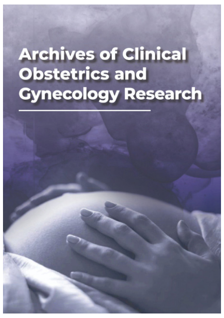
Archives of Clinical Obstetrics and Gynecology Research



Maternal mortality and its risk factors in Africa: A systematic review and meta-analysis

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- Received Date: 29 Oct 2021
- Accepted Date: 02 Nov 2021
- Publication Date: 17 Nov 2021

Keywords

Africa; Maternal mortality, Reproductive age women, Risk factors

Abbreviations

ANC: Antenatal care; CI: Confidence Interval; OR: Odd Ratio; EMOC: Emergency Obstetric Care; SPSS: Statistical Package for the Social Sciences; MMR: Maternal Mortality Ratio; WHO: World Health Organization

Abstract

Background: Maternal mortality is a significant global health problem, which affects women of reproductive age. Maternal mortality is especially high in Africa, where more women die during pregnancy and childbirths from preventable causes. This review therefore aim to assess maternal mortality ratio and identify its risk factors.

Methods: PubMed, Web of science, Embase, and Medline were searched for cohort, case-cotrol and cross-sectonal studies published between 2008 and 2021that assessed maternal mortality or its risk risk in Africa, or among African women. The preferred reporting items for a systematic review and meta-analysis was carefully considered while conducting this review. Random effect model was used to generate pooled estimates. Data were analyzed using StataCorp version 16.0 statistical software.

Results: A total of 1,657 articles were retrieved from searching four electronic databases. The sum of 1,639 records were excluded and a total of 18 studies were included into the the systematic review and meta-analysis. Using a random effect approach, this systematic review and meta-analysis estimated the MMR of 496/100,000 for Africa. Further, maternal age ≥ 35 years [OR = 2.50; 95% CI: (1.50, 4.15)], no formal education/illiterate mother [OR = 2.30; 95% CI: (1.50, 3.52)], no history of ANC attendance [OR = 2.42; 95% CI: (0.43, 13.50)], pregnancy complication/previous pregnancy-related illness [OR = 4.47; 95% CI: (3.03, 6.60)], delayed in seeking health care [OR = 5.12; 95% CI: (3.14, 8.34)], mother being referred [OR= 5.60; 95% CI: (4.16, 7.54)], and husband's education (illiterate/primary) [OR = 1.32; 95% CI: (0.69, 2.53)] were identified as risk factors of maternal mortality.

Conclusion: A high MMR of 496/100,000 live birth for Africa was estimate in this review. Also, several risk factors of maternal mortality were identified. Healthcare professionals are therefore reminded to regularly educate mothers about the risk and benefits of seeking early prenatal healthcare.

Introduction

Maternal mortality is described as the death of a pregnant woman or a woman within 42 days of the pregnancy's termination, regardless of the pregnancy's period or place, from any cause related to or induced by the pregnancy or its management, but not accidental or incidental causes [1]. In most developed countries, maternal mortality is estimated at per 100,000 live births and is the leading cause of death for women of reproductive age (15–49 years) [2]. Each years, Over 500,000 maternal deaths are estimated to occur globally, and 99% occur in developing countries, especially Sub-Saharan Africa [1,2]. Women of childbearing age have died from preventable causes related to pregnancy and childbirth for over two decades [3]. Globally, the Maternal Mortality Ratio (MMR) is estimated as 210 maternal deaths per 100,000 live births [4]. Sub-Saharan Africa has the highest MMR, with approximately 500 per 100,000 live births [4]. The MMR is described as "the number of maternal deaths per 100,000 live births over a specified time" [5]. Despite global attempts to minimize maternal mortality, the MMR remains high, roughly 15 times higher than developing countries [5]. According to WHO 2017 estimates, approximately 1500 women die per day due to pregnancy-related complications [3].

The factors that determine maternal mortality include the occurrence and resolution of an obstetric complication. Treatment delays are often associated with poor obstetric outcomes. Access to healthcare is one of three

Citation: Kolleh EM, Bestman PL, Bajinka O, Weamie SJTY, Luo J. Maternal Mortality and its Risk Factors in Africa: A Systematic Review and Meta-Analysis. 2022;2(1):1-12.

delays related to maternal mortality. In countries that are still seeking to avoid maternal death, this remains a significant concern. The reasons for these delays vary by region in most African countries. Additional risk factors include maternal age, parity, education, obstetric characteristics, lack of health facilities, qualified health personnel, socio-economic factors, and ethnic and religious affiliations [6]. The leading direct causes of maternal mortality in developing countries are hemorrhage, sepsis, obstructed labor, and hypertensive disorders [7]. In developing countries, maternal death due to bleeding occurs once every 1,000 deliveries, compared to 100,000 deliveries in developed countries [8]. According to a retrospective study conducted at a tertiary hospital in Nigeria in 2007, the most critical risk factors for maternal mortality were primiparity, hemorrhage, anemia, preeclampsia, and malaria [9].

Numerous socio-economic characteristics have been linked to an increased risk of maternal mortality. Some of these factors include inadequate health education, parity, prior obstetric experience, work history, social standing, and forms of care-seeking during pregnancy. Furthermore, there is evidence that women under the age of 24 and women age ≥ 35 years face an increased risk of maternal mortality [10]. Low spouse education was identified as a risk factor for maternal mortality in a study conducted in Tanzanian [11]. Women are seeking treatment face challenges since they are unaware of the benefits attached to skilled attendants, especially during labor and delivery emergencies. An overwhelming 15% of pregnant women in Kenya are unaware of the vital importance of hospital deliveries, according to a 2006 report [12]. The most significant risk factors for maternal death in Nigeria are primigravida and unbooked status [13].

Contraception is generally adequate for checking the increasing rate of maternal mortality by approximately 44% in developed countries [14]. Antenatal care (A.N.C.) is critical during pregnancy and cannot be overstated. International organizations recommend a minimum of four visits during A.N.C. participation, which includes two tetanus toxoid doses and folic acid supplementation. These interventions showed a lower risk of maternal morbidity and mortality. Moreover, women were more likely to deliver their babies in a specialist health facility when offered adequate prepartum treatment [11,16]. Despite the decreasing maternal mortality in some parts of the world, Sub-Saharan Africa still battles against this menace [17]. To our knowledge, there has been no systematic study or meta-analysis of the maternal mortality ratio and its related risk factors in Sub-Saharan Africa. In response to this, this review aims to assess the maternal mortality rate and identified risk factors associated with maternal mortality in Africa.

