BMJ Open

Place of death and associated factors among reviewed maternal deaths in Ethiopia: a generalised structural equation modelling

Neamin Tesfay ,[1] Rozina Tariku,[1] Alemu Zenebe,[1] Medhanye Habtetsion,[1] Fitsum Woldeyohannes [2]

To cite: Tesfay N, Tariku R, Zenebe A, *et al*. Place of death and associated factors among reviewed maternal deaths in Ethiopia: a generalised structural equation modelling. *BMJ Open* 2023;**13**:e060933. doi:10.1136/bmjopen-2022-060933

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-060933).

Received 12 January 2022
Accepted 12 January 2023

[1]Centre of Public Health Emergency Management, Ethiopian Public Health Institute, Addis Ababa, Ethiopia
[2]Health Financing Department, Clinton Health Access Initiative, Addis Ababa, Ethiopia

Correspondence to
Neamin Tesfay;
neamintesfaye2123@gmail.com

ABSTRACT

Objective The study aims to determine the magnitude and factors that affect maternal death in different settings.

Design, setting and analysis A review of national maternal death surveillance data was conducted. The data were obtained through medical record review and verbal autopsies of each death. Generalised structural equation modelling was employed to simultaneously examine the relationships among exogenous, mediating (urban/rural residence) and endogenous variables.

Outcome Magnitude and factors related to the location of maternal death.

Participants A total of 4316 maternal deaths were reviewed from 2013 to 2020.

Results Facility death constitutes 69.0% of maternal deaths in the reporting period followed by home death and death while in transit, each contributing to 17.0% and 13.6% of maternal deaths, respectively. Educational status has a positive direct effect on death occurring at home (β=0.42, 95% CI 0.22 to 0.66), obstetric haemorrhage has a direct positive effect on deaths occurring at home (β=0.41, 95% CI 0.04 to 0.80) and death in transit (β=0.68, 95% CI 0.48 to 0.87), while it has a direct negative effect on death occurring at a health facility (β=−0.60, 95% CI −0.77 to −0.44). Moreover, unanticipated management of complication has a positive direct (β=0.99, 95% CI 0.34 to 1.63), indirect (β=0.05, 95% CI 0.04 to 0.07) and total (β=1.04, 95% CI 0.38 to 1.70) effect on facility death. Residence is a mediator variable and is associated with all places of death. It has a connection with facility death (β=−0.70, 95% CI −0.95 to −0.46), death during transit (β=0.51, 95% CI 0.20 to 0.83) and death at home (β=0.85, 95% CI 0.54 to 1.17).

Conclusion Almost 7 in 10 maternal deaths occurred at the health facility. Sociodemographic factors, medical causes of death and non-medical causes of death mediated by residence were factors associated with the place of death. Thus, factors related to the place of death should be considered as an area of intervention to mitigate preventable maternal death that occurred in different settings.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ One of the main strengths of the study is the application of multivariate analysis (generalised structural equation modelling) to assess the effect of sociodemographic status, medical history and cause of maternal death simultaneously in determining the place of death in various settings.
⇒ The other strength of the study is the utilisation of a non-linear combination of estimators to compute the mediation effect of residence along with the direct, indirect and total effects on the place of maternal death.
⇒ The study does not capture the national estimate of maternal death, it encompasses a relatively limited geographical area and it only addresses public health facilities with poor implementation of community surveillance.
⇒ The study used cross-sectional research approach; hence, it is difficult to establish causality.

INTRODUCTION

Pregnancy and childbirth are accompanied by negative consequences that affect the lives of millions of women and families. The impact is more prominent in middle and lower income countries.[1–3] The burden of maternal death differs across the globe ranging from 12 maternal deaths per 100 000 live births in high-income regions to 546 maternal deaths per 100 000 live births for sub-Saharan African countries.[4 5] Efforts were made by countries to reduce maternal death and there has been a notable decline in maternal death, resulting in the achievement of Millennium Development Goals by several countries.[6] However, the goal was not achieved by all countries in 2015 due to the varying policies and programmes countries adopted towards maternal and child health.[7] Therefore, to alleviate these discrepancies a new global strategy was put in place to reduce maternal death to 70 per 100 000 live births in 2030.[8]

Ethiopia is one of the top maternal death-reporting countries in sub-Saharan Africa,

with an annual mortality rate of 401 per 100 000 live births,[9] which dropped from 871 per 100 000 live births in 2000.[10] Since 2000, Ethiopia has settled a national strategic plan to reduce maternal mortality by improving the governance and management of the health system.[11] The establishment of national maternal mortality surveillance system was one of the strategies designed by the government. It supports the effort of maternal death reduction by availing real-time data that are relevant for policy decisions beyond counting the number of deaths.[12]

Maternal death surveillance and response (MDSR) is a form of continuous surveillance that links the health information system and quality improvement processes from local to national level, which includes the routine identification, notification, quantification and determination of causes of all maternal deaths, as well as the use of this information to respond with actions that will prevent future deaths.[13]

