THE MEASUREMENT OF INEQUALITY IN THE REDUCTION OF CHILD MORTALITY IN PERU

LA MEDICIÓN DE LA DESIGUALDAD EN LA REDUCCIÓN DE LA MORTALIDAD INFANTIL EN EL PERÚ

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ABSTRACT

Objective: To define the feasibility of determining inequality in infant mortality according to the mother's educational level and according to the wealth quintile of the 1991-2013 period, considering the level of precision of said rates. **Methods:** The type of study was quantitative and observational, with a cross-sectional design based on repeated surveys. The data from the ENDES surveys corresponding to those of 1991, 1992, 1996, 2000, 2008 and 2013 were used. Infant mortality was determined using the direct method of synthetic cohort life tables. The level of precision of the estimates was determined by the relative error. **Results:** It´s observed that the level of precision of the estimates of these general rates has fluctuated between good and very good in the 1991-1992, 1996 and 2000 surveys; however, in 2008 and 2013 they only reach an acceptable level. Infant mortality rates tend to be lower as the mother's educational level improves, as well as the wealth quintile and elsewhere exists among successive surveys a tendency to reduce infant mortality in different categories. **Conclusion:** It is not feasible to determine the inequality of the measurement of Infant Mortality according to the mother's educational level and according to the wealth quintile in the period 1991-2013, because the sample size has not been increased, depending on the decreased mortality.

Key words: Infant mortality; Right to health; Health inequality; Precision (source: MeSH NLM).

RESUMEN

Objetivo: Definir la factibilidad de la determinación de la desigualdad en la mortalidad infantil según nivel educativo de la madre y según quintil de riqueza del periodo 1991-2013, considerando el nivel de precisión de dichas tasas. **Métodos:** El tipo de estudio fue cuantitativo y observacional, con un diseño de tipo transversal en base a encuestas repetidas. Se utilizó los datos de las encuestas ENDES correspondientes a las de 1991, 1992, 1996, 2000, 2008 y 2013. La mortalidad infantil se determinó mediante el método directo de tablas de vida de cohortes sintéticas. El nivel de precisión de las estimaciones se determinó mediante el error relativo. **Resultados:** Se observa que el nivel de precisión de las estimaciones de estas tasas generales ha oscilado entre bueno y muy bueno en las encuestas 1991-1992, 1996 y 2000; sin embargo en las de 2008 y 2013 solo llegan a un nivel aceptable. Las tasas de mortalidad infantil tiende a ser menor conforme mejora el nivel educativo de la madre, así como el quintil de riqueza; de otra parte existe entre las sucesivas encuestas una tendencia a la reducción de la mortalidad infantil en las diferentes categorías. **Conclusión:** No es factible la determinación de la desigualdad de la medición de la Mortalidad Infantil según nivel educativo de la madre y según quintil de riqueza en el periodo 1991-2013, porque no se aumento el tamaño de la muestra, en función de la disminución de la mortalidad.

Palabras clave: Mortalidad infantil; Derecho a la salud; Desigualdad en salud; Precisión de la medición (fuente: DeCS BIREME).

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INTRODUCTION

The reduction of infant mortality continues to be a very important social objective of sustainable development for around the world, which is why it has been a very important component of the Millennium Development Goal 4 (MDG) established in 1990, referring to the reduction of infant mortality (under 5 years) by 2/3. It is also important to emphasize that the right of the child to health means the reduction of unjust and avoidable inequalities in correspondence with the objective of health for all, according to what has been proposed by the World Health Organization (WHO) and other institutions[1].

Likewise, the document of the United Nations Children's Fund (UNICEF) The State of Latin American and Caribbean Children 2008 highlights the inequality in health in this region, which particularly affects children and points out that unequal access to health care and unequal health outcomes are a reflection of more far-reaching factors such as the environment, ethnicity, income level, educational level, and gender[2]. In Peru, the report of the Demographic and Family Health Survey (Endes) 1991, 1992 indicated that infant mortality reached 55 per 1000 nv[3] and for Endes 2013 it was already 16 per 1000 nv[4], evidencing not only the reduction of this mortality but also that Peru had already achieved in average terms the goal of its reduction by 2015, as part of the Millennium Development Goal (MDG) 4[5].

The results of this study may contribute to a better knowledge of the goal's achievement 4 MDG (reduction in Infant Mortality by 2/3 by 2015), according to socioeconomic condition and therefore in the reduction of their inequality, this, in turn, contributes to defining better strategies and policies to reduce health inequality.

