

Supplementary Online Content

Molina G, Weiser TG, Lipsitz SR, et al. Relationship between cesarean delivery rate and maternal and neonatal mortality. *JAMA*. doi:10.1001/jama.2015.15553.

eTable 1. Observed cesarean delivery rates for 172 WHO member states

eTable 2. Yearly number of births, total health expenditure per capita, cesarean delivery volume, and cesarean delivery rates for all 194 WHO member states

This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1: Observed yearly cesarean delivery rates (per 100 live births)			
Country	Year	Cesarean delivery rate	Source
Afghanistan	2010-2011	3.6	UNICEF Global databases 2014 based on MICS 2010, [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Albania	2011	30	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Algeria	2012	16.3	UNICEF Global databases 2014 based on MICS(Prelim) 2012, [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Argentina	2006	27.6	UNICEF Global databases 2014 based on DHS, MICS and other nationally representative surveys.[Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Armenia	2012	22.5	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Australia	2010	32.2	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed July 15, 2014).
Austria	2012	28.8	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Azerbaijan	2006	5.2	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Bahrain	2011	30	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed January 19, 2015).
Bangladesh	2011	17.1	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Belarus	2012	25.3	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.)Available from: http://data.euro.who.int/hfad/
Belgium	2011	20.2	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Belize	2011	28.1	UNICEF Global databases 2014 based on MICS 2011. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Benin	2011-2012	5.9	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed September 22, 2014).
Bhutan	2012	12	Ministry of Health, Royal Government of Bhutan. Annual Health Bulletin 2013, Health Management System, Ministry of Health, Royal Government of Bhutan. [Internet] p. 1-121. (accessed April 12, 2014) Available from: http://www.health.gov.bt/wp-content/uploads/ppd-files/health-bulletins/bulletins/ahb2013/ahbContent2013.pdf
Bolivia	2008	19.5	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Bosnia and	2009	17.5	European health for all database (HFA-DB), World Health Organization Regional Office for

Herzegovina			Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Botswana	2000-2008	7.7	World Health Organization. World Health Statistics 2010. <i>WHO Library Cataloguing-in-Publication Data</i> 2010; 88–94. http://www.who.int/gho/publications/world_health_statistics/EN_WHS10_Full.pdf . (accessed September 23, 2014).
Brazil	2012	55.6	Ministério da Saúde, Brasil. SVS/DASIS - Sistema de Informações sobre Nascidos Vivos – SINASC e SIP/ANS. 2012 [Internet] (accessed January 27, 2015) Available from: http://u.saude.gov.br/images/pdf/2014/outubro/14/ApresentaPARTO-NORMAL.10-10-14.pdf
Bulgaria	2011	33.1	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Burkina Faso	2010	2.1	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Burundi	2010	4.3	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Cambodia	2010	3.5	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Cameroon	2011	4.4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Canada	2011	26.2	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oece_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Cape Verde	2005	10.7	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Central African Republic	2010	4.5	UNICEF Global databases 2014 based on MICS 2010. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Chad	2010	1.5	UNICEF Global databases 2014 based on MICS 2010. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Chile	2012	49.6	UNICEF Global databases 2014 based on DHS, MICS and other nationally representative surveys.[Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
China	2011	36.3	UNICEF Global databases 2014 based on DHS, MICS and other nationally representative surveys.[Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Colombia	2010	36.9	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Comoros	2012	10.3	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Congo ^a	2011-2012	5.9	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Costa Rica	2011	21	UNICEF Global databases 2014 based on Other NS (Prelim)2011-2012.[Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Cote d'Ivoire	2011-2012	3.1	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Croatia	2012-	18.9	UNICEF Global databases 2014 based on Other NS 2012-2013.[Internet] (accessed January 19,

	2013		2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Cuba ^b	2005	35.6	Villar J, Valladares E, Wojdyla D, et al. Caesarean delivery rates and pregnancy outcomes: the 2005 WHO global survey on maternal and perinatal health in Latin America. <i>Lancet</i> 2006;367:1819-29
Cyprus	2010	11.4	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Czech Republic	2012	24.4	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Democratic Republic of the Congo	2010	7.2	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed January 19, 2015).
Denmark	2012	21.2	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Djibouti	2012	11	UNICEF Global databases 2014 based on Other NS (Prelim) 2012, [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Dominican Republic	2007	44.3	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 29, 2015).
Ecuador	2011	19.6	Ministerio de Salud Pública del Ecuador. Coordinación General de Desarrollo Estratégico en Salud 2012. Datos esenciales de salud: Una mirada a la década 2000-2010.[Internet] (accessed January 20, 2015) Available from: https://www.salud.gob.ec/wp-content/uploads/downloads/2013/05/Datos-esenciales-de-salud-2000-2010.pdf
Egypt	2008	30	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 20, 2015).
El Salvador	2012	28.2	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Equatorial Guinea	2011	6.6	UNICEF Global databases 2014 based on DHS, [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Eritrea	2010	2.8	UNICEF Global databases 2014 based on Other NS 2010. [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Estonia	2012	20	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed July 15, 2014).
Ethiopia	2011	1.6	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed September 22, 2014).
Fiji	2000-2008	7.1	World Health Organization. World Health Statistics 2010. <i>WHO Library Cataloguing-in-Publication Data</i> 2010; 88–94. http://www.who.int/gho/publications/world_health_statistics/EN_WHS10_Full.pdf . (accessed September 23, 2014).
Finland	2012	16.2	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
France	2012	20.7	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).

Gabon	2012	10.5	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com. (accessed January 20, 2015).
Gambia, The	2010	2.5	UNICEF Global databases 2014 based on MICS 2010. [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Georgia	2012	36.7	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 20, 2015.) Available from: http://data.euro.who.int/hfad/
Germany	2012	31.7	Statistisches Bundesamt Deutschland. [Internet] (accessed January 20, 2015) Available from : https://www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2013/10/PD13_357_231.html
Ghana	2008	6.4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com. (accessed January 29, 2015).
Guatemala	2008-2009	16.3	UNICEF Global databases 2014 based on DHS, MICS and other nationally representative surveys.[Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Guinea	2012	2.6	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com. (accessed January 20, 2015).
Guinea-Bissau	2010	2.3	UNICEF Global databases 2014 based on MICS 2010. [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Guyana	2009	13.7	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com. (accessed January 20, 2015).
Haiti	2012	5.8	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com. (accessed January 20, 2015).
Honduras	2011-2012	19.4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com. (accessed January 20, 2015).
Hungary	2012	35.3	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeid_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Iceland	2012	17	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
India	2005-2006	9.0	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com. (accessed January 20, 2015).
Indonesia	2012	12.9	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com. (accessed September 22, 2014).
Iran (Islamic Republic of)	2010-2011	45.6	UNICEF Global databases 2014 based on MICS/DHS (Prelim) 2010-2011. [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Iraq	2011	22.2	UNICEF Global databases 2014 based on MICS 2011. [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Ireland	2012	27.5	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeid_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Israel	2012	18.9	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeid_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Italy	2012	36.8	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeid_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).

Jamaica	2011	21.2	UNICEF Global databases 2014 based MICS 2011. [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Japan	2011	19.2	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Jordan	2012	29.9	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed September 22, 2014).
Kazakhstan	2010-2011	15.9	UNICEF Global databases 2014 based on MICS 2010-2011. [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Kenya	2008-2009	6.7	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 20, 2015)
Kyrgyzstan	2012	6.6	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed September 22, 2014).
Lao People's Democratic Republic	2011-2012	3.7	UNICEF Global databases 2014 based on MICS/DHS (Prelim) 2011-2012. [Internet] (accessed January 20, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Latvia	2011	23	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 20, 2015.) Available from: http://data.euro.who.int/hfad/
Lebanon	2008	40.8	DeJong J, Akik C, El Kak F, Osman H, El-Jardali F. The safety and quality of childbirth in the context of health systems: mapping maternal health provision in Lebanon. <i>Midwifery</i> 2010;26(5-2):549-557. doi:10.1016/j.midw.2010.06.012.
Lesotho	2009	7	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed September 22, 2014).
Liberia	2007	4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed September 22, 2014).
Lithuania	2011	23.2	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 20, 2015.) Available from: http://data.euro.who.int/hfad/
Luxembourg	2012	27	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oece_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Madagascar	2008-2009	1.5	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 20, 2014).
Malawi	2010	4.7	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed September 22, 2014).
Malaysia	2006	15.7	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Maldives	2009	34.4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 29, 2014).
Mali	2012-2013	2.9	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Malta	2011	33.5	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Marshall Islands	2007	9.3	UNICEF Global databases 2014 based on DHS 2007. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care