In Ethiopia, since 2013, a surveillance system was in place for reporting maternal deaths. Later on, in 2017, the system was expanded to include perinatal death.[14] The primary goal of the MDSR system is to eliminate preventable maternal death by generating strategically valid information to guide public health actions and monitor their impact.[15] Currently, the system is actively running throughout 10 regions and two city administrations of Ethiopia.[16]

One of the cardinal dimensions of MDSR is to identify the place where the mother died due to pregnancy and pregnancy-related complications. Place of maternal death is influenced by several factors, which goes from conception to delivery and from delivery to puerperium.[17] Availability of skilled birth attendant during delivery is a key determinant for a place of death. However, many poor and marginalised rural women have no access to skilled birth attendants. Skilled birth attendants are mainly available at the health facility level (ie, in a health centre and hospital).[18] Besides, various socioeconomic and cultural factors have been identified as contributing factors to determine the place of death. Medical cause of maternal death and poor utilisation of health services were factors mentioned in front line in relation to place of death.[19] In a resource-constrained country like Ethiopia, women often do not have the economic resources and education to make an informed decision about issues related to their health and well-being. Women are also denied access to reproductive health services and information due to various social, religious and cultural barriers.[20 21] Other factors that determine the place of death include distance, cost, poor service quality and substandard care.[22 23] Human resource constraints, poor infrastructure, inadequate equipment and supplies contribute to determining the place of death.[24–26]

Per the assessment of Ethiopian service availability and readiness assessment in 2018, only 48% of assessed facilities (both health centres and hospitals) provide the full service of basic emergency obstetric care. Similarly, only 75% of the hospitals provide compressive emergency obstetrics care.[27] Moreover, several women give birth at home unattended or with the assistance of relatives or other community members who do not have the basic training in delivery and maternal care.[28] In Ethiopia, 52% of women give birth at home.[29] Due to this, their place of delivery might be their place of death.[30]

Several studies were conducted to identify the factor leading to maternal death in connection with the place of death.[31–33] However, those studies lack depth in exploring relationships as most followed a univariate analysis. In that case, the model determines the direct effect only from the independent variable of the dependent variable, rather than the indirect effect via the mediator. In response to the above gap, this study is conducted through a retrospective historical data analysis approach using the generalised structural equation modelling (GSEM). GSEM is a more advanced and robust analysis approach than the traditional analysis methods because it assesses the associations between multiple independent variables and outcome variables in the same model even if outcome variables differ by their nature.[34] Therefore, our main objectives are (a) to assess the magnitude of maternal death in different settings and (b) to examine the association of various factors (non-medical cause of death (NMCOD), the medical cause of death (MCOD), time of death, socioeconomic status and medical history of the women) in relation to place of death among reviewed maternal deaths in Ethiopia.

METHODS

Study area

The study took place in Ethiopia, a country located in the horn of Africa with an estimated population of 114 963 588 in 2020.[35] The country has nine regional states and two city administrations. Ethiopia has 274 hospitals, 3545 health centres and 15 491 health posts that provide different levels of care. Currently, MDSR is in place in all facilities as one reportable event.

Study design

We carried out secondary data analysis by extracting data for seven consecutive years (2013–2020) reported from all regions and city administrations of Ethiopia, which included a total of 4316 reviewed maternal deaths.

Case definition

The surveillance data were reported to the next level using predefined case definitions implemented in facility and community settings.[14]

A. *Community case definition* (probable maternal deaths): death of a woman of reproductive age (between 15 and 49 years of age).[13]
B. *Suspected maternal deaths*: community case definition plus at least one of the following screening questions:
   – Died while pregnant.
   – Died within 42 days of termination of pregnancy.
   – Missed her menses before she died.

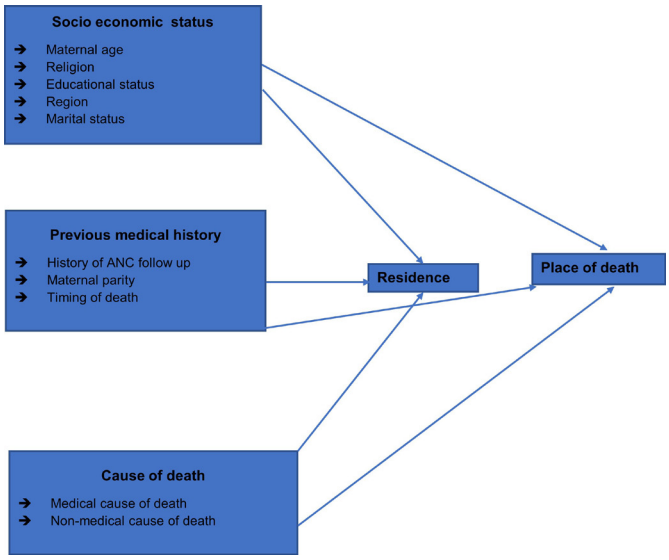

Figure 1 Hypothesised model for the place of death and associated factors among reviewed maternal deaths in Ethiopia, 2020. ANC, antenatal care.

