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REVIEW

Caesarean Section in the World: a new ecological approach

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Key words

Caesarean section • Neonatal mortality • Maternal mortality

Summary

Introduction. *This study aimed to estimate the most recent caesarean section rates in the world and examine the association between these rates and old and new indicators of health care.*
Methods. *Authors analyzed the Caesarean Section (CS) rates, also in geo-economic and economic groups, and correlated them to maternal and neonatal mortality, to births attended by skilled health personnel and to births among adolescents. Analysis of covariance and piecewise regressions were used for the statistical analysis.*
Results. *In 47.2% of the countries, the CS rate exceeded 15%. Countries of Latin America and the Caribbean along with Europe, North America and Oceania had the highest values. The analysis showed an inverse association between CS rates and Maternal Mortality (MMR) and Neonatal Mortality (NMR) for all geographical areas except for Europe. The greatest association was observed in lower-middle-income countries. In developing countries only 50% of cases, occur in medical facilities and only half of these are seen by medical, nursing and obstetrical staff. Age of the mother appears to influence the outcome and choice of delivery type. Countries where an high ABR rate is present have low CS use.*
Conclusions. *To best evaluate the consequences of the increasing rate of CS, it would be useful to identify the most sensitive outcome indicators.*

Introduction

The World Health Organization (WHO) considers the percentage of births by Caesarean Section (CS), a health care quality indicator, providing to protect health of mother and newborn. In 1985 the WHO affirmed that 'There is no justification for any region to have CS rates higher than 10-15% [1].
There are no studies that clearly assess the validity of this indicator, and there is no evidence that regions with lower percentage of CS provide better care. In addition, a very low rate (< 5%) may reflect a lack of access to obstetrical care and an inadequate level of assistance [2]. In this study the Authors analyzed the most recent worldwide CS rates from national health systems and correlated them to maternal (MMR) and neonatal mortality (NMR) [3] to percentage of births attended by skilled health personnel (BASHP) and to births among adolescents (ABR). Authors also analyzed the level of CS in different geographical areas and in relation to "pro capite" income of countries [4].
The study aimed to provide an update on the use of CS and examine correlation between CS and old and new reproductive health indicators, using a new ecological approach, to critically evaluate the WHO recommended range of CS.

Methods

Authors analyzed data of CS from 142 countries, using the Survey Systems of WHO/Regional Office for Europe for 48 countries in the European region [5], from the Demographic and Health Surveys (DHS) and from the WHO [6, 7] for 50 and 5 countries respectively. For 34 countries data were obtained by Ministerial Reports and National Institutes of Health Information on CS rates is not easily obtained for some countries due to the lack of adequate national recording systems; for five countries the data are derived from small-scale studies. Authors also considered the rates in regions with low, medium-low, medium-high and high income, according to the 2009 World Bank classification [4] and on seven geo-economic levels. The geo-economic levels are: East Asia and Pacific, Eastern Europe and Central Asia, Europe, Latin America and the Caribbean, the Middle East and North Africa, South Asia, sub-Saharan Africa. Authors do not consider North America (United States and Canada) and Oceania (Australia and New Zealand) since for both geographical levels we have only two countries.
On relations between percentage of CS and NMR, MMR, BASHP and ABR, two statistical analyses were performed: analysis of covariance (Ancova) and piecewise regressions.
The data were analyzed by using the GraphPad Prism version 5.00 software package. A p-value < 0.05 was considered statistically significant.

Results

Rates of CS worldwide

The most recent data show a CS global average of 14.8% with a range from 0.4% in Chad to 42.3% in Iran. In 67 (47.2%) countries analyzed, the CS rate was higher than 15%, in 39 (27.5%) between 5 and 15% and in 36 countries (25.3%) lower than 5% (Figure 1). Latin America and the Caribbean countries show an average rate of 23.7%, with national values ranging between 3% (Haiti) and 41.9% in the Dominican Republic; In Europe the average percentage is 22.8% and all European countries except the Netherlands (13.5%) exceed the limit set by WHO.
In the Middle East, North Africa and sub-Saharan regions percentages vary between 0.4 and 42.3, and percentages exceed 15% in only three countries (Iran, South Africa and Egypt). In East Asia and Pacific there are still countries where the use of CS is < 5%, such as Cambodia (1.8%) and Papua New Guinea (4.7%) as opposed to countries whose rates are among the highest in the world: South Korea (38.9%) and Japan (28.2). The region of South Asia appears to have the lowest average rate with values ranging between 2.7% (Nepal) and 8.5% (India) (Tab. I).
In 23 of 35 low-income countries (65.7%) the CS rate was less than 5%; in lower-middle-income countries values such low are found in 20% of countries and in those with upper-middle and high income no country has less than 5% (Tab. I).

Other reproductive health indicators

The average NMR value of analyzed countries is about 19.6 child deaths per 1,000 live births. South Asia and sub-Saharan region have the highest rates, with the highest values in Liberia (66‰), and Cote d'Ivoire (64‰). The NMR is in inverse proportion to income countries (Tab. I).
The average MMR value is of 303 deaths per 100,000 live births (range: 1 and 1,800/100,000) with the higher values in the regions where neonatal mortality is still high, in spite of some exceptions.
In the area of the Middle East and North Africa and Latin America and the Caribbean, the MMR still remains quite high. In Europe, the MMR is 6.7/100,000 ranging from Ireland (1/100,000) to 25/100,000 in Estonia. Nevertheless, the mortality rate ranged from a value of 770.7 in the poorest countries, to 27.9 in countries with higher income with the lower-income countries that achieve low mortality (Uzbekistan: 24/100,000 live births) and high-income countries with high mortality (Equatorial Guinea: 680/100,000 live births).
The average level of global BASHP was 79.2% (range: 5.7%-100%) with the lowest rates in South Asia (maximum value 46.6%) and greater variability in the sub-Saharan region ranging from 5.7 in Ethiopia to 94.2 in Botswana (Tab. I).
The only countries in which we observe high CS and BASHP < 80% are Paraguay (CS: 27.0%, BASHP: 77.1%), and Egypt (CS: 27.6%, BASHP: 78.9%). In countries with medium-high and high-income, BASHP reaches values of 95.0 and 98.1 respectively, while the average is still below 50% in the poorest countries.