Based on the considerations mentioned above, this research project had the following objective: to define the feasibility of determining inequality in Infant Mortality according to the mother's education level and according to the wealth quintile in that period, considering the level of precision of these estimates.

METHODS

The study is quantitative and observational since it uses the statistical information provided by the ENDES surveys of the National Institute of Statistics and Informatics (INEI) and there has been no intervention of the researcher on the units of study. Likewise, the design was transversal based on repeated surveys to study Infant Mortality. The information was obtained from the available databases of the ENDES 1991-1992,

1996, 2000, 2008 and 2013. In these surveys, they use the data provided by the mother, in which the health of each of her children is monitored over time (including the eventuality of their death), as well as social factors (mother's education level and data to determine the wealth quintile) and health interventions.

The target population for this study consisted of all the children of women aged 15 to 49 until they reached the age of one year, whether they died or not, study period (1991-2013). This group is part of the target population of 1991-1992, 2000, 2008 and 2013 ENDES surveys. Each of these samples in the surveys is probabilistic, from the area, stratified, multi-stage (two-stage or three-stage) and self-weighted, without replacement[3].

For the calculation of the infant mortality rates of the study, the same method used in the ENDES surveys has been used, explained in the document Guide to DHS Statistics by Rutstein S.O. and Rojas G. Demographic and Health Surveys. ORC Macro 2006[6]. The infant mortality rate used corresponds to the number of deaths in the first year of life per 1000 live births (LB). This document also indicates that this method, called direct because it uses the information of the mother on the eventual death of her child, is applied using the synthetic cohort life table modality in which the probabilities of dying of small age segments (based on the mortality experience of a real cohort) are combined to calculate mortality in the most common age groups. The software used in this study for the calculation of Infant Mortality is the same software used by INEI for the calculation of infant mortality of the ENDES surveys, the "IBM SPSS STATISTICS".

On the other hand, for the socioeconomic level, the mother's education level and the wealth quintile were used. The variable mother's education level (ordinal type) has been categorized in the same way as in the survey: no education, primary, secondary and higher. Likewise, the wealth quintile variable (composite indicator, ordinal type) has been categorized in the same way as it appears in the ENDES reports: poorer, poor, medium, richer, richer.

The following procedure has been used to determine the level of precision of the estimates of infant mortality rates for every five years, according to the mother's education level and the wealth quintile. First, after calculating the infant mortality rate according to the variables indicated, for each rate its standard error (SE), as well as the relative error (standard error/rate, SE/R) and the corresponding confidence intervals, have been determined, using the Sampling Error Module of ISSA software. These statistics have been obtained in the same way and with the same program used for

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the reports of the ENDES surveys, said program for the calculation of the standard error uses the method of repeated replications of Jacknife[7]. A second step was to categorize the relative errors (coefficient of variation) obtained for each of the estimates of infant mortality according to the condition of the educational level of the mother and according to the wealth quintile. For this purpose, a correspondence was established between the interval concerning each relative error obtained (coefficient of variation) and the level of precision of the estimate, under the following scale used by the National Institute of Statistics and Informatics (INEI in Spanish)[8].

In the precision scale of the estimator, the coefficient of variation results from the standard error/rate (SE/R) ratio expressed as a percentage. Mortality rates (< 5 years old and infant) are generally accepted as useful for analysis and interpretation, in DHS type surveys such as ENDES, with very good or good levels of precision, with a coefficient of less than 10%[9].

Moreover, for each estimated mortality rate, its 95% confidence intervals have been obtained based on its standard error, SE (R-2SE and R+2SE). In each of the five surveys, it was also determined whether or not there were significant differences in infant mortality rates between the pairs of extreme categories in each socioeconomic variable; thus for the educational level of the mother between uneducated and higher (S.D. SE/S) and the wealth quintile between the poorest and richest (S.D. P/R). For this purpose, the comparison between the confidence intervals of the two rates under evaluation has been used, assessing whether their values are included (overlapping) or not; if they

are included, it is assumed that there is no significant difference; and if they are not included, it is assumed that there is a significant difference between these rates[10]. This procedure has already been used in other studies of Infant Mortality to compare mortalities between different categories[11]. Likewise, for the measurement of inequality in infant mortality, the relative risk (RR) between these extreme categories has been determined.

Concerning ethical aspects, it should be pointed out that the research, as previously indicated, has used data from the ENDES surveys conducted periodically by INEI (National Institute of Statistics and Informatics), which were voluntarily accepted by the interviewees after receiving adequate information and maintaining the corresponding confidentiality.