C. *Standard case definition*: the death of a woman while pregnant or within 42 days of the end of pregnancy (irrespective of 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.[36]

Investigation and verification of death

After the death is distinguished using the above case definitions, the next step is the investigation and verification of death by the health extension workers at the community level. Whereas at a health facility level, the Public Health Emergency Management focal person is responsible for it. Following that, a verbal autopsy will be used to investigate and verify the community death. The investigation will only proceed after taking verbal consent from the family of the deceased woman. However, facility-based abstraction format is used for facility death.[14]

Review of death

Each completed verbal autopsy and facility-based maternal death abstraction will go through the review process by an established MDSR committee at the health facility. After the review, the death will be reported to the next level using case-based reporting format.[14]

Population under surveillance

All women of reproductive age in Ethiopia are eligible for the surveillance system.

Data type and source

Secondary data from the Ethiopian Public Health Institute, specifically from the Centre for Public Health Emergency Management, were used for the study.

Variable measure

The final case-based report has five distinct dimensions (reporting facility, socioeconomic status, medical history, cause of death (COD) and NMCOD) that provide a clear picture of the deceased woman. A hypothesised relationship was formulated for the variables based on literature review, plausibility of the relationship and the author's experience related to the place of death.[37 38] The proposed model was used to examine the effect of socioeconomic status, medical history and COD (medical and non-medical causes) on the place of death and possible mediation by residence (rural and urban) of the deceased women (figure 1).

The place of death studied includes health facility, transit and at home; they were endogenous variables measured with respective categories. Women deceased at a health centre and a hospital are declared as 'facility death', whereas women deceased at community and health post level are categorised as 'home death'. Similarly, women deceased while on the way to a health facility (a death on an ambulance and arrival from the referred facility) are considered as 'death in transit'.

Patient and public involvement

Neither the public nor the patient was involved in the design, conduct, reporting or dissemination plans of this research.

Study variable and measurement

Socioeconomic status and medical history

Reporting facilities comprised the name of a region, zone, district and health facility. The socioeconomic status includes age, residence, marital status and educational status of the deceased women. The medical history-related variable includes history of antenatal care (ANC) follow-up, parity and time of death (before delivery, during delivery and after delivery).

Medical cause of death

The MCOD was assigned using the standard WHO tool of the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, adopted for deaths during pregnancy, childbirth and puerperium. The assigned COD for each reviewed maternal death was grouped based on underlying causes of death during pregnancy, childbirth and the puerperium that is mutually exclusive from one another by its nature. The MCOD has nine groups: six of them are considered as a direct COD (direct obstetric deaths are those resulting from obstetric complications of the pregnancy state, from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above). The remaining three MCODs included under indirect MCOD, unspecified and coincidental.[36]

Non-medical cause of death

NMCOD is commonly known as the delay model developed by Thaddeus and Maine.[39] It is a framework that is used to evaluate the circumstances surrounding maternal

Table 1 Background characteristics and medical history among reviewed maternal deaths in Ethiopia, 2020

Variable	Category	Frequency	%
Age at death (years)			
	10–19	246	5.7
	20–29	2101	48.7
	30–39	1726	40.0
	40–49	243	5.6
Region			
	Addis Ababa	249	5.8
	Afar	62	1.4
	Amhara	1207	28.0
	Benishangul Gumuz	78	1.8
	Dire Dawa	163	3.8
	Gambella	31	0.7
	Harari	86	2.0
	Oromia	1295	30.0
	SNNP	555	12.9
	Somali	24	0.60
	Tigray	566	13.1
Residence			
	Rural	3671	85.1
	Urban	645	14.9
Marital status			
	Married	4030	93.4
	Unmarried	286	6.6
Religion			
	Christian	2712	62.8
	Muslim	1604	37.2
Educational level			
	Illiterate	3504	81.2
	Primary	459	10.6
	Secondary and above	353	8.2
Parity			
	0–1	1508	34.9
	2–4	1711	39.6
	5 and above	1097	25.4
History of ANC follow-up			
	Yes	1384	32.1
	No	2932	67.9
Time of death			
	Before delivery	856	19.8
	During delivery	649	15.1
	After delivery	2811	65.1

ANC, antenatal care; SNNP, Southern Nations, Nationalities, and Peoples' Region.

death. Maternal delays are classified into three, namely delay 1, delay 2 and delay 3.