Mauritania	2011	9.6	UNICEF Global databases 2014 based on MICS 2011. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Mauritius	2011	43.8	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Mexico	2012	46.9	Heredia-Pi I, Servan-Mori EE, Wirtz VJ, Avila-Burgos L, Lozano R. Obstetric care and method of delivery in Mexico: results from the 2012 National Health and Nutrition Survey. <i>PLoS One</i> 2014; 9 : e104166.
Micronesia (Federated States of)	2006	10.5	UNICEF Global databases 2014 based on Other NS 2008. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Moldova	2012	15.8	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Monaco	2012	17.4	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Mongolia	2010	20.9	UNICEF Global databases 2014 based on MICS 2010. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Montenegro	2010	23.6	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Morocco	2010-2011	16	UNICEF Global databases 2014 based on Other NS (Prelim) 2010-2011. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Mozambique	2011	4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Myanmar	2010	38	Ministry of Health, Department of Health Planning, Myanmar. Annual Hospital Statistics Report, 2010-2011. 2013 Jan; p236. [Internet] (accessed September 22, 2014). Available from: http://www.moh.gov.mm/file/Annual%20Hospital%20Statistics%20Report%202010-2011.pdf .
Namibia	2006-2007	13.4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Nauru	2007	7.5	UNICEF Global databases 2014 based on DHS 2007. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Nepal	2011	5.3	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Netherlands	2010	15.6	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oece_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
New Zealand	2012	25.4	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oece_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Nicaragua	2011-2012	29.7	UNICEF Global databases 2014 based on Other NS (Prelim) 2011-2012. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Niger	2012	1.6	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Nigeria	2008	1.9	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).

Norway	2011	17	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Oman	2012	15.2	Ministry of Health, Sultanate of Oman. Utilization of Health Services, Chapter 7: 65. [Internet] (accessed September 22, 2014). Available from: http://www.moh.gov.om/en/stat/2012/Chapters/CH07Y12.pdf .
Pakistan	2012-2013	15.9	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Panama	2009	20.2	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Papua New Guinea	2000-2008	4.7	World Health Organization. World Health Statistics 2010. <i>WHO Library Cataloguing-in-Publication Data</i> 2010; 88–94. http://www.who.int/gho/publications/world_health_statistics/EN_WHS10_Full.pdf . (accessed January 19, 2015).
Paraguay	2008	33.1	UNICEF Global databases 2014 based on Other NS 2008. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Peru	2012	27.6	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Philippines	2008	10.4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 29, 2015).
Poland	2012	31.6	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Portugal	2011	34.8	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Qatar	2009	17.4	Public Health Department, Supreme Health Council, Qatar. Annual Health Report 2009. [Internet] (accessed May 12, 2014). Available from: http://ghdx.healthdata.org/record/qatar-annual-health-report-2009 .
Romania	2011	36.3	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Russian Federation	2010	22.1	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Rwanda	2010	8.4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Samoa	2009	12.8	UNICEF Global databases 2014 based on DHS 2009. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Sao Tome and Principe	2008-2009	5.8	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Saudi Arabia	2010	22.3	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Senegal	2012-2013	3.8	UNICEF Global databases 2014 based on DHS(Reanalyzed) 2012-2013. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care

Serbia	2012	26.8	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Seychelles	2010	22.8	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Sierra Leone	2008	1.6	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 29, 2015).
South Korea	2012	36.9	Chung SH, Seol HJ, Choi YS, Oh SY, Kim A, Bae CW. Changes in the cesarean section rate in Korea (1982-2012) and a review of the associated factors. <i>J Korean Med Sci</i> . 2014;29(10):1341-1352.
Slovakia	2010	26.1	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Slovenia	2012	19.4	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
San Marino	2011	35.4	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.) Available from: http://data.euro.who.int/hfad/
Solomon Islands	2007	6.2	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Spain	2012	25.1	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Sri Lanka	2008	25.7	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
South Sudan	2010	0.6	UNICEF Global databases 2014 based on MICS 2010. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Saint Lucia	2012	18.5	UNICEF Global databases 2014 based on MICS 2012. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Sudan	2010	6.6	UNICEF Global databases 2014 based on SHHS revised 2010. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Suriname	2010	19	UNICEF Global databases 2014 based on MICS 2010. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Swaziland	2006-2007	7.9	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 29, 2015).
Sweden	2012	16.3	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Switzerland	2011	33	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeed_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Syrian Arab Republic	2009	26.4	UNICEF Global databases 2014 based on Other NS 2010. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care

Tajikistan	2012	4.5	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Tanzania	2010	4.6	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Thailand	2012	32	UNICEF Global databases 2014 based on MICS 2012. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
The former Yugoslav Republic of Macedonia	2011	24.9	UNICEF Global databases 2014 based on MICS 2011. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Timor-Leste	2009-2010	2.1	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Togo	2010	8.8	UNICEF Global databases 2014 based on MICS 2010. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Tonga	2012	17.4	UNICEF Global databases 2014 based on DHS (Prelim) 2012. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Trinidad and Tobago	2007	18.4	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Tunisia	2011-2012	26.7	UNICEF Global databases 2014 based on MICS 2011-2012. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Turkey	2012	48	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeid_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Turkmenistan	2012	6.6	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.)Available from: http://data.euro.who.int/hfad/
Tuvalu	2007	7.1	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Uganda	2011	5.4	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
United Kingdom	2012	24.4	OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oeid_bv_id=health-data-en&doi=data-00542-en . (accessed October 3, 2014).
Ukraine	2011	15.8	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.)Available from: http://data.euro.who.int/hfad/
United Arab Emirates	2007	20.9	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Uruguay	2007	33.6	UNICEF Global databases 2014 based on MoH 2007. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
United States of America	2011	32.8	Martin JA, Hamilton BE, Ventura SJ, Osterman MJ, Mathews TJ. Births: final data for 2011. <i>Natl Vital Stat Rep</i> 2013; 62: 1–69.
Uzbekistan	2012	10.5	European health for all database (HFA-DB), World Health Organization Regional Office for Europe, Updated April 2014, (accessed January 19, 2015.)Available from: http://data.euro.who.int/hfad/

Venezuela (Bolivarian Republic of)	2009	32.2	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Viet Nam	2010- 2011	20	UNICEF Global databases 2014 based on MICS 2010-2011. [Internet] (accessed January 19, 2015) Available from: http://www.data.unicef.org/maternal-health/delivery-care
Yemen	2009	6.5	World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en . (accessed October 3, 2014).
Zambia	2007	3.3	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).
Zimbabwe	2010- 2011	4.5	DHS Program. Demographic and Health Surveys. STATcompiler. www.statcompiler.com . (accessed January 19, 2015).

^aRegional (in the capital Brazzaville) cesarean delivery rate estimate

^bRegional estimate

eTable 2: Imputed yearly cesarean delivery rates, cesarean delivery volume, total health expenditure per capita, and live births for 194 WHO member states in 2012

Country	Live births (2012)	Total health expenditure per capita adjusted to 2012 US\$	Yearly number of Cesarean deliveries (95% CI) in 2012	Cesarean delivery rate per 100 live births (95% CI) in 2012
Afghanistan	1051434	51	42349 (36941-48549)	4.0 (3.5-4.6)
Albania	35738	228	9555 (7837-11650)	26.7 (21.9-32.1)
Algeria	945842	279	154172 (139653-170202)	16.3 (14.8-18.0)
Andorra	744	3057	229 (82.8-633.4)	30.8 (11.1-85.1)
Angola	933155	190	39405 (16080-96560)	4.2 (1.7-10.3)
Antigua and Barbuda	1478	681	421 (166-1071)	28.5 (11.2-72.5)
Argentina	694821	995	222318 (203130-243319)	32.0 (29.2-35.0)
Armenia	41223	150	9275 (7596-11326)	22.5 (18.4-27.5)
Australia	309045	6140	73793 (65519-83112)	23.9 (21.2-26.9)
Austria	79242	5407	22822 (19458-26767)	28.8 (24.6-33.8)
Azerbaijan	174761	398	31837 (27492-36869)	18.2 (15.7-21.1)
Bahamas	5730	1647	1705 (682-4260)	29.8 (11.9-74.4)
Bahrain	20530	895	6850 (5523-8497)	33.4 (26.9-41.4)
Bangladesh	3142018	26	441319 (409004-476188)	14.0 (13.0-15.2)
Barbados	3608	938	1142 (439-2969)	31.6 (12.2-82.3)
Belarus	115461	339	29212 (25145-33936)	25.3 (21.8-29.4)
Belgium	126862	4711	30034 (25880-34856)	23.7 (20.4-27.5)
Belize	7698	259	2090 (1564-2793)	27.2 (20.3-36.3)
Benin	370720	33	18210 (15383-21557)	4.9 (4.1-5.8)
Bhutan	14750	90	1770 (1308-2394)	12 (8.9-16.2)
Bolivia	272358	149	41104 (35818-47170)	15.1 (13.2-17.3)
Bosnia and Herzegovina	33865	447	9754 (8008-11881)	28.8 (23.6-35.1)
Botswana	47707	384	4684 (3696-5936)	9.8 (7.7-12.4)
Brazil	3005467	1056	1671040 (1582383-1764664)	55.6 (52.7-58.7)
Brunei Darussalam	6564	939	1469(579-3730)	22.4 (8.8-56.8)
Bulgaria	69406	516	17632 (14874-20901)	25.4 (21.4-30.1)
Burkina Faso	681631	38	22232 (18935-26102)	3.3 (2.8-3.8)
Burundi	443053	20	9683 (7947-11798)	2.2 (1.8-2.7)
Cambodia	385247	51	36676 (31832-42256)	9.5 (8.3-11.0)
Cameroon	818792	59	40231 (35031-46202)	4.9 (4.3-5.6)
Canada	382297	5741	148237 (134145-163809)	38.8 (35.1-42.8)
Cape Verde	10072	144	2226 (1673-2960)	22.1 (16.6-29.4)
Central African Republic	156047	18	4752 (3753-6018)	3.0 (2.4-3.9)
Chad	577882	31	11745 (9730-14178)	2.0 (1.7-2.5)
Chile	245468	1103	121752 (109624-135222)	49.6 (44.7-55.1)
China	16343410	322	4279733 (4099225-4468188)	26.2 (25.1-27.4)
Colombia	911775	530	276589 (253932-301268)	30.3 (27.9-33.0)
Comoros	25733	38	2650 (2017-3483)	10.3 (7.8-13.5)
Congo	164847	100	10583 (8723-12839)	6.4 (5.3-7.8)
Cook Islands	164	511	34 (10-115)	20.6 (6.0-70.1)
Costa Rica	73583	951	30254 (26076-35101)	41.1 (35.4-47.7)