The average ABR is 58.9% with considerable variation between different geographical areas and economic regions. Regions such as sub-Saharan Africa and South Asia have higher rates, respectively 120.1 and 90/1000 births vs Europe, which has the lowest values (11.7%).
Areas of the Middle East and North Africa, East Europe and Central Asia, North America, Oceania all retain rates of around 25%.
There is a clear decrease in ABR rates between regions with low-income and those with high-income, rising from a rate of 112.3 to 16.1 in the richest countries.

Piecewise results

Piecewise regression analysis shows that all four relations (CS *vs.* NMR, MMR, BASHP, ABR) undergo a reduction of minimal residual standard error, when each

Fig. 1. Caesarean Section rates by country, divided into three categories: < 5%, 5%-15% and > 15%, divided according to recommendations by the World Health Organization.

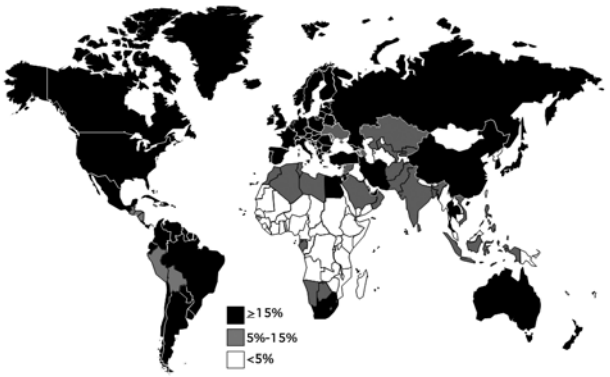
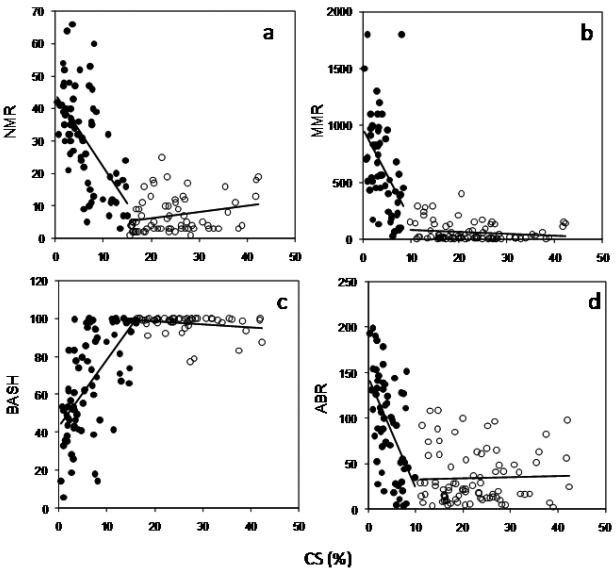


Fig. 2. The relationship between CS and a) NMR, b) MMR, c) BASHP, d) ABR after piecewise analysis. Black and white circles indicate countries with CS values below and above CS breakpoint respectively.



Tab. I. Percentage and range of CS, NMR (per 1,000 live births), MMR (per 100,000 live births), BASHP (%) and ABR (per 1000 women) in the Regional Area World Bank and by Income Group.

Regional area World Bank	CS	Range (min-max)	NMR	Range (min-max)	MMR	Range (min-max)	BASHP	Range (min.-max.)	ABR	Range (min.-max.)
Middle East and North Africa	14.8	1.4-42.3	13.4	3.0-41.0	107.6	4.0-430.0	89.8	35.7-99.2	25.8	3.8-80.0
Sub-Saharan Africa	4.0	0.4-20.6	37.8	9.0-66.0	776.1	210.0-1,800.0	55.9	5.7-94.2	120.1	40.0-198.9
East Asia and Pacific	14.3	1.8-38.9	16.6	1.0-48.0	219.5	6.0-540.0	79.9	41.0-100	35.1	2.1-70.0
South Asia	6.8	2.7-8.5	44.0	32.0-60.0	794.0	320.0-1,800.0	27.3	14.3- 46.6	90.0	20.3-151.0
Europe	22.8	13.5-38.2	2.8	1.0-5.0	6.7	1.0-25.0	99.6	98.0-100	11.7	3.8-25.9
East Europe and Central Asia	16.1	2.1-35.4	15.8	3.0-38.0	52.6	7.0-170.0	97.4	83.0-100	26.5	12.7-51.0
Latin America and Caribbean	23.7	3.0-41.9	13.4	4.0-32.0	164.8	16.0-670.0	83.6	26.1-99.9	77.1	41.7-108.5
North America	29.1	26.3-31.8	3.5	3.0-4.0	9.0	7.0-11.0	98.7	98.3-99.0	27.1	13.6-40.6
Oceania	27.3	23.7-30.8	3.0	3.0-3.0	6.5	4.0-9.0	100	100-100	22.3	16.0-28.6
Economical world regions										
Low income	3.3	0.4-9.9	38.1	12.0-66.0	770.7	24.0-1,800.0	49.8	5.7-99.9	112.3	25.5-198.9
Lower Middle income	12.7	1.7-42.3	23.8	7.0-64.0	301.5	18.0-1,100.0	76.1	35.2-100	62.9	4.6-141.0
Upper Middle income	20.9	5.6-41.9	13.3	3.0-46.0	119.2	8.0-520.0	95.0	71.0-100	46.3	3.8-144.0
High income	21.7	6.6-38.9	4.5	1.0-47.0	27.9	1.0-680.0	98.1	64.6-100	16.1	2.1-128.0
World total	14.8	0.4-42.3	19.6	1.0-66.0	303.0	1.0-1,800.0	79.2	5.7-100	58.9	2.1-198.9

model is divided into two regression lines (Fig. 2). Breakpoints are at 15% for NMR, 9% for MMR, 16% for BASHP and 9% for ABR (Tab. II). For all relations, regressions that occur in a range of CS falling between 0 and the breakpoint have the same sign as the overall relations (Figs. 3, 4). Regressions that occur for CS values greater than breakpoint have slopes not different from 0 ($p > 0.05$) for CS vs MMR, BASHP, ABR. The relation between CS and NMR for CS values greater than breakpoint is significant ($p < 0.05$) but positive, inverse to the overall relation.