Delay 1, which is a delay in deciding to seek care, is measured using five-item questions that include (1) visiting a traditional healer or traditional birth attendant first, (2) family having insufficient money, (3) lack of awareness of obstetric complications, (4) nearest healthcare facility is being more than 5 km away and (5) lack of decision to health facility due to perceived poor quality of care at a health facility. Similarly, delay 2, which is a delay in reaching a healthcare facility, is assessed using five-item questions that include (1) poor road condition or terrain, (2) long travel time from home to a healthcare facility (more than an hour), (3) cost of transportation, (4) lack of transportation and (5) no healthcare facility in the area (takes more than 1 hour to reach the healthcare facility). Furthermore, delay 3, which is a delay in receiving care at the healthcare facility, is also measured using four-item questions that include (1) presence of inadequate referral system, (ambulances not available, no fuel, breakdown and use of public transport), (2) shortage of equipment and supplies, (3) delayed management after admission (more than 30 min from the time of arrival to time of being assessed or receiving treatment) and (4) wrong assessment of risk, wrong diagnosis and wrong treatment. Responses to all questions related to delay were binary recorded as '1' for Yes and '0' for No. A row sum score of each delay was computed. Thus, we used the sum score of each delay and treated it as a continuous variable in the model.

Data processing, model building and analysis

Data were captured and coded in Epi Info V.7.2 and exported to STATA V.17 for further analysis. Missing data were handled through the listwise deletion method, whereby variables with missing values were excluded and the remaining data were analysed. Descriptive statistics and summary statistics were displayed using text, figures and tables. We employed one-way analysis of variance to compare the mean score of each delay among three groups (health facility, home and in transit) after checking normality and equal variance assumption. GSEM was employed to examine the relationship between various exogenous and endogenous or mediating variables. All endogenous variables were binary outcomes and fitted with binomial family and logit link function. The analysis started with the proposed model (figure 1), and changes were made iteratively by adding path links or including mediator variables if theoretically supported and comparing the information criteria of each model fit. Finally, the model identified with the lowest Bayesian information criterion (BIC) was retained. The model selection criteria were not solely dependent on the statistical significance of the effects. It also considered the theoretical plausibility, selection information criteria and model parsimony. Diagrammatically, the effect of each exogenous and mediating variable exerts on respective dependent variables, where indicated by the path unstandardised coefficient with a single-headed arrow. Furthermore, the correlation among disturbances was depicted by double arrow symbols. Statistically significant effects were assumed for $p<0.05$ at a CI of 95%. The mediation of effects was computed using the residence as a mediator, and the direct, indirect and total effects were determined using the non-linear combination of estimator

Table 2 Place of death by various socioeconomic factors and medical history among reviewed maternal deaths in Ethiopia, 2020

Variable	Category	Place of death		
		Home (n=752) n (%)	In transit (n=588) n (%)	Health facility (n=2976) n (%)
Age group (years)				
	10–19	47 (6.3)	36 (6.1)	163 (5.5)
	20–29	327 (43.5)	260 (44.2)	1514 (50.9)
	30–39	318 (42.3)	256 (43.5)	1152 (38.7)
	40–49	60 (8.0)	36 (6.1)	147 (4.9)
Region				
	Addis Ababa	12 (1.6)	19 (3.2)	218 (7.3)
	Afar	7 (0.9)	4 (0.7)	51 (1.7)
	Amhara	314 (41.8)	214 (36.4)	679 (22.8)
	Benishangul Gumuz	11 (1.5)	11 (1.9)	56 (1.9)
	Dire Dawa	5 (0.7)	4 (0.7)	154 (5.2)
	Gambella	5 (0.7)	1 (0.2)	25 (0.8)
	Harari	5 (0.7)	1 (0.2)	80 (2.7)
	Oromia	202 (26.9)	195 (33.2)	898 (30.2)
	SNNP	47 (6.3)	47 (8.0)	461 (15.5)
	Somali	7 (0.9)	0 (0.0)	17 (0.6)
	Tigray	137 (18.2)	92 (15.6)	337 (11.3)
Residence				
	Urban	48 (6.4)	49 (8.3)	548 (18.4)
	Rural	704 (93.6)	539 (91.7)	2428 (81.6)
Marital status				
	Married	700 (93.1)	449 (76.4)	2881 (96.8)
	Unmarried	52 (6.9)	139 (23.6)	95 (3.2)
Religion				
	Christian	531 (70.6)	400 (68.0)	1781 (59.8)
	Muslim	221 (29.4)	188 (32.0)	1195 (40.2)
Educational status				
	Illiterate	616 (81.9)	481 (81.8)	2407 (80.9)
	Primary	103 (13.7)	68 (11.6)	288 (9.7)
	Secondary and above	33 (4.4)	39 (6.6)	281 (9.4)
Parity				
	0–1	243 (32.3)	159 (27.0)	1106 (37.2)
	2–4	275 (36.6)	237 (40.3)	1199 (40.3)
	5 and above	234 (31.1)	192 (32.7)	671 (22.5)
History of ANC follow-up				
	Yes	236 (31.4)	184 (31.3)	964 (32.4)
	No	516 (68.6)	404 (68.7)	2012 (67.6)
Time of death				
	Before delivery	117 (15.6)	116 (19.7)	623 (20.9)
	During delivery	85 (11.3)	114 (19.4)	450 (15.1)
	After delivery	550 (73.1)	358 (60.9)	1903 (64.0)

ANC, antenatal care; SNNP, Southern Nations, Nationalities, and Peoples' Region.