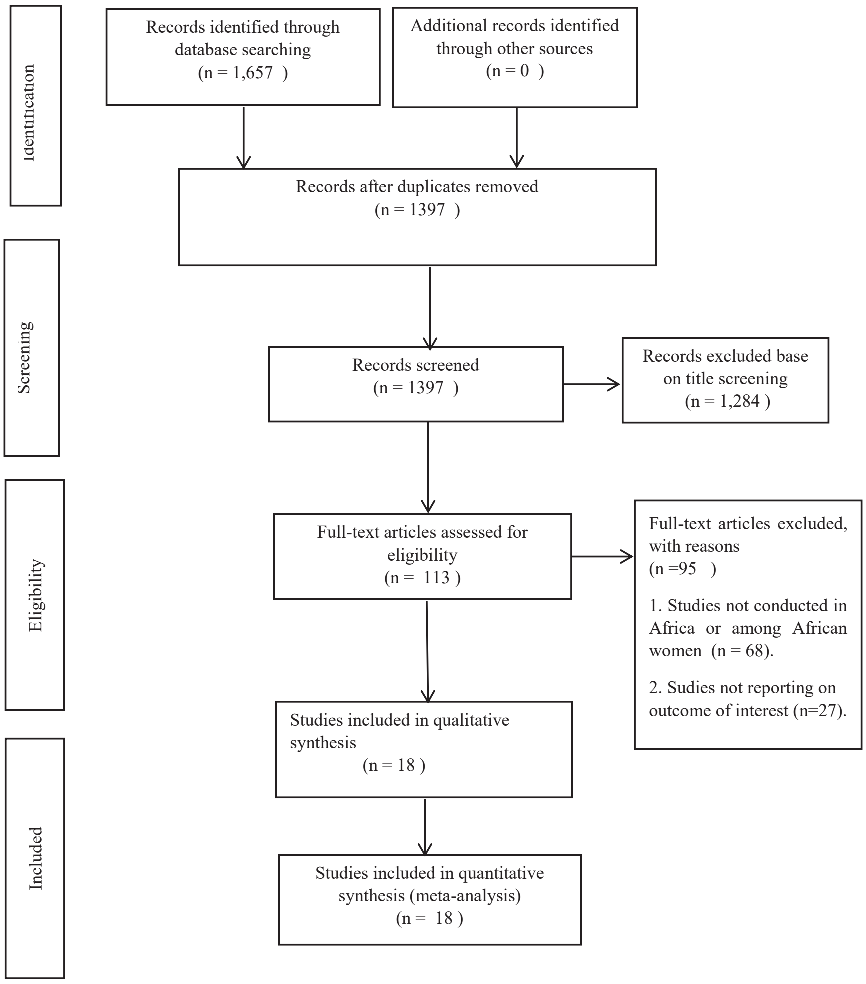

Figure 1: *PRISMA 2009 Flow Diagra*

Methodology

A systematic review and meta-analysis was conducted to estimated the maternal mortality ratio (MMR) of Africa and to identify factors that increase the risk of MMR in Africa. Four electronic databases (PubMed, Web of science, Embase, and Medline), were searched for cohort, case-cotrol and cross-sectonal studies published between 2008 and 2021 that assessed maternal mortality or its risk risk in Africa or among African women. A total of 1,657 articles were retrieved from searching four electronic databases. The sum of 1,639 records were excluded (260 duplicates, 1,284 records were exlcluded based on title screening, 68 records were excluded becuase those studies were not conducted in Africa or among African women, and 27 records were excluded because those studies din't report on outcome of interest to the current review). After all exclusion, a total of 18 studies were included into this systematic review and meta-analysis (See Figure 1). The preferred reporting items for a systematic review and meta-analysis was carefully considered while conducting this review. Two reviewers independently assessed studies for eligibility and methodological quality, and extracted data on maternal mortality ratio, and its risk factors.

Search strategy

A comprehensive search was conducted in four electronic databases (PubMed, Web of Science, Embase, and Medline). The search period for the four electronic databases was from the 2008 to 2021. We conducted an advanced search in PubMed using MeSH (Medical Subject Headings), with the following search strategy: ((maternal mortality [MeSH Terms]) AND (risk factors [MeSH Terms]), AND (Africa [MeSH Terms]). In the Web of Science core selection, the following search technique was used: advance search: Combining TS=maternal mortality AND TS=risk factors AND Africa (# 3 AND # 2 AND # 1: Indexes include the SCI-EXPANDED, SSCI, A & HCI, CPCI-S, CPCI-SSH, ESCI, CCR-EXPANDED, and I.C. (Period=20082021). In Embase, the search strategy was ('maternal mortality'/exp OR' maternal mortality '), AND (' risk factors'/exp OR 'risk factors'), AND ('Africa'/exp OR' Africa '), while in Medline, the search strategy was TS= "maternal mortality" AND TS= "risk factors" AND TS= "Africa" .

Study selection criteria

The review included studies that fulfilled any of the following criteria: (a) study subjects (women of reproductive age); (b) study population (African women); (c) study results (studies reporting on maternal mortality or risk factors in Africa); (d) article form (case-control, choort and cross-sectional research articles); and (e) publication date (article published beginning January 1, 2008, to 2021). The following criteria were used to exclude studies from this review: (a) studies published that is not on maternal mortality or its risk factors among African women; (b) computer-based studies that exclude human participants; (c) letters, editorials, review papers, and case reports; and (d) studies performed outside of Africa with non-African participants.

Data extraction

Two authors (E.M.K. and P.L.B) independently screened each retrieved articles and found papers with possible relevance for full-text analysis. The results were compared to eliminate the possibility of unnoticed errors. In the event of a disagreement, the corresponding author (J.Y.L.) was consulted, and the matter was discussed and settled by unanimous consent. Methodological and outcome variables from each of the included studies were collected using a standardized data extraction form. The data set contained the following variables: the last name and publication year of the first author, the region, the study design, maternal death, maternal near-miss, live birth, MMR and risk factors. A reported risk factor of MMR from each of the included studies was selected pooled for meta-analysis if only two or more studies reported the same risk factor with odd ratio and/or 95% confidence interval.