Tab. II. Results of piecewise analysis applied to relationships between Caesarian Section Rate (CS%) and Neonatal Mortality Rate (NMR, per 1,000 live births), Maternal Mortality Rate (MMR, per 100,000 live births), Births Attended by Skilled Health Personnel (BASHP, %) and Adolescent Birth Rate. See results for details (* But positive).

	NMR	MMR	BASHP	ABR
Residual standard error linear	11.9	300.9	19.2	43.2
Minimal residual standard error piecewise	9.3	245.0	16.2	37.3
% Reduction of residual standard error	22.0	18.6	15.7	13.8
CS breakpoint (%)	15	9	16	9
Relationship (p-level) < CS breakpoint	0.000	0.000	0.000	0.000
Relationship (p-level) p > CS breakpoint	0.04*	n.s.	n.s.	n.s.

Ancova results

Relations between CS and NMR ($r = -0.70$, $df = 138$, $p < 0.000$), MMR ($r = -0.65$, $df = 137$, $p < 0.000$), BASHP ($r = 0.66$, $df = 133$, $p < 0.000$), ABR ($r = -0.52$, $df = 140$, $p < 0.000$) are all significant (Tabs. III, IV). The analysis of covariance for different geographic areas showed significant differences in slopes for CS and NMR ($F = 3.52$; $p = 0.003$) with values ranged between 0.43 (inverse trend to the overall relation) and -0.67. Significant differences in slopes were found to be also related to CS and to MMR ($F = 7.24$; $p = 0.000$) and to ABR ($F = 3.25$; $p = 0.005$). For CS and MMR slope values ranged between -0.48 and -0.82 while for CS and ABR ranged between -0.52 and -0.83. No significant differences in slopes for CS and for BASHP ($F = 1.88$; $p = 0.091$). The analysis of covariance applied to the economic factor showed significant differences between slopes only for MMR ($F = 6.50$; $p = 0.000$) and for BASHP ($F = 4.34$; $p = 0.006$) (Tab. IV). In the first case slopes vary between -0.35 and -0.48 while for BASHP vary between 0.47 and 0.41.

Discussion and conclusions

Several studies have examined the CS rates in different geographical areas and shown a steady increase in use of this surgical technique [8-13]. One important study by Betran et al. on the global use of CS is the point of comparison with our work [14]. In this investigation, Authors implemented the number of analyzed countries, performed on updated data for the evaluation of threshold value of CS% through the correlation between CS and old and new reproductive health indicators using a new ecological approach.

This analysis does not consider all possible causes of CS% (e.g. dystocia, previous CS, breech presentation and fetal distress) modification since we used a macroecological approach that deliberately sacrifices a great deal of detail in order to figure out the overall picture.

A comparison by Betran et al. [14] showed either an increase of CS in 54% of surveyed countries in both studies, or a slight decrease in just 7.9% of countries, mostly in Africa, with one in Europe (Iceland: 17.9% *vs.* 15.6%) and one in Latin-America (Mexico: 39.1% *vs.* 37.5%).

An ecological study, that allows assessment to the association of CS rates with health outcomes at the population level among different countries, has several strengths and limitations [15].

The different sources, the precision of the dates, mainly the lack of national surveillance systems (e.g. Afghanistan) and the different reporting year, all represent a limitation and do not allow either to have a precise and reliable worldwide outlook, or to compare dates of all countries, without selection and follow-up bias.

The countries analyzed for which there are no nationally representative data are equally distributed in income regions.

Moreover, as well as to the data quality, cannot be excluded a possible alternative explanations of the data. Misclassification of exposure can be a source of bias in ecological design that may increase the associations [16]. Confounding can be complicated in international ecological comparisons, as the correlation of confounders among countries is usually higher than that in individual studies, and difficult to extricate [17].

In 47.2% of the surveyed countries, the CS rate exceed the 15%, with a 5.9% of countries more than in the previous analysis [11]. On the contrary, countries with CS < 5% tend to decrease (-4.8%).

Similar data of this investigation are obtained by Wylie [10], with slightly higher values.

A significant variability among rates exists within a single region and in the same economic group, the highest rate of CS was found in Iran (data from a study of a few hospitals in Teheran) a lower middle income country and a very low value in Oman (6.6%), the higher-income country.

Fig. 3. Caesarean Section rate vs Neonatal Mortality Rate (NMR, per 1,000 live births) (A), Maternal Mortality Rate (MMR, per 100,000 live births) (B), Birth Attended by Skilled Health Personnel (%) (C) and Adolescent Birth rate (per 1000) (D) in the World Bank Regional Areas.
(■) E. Asia & Pacific, East Asia & Pacific; (□) E. Europe & C. Asia, East Europe & Central Asia; (Δ) Lat. Am. & Car., Latin America & Caribbean; (●) M.E. & N. Africa, Middle East & North Africa.