Table 3 Underlying causes of death by place of death among reviewed maternal deaths in Ethiopia, 2020

Variables	Category	Place of death		
		Home (n=752) n (%)	In transit (n=588) n (%)	Health facility (n=2976) n (%)
Cause of death	Obstetric haemorrhage	512 (68.1)	417 (70.9)	1456 (48.9)
	Hypertensive disorders in pregnancy, childbirth and the puerperium (HDP)	47 (6.3)	47 (8.0)	512 (17.2)
	Pregnancy-related infection	59 (7.8)	31 (5.3)	261 (8.8)
	Other obstetric complications	7 (0.9)	5 (0.9)	115 (3.9)
	Pregnancies with abortive outcome	17 (2.3)	11 (1.9)	68 (2.3)
	Unanticipated complications of management	4 (0.5)	1 (0.2)	55 (1.8)
	Non-obstetric complication	68 (9.0)	49 (8.3)	345 (11.6)
	Unknown and undetermined	37 (4.9)	26 (4.4)	163 (5.5)
	Coincidental causes	1 (0.1)	1 (0.2)	1 (0.0)

technique.[40] In addition, variables that demonstrated statistical significance at an alpha level of 0.05 were only retained and presented in the result. Furthermore, the result of the final model was interpreted using OR=e^{β}.[41]

RESULTS

Sociodemographic status and medical history of the deceased women

A total of 4316 maternal deaths were included in the study. The mean age of the deceased women was 28.7±6.3 years (SD), and nearly half (48.7%) of them were in the age range of 20–29 years. Nearly 70% (69.2%) of the deceased women resided in Oromia and Amhara regions. Majority (81.2%) of the deceased women were illiterate, and 85.1% of them lived in a rural area. Besides, 67.9% of the deceased women had no history of ANC follow-up, and 65.1% of them were deceased after delivery (table 1).

Place of death

The proportion of maternal death at a health facility is 69.0% while at home and in transit are at 17.4% and 13.6%, respectively. Among the women deceased at a health facility, majority of them were aged 20–29, practised Christianity, resided in rural areas, were married, had no formal education, had no ANC follow-up and were deceased after delivery (table 2).

Comparison of COD among reviewed maternal deaths

Death due to obstetric haemorrhage (70.9%) for women who died in transit was higher than for women who died in a health facility and at home. However, the proportion of the remaining COD was higher for women who died at a health facility (table 3).

The mean score was higher in delay 1 for women deceased at home. Furthermore, the mean score of delay 2 and delay 3 was significantly higher for women who died during transit and in a health facility, respectively (table 4).

Factors associated with place of death among reviewed maternal deaths

The fitted model was relatively parsimonious and had the minimum BIC value compared with other competing models. Several variables, namely history of ANC follow-up, marital status, some of the MCOD (pregnancy-related infection, non-obstetric complication and abortive pregnancy outcome), were excluded from the final model as their contributions were not statistically significant at an alpha level of 0.05.

Accordingly, the model included 11 exogenous variables (age, parity, educational status, obstetric haemorrhage, hypertensive disorders in pregnancy, childbirth and the puerperium (HDP) and unanticipated complication of management, deceased before delivery, deceased during delivery, delay 1, delay 2 and delay 3). It included

Table 4 Comparison of NMCOD scores among reviewed maternal deaths in different places in Ethiopia, 2020

Domain of NMCOD and overall score	Place of death			P value
	Home (n=752) Mean (SD)	In transit (n=588) Mean (SD)	Health facility (n=2976) Mean (SD)	
Overall score	2.1 (1.5)	2.6 (1.8)	2.1 (1.7)	<0.0001
Delay 1	1.6 (1.2)	1.3 (1.2)	1.0 (1.1)	<0.0001
Delay 2	0.4 (0.8)	0.8 (1.0)	0.5 (0.8)	<0.0001
Delay 3	0.1 (0.4)	0.4 (0.6)	0.6 (0.7)	<0.0001

NMCOD, non-medical cause of death; SD, Standard deviation .

