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Correlation of Caesarean Section Rates to Maternal and Neonatal Mortality in the Eastern Mediterranean Region; A Population-Based Ecological Study

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Correlation of Caesarean Section Rates to Maternal and Neonatal Mortality in the Eastern Mediterranean Region; A Population-Based Ecological Study

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Abstract

Objective: To assess the relationship of CSR with MMR and NMR of the Eastern Mediterranean Region, (EMR) with the adjustment of health and socioeconomic variables.

Study design: An ecological study

Patients and methods: It was conducted using data obtained from the World Health Organization, Global Health Observatory database, 2015, United Nations Inter-Agency Group for Child Mortality Estimation (UN-IGME), and the United Nations Maternal Mortality Estimation Inter-Agency Group (UN-MMEIG) 2015). Mean ± standard deviation, range, median, and interquartile range were used for quantitative data. We used a multivariate logistic regression model to explore the effect of (a) antenatal clinic visits (ANC %), (b) skilled birth attendance (SBA) rate (% of deliveries attended by SBA), (c) total health expenditure (THE) per capita, and (d) female literacy rate (FLR%) on the studied relationship. Spline linear regression was used to find the most predictive variables for MMR and NMR. Statistical significance was set at $p < 0.05$.

Results: The mean CSR was 21.20±13.38, (1.8-52). A CSR of <10% was linked with the highest NMR and MMR, 33.0 (24.0-39.0) and 390.5(329.5-648.0), respectively. The most predictable variables for NMR and MMR were SBA % (B=-0.875; p< .001; R2=0.766 and adjusted R2=0.754) and FLR (F=15-24) [B=0.877; P<0.001; R2=0.77, adjusted R2=0.758], respectively.

Conclusions: There was a statistically significant inverse relationship between CSRs and maternal and neonatal mortality in MSs with <10% CSR. The improved mortality rates with higher CSR were linked with better socioeconomic and healthcare variables as compared to the prevailing rate of CS.

Keywords: Caesarean section, Eastern Mediterranean Region, Maternal and neonatal mortality

Abbreviations:

CSR: Caesarean Section Rate, NMR: Neonatal Mortality Rate

MMR: Maternal Mortality Rate, EMR: Eastern Mediterranean Region,

MS: Member State, ANC: Antenatal Clinic, SBA: Skilled Birth Attendant

THE: Total Health Expenditure, FLR: Female Literacy rate

Introduction

Caesarean section (CS) was introduced as a life-saving procedure for managing obstetric emergencies involving both the mother and child. Evidence suggests that a caesarean section rate of up to 10 %–15% at the population level is associated with reduced maternal and neonatal mortality.[1] Despite the current evidence, extreme CS trends have been observed around the world, with 29·7 million births occurring through CS in 2015.[2,3] Studies have reported CS as an independent risk factor for postpartum maternal death after controlling for indication bias and confounders.[4] The risk of stillbirth has been quoted as 23 times higher in women with previous CS than in other women. [5]

The Eastern Mediterranean Region (EMR), one of the six regions defined by the World Health Organization (WHO), shows extreme trends of CS among its twenty-two member states (MSs). Regional CSR ranges from the lowest level of 2% in Somalia to as high as 54% in Egypt. The MMR ranges from 4/100,000 (Kuwait) to 396/100,000 (Afghanistan) live births and from 1/1000 (Bahrain) to 46/1000(Pakistan) live births (Table 1). To date, approximately 26,000 mothers and 845,000 children under five years of age still die every year in the region.[6] There is a need to explore the effect

of CS trends on mortality outcomes in the region. Evidence from other regions yielded inconsistent results because the factors related to socioeconomic and healthcare sectors were not considered in the analysis of the studied relationship.[3,7] The latest evidence revealed that a substantial part of the crude association between CSR and mortality outcomes is highly dependent on these factors.[8] For that purpose, we conducted a study to explore the relationship between country levels of CSRs of EMR MSs with their corresponding MMR and NMR by adjusting their socioeconomic and healthcare indicators.

Methods

Design

A population-based ecological study was conducted to explore the relationship between CSRs and maternal and neonatal outcomes among twenty-two MSs of the EMR. The year of the analysis was 2016.

Definition of variables: The independent variable was CSR and is defined as the percentage of caesarean deliveries among all live births, irrespective of cause or indication. The dependent variables were MMR and NMR. The MMR is defined as the annual number of female deaths per 100,000 live births from any cause related to or aggravated by the pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy. NMR is defined as the number of deaths during the first 28 days of life per 1000 live births in a given year or in other periods. We selected four indicators related to socioeconomic and healthcare systems as potential confounders for this study. They were antenatal care coverage (ANC, 4+ visits), female literacy rate (FLR) % (15-24

years), total health expenditure (THE) per capita in U.S. dollars, and skilled birth attendance rate (SBA, % of deliveries attended by skilled health personnel).