Croatia	41822	908	7904 (6421-9731)	18.9 (15.4-23.3)
Cuba	108359	558	47651 (41731-54411)	44.0 (38.5-50.2)
Cyprus	13031	1949	3551 (2755-4578)	27.3 (21.1-35.1)
Czech Republic	108261	1432	26416 (22651-30806)	24.4 (20.9-28.5)
Côte d'Ivoire	727484	88	34134 (29550-39428)	4.7 (4.1-5.4)
Democratic Republic of Congo	2835175	15	54271 (47731-61708)	1.9 (1.7-2.2)
Denmark	58152	6304	12328 (10236-14849)	21.2 (17.6-25.5)
Djibouti	23914	129	2631 (2001-3459)	11.0 (8.4-14.5)
Dominica	1118	392	425 (160-1118)	37.9 (14.3-98.6)
Dominican Republic	217721	310	60065 (52996-68076)	27.6 (24.3-31.3)
Ecuador	327414	361	100976 (90463-112712)	30.8 (27.6-34.4)
Egypt	1898336	152	348804 (321777-378101)	18.4 (17.0-19.9)
El Salvador	127472	254	35947 (30830-41064)	28.2 (24.2-32.2)
Equatorial Guinea	26373	1138	1385 (1004-1910)	5.3 (3.8-7.2)
Eritrea	229002	15	9983 (8205-12145)	4.4 (3.6-5.3)
Estonia	14045	1010	2809 (2146-3677)	20.0 (15.3-26.2)
Ethiopia	3077044	18	151986 (137623-167847)	4.9 (4.5-5.5)
Fiji	18215	177	2583 (1962-3400)	14.2 (10.8-18.7)
Finland	59554	4232	9648 (7917-11757)	16.2 (13.3-19.7)
France	827527	4690	171298 (155565-188623)	20.7 (18.8-22.8)
Gabon	52603	397	5523 (4400-6933)	10.5 (8.4-13.2)
Gambia	76987	26	2801 (2139-3667)	3.6 (2.8-4.8)
Georgia	60813	333	22318 (19012-26200)	36.7 (31.3-43.1)
Germany	675577	4683	214158 (195508-234587)	31.7 (28.9-34.7)
Ghana	795036	83	67662 (59919-76405)	8.5 (7.5-9.6)
Greece	99835	2044	25461 (10331-62750)	25.5 (10.3-62.9)
Grenada	2048	478	519 (201-1338)	25.3 (9.8-65.3)
Guatemala	473390	226	73327 (65094-82603)	15.5 (13.8-17.4)
Guinea	427625	32	11118 (9186-13456)	2.6 (2.1-3.1)
Guinea-Bissau	62966	30	2392 (1807-3166)	3.8 (2.9-5.0)
Guyana	16451	235	3200 (2466-4153)	19.5 (15.0-25.2)
Haiti	264549	53	15344 (12866-18298)	5.8 (4.9-6.9)
Honduras	207443	195	47546 (41636-54295)	22.9 (20.1-26.2)
Hungary	90275	987	31867 (27519-36902)	35.3 (30.5-40.9)
Iceland	4522	3872	769 (530-1115)	17.0 (11.7-24.7)
India	25627859	61	2972195 (2835153-3115861)	11.6 (11.1-12.2)
Indonesia	4740780	108	611561 (570165-655962)	12.9 (12.0-13.8)
Iran (Islamic Republic)	1452294	490	442388 (410013-477319)	30.5 (28.2-32.9)
Iraq	1026083	226	148414 (134310-164000)	14.5 (13.1-16.0)
Ireland	72014	3708	19804 (16788-23362)	27.5 (23.3-32.4)
Israel	170867	2289	32294 (27901-37378)	18.9 (16.3-21.9)
Italy	535858	3032	197196 (179681-216417)	36.8 (33.5-40.4)
Jamaica	39344	318	12225 (10146-14731)	31.1 (25.8-37.4)
Japan	1046004	4752	316182 (291099-343427)	30.2 (27.8-32.8)
Jordan	175002	388	52326 (45966-59566)	29.9 (26.3-34.0)
Kazakhstan	379486	521	54440 (47885-61894)	14.3 (12.6-16.3)

Kenya	1533040	45	80556 (71709-90495)	5.3 (4.7-5.9)
Kiribati	2348	187	272 (106-701)	11.6 (4.5-29.9)
Kuwait	67779	1428	14753 (6167-35294)	21.8 (9.1-52.1)
Kyrgyzstan	154759	84	10214 (8405-12413)	6.6 (5.4-8.0)
Lao People's Democratic Republic	181245	40	13539 (11290-16237)	7.5 (6.2-9.0)
Latvia	19936	792	5106 (4050-6439)	25.6 (20.3-32.3)
Lebanon	58488	650	25382 (21731-29646)	43.4 (37.2-50.7)
Lesotho	56696	138	4095 (3205-5232)	7.3 (5.7-9.2)
Liberia	150923	65	7680 (6229-9468)	5.1 (4.1-6.3)
Libyan Arab Jamahiriya	130096	578	34821 (14260-85032)	26.8 (11.0-65.4)
Lithuania	30475	859	7116 (5748-8808)	23.3 (18.9-28.9)
Luxembourg	6000	7452	1620 (1189-2206)	27 (19.8-36.8)
Madagascar	778414	18	37987 (33011-43713)	4.9 (4.2-5.6)
Malawi	638327	25	18328 (15486-21690)	2.9 (2.4-3.4)
Malaysia	515851	419	114250 (102697-127103)	22.1 (19.9-24.6)
Maldives	7514	558	2162 (1622-2881)	28.8 (21.6-38.3)
Mali	703643	42	20406 (17319-24042)	2.9 (2.5-3.4)
Malta	4111	1835	1219 (875-1698)	29.6 (21.3-41.3)
Marshall Islands	1479	590	135 (76-239)	9.1 (5.1-16.2)
Mauritania	130826	52	8190 (6665-10064)	6.3 (5.1-7.7)
Mauritius	14719	444	5692 (4542-7133)	38.7 (30.9-48.5)
Mexico	2268428	618	1063893 (1000907- 1130842)	46.9 (44.1-49.9)
Micronesia (Federated States)	2433	405	244 (149-401)	10.0 (6.1-16.5)
Moldova	43586	239	6887 (5553-8540)	15.8 (12.7-19.6)
Monaco	257	6708	45 (21-96)	17.4 (8.2-37.1)
Mongolia	64003	232	9804 (8051-11939)	15.3 (12.6-18.7)
Montenegro	7300	493	1836 (1361-2477)	25.1 (18.6-33.9)
Morocco	736149	190	163562 (148373-180306)	22.2 (20.2-24.5)
Mozambique	994047	37	31378 (27081-36356)	3.2 (2.7-3.7)
Myanmar	920944	20	109219 (98056-121653)	11.9 (10.6-13.2)
Namibia	59555	473	6626 (5334-8233)	11.1 (9.0-13.8)
Nauru	257	564	32 (14-73)	12.5 (5.5-28.4)
Nepal	592293	36	73468 (65222-82756)	12.4 (11.0-14.0)
Netherlands	175927	5737	41629 (36291-47751)	23.7 (20.6-27.1)
New Zealand	61131	3292	15527 (13027-18508)	25.4 (21.3-30.3)
Nicaragua	138661	144	35615 (30879-41076)	25.7 (22.3-29.6)
Niger	854558	25	13673 (11406-16390)	1.6 (1.3-1.9)
Nigeria	7012004	94	244482 (223854-267010)	3.5 (3.2-3.8)
Niue	24	1270	3 (1-19)	12.8 (2.1-78.8)
North Korea	355698	76	62148 (26325-146717)	17.5 (7.4-41.2)
Norway	60223	9055	13132 (10935-15770)	21.8 (18.2-26.2)
Oman	70737	690	10752 (8870-13034)	15.2 (12.5-18.4)
Pakistan	4605131	34	732216 (684763-782958)	15.9 (14.9-17.0)
Palau	224	972	39 (11-133)	17.3 (5.0-59.5)
Panama	75087	723	24088 (20581-28193)	32.1 (27.4-37.5)
Papua New Guinea	210044	114	12112 (10048-14600)	5.8 (4.8-7.0)
Paraguay	159975	392	37010 (32132-42627)	23.1 (20.1-26.6)