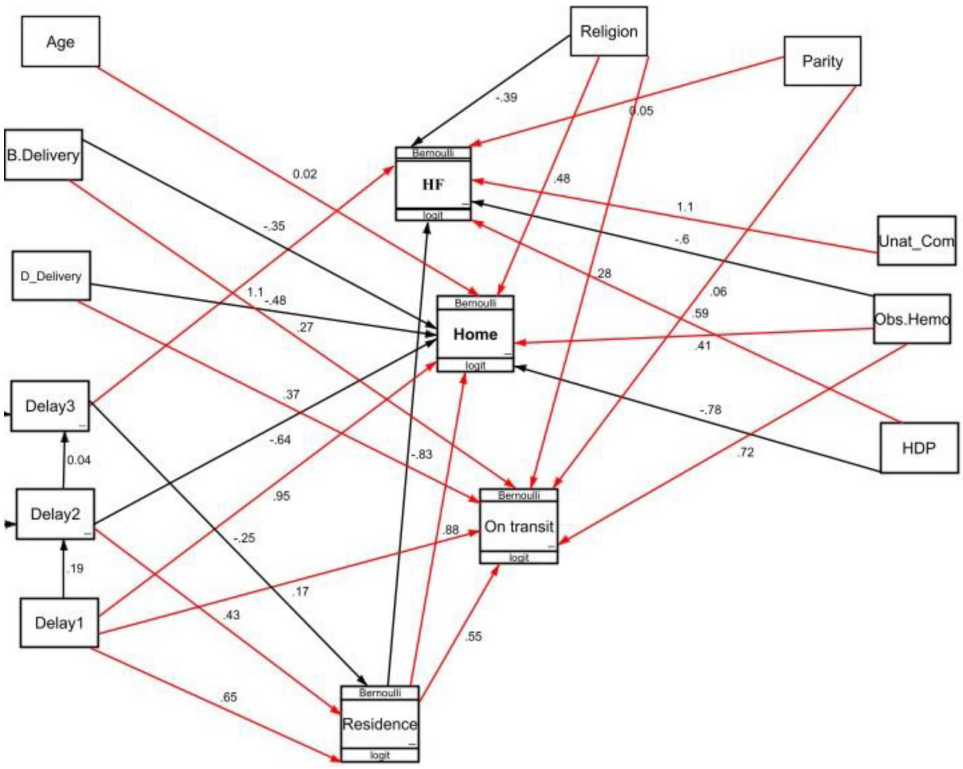

Figure 2 Generalised structural equation modelling (GSEM) predicting place of death among reviewed maternal deaths in Ethiopia, 2020. B.Delivery, before delivery; D_Delivery, during delivery, with β of unstandardised coefficients; HDP, hypertensive disorders in pregnancy, childbirth and the puerperium; HF, health facility; Obs.Hemo, obstetric haemorrhage; Unat_Com, unanticipated complication of management.

one mediator variable (residence) and three endogenous variables (death in a health facility, death at home and death during transit). Religion and obstetric haemorrhage were associated significantly with all endogenous variables. Moreover, nine exogenous variables, namely age, educational status, parity, death during delivery, obstetric haemorrhage, an unanticipated complication of management, delay 1, delay 2 and delay 3, were both directly and indirectly related to respective endogenous variables via the mediator variable of residence (figure 2).

Being resident in a rural area has a direct negative effect on health facility death (adjusted β=−0.70, 95% CI −0.95 to −0.46), whereas being resident in a rural area has a direct positive effect on death occurring during transit (adjusted β=0.51, 95% CI 0.20 to 0.83) and at home (adjusted β=0.85, 95% CI 0.54 to 1.17) (figure 2).

Among upstream variables (exogenous variables related to the mediator variable, rural residence), attending school up to primary has positive direct (adjusted β=0.41, 95% CI 0.03 to 0.79), indirect (adjusted β=0.02, 95% CI 0.001 to 0.030) and total (adjusted β=0.44, 95% CI 0.05 to 0.83) effects on death occurring at home. Regarding the MCOD, death due to HDP has a negative direct (adjusted β=−0.78, 95% CI −1.14 to −0.43) effect on death at home. Regarding death in transit, women deceased due to obstetric haemorrhage had a positive direct (adjusted β=0.68, 95% CI 0.48 to 0.87), indirect (adjusted β=0.003, 95% CI 0.001 to 0.005) and total (adjusted β=0.68, 95% CI 0.49 to 0.88) effect on transit death. Moreover, death due to unanticipated complication of management had a positive direct (adjusted β=0.68, 95% CI 0.48 to 0.87), indirect (adjusted β=0.003, 95% CI 0.001 to 0.005) and total (adjusted β=1.04, 95% CI 0.38 to 1.70) effect on facility death (table 5). The detailed interpretation of the result is available in online supplemental table S1.

DISCUSSION

This study can be taken as one of the most substantial studies done on maternal death using surveillance data. Residence was associated with all places of maternal death; it was also a significant mediator variable among the three places of maternal death, and the exogenous variables such as socioeconomic status, medical history and COD (both MCOD and NMCOD) were included in the model. All places of maternal deaths have direct, indirect and total effects with respective exogenous variables.