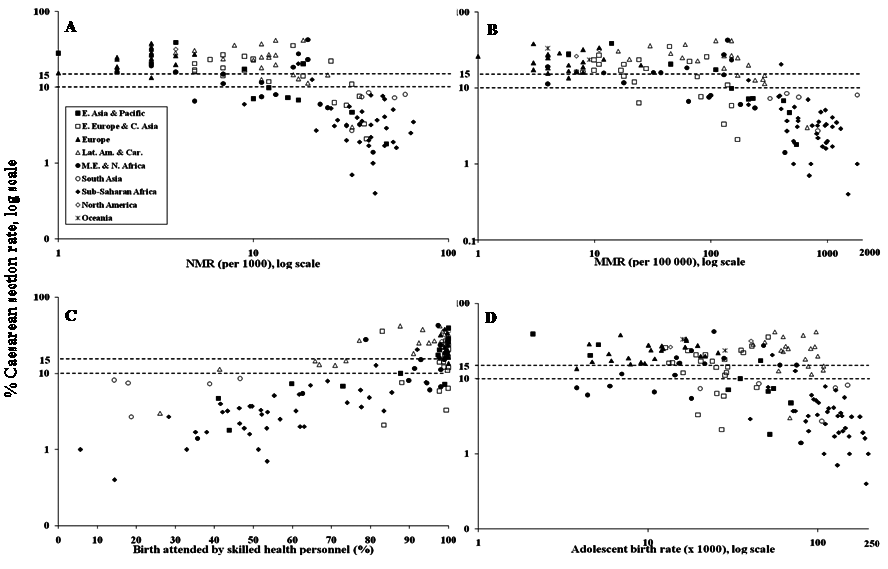
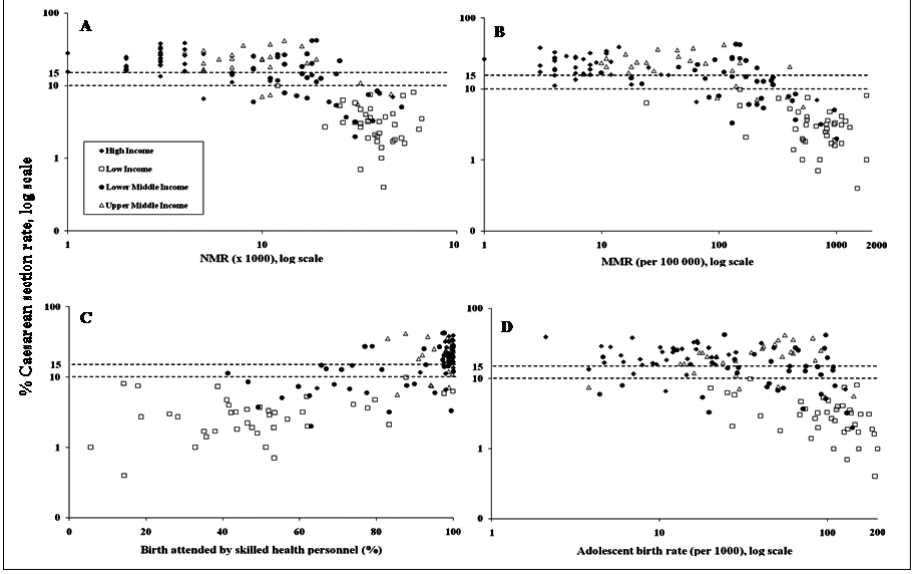


Fig. 4. Caesarean Section rate vs Neonatal Mortality Rate (NMR, per 1,000 live births) (A), Maternal Mortality Rate (MMR, per 100,000 live births) (B), Birth Attended by Skilled Health Personnel (%) (C) and Adolescent Birth rate (per 1000) (D) by income group.



Data on NMR and MMR caused by CS are only available for certain geographical areas, so Authors considered MMR, NMR and BASHP as reproductive health indicators, leaving delivery type out of the consideration.

The risk of death in the poorest countries during the neonatal period, is about three times higher than in medium-high-income countries, and eight times higher than in high-income countries.

MMR in low-income regions is almost 30 times higher than in high-income countries. A negative but statistically significant correlation has been observed on CS and MMR and NMR in low-income countries, while there is no correlation for medium-high-income countries [18].

This study show an inverse correlation between CS and NMR, and between CS and MMR, for all geographical areas except Europe.

The greatest association between CS, NMR and MMR was observed in lower-middle-income countries that have a CS mean value close to 15%, although with a larger value range.

Regarding the NMR, deaths mostly occur in the first few days after delivery, and precocious neonatal mortality represents almost 75% of total NMR [18] depending on sanitary, medical and nursing assistance during delivery.

In developed countries most deliveries occur in medical facilities with skilled medical and nursing personnel; in developing countries only 50% and half of these with medical, nursing and obstetrical staff [19]. Immediate access to emergency obstetrical care and better access to skilled personnel during pregnancy and delivery are crucial for ensuring a high level of care provided in a timely manner, when life-threatening complications arise.

BASHP is one of the key indicators of progress; the goal of improving maternal health should reduce maternal mortality by 75% between 1990 and 2015 [16]. In countries where the value is close to 100%, it is very important to identify new indicators able to provide useful information for estimating the level of prenatal care.

The age of the mother seems to influence the outcome of pregnancies and choice of delivery type. Teenage pregnancies, although very frequent in some countries, show a decreasing trend [20, 21].

A statistical association between CS use and ABR rate has been found; countries with a high ABR rate have low CS use.

In countries with high percentages of teenage pregnancy, the ABR could be used as a new indicator of reproduc-

Tab. III. The relationship between Caesarean section and Neonatal Mortality Rate (NMR, per 1,000 live births) and Maternal Mortality Rate (MMR, per 100,000 live births), Birth Attended by Skilled Health Personnel (BASHP, %) and Adolescent Birth rate of world and World Bank Regional Area (ANCOVA analysis).

