Evolution of fetal mortality in the setting of Argentine socioeconomic inequalities. Period 2007-2014

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ABSTRACT

Introduction. Few studies have established a relationship between adverse social conditions by geographic area (GA) and fetal mortality (FM).

Objective. To assess health inequalities in relation to FM by GA.

Population and methods. Descriptive, ecological study. The principal components of 525 GAs were analyzed. A socioeconomic status indicator and indices of inequality were developed and estimated, and the FM ratio was calculated.

Results. The Kunst and Mackenbach relative index of inequality ranged from 1.8 to 1.4 in the 2007/2008 and 2013/2014 biennia, and a higher FM ratio was estimated for the highly unfavorable socioeconomic level stratum.

Conclusion. The FM ratio is higher in this stratum. The gap between the ends of the socioeconomic spectrum narrowed towards the latest biennium. Regardless of this, in the GAs with a very unfavorable socioeconomic status, the FM ratio reduced in the latest biennium and increased in those with a very favorable socioeconomic status.

Key words*: fetal mortality, social inequality, epidemiological factors.*

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GLOSSARY

CI: confidence interval.
DEIS: Health Statistics and Information Department of the Ministry of Health of Argentina.
EPM: extended perinatal mortality.
FM: fetal mortality.
GA: geographic area.
INDEC: National Statistics and Censuses Institute of Argentina.
LBs: live births.
Ln: natural logarithm.
PCA: principal component analysis.
PR: Poisson regression.
Q1: quintile 1; very unfavorable socioeconomic status.
Q2: quintile 2; unfavorable socioeconomic status.
Q3: quintile 3; regular socioeconomic status.
Q4: quintile 4; favorable socioeconomic status.
Q5: quintile 5; very favorable socioeconomic status.
RII: relative index of inequality.
RII_{KM}: Kunst and Mackenbach relative index of inequality.
RR: relative risk.
SESI: socioeconomic status indicator.
SII: slope index of inequality.
UBNs: unmet basic needs.

INTRODUCTION

Each year, there are more than 2.6 million stillbirths globally in middle- and low-income countries, and three-fourths of the stillbirths occur in south Asia and sub-Saharan Africa.[1]

In 2014, the World Health Assembly approved a goal of a reduction to 12 or fewer stillbirths per 1000 births by 2030. By 2015, 94 countries had reached this goal,[1] including Argentina, where the fetal mortality (FM) rate by weight was 4.8 per 1000 live births (LBs).[2]

There is no knowledge of national measurements that report on the under-recording of FM, because, although the statistical operational definition by the World Health Organization (WHO) does not establish weight, age or the time of death for a statistical and legal recording, the Health Statistics and Information Department (Dirección de Estadística e Información en Salud, DEIS) provides information that shows that most jurisdictions record deaths occurred as of 22 weeks of gestation.

Health inequality is understood as the unfair disparities of health status among individuals from different social groups that may be associated

with various disadvantages, such as poverty, discrimination, and lack of access to goods or services. Health inequalities may be measured and assessed.[3] Such measurement is essential for improving a region's health status.[4]

According to the World Bank, for the 2007-2013 fiscal period, Argentina was classified as an upper-middle-income economy; for 2014, as a high-income economy; and for 2015, again as an upper-middle-income economy.[5]

Figure 1 shows the evolution of the overall FM rate in Argentina. Between 2007 and 2010, it decreased and reached 7.6 stillbirths per 1000 LBs, then it started increasing and reached 8.3 per 1000 LBs by 2014.