Per the assessment, more than two-thirds of deaths occurred at a health facility, whereas the proportion of death that occurred in transit and at home had almost similar contribution. Moreover, our estimate of health facility death was much greater than the known estimate of facility death in Ethiopia.[42 43] But it was comparable with some studies conducted on reviewed maternal death.[17 21 31] The high proportion of maternal death at the facility level in Ethiopia might be explained by the weak implementation of community-level surveillance in identifying and reporting deaths.[44] Besides, the

Table 5 The direct, indirect and total effects of sociodemographic status and cause of death (medical and non-medical causes of death) on determining the place of death among reviewed maternal deaths in Ethiopia, derived from the GSEM model, 2020

Characteristics	Direct effect (95% CI)	Indirect effect (95% CI)	Total effect (95% CI)
DV: home (effect measure is β)			
Age at death (years)			
10–19	–	–	–
20–29	0.0	0.0	0.0
30–39	0.03 (0.001 to 0.050)	0.003 (0.001 to 0.006)	0.033 (0.002 to 0.056)
40–49	0.09 (0.03 to 0.13)	0.008 (0.002 to 0.014)	0.10 (0.03 to 0.13)
Religion			
Christian	0.50 (0.32 to 0.69)	–	–
Muslim	0.0	–	–
Educational status			
Up to primary	0.42 (0.04 to 0.80)	0.02 (0.01 to 0.03)	0.44 (0.05 to 0.83)
Secondary and above	0.0		
Deceased before delivery			
Yes	−0.35 (−0.58 to −0.12)		
No	0.0		
Deceased during delivery			
Yes	−0.48 (−0.73 to −0.23)	0.005 (0.001 to 0.009)	−0.48 (−0.73 to −0.22)
No	0.0	0.0	0.0
Obstetric haemorrhage			
Yes	0.41 (0.22 to 0.60)	0.005 (0.003 to 0.008)	0.41 (0.22 to 0.61)
No			
HDP			
Yes	−0.78 (−1.13 to −0.44)	–	–
No	0.0	–	–
Delay 1	0.93 (0.86 to 1.06)	0.008 (0.005 to 0.011)	0.94 (0.80 to 1.06)
Delay 2	−0.64 (−0.80 to −0.48)	0.008 (0.005 to 0.011)	−0.63 (−0.79 to −0.47)
DV: in transit (effect measure is β)			
Religion			
Christian	0.25 (0.07 to 0.44)		
Muslim	0.0	–	–
Parity	0.05 (0.02 to 0.09)	0.0013 (0.006 to 0.0019)	0.06 (0.02 to 0.09)
Deceased before delivery			
Yes	0.27 (0.04 to 0.50)		
No	0.0	–	–
Deceased during delivery			
Yes	0.33 (0.09 to 0.57)	0.0028 (0.0004 to 0.0051)	0.33 (0.09 to 0.57)
No	0.0	0.0	
Obstetric haemorrhage			
Yes	0.68 (0.48 to 0.87)	0.003 (0.001 to 0.005)	0.68 (0.49 to 0.88)
No	0.0	–	–
Delay 2	0.58 (0.44 to 0.73)	0.004 (0.002 to 0.006)	0.59 (0.44 to 0.74)
DV: health facility (effect measure is β)			
Religion			

Continued

Table 5 Continued

Characteristics	Direct effect (95% CI)	Indirect effect (95% CI)	Total effect (95% CI)
Christian	−0.43 (−0.58 to −0.29)		
Muslim	0.0	–	–
Parity	−0.04 (−0.07 to −0.02)	−0.004 (−0.005 to −0.003)	−0.05 (−0.08 to −0.02)
Obstetric haemorrhage			
Yes	−0.60 (−0.77 to −0.44)	−0.009 (−0.0013 to −0.004)	−0.61 (−0.78 to −0.44)
No	0.0	0.0	
HDP			0.0
Yes	0.63 (0.36 to 0.90)		
No	0.0	–	–
Unanticipated complication of management			
Yes	0.99 (0.34 to 1.63)	0.05 (0.04 to 0.07)	1.04 (0.38 to 1.70)
No	0.0	0.0	0.0
Delay 1	−0.48 (−0.59 to −0.37)	−0.014 (−0.018 to −0.009)	−0.50 (−0.61 to −0.38)
Delay 3	1.01 (0.87 to 1.16)	0.009 (0.005 to 0.0013)	1.02 (0.87 to 1.17)

DV, Dependent Variable; GSEM, generalised structural equation modelling; HDP, hypertensive disorders in pregnancy, childbirth and the puerperium.

politicised nature of MDSR implementation makes the death reporting and review very challenging due to fear of blame and accountability by a higher official.[45]

Place of death is determined by various circumstances[46] and our study addressed this situation by exploring and analysing concurrently with the site of death outcome variables, residence in rural areas[47] and other potential predisposing factors (sociodemographic, medical and NMCOD).[32 48] Thus, this study adopted a rather unique and appropriate statistical technique and approach in identifying a complex network of relationships among the factors that affect the place of death.