	Linear Regression			ANCOVA			
	r	DF	p	F	DFn	DFd	p
NMR total	- 0.70	138	0.000	3.52	6	122	0.003
East Asia & Pacific	- 0.67	8	0.032				
East Europe & Central Asia	- 0.66	20	0.000				
Europe	0.43	22	0.034				
Latin America & Caribbean	- 0.54	18	0.013				
Middle East & North Africa	- 0.16	15	0.548				
South Asia	0.54	3	0.349				
Sub-Saharan Africa	- 0.38	36	0.017				
North America	-	-	-				
Oceania	-	-	-				
MMR total	- 0.65	137	0.000	7.24	6	121	0.000
East Asia & Pacific	- 0.82	8	0.003				
East Europe & Central Asia	- 0.55	20	0.008				
Europe	- 0.08	21	0.718				
Latin America & Caribbean	- 0.72	18	0.000				
Middle East & North Africa	- 0.26	15	0.316				
South Asia	0.03	3	0.959				
Sub-Saharan Africa	- 0.48	36	0.002				
North America	-	-	-				
Oceania	-	-	-				
BASHP total	0.66	133	0.000	1.88	6	117	0.091
East Asia & Pacific	0.70	8	0.025				
East Europe & Central Asia	0.02	21	0.935				
Europe	- 0.26	16	0.301				
Latin America & Caribbean	0.73	18	0.000				
Middle East & North Africa	0.38	15	0.135				
South Asia	0.37	3	0.539				
Sub-Saharan Africa	0.64	36	0.000				
North America	-	-	-				
Oceania	-	-	-				
ABR total	- 0.52	140	0.000	3.25	6	124	0.005
East Asia & Pacific	- 0.83	8	0.003				
East Europe & Central Asia	0.24	21	0.261				
Europe	0.25	22	0.247				
Latin America & Caribbean	- 0.27	18	0.249				
Middle East & North Africa	0.05	16	0.851				
South Asia	- 0.14	3	0.823				
Sub-Saharan Africa	- 0.52	36	0.000				
North America	-	-	-				
Oceania	-	-	-				

Tab. IV. The relationship between Caesarean section and Neonatal Mortality Rate (NMR, per 1,000 live births) and Maternal Mortality Rate (MMR, per 100,000 live births), Birth Attended by Skilled Health Personnel (BASHP, %) and Adolescent Birth rate of world and by income group (ANCOVA analysis).

	Linear Regression			ANCOVA analysis			
	r	DF	p	F	DFn	DFd	p
NMR total	- 0.70	138	0.000	2.27	3	132	0.083
High income	- 0.36	36	0.028				
Low income	- 0.22	37	0.179				
Lower middle income	- 0.42	35	0.009				
Upper middle income	- 0.40	24	0.044				
MMR total	- 0.65	137	0.000	6.50	3	131	0.000
High income	- 0.35	35	0.034				
Low income	- 0.27	37	0.097				
Lower middle income	- 0.47	35	0.003				
Upper middle income	- 0.48	24	0.013				
BASHP total	0.66	133	0.000	4.34	3	127	0.006
High income	0.41	29	0.023				
Low income	0.29	37	0.070				
Lower middle income	0.47	36	0.002				
Upper middle income	- 0.17	25	0.410				
ABR total	- 0.52	140	0.000	1.17	3	134	0.326
High income	- 0.24	36	0.145				
Low income	- 0.45	37	0.004				
Lower middle income	- 0.12	36	0.468				
Upper middle income	0.16	25	0.423				

tive health more specific to certain geographic areas and more related to lifestyles and religious beliefs.

Very interesting data are in countries where both the CS rate and ABR value are very high without clinical evidence of need for CS (e.g. Latin America countries).

In this biopolitical context, it may be possible to determinate the appropriate use of invasive and natural procedures either by outcome measurement and using both opportune indicators (NMR, MMR), or by indirect process indicators (BASPH and ABR).

A linear relation between CS and the indicators is not enough to explain these social and clinical trends completely.

With Piecewise regression and ANCOVA test the Authors provided the breakpoint beyond which an increased CS rate does not reflect an improvement in health care.

The corresponding CS rates for breakpoints can identify the correct use of the surgical procedure. The CS values corresponding to the discontinuity found for NMR and MMR are 16% and 9% respectively. In the case of NMR, an inverse trend was observed, explainable by a real increase of risk for neonatal health exceeding the threshold value.

In Brazil, the Dominican Republic, Iran and Turkey these situation could depend on marked differences in access to public health and/or cultural and religious conditioning.

The CS and MMR relation is easily understood, when the threshold value is over by 9% there is no trend reversal but it arrives at plateau. For higher values on discontinuity points, the process indicators do not show any correlations with CS.

Regarding the relationship between CS and BASHP, the only positive association among the percentages obtained over the discontinuity value is homogeneous except in certain countries (Egypt, Paraguay and Turkey), which present high CS levels and low values of assistance at delivery.

The highest values of dispersion over the discontinuity point was observed between CS and ABR. Latin America and Caribbean countries mostly have medium-high CS values that do not coincide with low percentages of teenage pregnancy.

Social and cultural reasons could be the causes of the data observed [22, 23]. Besides, one possible reason for the increased use of CS is the introduction of new technique developed by Stark et al. that addresses many obstetrician to choose the easy way rather then making efforts to promote natural childbirth [24]. Based on this ecological analysis, a possible optimum range in the use of CS between 9 and 16% was identified. All the countries should strive to adhere this range to properly safeguard maternal and neonatal health and for correct management of health economics.

Specific clinical, social and political factors of each country should be taken into consideration step-by-step, for better global evaluation of the actual CS trend, and this study could help support these findings.