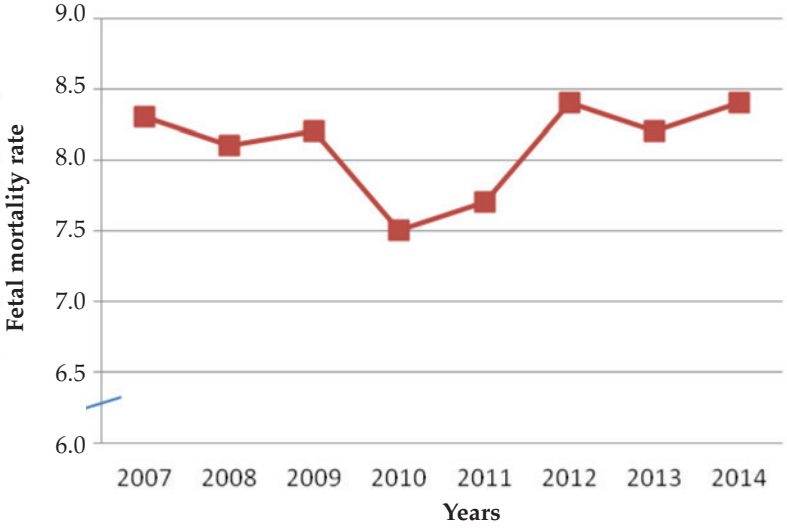
The objective of this study is to analyze FM behavior in the different geographic areas (GAs) of Argentina as characterized by their socioeconomic status for the 2007-2014 period.

MATERIALS AND METHODS

This was a descriptive, ecological study. Analyzed GAs or units corresponded to the 525 administrative subdivisions of the 24 political divisions of Argentina. These GAs were the basis for the development of a socioeconomic status indicator (SESI), which allowed to classify them according to their similar conditions. Using these new groupings, the set of observations related to FM was analyzed biennially for the 2007-2014 period.

According to the International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10),[6] statistical data should include all fetuses and newborns who weigh at least 500 grams, either live births or stillbirths. If weight is not recorded, deaths occurring as of 22 weeks of gestation should be recorded. When data are available, it is recommended to estimate the overall FM rate and the FM ratio using information systems. Both values were included in this study. The DEIS and the National Statistics and Censuses Institute of Argentina (Instituto Nacional de Estadísticas y Censos de la República Argentina, INDEC) were the secondary sources of data. Databases provided by the DEIS corresponded to statistical reports on stillbirths and live births for the 2007-2014 period. The variables and sociodemographic indicators corresponded to the 2010 National Population, Households and Housing Census and were retrieved from the INDEC website. The FM rate was defined as the ratio between total fetal deaths and the sum of the births (live births and stillbirths) per 1000; whereas the FM ratio was the ratio between total fetal deaths and the total live births per 1000 (criteria adopted by the DEIS).

FIGURE 1. *Evolution of fetal mortality rate (per 1000 live births and stillbirths). 2007-2014 period. Argentina*



Source: Developed based on data provided by the INDEC from the 2010 National Population, Households and Housing Census.

DEVELOPMENT OF THE SOCIOECONOMIC STATUS INDICATOR USING THE PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (PCA). This technique is used to reduce the dimensionality of a data set; it converts a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called "principal components." The PCA[7-9] was performed on the variables detailed below in the 525 GAs to determine as much homogeneous areas as possible from a structural perspective. When deciding which variables should be used in indirect measurements of socioeconomic status, the suggestion is to use those that summarize household wealth based on living conditions, access to utilities, level of education, and employment status.[3]

The variables used to develop the SESI were obtained from the 2010 National Population, Households and Housing Census as percentage of the population who lived in an urban area, had no access to running water or sewer system, had gas connection, met any indicator of unmet basic needs (UBNs), completed only primary education, owned a house, and were employed.