Table 1 A*: Assessment of methodological quality for case-control studies using Newcastle-Ottawa Quality Assessment Scale (N.O.S.)*

Study	selection			Comparability			Exposure		Total
	Is the case definition adequate	Representa-tiveness of the cases	Selection of Controls	Definition of Control	Comparabil-ity of cases & controls	Ascertain-ment of exposure	Ascertain-ment for cases and controls	Non-Response rate	
Tebeau, 2015	*	*	*	*	**	**	*		8
Moyo, 2018	*	*	*	*	**	**	*		9
Godefay, 2015	*	*	*	*	*	*	*		7
Ngonzi, 2016	*	*	*	*	*	*	*		7
Yego, 2014	*	*	*	*	*	*	*		7
Evjen- Ol-sen, 2008	*	*	*		*	*	*		7
Olopade, 2018	*	*	*		*	*	*		7

Table 1B: Assessment of methodological quality for Cohort studies using Newcastle-Ottawa Quality Assessment Scale (N.O.S.)

Study	Selection			Comparability			Outcome		Total
	Representa-tiveness of the exposed cohort	Selection of non-exposed cohort	Ascertain-ment of exposure	Demonstra-tion that outcome of interest was not present at the start of the study		Assessment of outcome	Follow-up long enough for outcomes to occur	Adequacy of follow up of cohorts	
B.Tlou, 2018	*	*	*	*	**	*	*	*	9
Sayinzoga, 2016	*	*	*	*	*	*			6
Bomela, 2020	*	*	*	*	*	*			6

Table 1 C: *Assessment of methodological quality for Cross-sectional studies using Newcastle-Ottawa Quality Assessment Scale (N.O.S.)*

Study	Selection			Comparability	Outcome		Total
	Representa-tiveness of the sample	Sample size	Non-respon-dents	Ascertainment of the exposure (risk factor)	Assessment ofthe outcome	Statistical test	
Yaya, 2014	*	*	**	**	*	*	8
Meh,2019	*	*	**	*	**	*	8
Etuk, 2019	*	*	**	*	*	*	7
Astatikie, 2017	*	*	*	*	**	*	7
Adanikin AI, 2019	*	*		*	**	*	7
Mbchu, 2017	*	*		*	*	*	6
Woldeyes, 2018	*	*		*	*	*	6
David, 2014	*	*		*	*	*	6

Data analysis

Using a random effect model, the total pooled effect size of MMR for Africa was estimated using the reported pooled MMR from the included studies. The effect sizes were computed using odds ratios, and 95% confidence interval. The Cochran Q-test was used to determine the degree of heterogeneity between studies, and I^2 statistic was used to explore statistical heterogeneity, defined as low when $I^2 <50$, moderate when $I^2 =$ 50–74% and high for $I^2 \geq 75\%$. In this review, the researchers agree that if ≥ 10 of the included studies reported MMR, than a distinct prediction model for meta-analysis should be performed. Because there was 13 studies that reported MMR, a meta-analysis was therefore performed with a funnel plots drawn to assess the possibility of publication bias. Visual analysis of the funnel plot was used to assess publication bias. Also, sensitivity analysis was performed to ascertain the strength of our findings by excluding one study at a time from the pooled results. All statistical analyses were performed using StataCorp version 16.0. (Stata, USA).

Assessment of methodological quality of the included studies

The New Castle Ottawa Scale was used to establish a standard for observational and cross-sectional research [18, 19]. The studies included in this review were evaluated for possible bias in their design, behavior, and analysis. The New Castle Ottawa Scale consisted of three categories, each with a maximum of ten stars. The methodological standard of the included studies was graded on a scale of one to ten (1-10) stars. The following algorithms were used to determine the quality of each study: Eight to ten stars were assigned for extremely

Table 2. *Characteristics of the included studies (n =18)*

Study	Year	Country	Study Design	Maternal Deaths	Near Miss	Live births	Mortality (M.M.R.)
B.Tlou et al	2018	South Africa	Cohort	212	NA	32,620	650/100,000
Bomela et al	2020	South Africa	Cohort	14,892	NA	10,687,687	139.3/ 100,000
Sayinzoga et al	2016	Rwanda	Cohort	1060	NA	1, 533 ,177	69.1/100,000
Yaya et al	2014	Ethiopia	Cross-sectional	49	NA	11,536	425/100,000
Meh et al	2019	Nigeria	cross-sectional	1561	NA	51,492	576/100,000
Etuk et al	2019	Nigeria	Cross-sectional	87	305	91,724	94/100,000
Astatikie et al	2017	Ethiopia	Cross-sectional	16	226	10,379	154/100,000
Adanikin AI et al	2019	Nigeria	Cross-sectional	998	1,451	91,724	85/100, 000
Woldeyes et al	2018	Ethiopia	Cross-sectional	24	138	2737	876/100,000
David et al	2014	Mozambique	Cross-sectional	71	564	27,916	254/ 100,000
Mbachu et al	2017	Nigeria	Cross-sectional	5	52	262	1908/100,000
Tebeu et al	2015	Cameroon	Case-control	26	NA	9045	287/100,000
Olopade et al	2008	Nigeria	Case-control	84	NA	8,724	963/100,000
Moyo et al	2018	Zambia	Case-control	100	300	400	
Godefay et al	2015	Ethiopia	Case-control	62	248	310	
Ngonzi et al	2016	Uganda	Case-control	139	417	556	
Evjen-Olsen et al	2008	Tanzania	Case-control	45	135	180	
Yego et al	2014	Kenya	Case-control	150	300	450	