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Appendix

Estimates and sources of CS rates

Country	Year	CS (%)	Source
Afghanistan	2006	8.1	Guidotti RJ, Kandasamy T Betrán AP, et al. *Monitoring perinatal outcomes in hospitals in Kabul, Afghanistan. The first step of a quality assurance process*. J Matern Fetal Neonatal Med 2009;22:285-92.
Albania	2007	25.6	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Algeria	2000	6.0	World health Organization (WHO). *WHOSIS WHO Statistical Information system*. WHO 2008. http://apps.who.int/whosis/data
Andorra	1999	23.7	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Argentina	2005	22.9	Ministerio de Salud de la Nación. *Dirección Nacional de Salud Materno Infantil. Anuario 2005 de Información Perinatal*. http://www.msal.gov.ar/htm/Site/promin/UCMISALUD/archivos/pdf/Anuario%20SIP%202005.pdf
Armenia	2007	14.1	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Australia	2006	30.8	Australian Institute of Health and Welfare (AIHW). *Australia's mothers and babies 2006*. http://www.aihw.gov.au/publications/per/amb06/amb06.pdf
Austria	2007	27.1	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Azerbaijan	2007	7.6	World Health Organization (WHO). European Health for All database (*HFA-DB*). Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Bahrain	1995	16.0	Naseeb T, Farid SM. B*ahrain Family health Survey 1995*. Manama: Ministry of Health 2000.
Bangladesh	2007	7.5	Demographic Health and Surveys (DHS). *Bangladesh Demographic and Health Survey 2007*. http://www.measuredhs.com
Belarus	2007	20.5	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Belgium	1999	16.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Benin	2006	3.6	Demographic *Health and Surveys (DHS)*. Benin 2006 DHS Final Report. http://www.measuredhs.com
Bolivia	2003	14.6	Demographic Health and Surveys (DHS). *Bolivia: Standard DHS, 2003*. http://www.measuredhs.com
Botswana	2000-08	7.7	World Health Organization (WHO). *World Health Report 2009*. Geneva, World Health Organization, 2009. http://who.int/whosis/whostat/EN_WHS09_Full.pdf
Brazil	2004	41.8	Ministério da Saúde. Informações e Análises. *Uma Análise dos Nascimentos no Brasil e Regiões*. Secretaria de Vigilância em Saúde. Ministério da Saúde. 2004. http://portal.saude.gov.br/portal/saude/gestor/visualizar_texto.cfm?idtxt=24455
Bulgaria	2007	26.8	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Burkina Faso	2003	0.7	Demographic Health and Surveys (DHS). *Burkina Faso: Standard DHS, 2003*. http://www.measuredhs.com
Cambodia	2005	1.8	Demographic Health and Surveys (DHS). *tuttoinsieme.docCambodia Demographic and Health Survey 2005*. http://www.measuredhs.com
Cameroon	2004	2.0	Demographic Health and Surveys (DHS). *tuttoinsieme.docCameroon DHS Final report 2004*. http://www.measuredhs.com
Canada	2005-06	26.3	Canadian Institute for Health information. *Giving Birth in Canada: Regional trends from 2001-2002 to 2005-2006*. 2007.
Cape Verde	1998	6.0	Instituto Nacional de Esattistica. I*nquerito Demografico e de Saude Reprodutiva cape Verde 1998*. Instututo Nacional de Estatistica, Avenida Amilcar cabral, CD 116 Praia cabo Verde 1999.
Central African Republic	1994-95	1.9	Ndamobissi R, Gora M, Nguelebe EO. *Enquete Demographique et de Sante, Republique Centrafricaine 1994-95*. Calverton, Maryland, USA; Direction des Statistiques et Sociale set Macro International INC 1995.

Chad	2004	0.4	Demographic Health and Surveys (DHS). *tuttoinsieme.docChad 2004 DHS Final Report*. http://www.measuredhs.com
Chile	2002	30.7	Ministerio de Salud. *Resumen Estadistico Mensual (REM) 02 Atencion de la Mujer*. Ministerio de Salud, Chile 2002.
China	2001-02	20.4	Sufang G, Padmadas SS, Fengmin Z, et al. *Delivery settings and caesarean section rates in China*. Bull World Health Organ 2007;85:755-62.
Colombia	2005	26.7	Demographic Health and Surveys (DHS). *tuttoinsieme.docColombia 2005 DHS Final Report*. http://www.measuredhs.com
Comoros	1996	5.3	Demographic and Health Surveys (DHS). *Comoros 1996 DHS Final report*. http://www.measuredhs.com
Congo Democratic Rep.	2007	4.1	Demographic and Health Surveys (DHS). *Congo Democratic Republic 2007 DHS Final Report*. http://www.measuredhs.com
Congo Rep.	2005	3.2	Demographic Health and Surveys (DHS). *tuttoinsieme.docCongo (Brazzaville) 2005 DHS Final Report*. http://www.measuredhs.com
Costa Rica	2003	36.0	Ministerio de Salud, CCS, UCR, PANI y OPS/OMS. *Informe anual 2003 Sistema Nacional de Análisis de la Mortalidad Infantil y del Sistema Nacional de Evaluación de la Mortalidad Materna*. 2004, pp. 1-79. http://www.cor.ops-oms.org/TextoCompleto/documentos/Informe%20Mortalidad%20infantil%20y%20materna.pdf
Cote d'Ivoire	1998	2.5	Demographic Health and Surveys (DHS). *Cote d'Ivoire 1998-99 DHS Final Report*. http://www.measuredhs.com
Croatia	2006	16.2	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Cuba	2002	28.5	Direcciòn Nacional de Estadistica. Ministerio de Salud Pùblica, Republica de Cuba
Czech Republic	2006	18.4	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Denmark	2007	21.4	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Dominican Republic	2007	41.9	Demographic Health and Surveys (DHS). *Dominican republic 2007 DHS Final Report*. http://www.measuredhs.com
Ecuador	1999	19.9	USAID/CDC/Naciones Unidas. Fondo de Poblaciòn. ENDEMAIN-III Ecuador. Informe General. Centro de Estudios de Poblacion y Desarrollo Social. Quito, Ecuador 2000
Egypt Arab Rep.	2008	27.6	Demographic Health and Surveys (DHS). *Egypt 2008 DHS Final Report*. http://www.measuredhs.com
El Salvador	2005-08	25.0	Asociación demografica salvadoreña. *Encuesta Nacional de Salud Familiar de 2008 (FESAL-2008)*. Informe resumido. Febrero 2009, pp. 1-51. http://www.fesal.org.sv/2008/informe/resumido/desargar/FESAL2008-InformeResumido.pdf
Equatorial Guinea	2006	7.0	Leke R, Stalls S. *Needs Assessment of maternal and neonatal health in equatorial guinea: trip report, 2007*. Conducted for eg Ing by engenderhealth. New York, October 15-23, 2007, pp. 1-27. ziaconsulting.org/EquatorialGuinea.doc
Eritrea	2002	2.7	Demographic Health and Surveys (DHS). *Eritrea 2002 DHS Final Report*. http://www.measuredhs.com
Estonia	2007	20.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Ethiopia	2005	1.0	Demographic Health and Surveys (DHS). *Ethiopia 2005 DHS Final Report*. http://www.measuredhs.com
Fiji	2000-08	7.1	World Health Organization (WHO). *World Health Report 2009*. Geneva, World Health Organization 2009. http://who.int/whosis/whostat/EN_WHS09_Full.pdf
Finland	2007	16.3	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
France	2003	18.8	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Gabon	2000	5.6	World health Organization (WHO). *WHOSIS WHO Statistical Information system*. WHO 2009. http://apps.who.int/whosis/data
Georgia	2007	22.2	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Germany	2006	27.8	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).