Peru	599066	337	165342 (150028-182220)	27.6 (25.0-30.4)
Philippines	2378019	119	242894 (222368-265313)	10.2 (9.4-11.2)
Poland	385359	854	121773 (109644-135225)	31.6 (28.5-35.1)
Portugal	89376	1905	25274 (21635-29524)	28.3 (24.2-33.0)
Qatar	22923	2029	7378 (5972-9116)	32.2 (26.1-39.8)
Romania	200767	420	50891 (44665-57984)	25.3 (22.2-28.9)
Russian Federation	1904267	887	371208 (342872-401886)	19.5 (18.0-21.1)
Rwanda	409880	66	26994 (23166-31454)	6.6 (5.7-7.7)
Saint Kitts and Nevis	745	825	214 (79-582)	28.8 (10.6-78.1)
Saint Lucia	2843	556	526 (349-792)	18.5 (12.3-27.9)
Saint Vincent and the Grenadines	1813	340	517 (196-1365)	28.5 (10.8-75.3)
Samoa	5058	245	512 (339-773)	10.1 (6.7-15.3)
San Marino	309	3792	103 (56-190)	33.2 (17.9-61.5)
Sao Tome and Principe	6535	109	681 (464-1000)	10.4 (7.1-15.3)
Saudi Arabia	561910	795	138538 (125155-153353)	24.7 (22.3-27.3)
Senegal	522961	51	19873 (16848-23439)	3.8 (3.2-4.5)
Serbia	61912	561	16592 (13961-19720)	26.8 (22.5-31.9)
Seychelles	1642	521	521 (346-785)	31.7 (21.0-31.9)
Sierra Leone	222014	96	7678 (6228-9467)	3.5 (2.8-4.3)
Singapore	53655	2426	15855 (6466-38874)	29.5 (12.1-72.5)
Slovakia	55698	1326	13144 (10945-15784)	23.6 (19.7-28.3)
Slovenia	22012	1942	4270 (3351-5442)	19.4 (15.2-24.7)
Solomon Islands	17285	148	1173 (839-1640)	6.8 (4.9-9.5)
Somalia	450666	20	8369 (3197-21911)	1.9 (0.7-4.9)
South Africa	1102479	645	144405 (57107-365151)	13.1 (5.2-33.1)
South Korea	472747	1703	174341 (164570-199018)	36.9 (34.3-41.5)
South Sudan	395852	27	12631 (10499-15196)	3.2 (2.7-3.8)
Spain	453584	2808	113850 (102327-126669)	25.1 (22.6-27.9)
Sri Lanka	368486	89	76911 (68372-86518)	20.9 (18.6-23.5)
Sudan	1262075	115	90762 (81071-101612)	7.2 (6.4-8.1)
Suriname	9605	521	2551 (1936-3361)	26.6 (20.2-34.5)
Swaziland	37189	259	2642 (2010-3473)	7.1 (5.4-9.3)
Sweden	113281	5319	18465 (15607-21846)	16.3 (13.8-19.3)
Switzerland	82368	8980	20801 (17669-24489)	25.3 (21.5-29.7)
Syrian Arab Republic	545646	105	104267 (93493-116283)	19.2 (17.1-21.3)
Tajikistan	264729	55	11913 (9875-14371)	4.5 (3.7-5.4)
Tanzania	1895269	41	83956 (74825-94202)	4.4 (3.9-5.0)
Thailand	700308	215	224098 (204793-245223)	32.0 (29.2-35.0)
The former Yugoslav	22690	327	6142 (4922-7663)	27.1 (21.7-33.8)
Timor-Leste	41264	50	2101 (1573-2806)	5.1 (3.8-6.8)
Togo	244672	41	11610 (9612-14023)	4.7 (3.9-5.7)
Tonga	2735	238	476 (313-724)	17.4 (11.4-26.5)
Trinidad and Tobago	19692	972	5111 (4053-6444)	26.0 (20.6-32.7)
Tunisia	204773	297	66888 (59213-75557)	32.7 (28.9-36.9)
Turkey	1267941	665	608612 (567367-652854)	48.0 (44.7-51.5)
Turkmenistan	111239	129	7342 (5941-9073)	6.6 (5.3-8.2)
Tuvalu	230	577	31 (14-72)	13.6 (6.0-31.2)
Uganda	1586642	44	57292 (50475-65030)	3.6 (3.2-4.1)

Ukraine	519764	293	126508 (114021-140363)	24.3 (21.9-27.0)
United Arab Emirates	138720	1343	43728 (38185-50075)	31.5 (27.5-36.1)
United Kingdom	815305	3647	198934 (181303-218281)	24.4 (22.2-26.8)
United States of America	3954808	8895	1227932 (1157720-1302403)	31.0 (29.3-32.9)
Uruguay	49472	1308	16772 (14118-19924)	33.9 (28.5-40.3)
Uzbekistan	625265	105	65653 (58087-74205)	10.5 (9.3-11.9)
Vanuatu	6653	116	639 (227-1799)	9.6 (3.4-27.0)
Venezuela (Bolivarian Republic)	601432	593	185393 (168683-203759)	30.8 (28.0-33.9)
Viet Nam	1407406	102	275453 (252867-300057)	19.6 (18.0-21.3)
Yemen	750778	71	49301 (43224-56231)	6.6 (5.8-7.5)
Zambia	605159	96	20958 (17807-24666)	3.5 (2.9-4.1)
Zimbabwe	433606	228	41079 (35795-47142)	9.5 (8.3-10.9)

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

Statistical Appendix

Total health expenditure per capita for countries without recent data

For countries (Somalia, North Korea, and Zimbabwe) that only had older total health expenditure data (from 2000 to 2004), multiple imputation was used to extrapolate older total health expenditure data to 2012. This was performed using a linear regression model with log of 2012 total health expenditure as the outcome and the given year for observed total health expenditure data as a covariate. The assumption underlying this analysis was a high correlation ($R^2 \geq 0.94$) between total health expenditure per capita in 2012 and any single year between 2000 and 2011 for all other WHO member states with 2012 total health expenditure data (N=191).

Sources of Available Cesarean Delivery Rate Data

Of all the 194 WHO member states, 172 countries had observed cesarean delivery rates from 2005 to 2012 from multiple sources (table 1). Health-related databases and the peer-reviewed literature on PubMed were searched for the most recent annual cesarean delivery rate using the following keywords (inter-changing “cesarean” with “caesarean” and “delivery” with “section”) and for all 194 WHO member states: “cesarean delivery”, “cesarean delivery rates”, and “cesarean delivery volume.” In total, 22 of the 194 countries had no available cesarean delivery rate data ranging from 2005–2012.

Table 1. Source of available national cesarean deliver rate data	
Data Source	Number of Countries (Total N=172)
Organization of Economic Co-operation and Development (OECD) Health Statistics Database ^{1,2}	25 ^a
European Health For All Database (HFA-DB) ³	20
Demographic and Health Surveys (DHS) Program Database ⁴	51
WHO Global Health Observatory Data Repository ⁵	17
WHO World Health Statistics 2010 report ⁶	4
UNICEF Global Databases 2014 ⁷	43
Peer-reviewed publications ^b	4
Ministry of health/national agency data sources ^b	8

^aAmong these, the OECD provided a cesarean delivery rate for 5 countries and the total number of annual cesarean deliveries for 20 countries.
^bSee eTable 1 for country-specific cesarean delivery rate data sources.

