  $p < 0.001$ . For late NMR, OR was 1.92, 95% CI was 1.34-2.73, and  $p < 0.001$ . For overall NMR, OR was 1.77, 95% CI was 1.48-2.11, and  $p < 0.001$ .

The same differences were observed among residents from outside CABA but the strength of the association for early NMR was different: OR 1.25, 95% CI: 1.04-1.49,  $p < 0.05$ . In this case, in terms of late NMR, no significant differences were observed: OR 0.87, 95% CI: 0.64-1.2,  $p < 0.86$ . For overall NMR, OR was 1.16, 95% CI was 0.97-1.39, and  $p < 0.09$ .

The analysis of neonatal mortality in the population with a birth weight between 500 grams and 1499 grams among residents from outside CABA shows that it is significantly higher (OR 2.09, 95% CI: 1.61-2.71,  $p < 0.001$ ). Among CABA residents, mortality is higher in the public subsector than in the SSP subsector (OR 1.61, 95% CI: 1.06-2.47,  $p < 0.03$ ). The same difference was observed among residents from outside CABA (OR 1.39, 95% CI: 1.01-1.93,  $p < 0.0441$ ) (Table 6).

TABLE 5. Neonatal mortality and mortality rates grouped by category, place of residence, and subsector of the health system. Years 2011 and 2012

Place of residence	CABA	Outside CABA	OR (95% CI)	<i>p</i>
Early neonatal mortality rate, ‰ (n)	4 (357)	4.38 (332)	1.09 (0.94-1.27)	0.23
Late neonatal mortality rate, ‰ (n)	1.42 (126)	2.17 (164)	1.53 (1.21-1.93)	< 0.001
Neonatal mortality rate, ‰ (n)	5.42 (483)	6.55 (496)	1.21 (1.07-1.37)	0.003
<b>Place of residence in CABA</b>				
Subsector of the health system	Public	SSP	OR (95% CI)	<i>p</i>
Early neonatal mortality rate, ‰ (n)	5.6 (171)	3.3 (186)	1.72 (1.4-2.12)	< 0.001
Late neonatal mortality rate, ‰ (n)	2.1 (64)	1.1 (62)	1.92 (1.34-2.73)	< 0.001
Neonatal mortality rate, ‰ (n)	7.8 (235)	4.4 (248)	1.77 (1.48-2.11)	< 0.001
<b>Place of residence outside CABA</b>				
Subsector of the health system	Public	SSP	OR (95% CI)	<i>p</i>
Early neonatal mortality rate, ‰ (n)	5.09 (174)	3.81 (158)	1.33 (1.08-1.66)	0.0086
Late neonatal mortality rate, ‰ (n)	2.03 (69)	2.3 (95)	0.87 (0.64-1.2)	0.4175
Neonatal mortality rate, ‰ (n)	7.1 (243)	6.11 (253)	1.16 (0.97-1.39)	0.09

CABA: Buenos Aires City, OR: odds ratio, CI: confidence interval, SSP: social security/private subsector.

## DISCUSSION

The first conclusion of this study is that, unlike any other district in Argentina, CABA has a very high rate of births and deaths from other jurisdictions, especially from Greater Buenos Aires, which is not reflected in official statistics that only consider the place of parental residence. This is a reflection of the urgent need to validate and articulate measures to integrate CABA and the nearest areas of Greater Buenos Aires into a single health region, both in terms of health care and statistical analysis. Otherwise, it would be like looking into half of the reality in relation to statistics and neonatal outcomes, for example.

The main strength of this study lies in record reliability. A potential weakness of this study is that the number of deceased infants born in CABA and whose parents lived outside CABA was established by cross-referencing birth and death record databases (using birth weight, maternal age, gender, birth date, and facility code records).

When numbers are compared, striking differences are observed by place of residence. While CABA residents have one of the lowest NMRs in Argentina (5.57‰), the rate is higher than the national mean rate among those who live outside CABA and use the same health system (10.3‰ versus 7.59‰).<sup>8</sup>

To address this problem, it is critical to recognize that the Argentine health system is characterized by segmentation and fragmentation (in terms of regulation and territory). This results in major hurdles for compliance with health rights.<sup>9</sup>

Another major aspect of health coverage is that it is distributed according to the population's income level. A national study indicated that dependence on public health services is greater as the family per capita income is lower.<sup>9</sup>

When analyzed by territory, the number of infant deaths is 10% higher in the province of Buenos Aires when comparing municipalities in a good situation and those in a bad situation, while such risk is 150% higher among the different municipalities of CABA.<sup>10</sup>

The health system established here is copied from the curative model, which, on the one side, shows a disproportionate increase in neonatal equipment and advanced techniques and, on the other side, provides services with a high prevalence of infections, few trained nurse staff, and health care providers who are seldom found in health facilities, lack practice guidelines or standards, and fail to complete their training on one technique before learning another.<sup>11</sup>

The number of antenatal care visits may provide information on pregnancy care, early access to the system, and the possibilities of implementing preventive or care measures. In 2011, 51.1% of pregnant women from Greater Buenos Aires and 57.8% of pregnant women from CABA had received adequate antenatal care,<sup>12</sup> and many of them did not meet acceptable requirements in terms of early initiation, distribution, comprehensiveness, and quality. Only 30% of antenatal care is started in an early manner during the first quarter.