Data sources: CS data was obtained from the World Health Statistics report, Global Health Observatory database, 2015 (Table 1). Most MSs have their CS data available from 2005 to 2013, apart from Egypt and the United Arab Emirates, for which the data were from 2014. Maternal and neonatal mortality rates were obtained from the United Nations Inter-agency Group for Child Mortality Estimation (UN-IGME) and the United Nations Maternal Mortality Estimation Inter-Agency Group (2015 estimates). The selected four indicators were obtained from various databases, as shown in the supplementary data file.

Statistical analysis: For convenience purposes, we divided twenty-two MSs into three groups based on the optimal CSR of 10 %–15% (Table 2). We examined the unadjusted relationship between country-level CSRs and maternal and neonatal mortality in each group. Mean ± standard deviation (SD), range, median, and interquartile range (IQR) were used to describe quantitative data, and frequency and percentage were used to describe qualitative data. We used the Kruskal-Wallis test to compare the CSR% groups (non-parametric data). Multivariate logistic regression analysis was conducted by adjusting for the four study indicators. Spline linear regression analysis was performed to identify the most predictive indicators for NMR and MMR. A two-way ANOVA was conducted to examine the interaction effect of the independent variables (CS-ANC, CS-THE, CS-SBA, CS-FLR) on dependent variables (NMR, MMR). Statistical significance was set at $p < 0.05$. All statistical analyses were performed using SPSS version 20 (IBM Corporation, Armonk, NY, USA) and STATA program version 11.No ethical approval was needed, as the data are openly available for official and public review.

Results: The mean CSR was 21.20 % (mean ±SD, range ± 13.38, 1.8-52), with a median of 20.3%. The NMR ranges from 1.0 to 46.0 (mean = 15.5 and median =10.5) while the MMR ranges from 4.0 to732.0 (mean =126.55 and median =47.5) [Table 3]. A CSR of <10% was linked with the highest

rate of neonatal and maternal mortality in the region [(33.0 (24.0-39.0) and 390.5(329.5-648.0)], respectively. MSs with CSR of >15% showed the highest values for all four indicators, that is, SBA%, ANC coverage (4 visits at least four visits), female literacy rate, and total expenditure on health per capita in US dollars [Median (IQR) = 99.0 (91.0-99.0), 85.0(71.0-96.0), 96.0 (91.0-99.0), and 366.0 (160.0-1190.0), respectively] (Table 4). The most predictable indicator for NMR was SBA (B=-.875; p< .001; R2=0.766 and adjusted R2=0.754). For the MMR, FLR was the most predictable indicator (F=15-24) [B=0.877; P< .001; R2=0.77, adjusted R2=0.758].

We tested both the NMR and MMR of subjects against combined independent variables in different CSR groups using a two-way analysis of variance (ANOVA) test. There was a significant interaction effect between CSR-SBA, CSR-FLR, and CSR-THE for NMR (Table 5). For the MMR, the interaction effect of CSR was non-significant [F (2.15) =1.38, P= 0.281, partial η squared=0.156, observed power= 0.251], [F (2.15) =918, P=0.421, partial η squared=0.109 and observed power=0.179], [F (1.16) =3.2, P=0.093, partial η squared=0.166 and observed power= 0.390], and [F (2.15) =1.29, P=0.305, partial η squared=0.146 power=0.236], showing insufficient evidence to reject the null hypothesis.

Discussion

Our study revealed that MSs with a CSR of less than 10 % have the highest maternal and neonatal mortality rates in the region. Those MSs belong to Group 1 and have an average CSR of 4.45%.[9] They are predominantly African countries and suffer from poor socioeconomic conditions, lack of health care infrastructure, and insufficient access to healthcare services. These factors account for more than 60% of the regional healthcare inequities.[10] Among those factors, insufficient access to facility-based delivery is identified as the main underlying factor for the low CSR in those MSs. For example, 48% of direct maternal deaths in Northern Somalia occur at home, as women cannot reach the hospital in an emergency.[11]