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

Calculation of number of cesarean deliveries from cesarean delivery rates at a country level

In order to estimate the number of cesarean deliveries performed in each country from the reported cesarean delivery rate per 100 live births, the number of live births (if not obtained from available sources) was calculated by multiplying the birth rate (per 1,000 in the population) by the total population and dividing by 1,000. From this estimate, the total number of cesarean deliveries performed in countries with observed cesarean delivery rates was estimated by multiplying the number of live births by the reported cesarean delivery rate per 100 live births, which equals $(\text{live births} \times \text{cesarean delivery rate})/100$.

Spearman correlation test to evaluate relationship between observed country-level cesarean delivery rate and population and health data

Of the 172 countries with reported cesarean delivery rates, a Spearman correlation test was performed on 168 that had all population and health data, which included total health expenditure per capita, life expectancy at birth, GDP per capita, percent urban population, total fertility rate, and birth rate. The following country-level population and health variables were found to be significantly correlated ($p < 0.0001$) with observed country-level cesarean delivery rate: total health expenditure per capita (Spearman $r = 0.6730$), life expectancy at birth (0.7453), GDP per capita (0.6765), percent urban population (0.6069), total fertility rate (-0.7575), and birth rate (-0.7499). Among these, the following were found to be co-linear: total health expenditure per capita and GDP per capita (Spearman $r = 0.9675$, $p < 0.0001$) and total fertility rate and birth rate (Spearman $r = 0.9848$, $p < 0.0001$). Total health expenditure per capita was retained in the model to estimate cesarean delivery rate because it had been chosen *a priori*, and total fertility rate was chosen because it had a higher Spearman r when evaluating its' correlation to observed cesarean delivery rate. Additionally, WHO region was significantly

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality associated with observed cesarean delivery rate ($R^2 = 0.4255$, $p < 0.0001$) when using the non-parametric rank regression approach.⁸

Comparing countries with and without available cesarean delivery rate data

Countries with available cesarean delivery rate data were compared with countries without any available cesarean delivery rate data by fitting exact bivariable logistic regression models⁹ to test whether the probability that missing cesarean delivery rate data was related to observed population and health data (defined as missing at random in the statistics literature) or did not depend on any of these observed data (defined as missing completely at random in the statistics literature).^{10, 11} Observed data refers to population and health data. If the probability that cesarean delivery rate data were missing depended on any of the observed population and health data, then this would support the inclusion of these population and health data in the model to estimate cesarean delivery rate for countries without any data. The only population and health variable that was significantly associated with whether cesarean delivery rate data was missing among the 194 WHO member states was WHO region (p -value=0.015) (table 1), and region was subsequently included in the final predictive model.

Developing Predictive Model for Imputing Cesarean Delivery Rate

Cesarean delivery rates were obtained for individual countries for the period ranging from 2005 to 2012 for 172 of the 194 WHO member states. Data for 2012 was available for 54 countries. For the 118 countries that did not have cesarean delivery rates available for 2012, 2012 rates were imputed from prior year information. This information was only available for a single year prior to 2012 for most of these countries. This precluded using repeated measures models to impute cesarean delivery rates for the year 2012. A predictive model was used for updating the cesarean delivery rate data to 2012 for countries ($N=118$) that had data ranging from 2005 to

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

2011. An important aspect of this modeling is that countries with cesarean delivery rate data ranging from 2005 to 2012 (N=172) were used in the predictive model for updating the cesarean delivery rate data to 2012 for countries that had cesarean delivery rate data ranging from 2005 to 2011 (N=118). Likewise, the same predictive model was used to impute 2012 cesarean delivery rate data for countries without any previously observed cesarean delivery rate data (N=22). The cesarean delivery rate was modeled as a function of all population/health data that were previously found to be correlated to cesarean delivery rate in univariate analyses. These population and health data included total health expenditure per capita, fertility rate, life expectancy, percent of urban population, and region information. The model included linear and quadratic effects of the year that cesarean delivery rate data was observed as well as pairwise interactions between the year variable and the other population/health data. This was performed in case the relationship (regression coefficients) between cesarean delivery rate and the other population/health variables changed over time. If the interaction terms between year and population/health data are significant then the effect of the population/health data depend on year (and thus change over time). None of the pairwise interactions were significant, nor was year itself statistically significant. Since none of these pairwise interactions were significant this supports the finding that the predictive model was similar over this time span (2005 to 2012).

Using the significantly correlated population and health variables, a total of 256 possible spline models were tested (combinations of 0 to 3 splines for each of the 4 continuous population and health variables: total health expenditure per capita, fertility rate, life expectancy, and percent of urban population). Region was included in the model as a categorical variable. The best fitting spline regression model between the log transformation of cesarean delivery rate and all correlated population and health variables had a cross-validation adjusted-R² of 0.7452. The cross-validation adjusted-R² was calculated as the square of the correlation between observed

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality and predicted values where the predicted cesarean delivery rate value for a country was obtained from the regression model without that country. This spline regression model included one inflection in the relationship between cesarean delivery rate and total health expenditure, and no inflections in the relationship between cesarean delivery rate and the remaining variables and took the following form:

$$\gamma = \beta_0 + \beta_1 (\log \text{expenditure}) + \beta_2 (\log \text{expenditure})x_i + \beta_3 (\text{life expectancy}) + \beta_4 (\text{percent urban population}) + \beta_5 (\text{region1}) + \dots \beta_9 (\text{region5})$$

where γ = log cesarean delivery rate; β_0 = the intercept of the line; $x_i = 0$ if total health expenditure per capita \leq \$267 and equals 1 if total health expenditure per capita $>$ \$267 and β_1 = slope of the line when $x_i = 0$; and $\beta_1 + \beta_2$ = slope of the line when if $x_i = 1$. The six regions include the African Region, South-East Asia Region, Eastern Mediterranean Region, Regions of the Americas, European Region and Western Pacific Region. The usual assumption of constant variance ($\hat{\sigma}^2$) of the outcome in the regression model was found to hold using the test proposed by White¹² ($p=0.55$ for the null of constant variance versus the alternative of heterogeneity of variance).

Multiple imputation approach in this study

The multiple imputation of cesarean delivery rate estimates for countries with missing cesarean rate data was based on Rubin's theory.¹¹ The predictive model for estimated missing cesarean delivery rate estimates was developed from cesarean delivery rates that were available for 172 countries. From the previous section, log cesarean delivery rate is distributed as approximately normal with mean γ and variance σ^2 , where γ is the regression equation in the previous section evaluated at a country's covariate values (population/health data). Then, in an imputation, the

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

missing cesarean delivery rate is sampled from a normal distribution with mean $\hat{\gamma}$ and variance $\hat{\sigma}^2$, where $\hat{\gamma}$ and $\hat{\sigma}^2$ are estimated from the spline regression approach. Then these imputations were repeated 300 times for all countries with missing cesarean delivery rates, creating 300 imputed datasets. From these 300 imputed datasets we were able to estimate all quantities of interest in this study (Table 2, etable 2, and Figures 1 and 2). First we estimated each quantity of interest in each of the 300 imputed datasets separately. Then, using Rubin's approach,¹¹ these 300 estimates were averaged to generate the final multiple imputation estimate. The standard error was estimated as the square root of the combination of the within and between imputation variance over the 300 imputed datasets.

A sensitivity analysis was performed to determine the effect imputed data had on the results (intercepts, slopes, or change-points) by cross-validation. Data from each country with imputed data was sequentially removed from the imputation resulting in 172 (number of countries with observed cesarean delivery rates) sets of 300 multiply imputed datasets. Sequentially removing each country did not change the intercepts, slopes, or change-points of the spline function that was fitted to find the best predictive model for cesarean delivery rate in the imputations.

Measurement Error in Cesarean Delivery Rate Data

Because cesarean delivery rate data were obtained from surveys, they might have measurement error,¹¹ i.e., more variability than if obtained from a complete count of the cesarean deliveries in a country (which would still have random error, but much less). This measurement error is not expected to be systematically high or low, and, therefore should not lead to biased estimates. The error could result in biased estimates if the error was in a covariate. In the imputation model, the cesarean delivery rate is the outcome, and should not bias the imputation model. To account in the model for the possible extra variability due to

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality measurement error in the cesarean delivery rate, the assumption was made that the number of cesarean deliveries in a country follows a negative binomial distribution; this gave much more variability than a Poisson distribution, which is often assumed for count data. The Poisson distribution is a special case of the negative binomial distribution in that the overdispersion parameter (which accounts for the extra variability) equals 1. The Akaike Information Criterion (AIC) was used to determine if negative binomial was a better fit than Poisson distribution.