Table 3. *Risk factors of maternal mortality*

Study	Risk factors 1	Risk factor 2	Risk factor 3	Risk factor 4	Risk factor 5	Risk factor 6	Rissk factor 7	Risk factor 8	Risk factor 9
Astatikie et al 2017	Maternal age ≥35 years				Pregnancy complication				
Tebeu et al 2015			No ANC Visit						
Olopade et al 2008	Maternal age ≥35 years8							Grand multipara	
Moyo et al 2018		No formal education	No ANC Visit	Previous medical condition	Pregnancy complication	Delayed to seek healthcare		Grand multipara	
Godefay et al 2015				Previous medical condition	Pregnancy complication				
Ngonzi et al 2016		No formal education	No ANC Visit			Delayed to seek healthcare	Mother being referred		
Evjen-Olsen et al 2008	Maternal age ≥35 years	No formal education							Husband's education
Yego et al 2014	Maternal age ≥35 years	No formal education		Previous medical condition	Pregnancy complication		Mother being referred		Husband's education

high methodological quality, five to seven stars for good methodological quality, and one to four stars for acceptable methodological quality. As in Table 1A, the methodological quality of the case-control studies was assessed using the New Castle Ottawa Critical Appraisal Checklist for case-control studies [17]. The methodological quality of the included study was graded on a scale of one to ten (1-10) stars. Each study quality was determined using the following scoring algorithms: 8–10 stars were assigned for excellent methodological quality, 5–7 stars for good methodological quality, and 1–4 stars for acceptable methodological quality. Also, as in Table 1B, the methodological quality for the cohort studies was assessed using the New Castle Ottawa Critical Appraisal Checklist for Cohort Studies [17]. The included articles were evaluated based on several criteria, including representative of the exposed cohort, whether the study demonstrated that the outcome of interest was present at the start of the study, whether the groups were comparable except for disease presence, and follow-up history. The methodological quality of each study was graded using the following algorithms: 8–10 stars indicated excellent methodological quality, 5–7 stars indicated good methodological quality, and 1–4 stars indicated acceptable methodological quality. Additionally, as shown in Table 1C, the methodological quality of cross-sectional studies was evaluated using the New Castle Ottawa Critical Appraisal Checklist for Cross-sectional Studies [18]. The included papers were evaluated on the following criteria: whether the sample size was representative, respondents rate, ascertainment of exposure, whether the groups were comparable except for the presence of disease, whether exposure was measured in a standard, accurate, and reliable manner, whether the results were assessed in a standard, valid, and reliable way, and whether statistical analysis was performed using standard software and procedure. The methodological quality of the included study was graded on a one-to-ten (1-10) star scale. The following scoring algorithms were used to evaluate the output of each study: 8–10 stars indicated excellent methodological quality, 5–7 stars indicate good methodological quality and 1–4 stars indicate acceptable methodological quality.

Table 2 Present a detailed overview of the characteristics of the included studies. The final systematic review and meta-analysis contained a total of 18 studies and three distinct research designs. Majority of the included studies (8) were cross-sectional, with seven being case-control and three being cohort. Ten of the studies included were performed in East Africa (four in Ethiopia and one each in Rwanda, Mozambique, Zambia, Uganda, Tanzania, and Kenya respectively), five from Aest Africa, Nigeria), two from Southern Africa (South Africa), and one from Central Africa (Cameroon). Furthermore, thirteen of the studies included data on the maternal mortality rate (MMR) that range from 69/100,000 in Rwanda to 1,908/100,000 in Nigeria.

Table 3. Risked factors of maternal mortality was extracted from eight of the included studies that assessed risk factors of maternal mortality in Africa. A risk factor was selected for further pooled analysis from the included studies only when it was found to have been reported in two or more of the included studies as a risk factor of maternal mortality in Africa,with odd ratio and /or 95% confidence interval. If a risk factor odd ratio was not reported but the study presented data that could allow the odd ratio to be calculated, that risk factor was consider for further assessment in the current systematic review and meta-analysis.

Results

A total of 1,657 articles were retrieved from searching four electronic databases. The sum of 1,639 records were excluded (260 duplicates, 1,284 records were exlcluded based on title and abstract screening, 68 records were excluded becuase those studies were not conducted in Africa or among African women, and 27 records were excluded because those studies din't report on outcome of interest to the current review). After all exclusion, a total of 18 studies were included into the the systematic review and meta-analysis.

Maternal mortality ratio (MMR)

Using the random effect model, the pooled maternal mortality ratio for Africa was estimated to be 496/100,000 (Figure 2). This review revealed a high degree of variability between studies using the random effect method (99.78%). Additionally, by removing studies from the pooled results one at a time and recalculating the MMR, a leave-one sensitivity analysis was performed to ascertain the strength of our findings. Based on this process, the MMR from the sensitivity analysis increase from 496/100,000 to 587/100,000 live births indicating that our finding was influenced by individual studies (Figure 3).

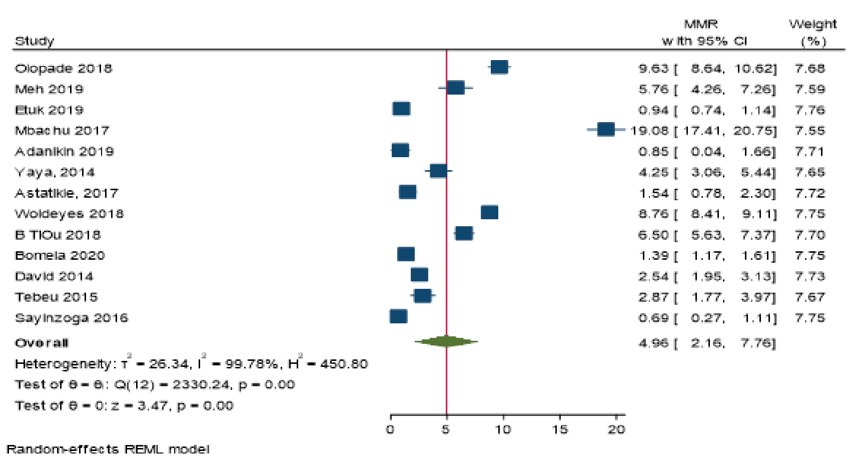

Figure 2: *Forest plot showing the pooled maternal mortality rate estimate using a random-effects model (n=13).*

