Table 1 Description of the included studies

Author	Publication year	Objectives of the study	Country[a]	Data sources
Ansariade and Manderson, (19)	2015	Determine the influence of urban and rural settings on antenatal care and birthing decisions and investigate if women's decision on antenatal care and birth assistance are geographically clustered	Indonesia, Sulawesi	Structured interview with women who delivered
Jain, et al. (20)	2015	Assess the influence of economic and geo- graphic access to health facilities on institutional deliveries	Pakistan	Health facilities; and household surveys
Tabatabai, et al. (21)	2014	Map and analyse the capacities of public and private hospitals to provide maternal health care	United Republic of Tanzania, Ruvuma	Hospital questionnaire; population census dataset
Sabde, et al. (22)	2014	Identify potential areas for further interventions to increase the effectiveness of the emergency obstetric transport system	India, Madhya Pradesh	Interviews with parturient women
Mwaliko, et al. (23)	2014	Determine the association between the place of delivery and the distance of a household from the nearest health facility, and assess the demographic characteristics of households with a delivery within a demographic surveillance system	Kenya, western	Database of Webuye health and demographic surveillance system; structured interviews with trained field assistants
Detres, et al. (24)	2014	Examine how GIS maps can be used by local organizations to engage the community in the discussion of maternal and child health data to modify service delivery	USA, Florida	Florida vital statistics birth and infant death records
Brown, et al. (25)	2014	Determine maternal ground transport times from community hospitals to the nearest hospital offering comprehensive (level III) neonatal care	USA	US census tract data; American hospital association annual survey
Nesbitt, et al. (26)	2014	Compare methods to measure potential spatial access to delivery care in low- and middle-income countries	Ghana	Kintampo Health Research Centre surveillance data; health facility assessment; Ghana registered midwives association
Tatem, et al. (27)	2014	Present methods to estimate women of childbearing age, and pregnancies and live births in relation to current health infrastructure	Afghanistan Bangladesh, Ethiopia, United Republic of Tanzania	Household survey data; United Nations statistics; new estimates of stillbirths, miscarriages and abortions from the Guttmacher Institute
McKinnon, et al. (28)	2014	Assess the effect of distance to emergency obstetric and newborn care services on early neonatal mortality and examine whether proximity to services contributes to socioeconomic inequalities in early neonatal mortality	Ethiopia	Ethiopian Demographic and Health Survey; Ethiopian national emergency obstetric and newborn care needs assessment (Ethiopian Ministry of Health); questionnaire filled by women
Wang, et al. (29)	2014	Estimate the influence of service readiness at health facilities on women's use of facility delivery care for delivery	Haiti	Haiti Demographic and Health Survey; Haiti service provision assessment survey
Gaspar, et al. (30)	2014	Evaluate the spatial distribution of public sector obstetric care	Brazil, Belo Horizonte	A system of obstetric information Municipal (SISMater®), Department of Health of Belo Horizonte (SMSA-BH);, cohort of 2956 newborns
Benedict, et al. (31)	2014	Explore geographical patterns in the risk of not utilizing using a skilled birth attendant during childbirth in women of different socioeconomic backgrounds	Ghana	Ghana Demographic and Health Survey; interviews with women
Blake, et al. (32)	2014	Explore the geographic relationships among between dairy farms, nitrate levels in drinking water, low birth weight and socioeconomic data at the Zip code level	USA, California	Zip codes, US census

Table 1 Description of the included studies *(Continued)*

Author	Publication year	Objectives of the study	Country[a]	Data sources
Almeida, et al. (33)	2014	Identify spatial patterns of in distribution of overall, early, and late neonatal mortality rates	Brazil, São Paulo	Department of information systems and information technology of the Brazilian national healthcare system
Arslan, et al. (34)	2013	Determine the spatial patterns of perinatal mortality, examine whether regional differences exist and whether these differences are linked to regional risk factors	Turkey, Kocaeli	Registry of births and deaths
Engjom, et al. (35)	2013	Assess the availability of obstetric institutions, the risk of unplanned delivery outside an institution and maternal morbidity in a national setting in which the number of institutions declined from 95 to 51 during over 30 years	Norway	Census data; Statistics Norway; medical birth registry
Sudhof, et al. (36)	2013	Identify potential gaps in access to emergency obstetric care	Rwanda, Kayonza	Birth registries at in eight health centres and the district hospital
Song, et al. (37)	2013	Assess spatial accessibility to maternity units	China, Shenzhen	Website of Shenzhen Health and Population and Family Planning Commission
Chong, et al. (38)	2013	Assess the usefulness of geospatial methods in identifying communities at high risk of smoking during pregnancy and timing of the first antenatal visit	Australia, New South Wales	New South Wales health ministry
Bowie C, et al. (39)	2013	Evaluate geographical access to health care facilities	Malawi	Malawi census; Ministry of Health facility surveys
Masters, et al. (40)	2013	Estimate travel times between populations and health facilities using geospatial techniques	Ghana	Ghanaian Ministry of Health
Yao, et al. (41)	2013	Present a geographical perspective on access to sexual and reproductive health care for rural women	Mozambique, Gaza province	Population survey data
O'Meara, et al. (42)	2013	Assess spatial autocorrelation in uptake of antenatal care and relationship to individual, household and village-level factors	Kenya, western	Survey data
Monyet al. (43)	2013	Investigate the availability and distribution of emergency obstetric care services in eight northern districts of Karnataka State in south India	India, Karnataka	Combination of self-reporting, record review and direct observation
Brown, et al.(44)	2012	Determine the percentage of women of reproductive age living within a 30- and 60- minute drive time of the nearest tertiary care perinatal centre	USA	US census tract data
Friedman, et al. (45)	2012	Evaluate the effect of an inverse relationship between health care use and distance to care related to emergency and essential surgical care	Haiti, central district	Retrospective review of operative logbooks; Haiti earthquake data portal
Gething, et al. (46)	2012	Develop a uniquely detailed set of spatially-linked data and a calibrated geospatial model to undertake a national audit of geographical access to maternity care at birth	Ghana	Ghana Ministry of Health; University of Ghana; project by the Ghana Ministry of Health and Ghana Health Service Core; Welfare Indicator Questionnaire survey
Blanford, et al. (47)	2012	Analyse the physical access of populations to health facilities with an emphasis on the effect of seasonal conditions and the implications of these conditions for availability of adequate health services, and provision of drugs and vaccinations	Niger	FAO Geo Network Portal; Niger Ministry of Health