Ghana	2003	3.7	Demographic Health and Surveys (DHS). *Ghana 2003 DHS Final Report*. http://www.measuredhs.com
Guatemala	2002	11.4	Ministerio de Salud Pùblic y Asistencia Social, Instituto Nacional de Estadìstica. *Guatemala Encuesta National de Salud Materno Infantil 2002*. Instituto Nacional de Estadìstica (INE) 2003.
Guinea	2005	1.7	Demographic Health and Surveys (DHS). *Guinea 2005 DHS Final Report*. http://www.measuredhs.com
Haiti	2005-06	3.0	Demographic Health and Surveys (DHS). *Haiti 2005-06 DHS Final Report*. http://www.measuredhs.com
Honduras	2005-06	13.0	Demographic Health and Surveys (DHS). *Honduras 2005-06 DHS, Final Report*. http://www.measuredhs.com
Hungary	2005	27.4	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Iceland	2005	15.6	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
India	2005-06	8.5	Demographic Health and Surveys (DHS). *India 2005-06 DHS Final Report*. http://www.measuredhs.com
Indonesia	2007	6.8	Demographic Health and Surveys (DHS). *Indonesia 2007 DHS Final Report*. http://www.measuredhs.com
Iran Islamic Rep.	2007	42.3	Moini A, Riazi K, Ebrahimi A, et al. *Caesarean section rates in teaching hospitals of Tehran: 1999-2003*. East Mediterr Health J 2007;13:457-60.
Ireland	2005	26.2	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Israel	2007	19.1	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Italy	2005	38.2	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Japan	1998-04	28.2	Nakagawa M, Kinouchi K, Miyagawa Y, et al. *7 year survey of anesthesia for caesarean section-comparison of tetracaine and bupivacaine as intrathecal anesthetic agents*. Masui 2007;56:61-8.
Jordan	2007	18.5	Demographic Health and Surveys (DHS). *Jordan 2007 DHS Final Report*. http://www.measuredhs.com
Kazakhstan	2007	11.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Kenya	2003	4.0	Demographic Health and Surveys (DHS). *Kenya 2003 DHS Final Report*. http://www.measuredhs.com
Korea Rep.	2003	38.9	Health Insurance Review Agency (HIRA). *2003 Caesarean Section Delivery Rates Report*. Seoul: HIRA 2003.
Kuwait	1996	11.2	Alnesef Y, Al-Rashoud RH, Farid SM. *Kuwait family Health Survey 1996*. Kuwait: Ministry of health 2000.
Kyrgyz Rep.	2007	5.8	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Latvia	2007	23.3	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Lebanon	1999-00	23.3	Lebanese Republic Ministry of Health and UNICEF. *National Perinatal Survey, Lebanon 1999-2000*. Lebanese Republic Ministry of Health 2001.
Lesotho	2004	5.1	Demographic Health and Surveys (DHS). *Lesotho 2004 DHS Final Report*. http://www.measuredhs.com
Liberia	2007	3.5	Demographic Health and Surveys (DHS). *Liberia 2007 DHS Final Report*. http://www.measuredhs.com
Libya	1995	7.5	Pan Arab Project for Child Development (PAPCHILD). *Arab Libyan maternal and Child Health Survey 1995*. The great Socialist People,s Libyan Arab Jamahiria The General People's Committee for Health and Social Insurance, EL-Faressia st Cario, League of Arab States 1998.
Lithuania	2007	20.5	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).

Luxembourg	2004	24.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Macedonia FYR	2006	16.9	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Madagascar	2003-04	1.0	Demographic Health and Surveys (DHS). *Madagascar 2003-2004 DHS Final Report*. http://www.measuredhs.com
Malawi	2004	3.1	Demographic Health and Surveys (DHS). *Malawi 2004 DHS Final Report*. http://www.measuredhs.com
Mali	2006	1.6	Demographic Health and Surveys (DHS). *Mali: 2006 DHS Final Report*. http://www.measuredhs.com
Malta	2007	32.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Mauritania	2000-01	3.2	Demographic Health and Surveys (DHS). *Mauritania: 2000-01 DHS Final Report*. http://www.measuredhs.com
Mexico	2005	37.5	Salud Mexico. Secretaria de Salud. Anexos. http://portal.salud.gob.mx/sites/salud/descargas/pdf/pnsanexos.pdf
Moldova Rep.	2007	11.9	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Montenegro	2007	12.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Morocco	2003-04	5.4	Demographic Health and Surveys (DHS). *Morocco 2003 -04 DHS Final Report*. http://www.measuredhs.com
Mozambique	2003	1.9	Demographic Health and Surveys (DHS). *Moçambique Inquérito Demográfico e de Saúde 2003*. http://www.measuredhs.com
Namibia	2006-07	12.7	Demographic Health and Surveys (DHS). *Namibia 2006-07 DHS Final Report*. http://www.measuredhs.com
Nepal	2006	2.7	Demographic Health and Surveys (DHS). *Nepal Demographic and Health Surveys 2006*. http://www.measuredhs.com
Netherlands	2005	13.5	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
New Zealand	2004	23.7	New Zealand Ministry of Health. *Report on Maternity 2004*. Wellington, New Zealand: New Zealand Ministry of Health 2007. http://www.moh.govt.nz
Nicaragua	2001	14.7	Demographic Health and Surveys (DHS). *Nicaragua 2001 DHS Final Report*. http://www.measuredhs.com
Niger	2006	1.0	Demographic Health and Surveys (DHS). *Niger 2006 DHS Final Report*. http://www.measuredhs.com
Nigeria	2008	1.8	Demographic Health and Surveys (DHS). *Nigeria 2008 DHS Final Report*. http://www.measuredhs.com
Norway	2006	16.6	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Oman	1995	6.6	Suilaman AJM, Al-Riyami A, farid SM. *Oman Family Health Survey 1995*. Muscat: Ministry of Health 2000.
Pakistan	2006-07	7.3	Demographic Health and Surveys (DHS). *Pakistan 2006-07 DHS Final Report*. http://www.measuredhs.com
Palestine	2006	15.0	Palestinian Central Bureau of Statistics. *Palestinian Family Health Survey, 2006*. Preliminary Report. April, 2007, pp. 1-60. http://www.pcbs.gov.ps/Portals/_pcbs/PressRelease/English_Report.pdf (Last access: September 9, 2009).
Panama	1999	18.2	Belizán JM, Althabe F, Barros FC, et al. *Rates and implications of caesarean sections in Latin America: ecological study*. BMJ 1999;319:1397-402.
Papua New Guinea	2002	4.7	Papua New Guinea Department of Health. Information provided by Dr Nicholas mann on 29 July 2003. Papua New Guinea Department of Health, PO Box 807, Waigani NCD, Papua New Guinea.
Paraguay	2004	27.0	Centers for Disease Control and Prevention. Department of Health and Human Services. International Reproductive Health Surveys and Comparative Reports: Surveys and Comparative Reports: Paraguay 2004 Reproductive Health Survey. Paraguay 2004 Reproductive Health Survey, Final Report. English Language Executive Summary. http://cdc.gov/reproductivehealth/Surveys/Paraguay04.htm#Maternal%20Health