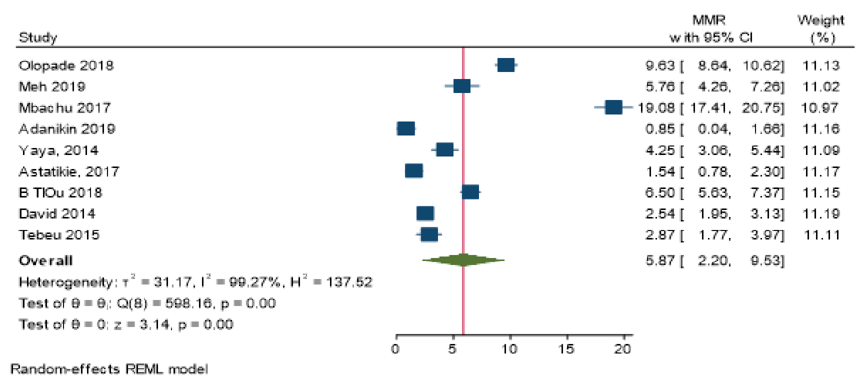

***Figure 3**: Forest plot showing the pooled estimate of maternal mortality rate after sensitivity analysis (n=9)*

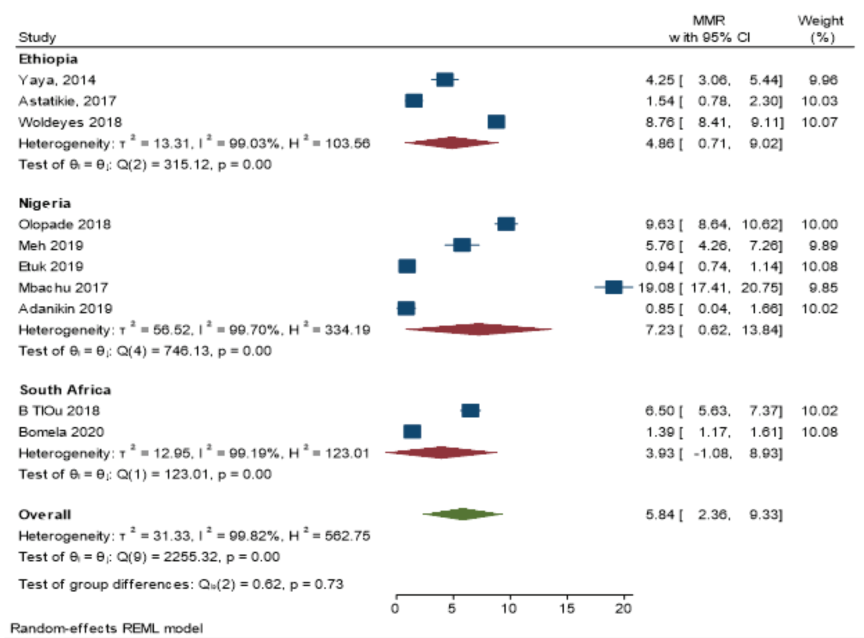

***Figure 4**: Forest plot for pooled maternal mortality rate by subgroup analysis (Nigeria, Ethiopia, and South Africa)*

A sub-group analysis by country showed that the magnitude of MMR in Nigeria was 723/100,000 with substantial heterogeneity between studies. Ethiopia had an MMR of 486/100,000 with high heterogeneity of 99.03%, while South Africa had the lowest overall MMR of 393/100,000 (Figure 4). Finally, the overall MMR from the sub-group analysis by countries was 584/100,000, for Africa. With I2 of 99.82%, which indicated that the high level of heterogeneity in this review was not only related to differences in methodology, and sample size, of the included studies but also it was related to regional differences among countries.

Risk factors of maternal mortallity

Based on the current review analysis, maternal age ≥ 35 years [OR = 2.50; 95% CI: (1.50, 4.15)], no formal education/ illiterate mother [OR = 2.30; 95% CI: (1.50, 3.52)], no history of ANC attendance [OR = 2.42; 95% CI: (0.43, 13.50)], pregnancy complication/previous pregnancy-related illness [OR = 4.47; 95% CI: (3.03, 6.60)], delayed in seeking health care [OR = 5.12; 95% CI: (3.14, 8.34)], mother being referred [OR = 5.60; 95% CI: (4.16, 7.54)], and husband's education (illiterate/primary) [OR = 1.32; 95% CI: (0.69, 2.53)] were identified as risk factors of maternal mortality.