Propagation of uncertainty and its use in the generation of 95% confidence intervals

The negative binomial was found to be a better fit than the Poisson distribution for the number of cesarean delivery since it had a smaller Akaike Information Criterion (AIC) (AIC = 4043 for negative binomial; AIC = 44,476,500 for Poisson distribution). Thus the 95% confidence intervals in eTable 2 were derived from multiple imputation assuming the cesarean delivery volume follows a negative binomial distribution. In the negative binomial distribution one must estimate both the mean for each country and an overdispersion parameter, where the mean can vary across countries but the overdispersion parameter is the same across countries. For countries without missing 2012 cesarean delivery rate data, the cesarean delivery volume will be the same across all imputations and the negative binomial estimate for these countries will be the observed 2012 cesarean delivery volume. For countries with missing 2012 cesarean delivery rate data, the imputed 2012 cesarean delivery volume will be different across all 300 imputed datasets. For these countries, the multiple imputation negative binomial estimate was average of the imputed cesarean delivery volumes over the 300 imputed datasets. To calculate the standard errors and the 95% CI, we needed to calculate the overdispersion parameters for each imputed dataset.

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

The unadjusted relationship between cesarean delivery rate estimates for 2012 with maternal and neonatal mortality

In the unadjusted analysis, for cesarean delivery rate estimates of 7.2 per 100 live births or less the correlation between cesarean delivery rate and maternal mortality ratio was significant with an unadjusted slope coefficient of -88.3, 95% CI -104.3 to -72.4, $p < 0.0001$. For cesarean delivery rate estimates of >7.2 to 19.1 per 100 live births, the unadjusted slope coefficient was -16.1, 95% CI -21.9 to -10.2, $p < 0.0001$. To interpret these slopes, for example the value of -88.3 when evaluating the relationship between maternal mortality ratio and cesarean delivery rate represents a decrease of 88.3 maternal deaths per 100,000 live births for each additional cesarean delivery per 100 live births. Similar to the adjusted analysis, cesarean delivery rate estimates above 19.1 per 100 live births were not correlated with maternal mortality ratios (cesarean delivery rate estimate >19.1–27.3 per 100 live births, unadjusted slope coefficient 0.1, 95% CI -7.0 to 7.3, $p = 0.97$; cesarean delivery rate estimate >27.3 per 100 live births, unadjusted slope coefficient 0.2, 95% CI -3.5 to 3.9, $p = 0.92$).

Like with the adjusted analysis, there was a significant inverse correlation up to a cesarean rate estimate of 19.4 (95% CI 18.6–20.3) and neonatal mortality rate (unadjusted slope coefficient -1.6, 95% CI -1.8 to -1.4, $p < 0.0001$). Above 19.4%, estimated cesarean delivery rate was not correlated with neonatal mortality rate (unadjusted slope coefficient 0.004, 95% CI -0.150 to 0.143, $p = 0.96$).

First Sensitivity Analysis

Sensitivity analyses were performed with 76 countries having the highest quality cesarean delivery rates available from the OECD (N=25) and DHS (N=51). This regression showed (CV adjusted-R² = 0.7008) that cesarean delivery rate estimate in 2012 and maternal mortality ratio

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality in 2013 had 2 change-points at 6.9% (95% CI 4.6–9.2%) cesarean deliveries per 100 live births and 20.1 cesarean deliveries per 100 live births (95% CI 15.6–24.5%). As cesarean delivery rates increased, maternal mortality fell up to 6.9 cesarean deliveries per 100 live births (slope coefficient -53.1, 95% CI -92.7 to -13.4, $p < 0.009$). Maternal mortality fell less rapidly between cesarean delivery rates of >6.9 and 20.1 cesarean deliveries per 100 live births (slope coefficient -21.3, 95% CI -32.2 to -10.5, $p < 0.0001$). No further gain in maternal mortality was observed for cesarean delivery rates estimate greater than 20.1 cesarean deliveries per 100 live births. A sensitivity analysis evaluating the relationship between the 2012 cesarean delivery rate estimate for these 76 countries and neonatal mortality rate in 2012 showed similar results. The regression model (CV adjusted-R² = 0.6465) had 3 change-points (5.0 cesarean deliveries per 100 live births (95% CI 3.4–6.7), 12.6 cesarean deliveries per 100 live births (95% CI 8.1–17.2%), and 24.0 cesarean deliveries per 100 live births (95% CI 19.5–28.4%). Neonatal mortality fell with increasing cesarean delivery rates for cesarean delivery rates between 12.6–24.0 cesarean deliveries per 100 live births (slope coefficient -1.4, 95% CI -2.3 to -0.4, $p = 0.004$). Neonatal mortality was not influenced by cesarean delivery rates less than 12.6 cesarean deliveries per 100 live births and greater than 24.0 cesarean deliveries per 100 live births.

Second Sensitivity Analysis

A second sensitivity analysis excluding the 9 countries with the least reliable data was performed. This regression showed that cesarean delivery rate estimate in 2012 and maternal mortality ratio in 2013 had 3 change-points at 7.1 cesarean deliveries per 100 live births (95% 7.0–8.0), 18.9 cesarean deliveries per 100 live births (17.9–19.8), and 27.5 cesarean deliveries per 100 live births (26.4–28.2) per 100 live births. As cesarean delivery rates increased, maternal mortality fell up to 7.1 cesarean deliveries per 100 live births (adjusted slope

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality coefficient -66.9, 95% CI -87.3 to -46.6, $p < 0.0001$). Maternal mortality fell less rapidly between cesarean delivery rates of >7.1 to 18.9 per 100 live births (adjusted slope coefficient -9.8, 95% CI -16.2 to -3.4, $p = 0.003$). No further gain in maternal mortality was observed for cesarean delivery rate estimates greater than 18.9. This sensitivity analysis also had similar results with regards to the relationship between 2012 cesarean delivery rate estimate and neonatal mortality rate in 2012. The regression showed that cesarean delivery rate estimate in 2012 and neonatal mortality rate in 2012 had 1 change-point at 19.4 (95% CI 17.4–21.4) per 100 live births. As cesarean delivery rates increased, neonatal mortality fell up to 19.4 cesarean deliveries per 100 live births (adjusted slope coefficient -1.6, 95% CI -1.8 to -1.4, $p < 0.0001$).

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

REFERENCES

1. OECD iLibrary. Health Care at a Glance: Health Care Activities, Caesarean sections. http://www.oecd-ilibrary.org/sites/health_glance-2013-en/04/08/index.html;jsessionid=lw2d1sbqyqez.x-oecd-live-02?contentType=&itemId=%2fcontent%2fchapter%2fhealth_glance-2013-39-en&mimeType=text%2fhtml&containerItemId=%2fcontent%2fserial%2f19991312&accessItemId=%2fcontent%2fbook%2fhealth_glance-2013-en. (Accessed October 3, 2014).
2. OECD Database. OECD Health Statistics. http://stats.oecd.org/BrandedView.aspx?oecd_bv_id=health-data-en&doi=data-00542-en. (Accessed October 3, 2014).
3. European health for all database (HFA-DB), World Health Organization Regional Office for Europe. <http://data.euro.who.int/hfad/> (Accessed January 19, 2015).
4. DHS Program. Demographic and Health Surveys. STATcompiler. <http://legacy.statcompiler.com>. (Accessed September 22, 2014).
5. World Health Organization. Global Health Observatory Data Repository: Births by caesarean section (%). <http://apps.who.int/gho/data/node.main.REPWOMEN39?lang=en> (Accessed October 3, 2014).
6. World Health Organization. World Health Statistics 2010. 2010:88-94.
7. UNICEF. Maternal Health: Delivery of Care - Cesarean Section Database. <http://data.unicef.org/maternal-health/delivery-care.html>. (Accessed January 19, 2015).
8. Conover W, Iman R. Rank Transformations as a Bridge Between Parametric and Nonparametric Statistics. *Am Stat.* 1981(35):124-9.

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

9. Mehta CR, Patel NR. Exact logistic regression: theory and examples. *Stat Med*.

1995;14(19):2143-2160.

10. Horton N, Lipsitz S. Multiple Imputation in Practice: Comparison of Software Packages for Regression Models with Missing Variables. *Am Stat*. 2001;55(3):244-254.