ESTIMATION OF THE SLOPE INDEX OF INEQUALITY AND THE KUNST AND MACKENBACH RELATIVE INDEX OF INEQUALITY

The relationship between health and socioeconomic status is an important topic that calls for the measurement of such inequality.[3] Socioeconomic status categories were classified in a scale from the lowest to the highest. Each category had a proportional value (or relative weight) according to the size of the variable "number of live births per socioeconomic inequality stratum;" an x value that was divided by 2, thus obtaining a mean. Then, for another variable, the accumulated relative weight was estimated and, lastly, the population relative weight was obtained, which consisted in the accumulation of the relative weight plus the relative weight of the previous column, as shown in *Table 1* for the 2007-2008 biennium. A Poisson regression (PR) analysis was performed here as in different studies.[10-11] The slope index of inequality (SII) (represented by alpha = regression slope coefficient) and the Kunst and Mackenbach relative index of inequality (RII_{KM}) (defined as the ratio between the alpha regression slope coefficient and the same alpha coefficient plus the beta coefficient from the population relative weight variable) were estimated. Some authors refer to these as relative indices of inequality.[12-16] Both were estimated at an alpha significance level= 0.05, together with their 95% confidence intervals (CIs).

In the PR analysis, the variable "population relative position" was used as an independent variable; the number of fetal deaths, as a dependent variable; and the number of live births, as an independent adjustment variable for the model (also called offset variable), and although it was not represented by any coefficient included in the model, it was used to model the FM ratio when time periods differed. The Poisson model equation was Ln (number of fetal deaths) = Ln (number of live births) + alpha + beta (population relative position) + ei (random error). The number of recorded fetal deaths and live births was estimated for the department where the mother lived. Collected data were processed using Microsoft Office; the PR model was developed using the GLM.1 package from the R. software, version 3.3.1; and the PCA was done using the IBM software SPSS 17.0. The map of Argentina was prepared using the gvSIG software, version 2.1.0. The studied variables from the 2010 National Population, Households and Housing Census conducted by the INDEC were processed using the Redatam SP statistical software package.

TABLE 1. *Population relative weight estimated based on the number of live births and the socioeconomic status indicator. 2007-2008 biennium. Argentina*

Socioeconomic status, 2007/2008 biennium	Live births	Relative weight	(Relative weight)/2	Accumulated relative weight	Population relative weight
Very unfavorable	82 899	0.057	0.029	0.057	0.029
Unfavorable	124 760	0.086	0.043	0.143	0.100
Regular	214 751	0.148	0.074	0.292	0.218
Favorable	350 431	0.242	0.121	0.534	0.413
Very favorable	674 411	0.466	0.233	1.000	0.767

Source: Developed based on data provided by the DEIS.

RESULTS

Once the PCA was completed, homogeneous groups made up of 105 GAs were established; each represented quintiles 1 to 5 (Q1-Q5). These groups corresponded to the SESI strata defined as Q1: very unfavorable socioeconomic status; Q2: unfavorable socioeconomic status; Q3: regular socioeconomic status; Q4: favorable socioeconomic status; Q5: very favorable socioeconomic status.

Table 2 shows the median percentages for the different SESI strata based on the studied variables after the PCA was performed. For Q1, population living in an urban area: 53%; households with no running water: 39.3%; households without sewer system: 100%; households with gas connection: 0.0%; households with any UBN: 21.6%; population who completed only primary education: 52.9%; population who owned a house: 69.6%; and employment rate: 47.7%.

Figure 2 shows the representation of the 525 GAs of Argentina into SESI quintiles (the darkest shade represents Q1). The frequency of GAs in Q1 may be observed in a descending order. In the province of Santiago del Estero, 22 GAs were classified as having a very unfavorable socioeconomic status, in the province of Chaco, 15; in the province of Misiones, 10; for the rest of the provinces, GAs are shown in the table accompanying the figure.