Table 1 Description of the included studies *(Concluded)*

Author	Publication year	Objectives of the study	Country[a]	Data sources
Massey, et al. (48)	2011	Identify priority regions for the expansion of human resources for health	Senegal	National agency for demography and statistics; WHO
Gabrysch, et al. (49)	2011	Quantify the effects of distance to care and level of care on women's use of health facilities for delivery	Zambia	National household data from the Zambian Demographic and Health Survey; national facility data from the Zambian health facility census
Bailey, et al. (50)	2011	Provide a set of multicriteria decision analyses to help health planners make informed decisions about interventions to increase access to emergency services	Ethiopia	Ethiopian national survey on baseline assessment of emergency obstetric and newborn care; spatial population data from Land Scan™ population data
Gjesfjeld & Jung. (51)	2011	Examine maternity care access for expectant mothers	USA, Dakota	North Dakota department of vital records
Grzybowski, et al. (52)	2011	Systematically document newborn and maternal outcomes in terms of travel distance to access the nearest maternity services with caesarean section capability	Canada, British Columbia	British Columbia Perinatal Health Program
Fisher and Myers (53)	2011	Test the appropriateness of new, inexpensive and simple GIS tools in poorly resourced areas of a developing country	Indonesia, Nusa Tenggara Timur	Cybertracker; health data collected by district and subdistrict health officer departments and clinics
Bloch, et al. (54)	2011	Examine spatial patterns of neighbourhood contextual factors of stress with preterm birth and country of birth (USA or elsewhere)	USA, Philadelphia	Census data; de-identified geocoded Philadelphia birth records; publicly available Philadelphia police department crime statistics.
Målqvist, et al. (55)	2010	Examine the association between distance from the mother's home to the closest health facility and neonatal mortality, and investigating investigate the influence of distance on patterns of perinatal health care use	Viet Nam, Quang Ninh	Interviews with mothers and staff; medical records; VidaGIS database
Pilkington, et al. (56)	2008	Describe the effect of maternity unit closures on distance and mean travel time between pregnant women's homes and maternity units	France	French national perinatal surveys; vital statistics registries
Dummer, et al. (57)	2004	Investigate whether geographical accessibility to hospitals affected the risk of infant mortality	England, Cumbria	Cumbrian births database
Heard, et al. (58)	2004	Identify whether access to reproductive health services partly explains the use of modern contraception	Malawi	Malawi health facilities inventory; Malawi demographic and health survey

WHO=World Health Organization; GIS=geographical information system; USA=United States of America; FAO=Food and Agriculture Organization.
[a]Where the region is not specified, the study done at the national level.

the leading causes of maternal deaths *(73)*. Little attention was paid to these health factors in the studies in our review, which may be because the data sources used in these studies did not include these kind of health-related factors.

The articles included in our study used and combined various data sources, which provides better results and allows greater understanding. Our review showed that the effects variables such as environmental factors, political policies, exposure to infectious diseases during pregnancy and nutritional status on maternal mortality are largely ignored. Evidence indicates important linkages between the water and sanitation environment

and maternal and perinatal mortality *(34,74)*. Although we believe there is a relation between the above-mentioned groups of variables and maternal mortality, it is difficult to know which variable is the strongest determinant. In addition, the strength of the association of these variables with maternal mortality may differ by region. However, proposing a dataset for research in this field would direct researchers to a unique guideline and standard data set *(75)*. Despite the rapid growth of technologies and health information systems, most of health information systems do not merge patients' records with external datasets. This fact can explain why isolated data systems cannot be used to recognize how the physical and environmental context of each patient influences his/her health choices