11. Rubin DB, ed. *Multiple imputation for Nonresponse in Surveys*. New York: J Wiley & Sons; 1987.

12. White H. A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica*. 1980;48(4):817-838.

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

Data Source Appendix

Organisation for Economic Cooperation and Development (OECD)

In collecting and reporting data, the OECD takes the following seven dimensions into account when considering data quality: relevance; accuracy; credibility; timeliness; accessibility; interpretability; and coherence.¹ The OECD has procedures for reviewing the quality of existing statistical activities conducted across the OECD.¹ Furthermore, evaluation of the rates of surgical procedures that the OECD publishes has found that the variation of cesarean delivery between countries is less than that reported for other procedures.²

Demographic and Health Surveys (DHS)

According to the DHS website, “Demographic and Health Surveys (DHS) are nationally-representative household surveys that provide data for a wide range of monitoring and impact evaluation indicators in the areas of population, health, and nutrition. The Standard DHS Surveys have large sample sizes (usually between 5,000 and 30,000 households) and typically are conducted about every 5 years, to allow comparisons over time.”³ The entire survey process includes the time to complete a survey (18-20 months), survey preparation and questionnaire design, training and fieldwork, data processing, and final reporting, data preparation and dissemination.³ Due to DHS’s standardization in survey design, training, survey administration, data collection and data processing⁴, its data are considered the gold standard for population-based surveys.⁵ In their report demonstrating that officially reported rates of diphtheria-tetanus-pertussis vaccination were higher than those reported by DHS data, Murray CJL et al. considered DHS data to be the gold standard because they allow “comparative analyses, since the surveys use standardized instruments, training, data collection and data processing.”⁶

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

European Health for All Database⁷

The European Health for All Database (HFA-DB) reports health statistics based on official registries and surveys collected from various sources, including individual government agencies, WHO, and international organizations for the 53 countries in the WHO European Region.⁸ These countries are given recommended definitions for most indicators that are collected and reported by the HFA-DB, and there is a process by which differing indicator definitions are reconciled. In order to ensure that data from individual countries are comparable, there is a uniform process for compiling, validating, and processing all collected data. However, “since health data recording and handling systems vary between countries, so do the availability and accuracy of data reported to WHO”.⁷

WHO Global Health Repository⁹

Data reporting births by cesarean section are obtained from household health surveys or from service or facility records. Household surveys collect data on birth history by administering “detailed questions on the last-born child or all children a woman has given birth to during a given period preceding the survey (usually 3 to 5 years), including characteristics of the birth(s).”⁹ Data obtained from service or facility records uses the number of women who gave birth by caesarean section at the respective service/facility as the numerator. WHO estimates the number of live births (denominator) by either using the number of live births to women who were surveyed, or if using data from service or facility records, then the number of live births (denominator) is estimated from census projections or vital registration data. If regional estimates are used to represent country-level cesarean delivery rates, these are weighted averages of the country data. In order to ensure that regional data are indeed representative of national data, regional data is only reported if it represents at least 50% of live births in the

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality region. A weakness of data on births by cesarean section reported by WHO Global Health Repository is that it lacks any data on clinical indication, and thus the appropriateness of cesarean delivery cannot be ascertained.⁹ However, this applies to all of the databases that are used as sources in this study.

UNICEF Data¹⁰

The United Nations Children's Fund (UNICEF) reports on data from the Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS), National Family Health Survey (NFHS), Reproductive Health Surveys (RHS), the Sudan Household Survey (SHHS) and other national surveys. We used cesarean delivery rate data from UNICEF if countries did not have a cesarean delivery rate ranging from 2005 to 2012 from the primary sources (OECD, HFA-DB, or DHS). Most of the countries that we used data from UNICEF came from MICS and other national surveys.

The Multiple Indicator Cluster Surveys (MICS) was created in 1995 and consists of “Trained fieldwork teams conduct[ing] face-to-face interviews with household members on a variety of topics – focusing mainly on those issues that directly affect the lives of children and women.”¹⁰ Data collected and reported by MICS surveys is used by agencies and governments to report on progress being made towards goals, such as the Millennium Development Goals (MDG) indicators and are expected to be used in subsequent international goals, including Sustainable Development Goals. MICS ensures the quality of collected data with support from UNICEF with regional workshops that focus on survey design, data processing, and data interpretation, further analysis and dissemination. Additionally, “Effective on-site support is provided by country MICS coordinators and UNICEF focal points, backed up by technical assistance at the regional and global levels”.¹⁰

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

Regarding MICS data collection, “Depending on the sample size and the time allocated to undertake a survey, required numbers of fieldwork teams receive training in the administration of customized questionnaires used in the survey, as well as on fieldwork procedures. The MICS programme recommends at least three weeks of training, supported by a regional expert as needed. Fieldwork is usually completed within two to four months. Each survey team has a supervisor who oversees day-to-day operations and troubleshoots problems. Interviewers conduct face-to-face interviews with eligible respondents, while the field editor checks the integrity of every questionnaire by reviewing them for possible errors or omissions. Fieldwork teams also include a measurer, who is equipped and trained to measure the weights and heights of children under 5, assisted by a second team member. Fieldwork teams use a number of tools and guidelines for quality assurance purposes – these include questionnaire editing guidelines and detailed instructions for all fieldwork team members.”¹¹

Regarding MICS data processing, “Data processing tools for entering and processing data are customized by survey teams, to reflect the customization that other survey tools have undergone – such as the questionnaires. Much of this work is carried out during the MICS data processing workshop. As the questionnaires for the first cluster of households are completed, they are sent to a centralised office where the data are entered – twice. The two datasets are then compared, to make sure no data entry errors have been introduced. Field check tables are tabulated and sent back to the field supervisor to provide feedback on the overall process and the progress of individual interviewers, providing a further check for internal consistency. Tools and support are also available for those teams willing to collect data through computer-assisted personal interviewing (CAPI), using tablets or laptops. While the use of such devices can save

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

time and enhance accuracy, interviewers must be skilled in using them, enhanced quality controls must be established, and extended technical support made available.”¹²

Maternal mortality ratio and Neonatal mortality rate

Maternal mortality ratio (MMR)¹³ and neonatal mortality rate (NMR)¹⁴ are standard metrics that have been measured, validated and modeled by many worldwide data collection agencies (agencies like WHO, UNICEF, UNFPA, The World Bank and the United Nations Population Division).

The WHO defined maternal deaths as “the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes”.¹³ Maternal mortality is reported as a ratio (number of maternal deaths in a time period divided by number of live births during the same time period). This captures a woman’s risk of dying during a single pregnancy, and it is the preferred measure of maternal mortality because it describes the frequency of maternal death relative to its risk pool, as measured by the number of live births.¹⁵ Neonatal mortality rate is the number of neonates dying before reaching 28 days of age, per 1,000 live births in a given year.¹⁶ “Estimates of neonatal mortality rates are produced using a statistical model that uses under-five mortality rates as an input. These methods provide a transparent and objective way of fitting a smoothed trend to a set of observations and of extrapolating the trend to the present.”¹⁴

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

Other secondary sources for cesarean delivery rates by country

* These countries (N=9) were excluded in the sensitivity analysis to assess the effect of countries with cesarean delivery rate data that came from the least reliable sources.

Bhutan*

Cesarean delivery rate data came from Annual bulletin from the Ministry of health¹⁷. There is no information on data quality.

Brazil*

Cesarean delivery rate data came from Brazilian Ministry of Health report.¹⁸ There is no information on data quality.

Cuba*

Cesarean delivery rate data came from a regional estimate from Villar et al Lancet publication¹⁹. Villar et al wrote that, "After country selection, we identified a representative sample of geographic areas within each country and, within these geographic areas, a representative sample of care units. We selected countries with a probability proportional to the population of the country, provinces with a probability proportional to the population of the province, and health institutions with a probability proportional to the number of deliveries per year."

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

Furthermore, “each country [was initially stratified] by its capital city (always included) and two other randomly-selected administrative geographic areas (provinces or states). Within these three areas, we undertook a census of hospitals that reported more than 1000 deliveries in the previous year. We then stratified data by province or state, choosing a representative sample of up to seven institutions each. If there were seven or fewer eligible institutions, we included them all. We included all women admitted to the selected institutions for delivery during a fixed data collection period of either 2 or 3 months, depending on the total number of expected deliveries per institution for the complete year (3 months if ≤ 6000 per year; 2 months if > 6000 per year).”

Ecuador*

Cesarean delivery rate data came from Ecuadoran Ministry of Health.²⁰ There is no information on data quality.

Germany

Cesarean delivery rate data came from the Statistisches Bundesamt Deutschland.²¹ Data is collected by the German Federal Health Monitoring System. Data sources are hospital statistics. Hospitals are surveyed annually for multiple data including the number of cesarean deliveries.²²

Lebanon*

Cesarean delivery rate data came from the DeJong et al study²³ that employed a “self-completion questionnaire [that] was sent to private hospitals by the Syndicate of Private Hospitals in collaboration with the study team and to all public hospitals in Lebanon with a functioning maternity ward by the study team in cooperation with the Ministry of Public Health.” The authors reported an “overall response rate to the survey (46% of eligible hospitals) and the

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

deliveries reported by these hospitals account for about 42% of all live births that are reported to have taken place nationally in Lebanon in 2008.”