Peru	2000	12.7	Demographic Health and Surveys (DHS). *Peru 2000 DHS Final Report*. http://www.measuredhs.com
Philippines	2003	7.3	Demographic Health and Surveys (DHS). *Philippines 2003 DHS Final Report*. http://www.measuredhs.com
Poland	1997	16.1	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Portugal	2005	34.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Qatar	1998	15.9	Al-Javer KA, Farid SM. *Qatar family Health Survey 1998*. Doha: Ministry of Health, 2000.
Romania	2006	23.6	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Russian Federation	2006	18.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Rwanda	2005	2.9	Demographic Health and Surveys (DHS). *Rwanda 2005 DHS Final Report*. http://www.measuredhs.com
Saudi Arabia	2001	11.6	Central Department of Statistics, Ministry of Health. *Statistical yearbook*. Thirty Seventh Issue, 1421/1422 AH. Ministry of Health 2001
Senegal	2005	3.3	Demographic Health and Surveys (DHS). *Senegal 2005 DHS Final Report*. http://www.measuredhs.com
Serbia	2007	16.9	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Slovak Rep.	2005	20.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Slovenia	2007	16.8	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
South Africa	2003	20.6	Demographic Health and Surveys (DHS). *South Africa 2003 DHS Final Report*. http://www.measuredhs.com
Spain	2005	25.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Sudan	1993	3.7	Pan Arab for Child Development (PAPCHILD). *Sudan maternal and Child health Survey 1992/93*. Federal Ministry of Health National Directorate of Motherhood, Childhood & Family Planning National Centre of Health Information. 1995. Republic of Sudan, League of Arab States 1993.
Swaziland	2006-07	7.9	Central Statistical Office (CSO) [Swaziland], and Macro International Inc. 2008. *Swaziland Demographic and Health Survey 2006-07*. Mbabane, Swaziland: Central Statistical Office and Macro International Inc.
Sweden	2006	17.3	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Switzerland	2005	28.9	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Syrian Arab Rep.	2002	15.0	Central Bureau of Statistics (Syria). *The family health survey in the Syrian Arab Republic. 2002*. Syrian Arab Republic and the Pan Arab Project for Family Health (PAPFAM) of League of Arab States. http://www.un.org.sy/forms/publications/files/fhs.pdf
Tajikistan	2006	2.1	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Tanzania	2004-05	3.2	Demographic Health and Surveys (DHS). *Tanzania 2004 -05 DHS Final Report*. http://www.measuredhs.com
Thailand	2000-08	17.4	World Health Organization (WHO). *World Health Report 2009*. Geneva: World Health Organization 2009. http://who.int/whosis/whostat/EN_WHS09_Full.pdf
Togo	1998	2.0	Demographic Health and Surveys (DHS). *Togo 1998 DHS Final Report*. http://www.measuredhs.com
Tunisia	1995	8.0	Ministére de la Santé Publique. Office National de la Famille et de la Population. *L'Enquete Tunisienne sur la Santé de la Mére et de l'Enfant. Rapport Principal 1996*. Project Pan Arab pour la Promotion de l'Enfance. Tunisia: Ministére de la Santé Publique 1996.
Turkey	2007	35.4	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).

Turkmenistan	2006	3.3	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
Uganda	2006	3.1	Demographic Health and Surveys (DHS). *Uganda 2006 DHS Final Report*. http://www.measuredhs.com
Ukraine	2006	14.2	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
United Arab Emirates	1995	15.8	Fikri M, Farid SM. *United Arab Emirates family Health Survey 1995*. Abu Dhabi: Ministry of Health 2000.
United Kingdom	2004	22.0	World Health Organization (WHO). *European Health for All database (HFA-DB)*. Regional Office for Europe, Copenhagen. http://www.euro.who.int/hfadb (Updated August 2009).
United Sates	2007	31.8	Hamilton BE, Martin JA, Ventura SJ. *Births: Preliminary Data for 2007*. National Vital Statistics Reports (CDC) 2009;57(12):1-23.
Uruguay	2000	23.8	Instituto Nacional de Estadistica. *Area Sociodemografica*. Fascicolo 1.5: *Salud*. Montevideo, Uruguay: Instituto Nacional de Estatistica 2002. (Internet communication of 24 April 2003 at http://www.ine.gub.uy).
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