Table 3 shows the SII and RII_{KM}, which decrease towards the 2013/2014 biennium. The SII for the 2007/2008 biennium was -0.617 (95% CI: -0.682:-0.551), and the RII_{KM} was 1.853 (95% CI: 1.207:2.499). Towards the end of the series, in the 2013/2014 biennium, the SII was -0.345 (95% CI: -0.409:-0.281), and the RII_{KM} was 1.412 (95% CI: 1.306:1.519). Both indices showed a significant alpha value = 0.05 for the entire series. The gap between Q1 and Q5 in terms of health inequality in relation to FM, comparing the 2007/2008 biennium to the 2013/2014 biennium, narrowed by 44.1%, as estimated using the SII. The negative sign in the SII means that the higher FM ratio values are observed in the most vulnerable group (Q1). Another interpretation may be done based on the RII_{KM}: for each unit of increment of the RII_{KM}, the FM ratio increased from 1.853 to 1.412.

Figure 3 shows that, in all socioeconomic strata (Q1-Q5), the FM ratio tended to decrease towards the 2009/2010 biennium and then started to increase slightly towards the 2013/2014 biennium. The FM ratio estimated based on the very unfavorable socioeconomic status Q1 compared to the very favorable socioeconomic status Q5 shows that, in the beginning of the series, the gap was wide (it accounted for 57.67%) and for the subsequent biennia, it accounted for 41.32%, 36.55%, and 29.21%, always showing a greater inequality in Q1. The gap between the ends of the socioeconomic spectrum narrowed towards the latest biennium.

The FM ratio estimated for the 2007/2008 biennium per 1000 LBs was 10.75 for Q1 and 6.82 for Q5; and for the 2013/2014 biennium, it was 9.52 for Q1 and 7.37 for Q5.

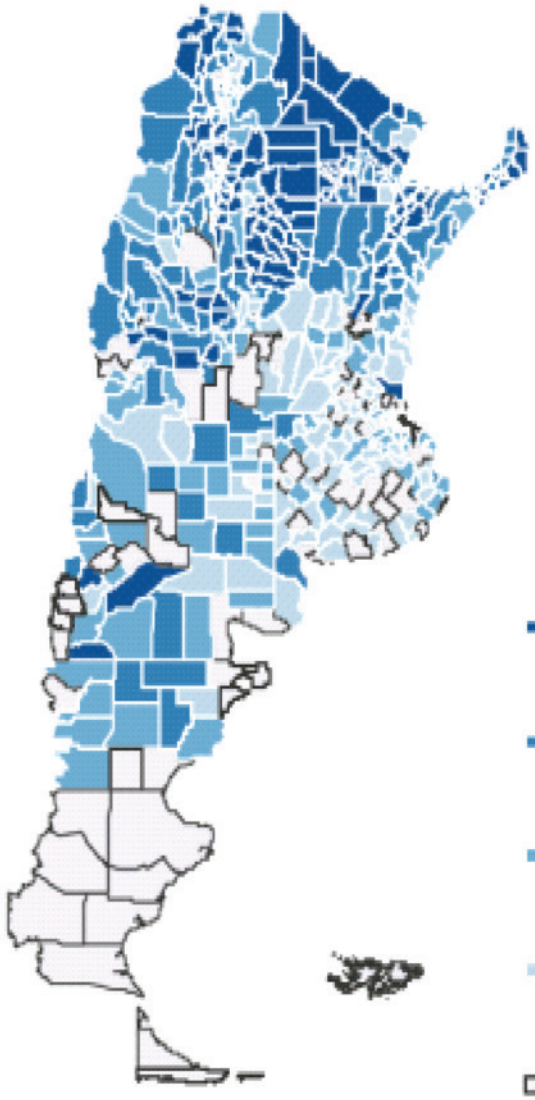
The FM ratio is higher in the GAs with a very unfavorable socioeconomic status across Argentina. Regardless of this, in the GAs with

TABLE 2. *Median values corresponding to the variables selected to develop the socioeconomic status indicator by quintiles*