According to our study, the two main predictors for NMR and MMR were the low SBA rate and FLR. The role of these indicators in improving access to health care services has been well established in the literature; however, their application at the country level is facing contextual challenges, including a lack of finances, essential equipment, medications, and poor quality of training in the region. The WHO has adopted the SBA rate as a key coverage-monitoring indicator for the Sustainable Development Goal 3.1; however, achieving its standard level in MSs with limited resources and highest mortality figures is challenging. [12] For example, only 20% of births in Sudan, 45% in Yemen, 46% in Afghanistan, and 9.4% in Somalia are attended by SBAs.[13] Similarly, in Afghanistan, a low FLR of only 17% undermines the increased SBA coverage, as women with a poor understanding of good maternal health during childbirth do not know when to seek help. [14] Evidence suggests that substandard care during and after the procedure in low- and middle-income countries is associated with 100 times higher maternal death than in high-income countries.[10] That is in contrast to MSs such as Saudi Arabia and Qatar (Group 3) with 99% and 96% female literacy rates, respectively, showing much better maternal and child health outcomes.[9]

We observed the lowest MMR and NMR in Group 3(middle-and high-income MSs) with a CSR of more than 15%, much above the WHO cut-off. We also found the highest values for all four indicators in that group, highlighting better socioeconomic conditions and healthcare facilities among the MSs. Further analysis revealed a significant interaction effect of SBA, FLR, and per capita with CSR on NMR. This may explain why the crude association between reduced mortality outcomes with high CSR in that particular group is mainly due to better socioeconomic and healthcare indicators due to the high rate of facility-based deliveries. This is in line with the available evidence that increasing the caesarean section rate above a certain threshold is no longer associated with reduced mortality; instead, socioeconomic factors play a significant role in improving maternal and neonatal outcomes after.[3] However, our data was insufficient to show any significant interaction effect on MMR. The same phenomenon was observed in group 2. Pakistan and Djibouti from this group have the optimal CSRs.

However, they show much higher mortality ratios than Kuwait in the same group, which exhibit better socioeconomic and health care infrastructure indicators.

Egypt, Iran, and Lebanon showed the highest increase in their CSR (>40%). The high trend of CS could be an indication of easy access to facility-based delivery, but such an exponential rise does indicate overuse of this procedure without any medical indications.[15] The subsequent repeat CSs have resulted in an increasing number of severe but uncommon and potentially fatal maternal complications such as abnormal placenta (AbP, i.e. placenta acreeta/increta and percreta), postpartum haemorrhage (PPH), emergency hysterectomy (removal of the uterus), and maternal death. PPH is the leading cause of maternal death in the developing world and accounts for 28% of global maternal deaths, whereas emergency hysterectomy with reported maternal morbidity of 60 % and mortality of 7%. [16,17] Previous studies in those MSs have shown various underlying determinants for high CSR, including high women's wealth quintile, lack of evidence-based practice for the management of labour, lack of instrumental deliveries, women's preferences, financial incentives associated with CS, and clinicians' fear of litigation.[18,19,20] MSs with extreme CS trends have reasonable healthcare infrastructure but cannot deal with a high number of complications associated with CSs. Therefore, their maternal and child health indexes did not show the same improvement rate as high-income MSs in the region with lower CSRs. For example, Saudi Arabia, Qatar, UAE, Bahrain, Abu Dhabi, and Oman have shown a moderate increase in CSR of up to 25%, but achieved a reduction in MMR between 25 and 50% compared to levels in 1990.[21] Policymakers, healthcare providers, and government officials expressed their concern about the financial impact of medically unnecessary CSs on the healthcare system. For example, the average cost of CS in Egypt is 1,076 L.E., while vaginal delivery costs 664 L.E (1US $=8.8EGP). In 2014, overuse of CS deliveries cost the Egyptian health care system L.E. 929,664,000 (calculated based on the number of deliveries of 2.7 million, a current CSR of 52% using 20% as the threshold rate to define the overuse of CS.[22] According to the study conducted among refugee women in Lebanon, $1.4 million were spent by UNHCR (United Nation High Commission for Refugees) on

2,244 CSs, in comparison to the same amount of money spent on 4,131 natural vaginal deliveries, extracting financial portions from other essential medical procedures.[23] Evidence suggests that the cost of the global saving of reducing the CS rates to 15% is about $2.32 billion (U.S. dollars); the cost to attain a 10% CSR is $432 million (U.S. dollars). If all the resources currently devoted to 'excess' CS be directed towards countries where additional procedures are 'needed', the 'needed' procedures could be fully financed.[24]

To our knowledge, this is the first study to explore the relationship between CSR and MMR and NMR in the EMR. We used the most updated data from sources that used rigorous methods and quality assurance practices. However, this was population-based data and could mask substantial CSR variations within healthcare facilities in each MS. The results are, therefore, open to bias and may not be applicable at the facility level. We could not use a single data point for some MSs, and the most recent data were not available. We have mainly focused on mortality as a primary outcome in our study; however, the morbidity associated with CS is highly accountable for a better quality of women's lives and should be explored in future research.