RESULTS

This research shows that the results of the study are consistent with the official results of the ENDES reports, the general infant mortality rates (R) in 1991, 1992, 1996, 2000, 2008 and 2013 ENDES five-year periods, and their statistical characteristics, which are shown in table 1. On the other hand, the level of precision of the estimates of these general rates has oscillated between good and very good in 1991, 1992, 1996 and 2000 surveys; however, in the 2008 and 2013 surveys, they only reach an acceptable level. On the other hand, the sample size (N-WEIG) in the different surveys has oscillated between 6000 and 8000, except for the 1996 and 2000 surveys where there was an appreciable increase.

Table 1. Peru: Infant Mortality Rate for 0-4 years prior to the ENDES survey

ENDES	R	SE	SE/R	R-2SE	R+2SE	N-UNWEIG	N-WEIG	Precision
1991-1992	54'488	2'741	0'05	49'007	59'969	9652	8803	G
1996	42'847	2'014	0'047	38'819	46'874	17963	16029	VG
2000	33'311	2'013	0'06	29'285	37'337	14088	12580	G
2008	19'724	2'158	0'109	15'408	24'04	6742	6160	AC
2013	16'5	1'7	0'102	13'1	19'8	9251	8446	AC

Legend: R: Infant Mortality Rate, SE: standard error, SE/R: relative error, R-2SE: rate minus 2 standard error, R+2SE: rate plus 2 standard error, N-UNWEIG: unweighted observation units, N-WEIG: weighted observation units, Precision (SE/R in %) : < 5% VG (Very Good), 5- < 10% G (Good), 10 % - < 15% AC (Acceptable), 15% y + R (Reference).

Source: INEI/ENDES. Elaboration RFM

The results obtained in the study of infant mortality rates according to condition, level of education of the mother during the study period (1991, 1992, 2013) can be seen in table 2. It is evident that in each of the different surveys (1991-1992, 1996, 2000, 2008 and 2013), infant mortality rates tend to be lower as the mother's level of education improves, and on the other hand, there is a tendency among successive surveys to reduce infant mortality in the different categories. It is useful to point out that the level of precision of these estimates is not yet being considered.

Table 2. Peru: Infant Mortality Rate according to Mother's Education for 0-4 years before the ENDES survey.

ENDES	Education	R	SE	SE/R	R-2SE	R+2SE	N-UNWEIG	N-WEIG	Precisión	D.S. SE/SU	R.R. SE/SU
1991-1992	without Educ.	72'924	9'028	0'124	54'867	90'98	1025	954	AC		
	Primary	79'941	4'891	0'061	70'158	89'724	4314	3639	B		
	Secondary	34'107	3'359	0'098	27'39	40'824	3215	2996	B		
	Superior	13'258	3'454	0'26	6'351	20'165	1098	1215	R	Yes	5'5
1996	without Educ.	58'886	6	0'102	46'886	70'887	2022	1634	AC		
	Primary	54'5	3'26	0'06	47'98	61'02	8076	6526	B		
	Secondary	30'402	2'998	0'099	24'406	36'399	5655	5576	B		
	Superior	27'878	4'273	0'153	19'332	36'425	2210	2293	R	Yes	2'11
2000	without Educ.	48'508	6'511	0'134	35'485	61'531	1330	1017	AC		
	Primary	41'664	3'298	0'079	35'068	48'259	6350	5049	B		
	Secondary	29'308	3'246	0'111	22'816	35'801	4496	4528	AC		
	Superior	12'919	3'236	0'25	6'447	19'391	1912	1986	R	Yes	3'75
2008	without Educ.	29'01	10'577	0'365	7'857	50'164	321	301	R		
	Primary	32'517	4'499	0'138	23'519	41'515	2461	2104	AC		
	Secondary	14'313	3'065	0'214	8'183	20'443	2590	2439	R		
	Superior	6'8	2'242	0'33	2'316	11'283	1370	1316	R	No	4'26
2013	without Educ.	35'3	11'6	0'3	12'1	58'6	305	232	R		
	Primary	13'4	2'3	0'2	8'9	18'0	2857	2222	R		
	Secondary	15'3	2'3	0'2	10'7	20'0	4090	3904	R		
	Superior	19'6	4'5	0'2	10'6	28'6	1999	2087	R	No	1'8

Legend: R: Infant Mortality Rate, SE: standard error, SE/R: relative error, R-2SE: rate minus 2 standard error, R+2SE: rate plus 2 standard error, N-UNWEIG: unweighted observation units, N-WEIG: weighted observation units, Precision (SE/R in %) : < 5% VG (Very Good), 5- < 10% G (Good), 10 % - < 15% AC (Acceptable), 15% y + R (Reference), S.D. WE/HE: the significant difference between Without Education and Higher Education, R.R. WE/HE: relative risk between Without Education and Higher Education.