Three of the studies included in this review identified an association between maternal age ≥ 35 and maternal mortality rates. Ethiopia, Tanzania, and Kenya were all sites for these studies. The total pooled odds ratio calculation [OR = 2.50; 95 percent confidence interval [CI]: (1.50, 4.15)] indicated that maternal age ≥ 35 years was associated with an increased risk of maternal mortality in Africa. Additionally, heterogeneity (I2 = 17.0 percent) between studies was observed to be less than 50% (Figure 5), however a disparity in the pooled odds ratio estimated by country was observed. Tanzania had the highest estimate [OR = 3.14; 95% CI: (1.33-7.44), Kenya had the second-highest estimate [OR = 2.88; 95% CI: (1.61-5.12)], and Ethiopia had the lowest estimate [OR = 1.10; 95% CI: (0.35-3.50). Further, data on mothers with no formal education/ illiteracy was gathered from four studies that examined the relationship between a mother's educational status and the risk of maternal mortality. Tanzania, Zambia, Uganda, and Kenya were the locations of these studies. According to the current review's finding [OR = 2.30; 95 percent confidence interval [CI]: (1.50, 3.52)], mothers who lack formal education or are illiterate face an increased risk of maternal mortality in Africa. A heterogeneity (I2 = 59.0%) between studies, was observed to be less than 75% (Figure 6). However, a disparity in the pooled odds ratio estimated by country was observed. Kenya had the highest estimate [OR = 4.34; 95 percent CI: (2.31-8.14)], while Tanzania had the lowest estimate [OR = 1.28; 95 percent CI: 0.62-2.63). Non history of ANC attendance was also identified as a risk factor for maternal mortality. Three of the studies included measured the risk of maternal mortality due to the mother's ANC attendance history. The three studies on no ANC attendance history were pooled and further assessed for risk of maternal mortality. The research was carried out in Zambia, Uganda, and Cameroon. According to the pooled odds ratio calculation [OR = 2.42; 95 percent confidence interval [CI]: (0.43, 13.50], mothers without a history of ANC attendance are at an elevated risk of maternal mortality in Africa. Additionally, heterogeneity between studies (I2 = 85.0 percent) was less than 90.0% (Figure 7), and a disparity in the pooled odds ratio estimate by country was observed. The highest estimate was in Cameroon [OR = 28.20; 95% confidence interval [CI]: (3.30-241.17)], while the lowest estimate was in Zambia [OR = 0.39; 95% CI: 0.11-1.33). Pregnancy complications/previous pregnancy-related condition was identified as a risk factor maternal Mor Data from four included studies were pooled and analyzed to determine the relationship between prior pregnancy complications and maternal mortality rates. The studies from which the data for the analysis was gathered were conducted in Ethiopia (two), Zambia, and Kenya. According to the our pooled odds ratio finding [OR = 4.47; 95% confidence interval [CI]: (3.03, 6.60), mothers who have had a prior pregnancy complication face a high risk of maternal mortality in Africa. Additionally, heterogeneity between studies (I2 = 46.0 percent) was less than 50.0 percent (Figure 8), and a disparity in the pooled odds ratio estimate by country was observed. Kenya had the highest OR estimate [OR = 6.14; 95 percent CI: (3.99-9.45), while Ethiopia had the lowest [OR = 2.99; 95 percent CI: 1.27-7.02). The risk of maternal mortality associated with mothers delay in seeking healthcare was assessed by pooling data from the included studies to analyzed and determine the level of maternal mortality risk post on mothers who delay in seeking healthcare. Data for this analysis was pooled from two studies conducted in Zambia and Uganda. According to the pooled odds ratio [OR = 5.12; 95 percent confidence interval [CI]: (3.14, 8.34) finding, mothers who delayed in seeking healthcare are at an increased risk of maternal mortality in Africa (Figure 9). Data on maternal referral were pooled from the included studies for this review. According to the pooled odds ratio estimate [OR = 5.60; 95 percent confidence interval [CI]: (4.16, 7.54)], mothers referred from one health facility to another face a high risk of maternal mortality in Africa (Figure 10). Two studies conducted in Tanzania and Kenya reported low level of maternal husband as a risk factor of maternal mortality in Africa. Base on the present review analysis, husband education (illiterate or primary) is a risk factor of maternal mortality in Africa (see Figure 11 for detail).

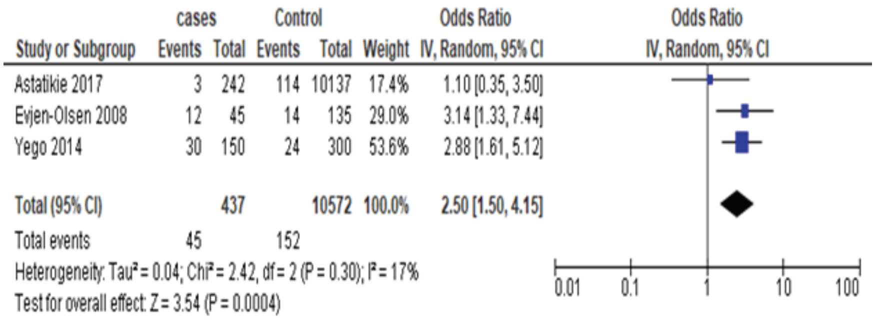

Figure 5: *Forest plot showing the pooled odds ratio estimate for maternal age (n=3)*

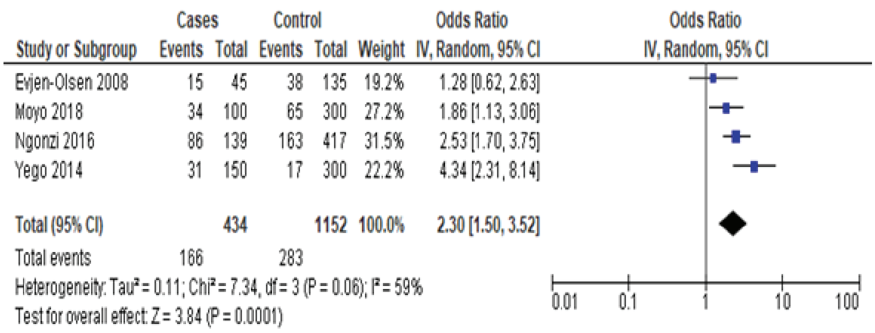

Figure 6: *Forest plot showing the pooled odds ratio estimate for no formal education/illiterate mother (n=4)*

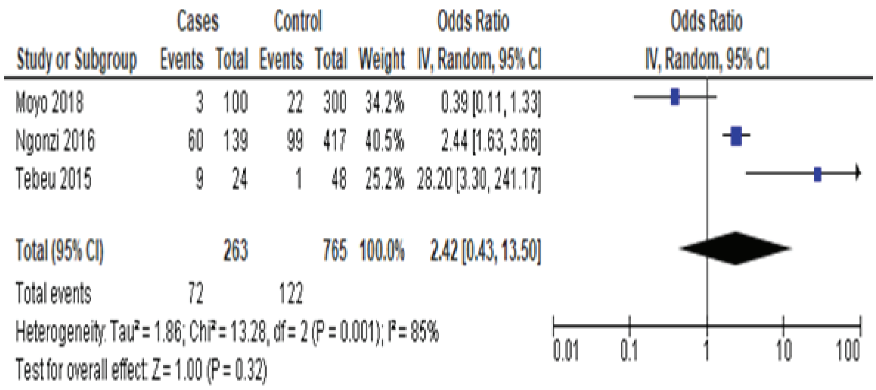

Figure 7: *Forest plot showing the pooled odds ratio estimate for No A.N.C. attendance (n=3)*

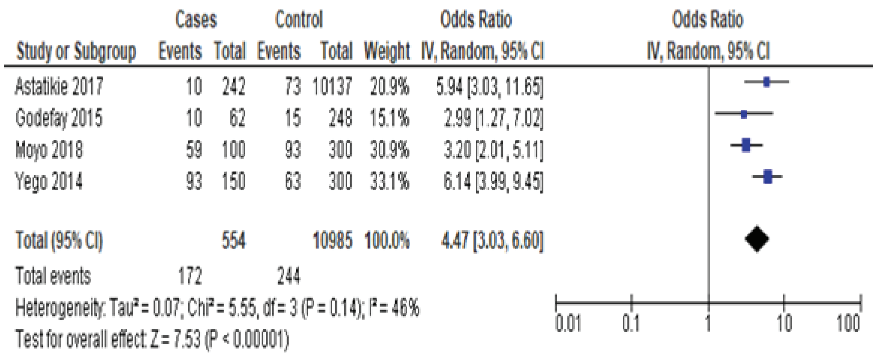

Figure 8: *Forest plot showing the pooled odds ratio estimate for pregnancy Complication/Previous Pregnancy-related condition (n=4)*