Variables	Very unfavorable socioeconomic status (Q1)	Unfavorable socioeconomic status (Q2)	Regular socioeconomic status(Q3)	Favorable socioeconomic status(Q4)	Very unfavorable socioeconomic status (Q5)
	Median	Median	Median	Median	Median
Population living in an urban area (%)	53.0	66.0	73.0	82.0	96.0
Households with no running water (%)	39.3	18.7	17.6	12.0	4.7
Households without sewer system (%)	100.0	88.6	69.5	50.2	23.3
Households with gas connection (%)	0.0	0.0	41.4	55.6	78.3
Households with any UBN (%)	21.6	14.6	9.5	5.0	6.2
Population who completed only primary education (%)	52.9	45.8	43.0	41.8	33.1
Population who owns a house (%)	69.6	67.8	68.5	71.0	66.5
Employment rate (%)	47.7	53.8	59.7	60.8	63.8

Source: Developed based on data provided by the INDEC from the 2010 National Population, Households and Housing Census.
UBNs: unmet basic needs.

FIGURE 2. *Representation of geographic areas by quintiles of the socioeconomic status indicator and frequency distribution table by province departments with a very unfavorable socioeconomic status. Argentina. 2010*



Province	Number of departments in Q1: very unfavorable socioeconomic status
Santiago del Estero	22
Chaco	15
Corrientes	11
Misiones	10
Salta	8
Tucumán	7
Formosa	6
Córdoba	5
Jujuy	5
San Juan	4
Catamarca	3
La Rioja	2
Río Negro	2
San Luis	2
Entre Ríos	1
Neuquén	1
Santa Fe	1

Source: Developed based on data provided by the DEIS, Ministry of Health of Argentina.

TABLE 3. *Poisson regression coefficients and 95% confidence intervals for the slope index of inequality and the Kunst and Mackenbach relative index of inequality. Argentina. 2007-2014 period*

Fetal	2007/2008 biennium	2009/2010 biennium	2011/2012 biennium	2013/2014 biennium
SII	-0.617 (p 2E-16*)	-0.467 (p 2E-16*)	-0.419 (p 2E-16*)	-0.345 (p 2E-16*)
(95% CI) SII	-0.682 -0.551	-0.533 -0.401	-0.485 -0.354	-0.409 -0.281
RII_{KM}	1.853	1.595	1.521	1.412
(95% CI) RII_{KM}	1.207 2.499	1.487 1.702	1.414 1.627	1.306 1.519

SII: slope index of inequality; RII_{KM}: Kunst and Mackenbach relative index of inequality; CI: confidence interval; *p*: *p* value; *: significant *p* value, alpha significance level = 0.05.
Source: Developed based on data provided by the DEIS and the database of the 2010 National Population, Households and Housing Census conducted by the INDEC.

a very unfavorable socioeconomic condition, the FM ratio reduced in the latest biennium and increased in those with a very favorable socioeconomic status.

DISCUSSION

This study was useful to observe and measure the existing health inequality. The set of the more unfavorable GAs of Argentina —Q1— had the highest FM ratio, and differences were observed in the different GAs described based on the SESI. These conditions were highly heterogeneous: more unfavorable areas accounting for inequality were in the north and central regions of Argentina; and the more favorable GAs were in the south of the country, with some exceptions. It is worth noting that, although the SII reduced by 44.1% when comparing the first and the latest biennia, such reduction may not have been completely accompanied by the reduction in the FM ratio, given that, as in many biological events, multiple variables were involved that were not included in this study.