Source: INEI/ENDES. Elaboration RFM

It can also be seen that the level of precision (derived from the relative error, SE/R) of these estimates in the different categories has been mostly acceptable (10% - <15%) and reference (15% and +) and to a lesser extent good (5% - < 10%) in the 1991, 1992, 1996 and 2000 surveys, while for the following five-year periods (2008 and 2013), it had decreased for the most part to a single referential level (15% and +). On the other hand, comparing based on their confidence intervals, infant mortality rates between the extreme categories, between without education and higher education (D.S. WE/HE), it is noted in the 1991-1992, 1996 and 2000 surveys that there would be significant differences (despite their level of precision), but not in the 2008 and 2013 surveys. Likewise, the relative risk results with unstable values when comparing the different surveys of infant mortality rates of these extreme categories, without education/higher education (RR: WE/HE).

The results obtained in the study of infant mortality rates by wealth quintile (Wealth Index) in the ENDES 2008 and 2013 (data from the previous five-year periods are not available) table 3. As the wealth quintile improves, infant mortality decreases, there is also a marked decrease in infant mortality rates between the ENDES 2008 and the ENDES 2013 in the different categories (except for the poorest category in 2013).

The level of precision (derived from the relative error, SE/R) of these estimates in the different wealth quintile categories has been both in the 2008 survey and in the 2013 survey, mostly only referential (15% and +). On the other hand, by comparing (based on their confidence intervals) the infant mortality rates between the extreme categories, this is the poorer and the richer it is noted that there would be significant differences (despite their level of precision) both in 2008 and 2013. Also concerning relative risk, comparing in each survey the infant mortality rates of the extreme categories, poorest/richest (RR: P/R), it is evident that their values are too unstable between the two surveys.

Table 3. Peru: Infant Mortality Rate according to Household Wealth Index for 0-4 years before the ENDES survey.

ENDES	index	R	SE	SE/R	R-2SE	R+2SE	N-UNWEIG	N-WEIG	Precision	S.D. P/R	RR: P/R
2008	Poorer	52'066	8'952	0'172	34'162	69'97	919	760	R		
	Poor	20'994	3'604	0'172	13'786	28'201	1881	1569	R		
	Medium	18'388	3'758	0'204	10'872	25'905	1816	1469	R		
	Rich	17'263	5'658	0'328	5'946	28'58	1149	1090	R		
	Richest	2'389	1'082	0'453	0'225	4'552	977	1271	R	Si	21'79
2013	Poorer	19'7	2'6	0'1	14'5	24'9	3069	2094	AC		
	Poor	20'1	3'7	0'2	12'7	27'4	2515	1962	R		
	Medium	13'0	3'3	0'3	6'4	19'6	1764	1827	R		
	Rich	18'0	5'6	0'3	6'8	29'2	1193	1462	R		
	Richest	7'4	4'4	0'6	-1'4	16'2	710	1100	R	Si	2'66

Legend: R: Infant Mortality Rate, SE: standard error, SE/R: relative error, R-2SE: rate minus 2 standard error, R+2SE: rate plus 2 standard error, N-UNWEIG: unweighted observation units, N-WEIG: weighted observation units, Precision (SE/R in %) : < 5% VG (Very Good), 5- < 10% G (Good), 10 % - < 15% AC (Acceptable), 15% y + R (Reference), D.S. P/R: Significant Difference Between Poorest and Richest, R.R. P/R: Significant Difference Between Poorest and Richest.
Source: INEI/ENDES. Elaboration RFM

DISCUSSION

ENDES has some limitations of its own in using the interview as a source of information; although the birth and death of a child are impact events, errors on the part of the mother in answering the survey questions cannot be ruled out[3].

Concerning the general infant mortality rates found in the study in the five-year periods of the ENDES 1991, 1992, 1996, 2000, 2008 and 2013 (table 1), they are very similar to the values found and presented in the respective official reports of these ENDES[3,12,13,14]. This result was to be expected, considering that the same database and the same procedure were used for its estimation. On the other hand, these results ratify that Peru had already reached the objective of reducing infant mortality to less than 17 per 1000 nv, in average terms, by the ENDES 2013 (with a mortality of 16.5 per 1000 nv). This important achievement for the country cannot obviate the need to analyze progress in reducing inequality in this mortality, according to social factors such as socioeconomic status, as pointed out by UNICEF in the document Narrowing the gaps to meet the Goals 2010[15].