Articulation between health promotion activities developed at a community level and primary health care services, and that between these services and maternity centers where mother and child care is provided is still insufficient. Poverty makes the situation worse because it intensifies the negative impact that the lack of care has on women regarding the preservation of their reproductive health and the adequate prognosis of their pregnancy and their newborn infants.<sup>13</sup>

TABLE 6. Neonatal mortality in the population born with 500-1499 grams by place of residence and subsector of the health system. Years 2011 and 2012

Place of residence	CABA	Outside CABA	OR (95% CI)	<i>p</i>
Neonatal mortality, % (n)	10.23 (103)	19.28 (182)	2.09 (1.61-2.71)	< 0.001
<b>CABA</b>				
<b>Subsector of the health system</b>	<b>Public</b>	<b>SSP</b>	<b>OR (95% CI)</b>	<b><i>p</i></b>
Neonatal mortality, % (n)	20 (47)	12 (56)	1.61 (1.06-2.47)	< 0.03
<b>Outside CABA</b>				
<b>Subsector of the health system</b>	<b>Public</b>	<b>SSP</b>	<b>OR (95% CI)</b>	<b><i>p</i></b>
Neonatal mortality, % (n)	22.05 (97)	16.87 (85)	1.39 (1.01-1.93)	0.0441

CABA: Buenos Aires City, OR: odds ratio, CI: confidence interval, SSP: social security/private subsector.

Approximately 70 000 adolescents from developing countries die every year due to pregnancy- and childbirth-related conditions. Pregnant adolescents tend to come from low income households and have poor nutrition.<sup>14-16</sup> In our study, the estimated percentage of girls younger than 18 years old giving birth in the public subsector was five times higher than in the SSP subsector.

Poor and illiterate or poorly-educated girls are more likely to become pregnant than rich, educated girls from urban regions.<sup>14</sup> Birth death rate, morbidity and infant deaths are 50% higher among newborn infants born from adolescents than among those born from 20-29-year-old girls.<sup>17-19</sup>

In the analysis of the population with a birth weight between 500 grams and 1499 grams, the discussion focuses on the ratio of nurses and the level of care. It has been demonstrated that survival is associated with the number of specialized nurses.<sup>20</sup> Having more than 1.2 nurses/patient reduces the probability of mortality by 42%.<sup>20</sup> Callaghan showed that the chance of death decreased by 82% when the nurse/patient ratio was 1.7 or higher.<sup>3</sup> Studies conducted in other settings also described such differences.<sup>21</sup>

An inadequate regionalization of perinatal care in the metropolitan area is also a major aspect of this analysis. Regional programs were designed to organize services so that women and children at high risk would receive care at hospitals with the experience and technology necessary to ensure their optimal care. Maternity centers were classified into three levels of care, transport systems were established, and links were developed to maintain training at the lower care settings that referred patients to tertiary care settings. Experiences from different countries have been published, which assessed results from regionalized perinatal systems regarding a single indicator: neonatal mortality, especially among newborn infants with a birth weight of less than 1500 grams. In different settings and health systems, regionalization appears to have a positive effect on mother and child indicators. Experiences from Canada, Portugal, Chile, and the United Kingdom support this policy as a manner of health care organization.<sup>22</sup>

Finally, the following is prevalent in public hospitals: adolescent pregnancy, a lower level of education, lack of antenatal care, lower corticosteroid use, presence of gestational diabetes (in relation to malnutrition), and chorioamnionitis. Such higher risk may be related to poverty, poor nutrition, smoking, alcohol use,

and poor health conditions prior to pregnancy.<sup>23</sup>

It is necessary to further broaden research on neonatal mortality, place of residence, living conditions, access to the health system and health care providers, which have a direct impact on newborn infants' survival possibilities.

As a result of this discussion, it is possible to appreciate the value that our society gives to health and realize that its centrality is vital for the full achievement of individual opportunities. Health and health equity should become collective goals that involve every government and civil society sector, not just the health sector, and specifically, they should not be exclusively restricted to the health system.

Therefore, the challenge remains to know the characteristics of our health inequalities and their determinants, which play different roles in the different sectors of our population.

## CONCLUSION

Unlike any other district in Argentina, CABA has a very high rate of births and deaths from other jurisdictions, especially from Greater Buenos Aires, which is not reflected in official statistics that only consider the place of parental residence.

Future studies should focus on broadening knowledge on associated social determinants. ■

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