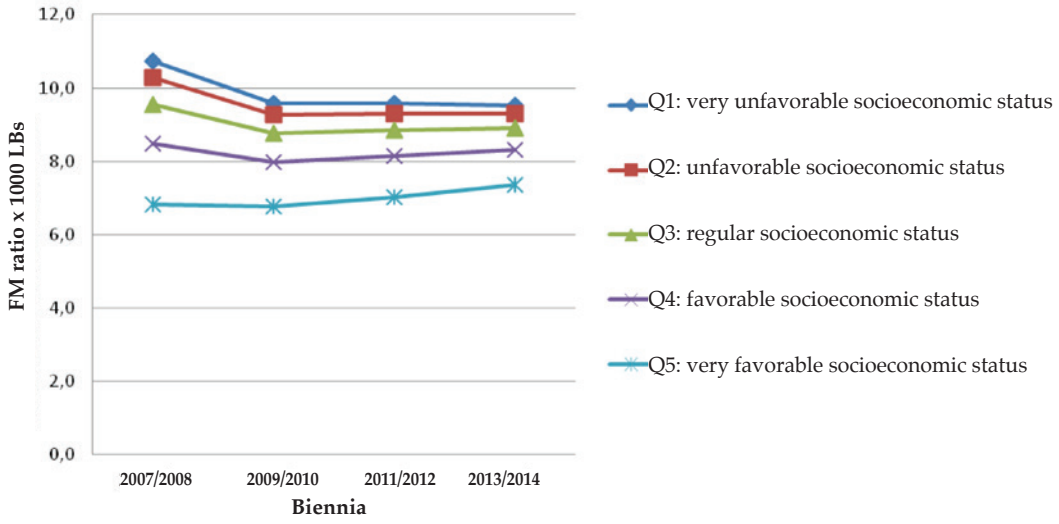
Outside of the developed world, the lowest FM rates were observed in Eurasia, South-East Asia, and Latin America and the Caribbean (12, 13, and 13 per 1000 LBs, respectively). India has the highest FM rate worldwide, which ranges from 20 to 66 per 1000 LBs.[17] In a simple comparison with the United States of America, the FM rate was 6.05 per 1000 LBs in 2006 and increased slightly by 2007, for which only deaths occurred as of 20 weeks of gestation were taken into consideration.[18] In Argentina, the overall FM rate was 8.3 per 1000 LBs in 2007, and at present it meets the WHO goal for 2030.

Among high-income countries, 90% of deaths take place in the antenatal period, in association with different risk factors.[19] Some authors have conducted research to prevent these.[20-21]

Few studies analyzed the overall FM by GA and socioeconomic status. Pearson et al. described the ethnic and socioeconomic conditions of fetal and neonatal mortality in a region of London and found that the rate of stillbirths and neonatal mortality among parents from unfavorable social situations was twice as much as that among parents from a favorable social condition (16.8 versus 8.6 per 1000 LBs), so they concluded that the working class population had needs that were not addressed by the government.[22] These problems may also be present in certain GAs of Argentina. The FM ratio was Q1= 10.75 and Q5= 6.82 for the 2007/2008 biennium and Q1= 9.52 and Q5 = 7.37 for the 2013/2014 biennium (both per 1000 LBs). The relative differences between quintile estimations were high, 57.67% and 29.24%, respectively, indicating the measurement of health inequality observed in this study. In addition, the FM ratio was highest for Q1 over the entire study period.

A study carried out in Sweden several years

FIGURE 3. *Fetal mortality ratio estimated according to the socioeconomic status indicator. Argentina. 2007-2014 period*



FM: fetal mortality
Source: Developed based on data provided by the DEIS and the database of the 2010 National Population, Households and Housing Census conducted by the INDEC.

ago showed that a low socioeconomic level was associated with a higher risk for FM.[23] Another study conducted in Spain concluded that the FM rate ranged from 1.0 to 4.7 per 1000 LBs and that the risk for FM among mothers who had completed, at most, secondary education was double that among mothers who had completed tertiary education, relative risk (RR) = 2.13 (95% CI: 1.74-2.60).[24]

In England, the socioeconomic inequality in relation to the overall FM rate and the cause of death specific rate was assessed using a deprivation index and showed that the FM rates were twice as high in the areas with a higher deprivation, RR = 2.1 (95% CI: 2.0-2.2).[25]

This study described the persistent inequality in FM ratio among the SESI groups and found similar results, although different methodologies were used.