Mexico

Cesarean delivery rate data came from a study²⁴ published in PLOS one by Heredia-Pi et al in 2014. This was a “cross-sectional study... based on data collected through the 2012 National Health and Nutrition Survey (ENSANUT), a probabilistic survey that is representative at the national and state level, as well as by urban/rural stratum.” More information can be found in the study publication.²⁴

Myanmar*

Cesarean delivery rate data came from the Annual Hospitals Statistics Report²⁵ from the Ministry of Health. There is no information on data quality.

Oman*

Cesarean delivery rate data came from a Ministry of Health report.²⁶ There is no information on data quality.

Qatar*

Cesarean delivery rate data came from the Public Health Department of Qatar.²⁷ There is no information on data quality.

South Korea*

Cesarean delivery rate data came from a study²⁸ by Chung SH et al, who obtained 2012 data from nationally published reports. There is no information on data quality.

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

United States

The cesarean delivery rate data for the United States came from National Vital Statistics Reports: Births: Final Data for 2011²⁹ from The U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics, and National Vital Statistics System. "Data shown in this report for 2011 are based on 100% of live birth certificates filled in all states and the District of Columbia (DC). The data are provided to the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) through the Vital Statistics Cooperative Program (VSCP)."²⁹ Information on methodology and measurement is available.³⁰

REFERENCES

1. Brackfield D. OECD Quality Framework and Review, Organisation for Economic Cooperation and Development (OECD). Available from: <http://www.oecd.org/dataoecd/20/12/45122222.pdf>. (Accessed May 05, 2015).
2. McPherson K, Gon G, Scott M. International Variations in a Selected Number of Surgical Procedures. *OECD Health Working Papers*. 2013.
3. The DHS Program: Demographic and Health Surveys. DHS Overview. Available from: <http://dhsprogram.com/What-We-Do/Survey-Types/DHS.cfm>. (Accessed May, 15, 2015).
4. ORC Macro. Model "A" Questionnaire with Commentary for High Contraceptive Prevalence Countries. *ORC Macro*. 2001; MEASURE DHS+ Basic Documentation No. 1 (Calverton, MD, U.S.A.). Available from: <http://dhsprogram.com/pubs/pdf/DHSQ4/DHS-IV-Model-A.pdf.pdf> (Accessed May, 10, 2015)

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

5. The DHS Program. Press Release: Macro International awarded MEASURE DHS Phase III contract. Available from: <http://dhsprogram.com/Who-We-Are/News-Room/Macro-International-awarded-MEASURE-DHS-Phase-III-contract.cfm>. (Accessed May 21, 2015).
6. Murray CJ, Shengelia B, Gupta N, Moussavi S, Tandon A, Thieren M. Validity of reported vaccination coverage in 45 countries. *Lancet*. 2003;362(9389):1022-1027. doi: S0140-6736(03)14411-X [pii].
7. Norwegian Social Science Data Services (NSD). The Macro Data Guide. Available from: <http://www.nsd.uib.no/macrodataloguide/set.html?id=48&sub=2>. (Accessed May 10, 2015).
8. World Health Organization Regional Office for Europe. European Health for All Database. Available from: <http://www.euro.who.int/en/data-and-evidence/databases/european-health-for-all-database-hfa-db>. (Accessed May 21, 2015).
9. World Health Organization. Births by cesarean section (%), Indicator and Measurement Registry version 1.7.0. Available from: http://apps.who.int/gho/indicatorregistry/App_Main/view_indicator.aspx?iid=68. (Accessed May 10, 2015).
10. Multiple Indicator Cluster Surveys (MICS), The United Nations Children's Fund (UNICEF). Multiple Indicator Cluster Surveys (MICS). Available from: <http://mics.unicef.org/about>. (Accessed May 10, 2015).
11. Multiple Indicator Cluster Surveys (MICS), The United Nations Children's Fund (UNICEF). MICS Tools: Data Collection. <http://mics.unicef.org/tools#data-collection>. (Accessed May 21, 2015).
12. Multiple Indicator Cluster Surveys (MICS), The United Nations Children's Fund (UNICEF). MICS Tools: Data Processing. <http://mics.unicef.org/tools#data-processing>. (Accessed May 21, 2015).

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

13. World Health Organization, UNICEF, UNFPA, The World Bank, The United Nations. *Trends in Maternal Mortality: 1990 to 2013. Estimates by WHO, UNICEF, UNFPA, The World Bank and The United Nations Population Division*. Switzerland, Geneva: WHO Library Cataloguing-in-Publication Data; 2014.

http://apps.who.int/iris/bitstream/10665/112682/2/9789241507226_eng.pdf (Accessed May 10, 2015).

14. United Nations Children's Fund, World Health Organization, The World Bank, United Nations. *Levels & Trends in Child Mortality: Report 2014. Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation*. The United Nations Children's Fund; 2014.

http://www.childmortality.org/files_v19/download/unicef-2013-child-mortality-report-LR-10_31_14_195.pdf (Accessed May 10, 2015).

15. Wilmoth JR, Mizoguchi N, Oestergaard MZ, et al. A New Method for Deriving Global Estimates of Maternal Mortality. *Stat Politics Policy*. 2012;3(2):2151-7509.1038. doi: 2151-7509.1038 [pii].

16. World Bank. World Development Indicators. <http://data.worldbank.org/indicator>. (Accessed September 12, 2014).

17. Ministry of Health, Royal Government of Bhutan. Annual Health Bulletin 2013, Health Management System, Ministry of Health, Royal Government of Bhutan. p. 1-121. Available from: <http://www.health.gov.bt/wp-content/uploads/ppd-files/health-bulletins/bulletins/ahb2013/ahbContent2013.pdf> (Accessed April 12, 2014)

18. Ministério da Saúde, Brasil. SVS/DASIS - Sistema de Informações sobre Nascidos Vivos – SINASC e SIP/ANS. 2012 Available from:

<http://u.saude.gov.br/images/pdf/2014/outubro/14/ApresentaPARTO-NORMAL.10-10-14.pdf> (Accessed January 27, 2015)

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

19. Villar J, Valladares E, Wojdyla D, et al. Caesarean delivery rates and pregnancy outcomes: the 2005 WHO global survey on maternal and perinatal health in Latin America. *Lancet* 2006;367:1819-29

20. Ministerio de Salud Pública del Ecuador. Coordinación General de Desarrollo Estratégico en Salud 2012. Datos esenciales de salud: Una mirada a la década 2000-2010. Available from: <https://www.salud.gob.ec/wp-content/uploads/downloads/2013/05/Datos-esenciales-de-salud-2000-2010.pdf> (Accessed January 20, 2015)

21. Statistisches Bundesamt Deutschland. Available from : https://www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2013/10/PD13_357_231.html (Accessed January 20, 2015)

22. German Federal Health Monitoring System. The Information System of the Federal Health Monitoring System. Available from: https://www.gbe-bund.de/gbe10/pkg_isgbe5.prc_isgbe?p_uid=gastd. (Accessed May 20, 2015)

23. DeJong J, Akik C, El Kak F, Osman H, El-Jardali F. The safety and quality of childbirth in the context of health systems: mapping maternal health provision in Lebanon. *Midwifery* 2010;26(5-2):549-557. doi:10.1016/j.midw.2010.06.012.

24. Heredia-Pi I, Servan-Mori EE, Wirtz VJ, Avila-Burgos L, Lozano R. Obstetric care and method of delivery in Mexico: results from the 2012 National Health and Nutrition Survey. *PLoS One* 2014; **9**: e104166.

25. Ministry of Health, Department of Health Planning, Myanmar. Annual Hospital Statistics Report, 2010-2011. 2013 Jan; p236. Available from: <http://www.moh.gov.mm/file/Annual%20Hospital%20Statistics%20Report%202010-2011.pdf>. (Accessed September 22, 2014).

TITLE: The relationship between cesarean delivery rate and maternal and neonatal mortality

26. Ministry of Health, Sultanate of Oman. Utilization of Health Services, Chapter 7: 65.

Available from: <http://www.moh.gov.om/en/stat/2012/Chapters/CH07Y12.pdf>. (Accessed September 22, 2014).

27. Public Health Department, Supreme Health Council, Qatar. Annual Health Report 2009.

Available from: <http://ghdx.healthdata.org/record/qatar-annual-health-report-2009>. (Accessed May 12, 2014).

28. Chung SH, Seol HJ, Choi YS, Oh SY, Kim A, Bae CW. Changes in the cesarean section rate in Korea (1982-2012) and a review of the associated factors. *J Korean Med Sci*.

2014;29(10):1341-1352.

29. Martin JA, Hamilton BE, Ventura SJ, Osterman MJ, Mathews TJ. Births: final data for 2011.

Natl Vital Stat Rep 2013; 62: 1–69.

30. National Center For Health Statistics. 2011 addendum to the 2010 user guide for the natality public-use file. Hyattsville, MD. Available from:

http://www.cdc.gov/nchs/data_access/Vitalstatsonline.htm. (Accessed May 21, 2015)