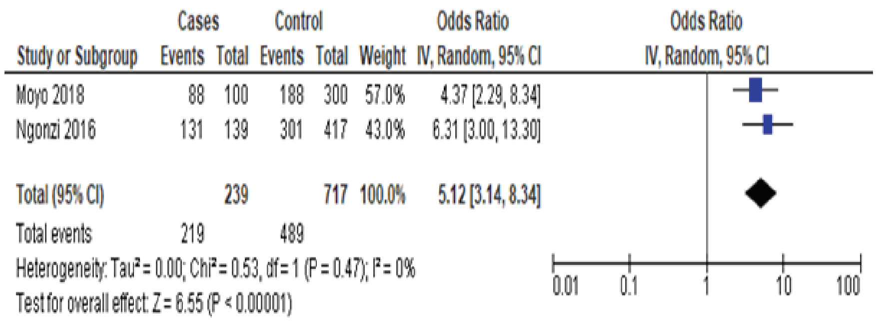

Figure 9: *Forest plot showing the pooled odds ratio estimate for Delay to seek health care (n=2)*

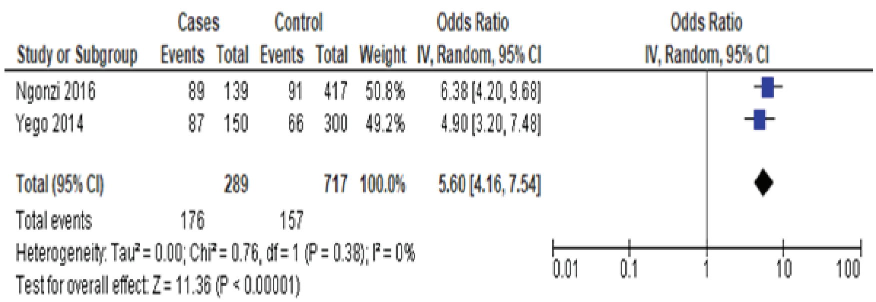

Figure 10: *Forest plot showing the pooled odds ratio estimate for Mother being referred (n=2)*

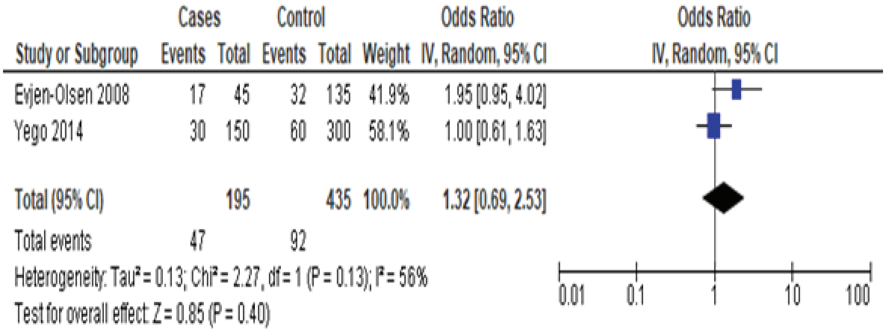

Figure 11: *Forest plot showing the pooled odds ratio estimate for Husband educational level: illiterate/Primary (n=2)*

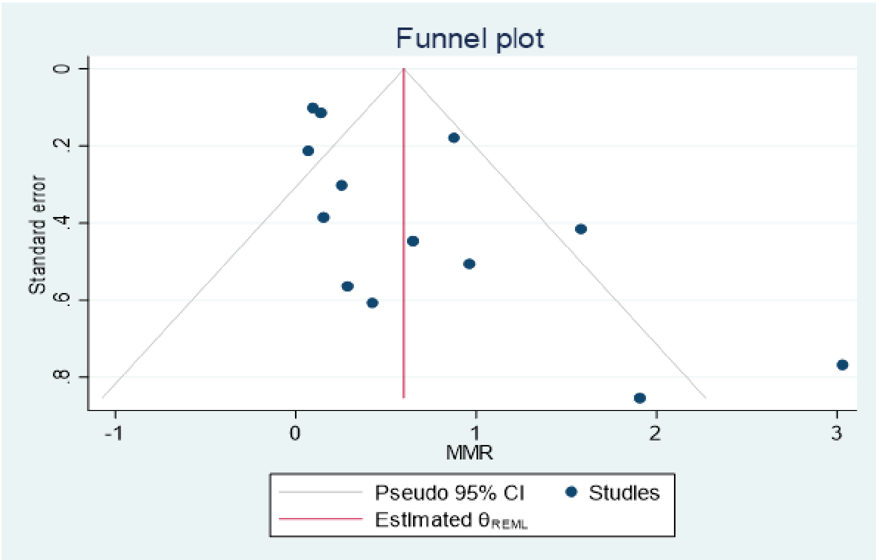

Figure 12: *Funnel plot depicting distribution of log OR as a measure of publication bias.*

Publication bias

A funnel plot and Egger's test were used to assess publication bias among the studies included in the meta-analysis. Egger's examination revealed no evidence of publication bias (P = 0.25), and funnel plots were symmetrical in form (Figure 12).

Discussion

Based on this systematic review and meta-analysis, Africa's MMR is 496/100,000 live births. This result is significantly higher than the WHO's approximate global MMR of 210/100,000 live births and considerably lower than the previously recorded MMR for Africa of 500/100,000 live births [4]. Recent improvements may have influenced Africa's MMR decline in the healthcare delivery systems of the majority of African countries. Additionally, the decline in the MMR in Africa may be attributed to the various interventions implemented in recent years in the majority of local, national, and regional settings in Africa, including improved quality and widespread access to Emergency Obstetric Care (EMOC) and a higher proportion of facility-based deliveries [20-23]. Maternal ≥ 35 years, age, lack of formal education/illiterate mother, non-attendance at ANC, presence of a risk condition/previous medication condition, pregnancy complication, Delay in seeking health care, the mother being referred, and husband education (illiterate/primary) were identified as risk factors for maternal mortality in Africa.