The recommendation for the future is to implement a probability sample at a national level of pregnant women living in the 105 most vulnerable GAs and to study the situation of access to the public health system and the risk factors associated with pregnancy or whether there are other conditions that have hindered the narrowing of the present gap in the FM ratio observed in Argentina over the past years.

It is worth noting that the ecological nature of this study prevented us from establishing the reasons in more depth.[26,27] Different actions are required, including the one mentioned above, to reduce stillbirths.[28]

The analyzed death records are of compulsory registration. These records allow the continuity of national statistical series and provide information developed in accordance with internationally comparable conventions.[29] Further research on the under-recording of FM in Argentina is required. In other countries, some authors[30-34]have proposed how to carry it out.

One of the limitations of this study was that only the overall FM ratio was estimated. In a follow-up of this study, the following rates should probably be estimated: FM by weight, FM by gestational age and/or perinatal mortality.

CONCLUSION

The FM ratio is higher in the GAs with a very unfavorable socioeconomic status across Argentina. The gap between the ends of the socioeconomic spectrum narrowed towards the latest biennium. Regardless of this, the comparison between the 2007/2008 and the 2013/2014 biennia shows that, in the GAs with a very unfavorable socioeconomic status, the FM ratio reduced in the latest biennium and increased in those with a very favorable socioeconomic status. ■

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REFERENCES

1. Lawn JE, Blencowe H, Waiswa P, et al. Stillbirths: rates, risk factors, and acceleration towards 2030. *Lancet* 2016; 387(100018):587- 600.
2. Dirección de Estadísticas e Información de Salud. EstadísticasVitales, InformaciónBásica. Argentina 2015. Ministerio de Salud de la Nación. 2016; 5(59).
3. OrganizaciónPanamericana para la Salud. Manual para el monitoreo de las desigualdadesensalud, con especial énfasisenlospaíses de ingresosmedianos y bajos. Washington, DC: OPS; 2016.
4. Schneider MC, Castillo-Salgado C, Bacallao J, et al. Métodos de medición de las desigualdades de salud. *Rev Panam Salud Pública* 2002; 12(6):398-414.
5. The World Bank. World Bank Country and Lending Groups. March 2017. [Internet] 2017. [Accessed on: May 2nd, 2017]. Available at: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.
6. OrganizaciónPanamericana de la Salud. ClasificaciónInternacional de Enfermedades y ProblemasRelacionados con la Salud. Manual de Instrucciones. 10a rev. Washington, DC: OPS; 2008; 2(554).
7. Vyas S, Kumaranayake L. Constructing socio-economic status indices: How to use principal components analysis. *Health Policity Plan* 2006; 21(6):459-68.
8. Hair J, Anderson R, Tatham R, Black W. Análisis Multivariante. 5.ta ed. Madrid. Prentice-Hall; 1999.
9. Carello G, Gratti Patricia, Mai V. Calidad de Vida en la Ciudad de Buenos Aires: unapropuesta de configuración de espacioshomogéneos. *Población de Buenos Aires* 2006; 3(3):7-16.
10. Coxe E, West S, Aiken L. The Analysis of Count Data: A Gentle Introduction to Poisson Regression and Its Alternatives. *J Pers Assess* 2009; 91.(2):121-36.
11. Frome E. The analysis of rates using Poisson Regression Models. *Biometrics* 1983; 39(3): 665-74.
12. Keppel K, Pamuk E, Lynch J, et al. Methodological Issues in Measuring Health Disparities. *Vital Health Stat 2* 2005; 141:1-16.
13. Marang-van de Mheen P, Davey Smith G, Hart C, et al. Socioeconomic differentials in mortality among men within Great Britain: time trends and contributory causes. *J Epidemiol Community Health* 1998; 52(4):214-8.
14. Pamuk E. Social Class Inequality in Mortality from 1921 to 1972 in England and Wales. *Popul Stud (Camb)* 1985; 39(1):17-31.