Although progress in reducing maternal and child mortality has accelerated in the past 15 years in the EMR, there is still much to do to reduce preventable deaths. MSs who underuse CS with high maternal and neonatal mortality should promote increased access to emergency and urgent CS. The evidence suggests that maternal mortality may decrease by as much as 92% with increased access.[25] The task-shifting strategy, skill upgrade training, and capacity building (one institution is able to provide comprehensive Emergency Obstetric Care, requires the ability to perform a safe CS and blood transfusion with availability to per 500,000 people), with a focus on the safety and quality of the procedure of the health care system can result in better overall maternal and child health outcomes.[26,27] MSs with high caesarean section rates need training and education for standard intrapartum care and instrumental deliveries to reduce unnecessary CSs. Other non-clinical factors, such as a change in health-seeking behaviours through community education and legislative changes

with political commitment, should also be addressed to improve maternal and child health care quality. Many authors have identified them as significant drivers to improve their uptake or reduce unnecessary CS. This is in line with the WHO recommendation that reducing mortality outcomes requires improvements in overall maternal health care quality rather than striving to achieve a particular CSR.[28]

In conclusion, regional CSR and mortality outcomes follow socioeconomic inequities in maternal and child health services. We found a statistically significant inverse relationship between CSR and maternal and neonatal mortality in MSs with a CSR of <10%. The improved mortality rates in MSs with >15% of CSR were strongly linked with better socioeconomic conditions and healthcare facilities. The SBA, FLR, and THE per capita have a significant interaction effect with CSR for NMR in all three groups of the study; however, there was insufficient evidence to prove such an effect for MMR.

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Table 1: The Caesarean Section Rates (CSR) (%), Maternal Mortality Rates (MMR) (/100,000 live birth rate) and Neonatal Mortality Rates (NMR) in 22 MSs of the Eastern Mediterranean Region (EMR)

	Member States	**MMR (2015)/100,000**	**NMR (2015)/1000**	**CSR %**
1	AFGHANISTAN	396	36	4
2	BAHRAIN	15	1	26
3	DJIBOUTI	229	33	15
4	EGYPT	33	13	52
5	IRAN	25	10	48
6	IRAQ	50	18	22
7	JORDON	58	11	28
8	KUWAIT	4	3	12
9	LEBANON	15	5	46
10	LIYBIA	9	7	21
11	MOROCCO	121	18	16
12	OMAN	17	5	17
13	PAKISTAN	178	46	14
14	PALESTINE	45	12	19.1
15	QATAR	13	4	20
16	SAUDI ARABIA	12	8	21
17	SOMALIA	732	40	2
18	SUDAN	311	30	7
19	SYRIA	68	7	21
20	TUNISIA	62	8	27
21	UNITED ARAB EMIRATES	6	4	24
22	YEMEN	385	22	5

Source for CS rate: World Health Organization (WHO) 2015, World Health Statistics 2015, Source for MMR: Trends in Maternal Mortality: 1990 to 2015: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nation Population. Source of NMR: Levels & Trends in Child Mortality Reports 2015, Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation

Table 2: Member States (MSs) are classified in to three groups according to the recommended optimal CSR* of (10-15%) by the World Health Organization.

CSR	Member States in Eastern Mediterranean Region
CSR <10%	Afghanistan[LI*], Somalia[LI], Sudan[LI], Yemen[LI] **(18% MS)**
CSR 10-15%	Djibouti[LI], Kuwait[HI*], Pakistan[LI] **(14% MS)**
CSR >15%	Jordan[MI*], Lebanon[MI], Egypt[MI], Syria[MI], Tunisia[MI], Libya[MI], Iraq[MI] Iran[MI], Palestine[MI], Saudi-Arabia[HI], Bahrain[HI], Morocco[MI],Oman[HI], United Arab Emirates[HI] **(68%MS)**

Table 3: Prevalence of the studied variables and indicators among three groups of *MSs

Studied Variables and indicators	N	The studied group (22)	
		Mean ±SD (range)	Median (IQR)
***CSR% 2015 (WHO)**	22	21.20±13.38 (1.8-52)	20.3 (13.48-26.25)
<10%	4	4.45±2.16	
10-15%	3	13.63±1.58	
>15%	15	27.17±11.68	
***SBA %**	22	83.14±22.39 (40-100)	96.0 (69.25-99.0)
***ANC coverage 4 visits**	22	70.05±26.59 (23-100)	80.5 (40.75-90.25)
Female Literacy rate	22	84.04±20.89 (26.0-99.0)	93.5 (76.85-98.0)
Total expenditure on health per capita in US dollars	22	489.95±554.24 (13.0-2030)	257.5 (79.5-776.0)
***NMR**	22	15.5±13.27 (1.0-46.0)	10.5 (5.0-24.0)
***MMR**	22	126.55±183.01 (4.0-732.0)	47.5 (14.5-190.75)