We found that maternal age to be associated with increased maternal mortality in Africa. This finding is consistent with those of other studies [5,24,25], which showed a high risk of maternal mortality for women age ≥ 35 years. Maternal aged ≥ 35 years were found to have a higher risk of maternal mortality than women under 35. Various factors contribute to this, including declining overall health in older women and a decrease in their health-seeking activity, both of which put them at greater risk of miscarriage and congenital disabilities. Additionally, younger women may have had husbands with a higher educational degree or are less averse to using modern health facilities, increasing their chances of receiving better health care than older women. In Africa, maternal mortality has been linked to a lack of formal education/an illiterate mother. In Kenya, a study revealed a significant association between mother illiteracy/low maternal education and the risk of maternal death [5]. Similarly, in Ugandans, mothers who lack formal education are at a higher risk of maternal mortality [26]. Based on these findings, additional efforts should be made to educate women about health. While we assessed the risk of maternal mortality in the absence of formal education, we recommend that health care providers conduct training sessions on health-related topics and childbirth readiness during antenatal visits, as each pregnancy is potentially complicated. No ANC attendance was identified as a factor that increases the odds of maternal mortality in Africa. This result is consistent with previous research indicating that inadequate prenatal care can increase the risk of maternal death [26-28]. Mothers who are not screened antenatal are predisposed to poor maternal obstetrical outcomes, as they present late in very critical states with complications. Women living in low-resource environments are more likely to miss crucial prenatal care appointments due to healthcare access barriers. As a result, clinicians are urged to conduct additional health education activities in neighborhoods to educate women and families about the critical nature of ANC for expectant mothers and their unborn children. Our study found a strong association between increased maternal mortality in Africa and pregnancy complications/previous pregnancy-related conditions. This result is consistent with previous research on the associations between maternal mortality and pregnancy complications or pre-existing pregnancy-related conditions [5,29]. As a result, all health facilities should improve their management and referral practices for women who can experience complications during labor and childbirth. Additionally, all pregnant women who visit healthcare facilities should be evaluated for early identification and timely treatment of these conditions. Screening and documentation of pre-existing disease should be prioritized in antenatal care services, triggering exceptional follow-up of high-risk pregnant and delivery women to ensure maternal protection.

Our review found that delay in seeking healthcare by gravid women, increase the risk of potential maternal complication and death. This result is consistent with the findings of Shah et al. [30], who demonstrated that delaying access to healthcare increases the risk of maternal death. Additionally, Cham et al. (2005) found that women who died of maternal causes were more likely to have delayed seeking prompt and appropriate obstetric care [31]. Delays in seeking treatment can be classified into two categories: delays in seeking care and delays in reaching a health facility. These delays may be attributed to the distance traveled, the lack of available transportation, or financial constraints. Therefore, women's empowerment projects should be a top priority in the majority of rural African communities. Maternal child health (MCH) networks in rural African regions should be strengthened and expanded. In Africa, being referred has been described as a risk factor for maternal mortality. Earlier research has found that mothers transferred from lower to higher-level health facilities are frequently in critical states, putting them at a high risk of death [5,26,32]. Mothers referred from a peripheral health facility to a higher level of care are typically at an increased risk of death [33].

Furthermore, the current study found a link between a husband's education and maternal mortality. Illiteracy/primary education status, in particular, was established as a risk factor for maternal death in Africa. This result is consistent with previous research indicating that husbands with no or limited educational status are at an elevated risk of maternal mortality [24]. Additionally, an Indian study found a strong correlation between a low level of education for the husband and the likelihood of maternal mortality [34]. In settings where the risk of maternal mortality is high, it is critical to understand the position and power of decision-makers. The significance of husbands' expertise may be related to the fact that husbands are often the decision-makers in many families in developing countries. They determine which health facilities can provide delivery services to a mother.

Strengths and limitations

Numerous strengths characterize this systematic review and meta-analysis. Firstly, this systematic review and meta-analysis are the first to examine the maternal mortality ratio and the risk factors in Africa. Second, we followed the most recent Preferred Reporting Items for Systematic Reviews and Meta-Analysis [35]. Third, we used a structured and broad search strategy that was not language-restricted. Furthermore, there are some drawbacks to this systematic analysis. None of the studies included in the examination were initially carried out in Northern Africa, which could have affected the overall results of the evaluation. Secondly, we could not quantify additional maternal mortality risk factors, such as place of delivery, religious affiliation, the quality of healthcare given, and household income.

Conclusion

Despite global efforts to prevent maternal mortality, this review findings revealed a high MMR of 496/100,000 live birth for Africa. Also, among risk factors identified, mother being referred, delayed in seeking healthcare, and pregnancy complication/previous pregnancy related illness were noted to have higher odds toward maternal mortality. Therefore, healthcare professionals are reminded to regularly educate mothers about the importance of seeking early prenatal healthcare and the risk associated with delay in attending regular prenatal healthcare. Further, clinicians are encourage to carefully assess all mothers during regular prenatal visit, with special attention towards mothers ≥35 years, for early identification and prevention of risk condition that might threaten the life of a mother, child or both. Clinicians are also reminded to be more vigilant, during the labor and delivery period to help identify women with complication, summon assistance and ensure prompt treatment and transfer when necessary.

Ethical approval and consent to participate

Not applicable

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this review are included in the manuscript.

Competing interests

The authors declare that they have no competing interests.

Funding

The research is supported by the National Natural Science Foundation of China, research project (grant number 81172680). This funding source was not involved in the design, data collection, testing, or analysis of the study or manuscript writing.

Authors' contributions

JYL did supervision, contributed to the conceptualization, validation and provided the funding acquisition of the manuscripted. EMK and PLB performed data curation, formal analysis, and contributed to the methodology and conceptualization of the manuscript. OB, SJYW and JYL contributed to the methodology and visualization of tthe manuscript. EMK and PLB wrote the original draft of the manuscript and all the authors review the manuscript, and approved its submission to a journal for publication.

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