15. Pamuk E. Social Class Inequality in Mortality from 1921 to 1980 in England and Wales. *Eur J Popul* 1988; 4(1):1-21.
16. Hayes L, Berry G. Sampling variability of the Kunst-Mackenbach relative index of inequality. *J Epidemiol Community Health* 2002; 56(10):762-5.
17. Bhati DK. Stillbirths: a high magnitude public health issue in India. *South-East Asia J Public Health* 2013; 3(1):3-9.
18. MacDorman M, Kimeyer S, Wilson E. Fetal and Perinatal Mortality, United States, 2006. *Natl Vital Stat Rep* 2012; 60(8):1-23.
19. Flenady V, Wojcieszek AM, Middleton P, et al. Stillbirths: recall to action in high-income countries. *Lancet* 2016; 387(10019):691-702.
20. Fretts R. Stillbirth epidemiology, risk factors, and opportunities for stillbirth prevention. *Clin Obstet Gynecol* 2010; 53(3):588-96.
21. Stillbirth Collaborative Research Network Writing Group. Association between stillbirth and risk factors known at pregnancy confirmation. *JAMA* 2011; 306(22):2469-79.
22. Pearsons L, Duley L, Alberman E. Socio-economic and ethnic factors in stillbirth and neonatal mortality in the NE Thames Regional Health Authority (NETRHA) 1983. *Br J Obstet Gynaecol* 1990; 97(3):237-44.
23. Stephansson O, Dickman PW, Johansson AL, et al. The influence of socioeconomic status on stillbirth risk in Sweden. *Int J Epidemiol* 2001; 30(6):1296-301.
24. Luque-Fernández MA, Lone NI, Gutiérrez-Garitano I, et al. Stillbirth risk by maternal socio-economic status and country of origin: a population-based observational study in Spain, 2007-08. *Eur J Public Health* 2012; 22(4):524-9.
25. Seaton SE, Field DJ, Draper ES, et al. Socioeconomic inequalities in the rate of stillbirths by cause: a population-based study. *BMJ Open* 2012; 2(3):e001100.
26. Macintyre S, Ellaway A. Ecological approach: rediscovering the role of the physical and social environment. In: Berkman L, Kawachi I. *Social Epidemiology*. Nueva York: Oxford University Press; 1998.Pages.332-48.
27. Susser M. The logic in ecological: I. The logic of analysis. *Am J Public Health* 1994; 84(5):825-9.
28. Frøen JF, Friberg IK, Lawn JE, et al. Stillbirths: progress and unfinished business. *Lancet* 2016; 387(10018):574-86.
29. García O, Sarasqueta P, Schwarcz R. Morbi-MortalidadMaterna y MortalidadInfantilen la República Argentina. Estrategias para mejorar el desempeño de losservicios de saludmaternoinfantil. Buenos Aires: Dirección Nacional de Salud Materno Infantil; 2004.
30. Duke W, Williams L, Correa A. Using active birth defects surveillance programs to supplement data on fetal death reports: Improving surveillance data on stillbirths. *Birth Defects Res A Clin Mol Teratol* 2008; 82(11):799-804.
31. Martin JA, Hoyert DL. The national fetal death file. *SeminPerinatol*2002; 26(1):3-11.
32. Makelarski JA, Romitti PA, Caspers KM, et al. Use of active surveillance methodologies to examine over-reporting of stillbirths on fetal death certificates. *Birth Defects Res AClin Mol Teratol* 2011; 91(12):1004-10.
33. Heuser CC, Hunn J, Varner M, et al. Correlation between stillbirth vital statistics and medical records. *Obstet Gynecol* 2010; 116(6):1296-301.
34. Lydon-Rochelle MT, Cárdenas V, Nelson JL, et al. Validity of maternal and perinatal risk factors reported on fetal death certificates. *Am J Public Health* 2005; 95(11):1948-51.