SD: Standard deviation IQR: interquartile range
CSR: caesarean section rate *SBA: Skilled birth attendance
*ANC: Antenatal clinic *NMR: neonatal mortality rate.
*MMR: Maternal mortality rate. *MSs: Member States

Table 4: Mean National Estimates of NMR*, MMR*, SBA*, ANC*, LR* and THE* per Capita in US dollars for three groups according to their CSR*

	*CSR% 2015				
	<10% Median (IQR)	**10-15% Median (IQR)**	**>15% Median (IQR)**	**Kruskal-wallis test**	**P value**
NMR	33.0 (24.0-39.0)	33.0 (3.0-46.0)	8.0 (5.0-12.0)	8.27	0.016*
MMR	390.5 (329.5-648.0)	178.0 (4.0-229.0)	25.0 (13.0-58.0)	9.93	0.007*
SBA %	44.5 (41.0-69.75)	58.0 (40.0-100.0)	99.0 (91.0-99.0)	8.40	0.015*
ANC (4 visits at at least)	25.5 (23.5-65.75)	60.0 (37.0-88.0)	85.0 (71.0-96.0)	7.32	0.026*
FLR (F=15-24)	54.9 (27.5-83.2)	64.0 (63.0-94.0)	96.0 (91.0-99.0)	10.41	0.005*
THE per capita in US dollars	66.0 (24.75-132.0)	82.0 (38.0-1169.0)	366.0 (160.0-1190.0)	8.25	0.016*

*Significant at p<0.05 *CSR: caesarean Section Rate *SBA: Skilled birth attendance.
*ANC: Antenatal Clinic FLR: Female literacy rate * Total health expenditure
*NMR: Neonatal Mortality Rate *MMR: Maternal mortality rate.

Table 5: A two-way analysis of variance between *NMR, *CSR% and selected variables

NMR	F	P value	Partial η squared	Observed power
CSR-*SBA	(2.15)=11.43	**.001**	.604	.978
CSR-*ANC coverage	(2.15)=2.08	.16	. 217	.359
CSR-*LR	(1.16)=26.4	**.000**	.623	.998
CSR-*THE	(3.13)=7.35	.004	.629	.936

Significance: P value of <0.05 CSR: caesarean section rate *SBA: Skilled birth attendance *ANC: Antenatal clinic FLR: female literacy rate * Total health expenditure *NMR: neonatal mortality rate. *MMR: Maternal mortality rate

Supplementary file
Data sources

Country name	ANC coverage atleast 4 visits	Total health expenditure per capita in US dollars	Skilled Birth Attendance%	Female literacy rate (15-29) years
Afghanistan	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Bahrain	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Djibouti	EDSF-PAPFAM 2002-Djibouti,Profile) 2012	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Egypt	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Iran	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Iraq	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Jordan	International D.Inf. Jordan Population and Family health Survey 2012. Calverton, Maryland, USA: Department of Statistics and ICF International; 2012.	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Kuwait	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Lebanon	DHS, Multiple MICS, World Health Organization (WHO), UNICEF.	DHS, MICS, WHO and UNICEF.	DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012
Libya	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012
Morocco	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Oman	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Pakistan	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Palestinian	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Qatar	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Saudi Arabia	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Somalia	MELINEUM GOAL DEVELOPMENT DATABASE,2014	WHO estimates 2005 http://www.who.int/nha/country/SOM.xls	DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	CENTERAL INTELLIGENC AGENCY ESTIMATES (CIA World Factbook),2001
Sudan	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
Syria	SYRIAN FAMILY HEALTH SURVEY,2011	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	SYRIAN FAMILY HEALTH SURVEY 2011	DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012
Tunisia	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	
United Arab Emirates	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014		DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012
Yemen	MELINEUM GOAL DEVELOPMENT DATABASE,2014	Global Health Expenditure Database. Data Explorer. World Health Organization. (http://apps.who.int/nha/database) 2014	Eastern Mediterranean Region. Framework for health information systems and core indicators for monitoring health situation and he DHS, Multiple MICS, World Health Organization (WHO), UNICEF.2012	

Supplementry appendix 1: Data sources for the selected study indicators