Mother's education level

The decrease in infant mortality concerning the level of education of the mother in each of the ENDES 1991, 1992, 1996, 2000, 2008 and 2013 (table 2) is similar to the findings of the official reports of the ENDES of those years; this result is the expected one, in fact many years ago in studies carried out in different countries, it was found that the lower level of education of the mother was related to higher levels of infant mortality 2[16,17].

The decrease found in this study in the precision of the estimates of infant mortality rates referred to the different categories of education of the mother, from a good and acceptable level to a referential level in the ENDES 2008 and 2013 (table 2), is due to the limited size of the samples of the different surveys, which did not vary fundamentally between the 1991, 1992 and 2013 surveys (table 1), although in that period not only infant mortality but also the birth rate has decreased. This reduction in the level of precision is even greater than that observed for general infant mortality, and can be explained by the fact that the higher level of disaggregation (four categories of educational level) determines fewer observation units per category and, consequently, greater standard error and relative error (coefficient of variation). In this regard, according to Korenromp E.L., as the mortality rates (infant and child) calculated with DHS type surveys fall, larger sample sizes are required to maintain the precision of the estimates of these rates[18].

On the other hand, the non-significant difference found in the last surveys 2008 and 2013, in the infant mortality determined by the two extreme levels of education of the mother, is because the very high standard errors of these rates or the reduced sample size, determine very wide confidence intervals, which will not allow us to adequately differentiate between the levels of education of the mother. In this regard, Knezevic A. in his work Overlapping Confidence Intervals and Statistical Significance 2008,[19] about the interpretation of two statisticians whose confidence intervals overlap or do not overlap; the author says that if the intervals do not overlap, the statisticians are necessarily significantly different; on the other hand, if they overlap, it is not necessarily true that they are not significantly different.

Wealth quintile

The decrease found in this study in infant mortality concerning the best wealth quintile in each of the 2008 and 2013 ENDES surveys (table 3) is similar to the respective official ENDES reports for those years, although these official rates are for five years earlier in 2008 and ten years earlier in 2013[13]. This result is the expected one, since for many years in multiple studies carried out in developing countries, it has already been found that the poorest families have higher levels of mortality than non-poor families, in childhood[2, 16,17].

Concerning the level of precision found, which is only referential in most of the estimates of infant mortality rates in the different wealth quintile categories in the ENDES 2008 and 2013 (table 2), it is due to the limited size of the samples from the two surveys, which did not vary fundamentally between the 1991, 1992 and 2013 surveys (table 1), even though not only infant mortality but also the birth rate has decreased in that period. As previously noted, according to Korenromp E.L., as mortality rates (infant and child) decline, larger sample sizes are required to maintain the accuracy of estimates of these rates[18].

The significant differences found between the poorest and richest strata in the infant mortality rates in the 2008 and 2013 surveys are the expected ones, due to what was previously pointed out regarding the relationship between poverty and infant mortality. In this regard, it is useful to bear in mind Knezevic A. in his work Overlapping Confidence Intervals and Statistical Significance 2008[19], about the interpretation of two statisticians whose confidence intervals may or may not overlap. As for the poorest/richest relative risk (RR) presented differently between the 2008 and 2013 ENDES surveys, it could also be noted that it is directly related to the different and small sample

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sizes for estimates of infant mortality rates at these levels, which also affects the level of precision. The decrease in the level of precision, as pointed out by Curtis S.L. in Assessment of the Quality of Data Used for Direct Estimation of Infant and Child Mortality in DHS II Surveys. 1995, distorts the analysis of infant mortality differentials and trends, making it difficult to distinguish between genuine differences and sample variations[20].

It should be noted that the regular reports of the ENDES present differentials in infant mortality rates according to the educational level of the mother and according to wealth quintile; these estimates are generally not for the five years before each survey, but for ten years. This period is considered very long for monitoring changes in this mortality. In this regard, Pederson J. and Liu J. in their work Child Mortality Estimation: Apropiate periods for Child Mortality Estimates from Full Birth Histories 2012[21] recommend the application of surveys that allow mortality estimates even for periods less than five years.

CONCLUSION

The Demographic and Family Health Survey ENDES is very important, so we conclude that although the estimates obtained of infant mortality rates by level of education of the mother and wealth quintile are for

the five years before the survey, the level of precision is only referential from ENDES 2008.

It is not feasible to measure inequality in infant mortality by educational level of the mother and by wealth quintile in the period 1991-2013, taking into account that the level of precision of these rates has decreased, because the sample size did not increase, even though infant mortality decreased.

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