Sociodemographic variables (age and educational status), time of death (deceased during and after delivery) and COD (MCOD and NMCOD) predict directly and independently for the different places of death except for the time of death; all these variables were also indirect predictors of a site of death through residence as mediator. Residence area (rural or urban) of deceased women was positively associated with death occurring at home[49] and in transit, whereas it was negatively related to facility death. This finding was coherent with other reports.[50 51] Women who resided in rural areas were less likely to receive adequate healthcare due to the absence of a facility with reasonable distance, lack of information and cultural beliefs and practices.[52] As a mediator variable, residence was positively associated with age at death, parity, time of death, COD (both MCOD and NMCOD) and educational status for deaths that occurred at home and during transit, but negatively related to health facility death within respective predictor variables except for delay 3.

The association between level of education and death at home could potentially be related to the likelihood that less educated women tend to have lower access to obtain information regarding pregnancy complications, which could potentially jeopardise making informed decisions on the utilisation of healthcare services.[53] Age at death is also positively associated with death occurring at home, and this may not be surprising as ageing leads to non-specific deterioration of most physiological functions. Moreover, history of successful delivery at home can contribute to it.[54–56] Women were less likely to die at home before and during delivery, which suggests that maternal death is more likely to occur at home after having birth. In connection with this, obstetric haemorrhage had a significant positive association with death occurring at home. This might be due to postpartum haemorrhage that takes place after delivery of the fetus, which could be managed and prevented easily by active management of the third-stage labour, which can be handled at the health facility.[57] Unlike obstetric haemorrhage, HDP was negatively associated with a home death. The finding was consistent with studies in Canada and Norway, which reported that several women who died from HDP received substandard care in a health facility.[58] The same finding was obtained from this study. This suggested that prompt recognition of pre-eclampsia and its proper management can reduce the worst complications of the disorder.[59] Furthermore, as the score of delay 1 rises, it will likely increase the risk of dying at home, and those attributed to barriers associated with healthcare-seeking behaviour such as the preference for traditional healers,[60] low women autonomy and knowledge of danger signs continue to lead to delay in decision and departure to seek care.[61] Besides, negative past experiences and expectations of poor quality of care were also important factors contributing to death occurring at home.[62]

Obstetric haemorrhage is an independent positive predictor for death occurring during transit. However, it is negatively associated with facility-level death, probably likened to death that occurred during transit in connection with poor obstetric referral services explicated by the absence of life-saving medical assistance during transporting to the referred facility.[63] Thus, this result suggested the paramount importance of non-pneumatic antishock garment usage during the referral process to reduce preventable maternal deaths.[64 65] On the contrary, the risk of dying due to obstetric haemorrhage at the facility is low because of the availability of mini-blood banks and tranexamic acid in facilities that provide caesarean section service.[16 66] Furthermore, unanticipated complications of management became a key factor, which is commonly related to the administration of anaesthesia,[67] contributing to facility death. The possible reason for anaesthesia-related maternal mortality includes the role of general anaesthesia, inadequate supervision of trainee anaesthetists and a lack of appropriate monitoring.[68–70] This demonstrates that health facilities should be vigilant while undertaking anaesthesia to reduce anaesthesia-related maternal death.

Women who had a high score of delay 2 were more likely to die during transit. This finding was coherent with studies in Ethiopia and Afghanistan that commonly relate to delays in reaching health service providers.[71 72] This might be because of the distance to the health facility and inadequate ambulance services.[73] In connection with this, delay 3 is a significant factor in determining facility-level death. In particular, delay 3 had a solid linkage with multiple referrals, delay in initiating treatment and absence of adequate skilled personnel.[74]

The study has the following limitations that need to be acknowledged: (1) Nearly all the reviewed deaths were collected from public health facilities with limited involvement of private healthcare providers, affecting the inclusiveness of the study. (2) The implementation of MDSR system, despite being planned to be rolled out nationally, is not completely achieved. Several health facilities are not properly recording maternal death, and this affects the representativeness of the study. (3) Despite commendable achievements in recording facility-based maternal deaths, the community-based surveillance of maternal deaths under the MDSR system has a long way to go, and this affects the comprehensiveness of the study. (4) The study adopted a correctional research design, and hence it is difficult to make any temporal causality from the study findings.

CONCLUSION

Almost 7 in 10 maternal deaths occurred in a health facility. Sociodemographic factors (age, residence and level of education), medical history (parity and time of death), the MCOD (obstetric haemorrhage, HDP, unanticipated management of complication) and the NMCOD (delay 1, delay 2 and delay 3) mediated by residence (rural area) were factors associated with place of death. A higher proportion of facility death could be suggestive of strengthening community surveillance. Community surveillance needs concerted effort in the engagement of political leaders and health extension workers in identifying and reporting community death. Besides, urgent emphasis is needed in unanticipated complication management parallel with the dominant causes of maternal death. Furthermore, policies and strategies should be revised, designed and implemented in consideration of the place of maternal death to mitigate preventable deaths.

Acknowledgements We are grateful for the support and facilitation from EPHI, specifically to the national and subnational public health emergency management staff and managers.

Contributors NT designed the study, collected and analysed the data, and wrote the first draft with input from FHW, RT, AZ and MH. All authors edited the manuscript and approved the final version. Guarantor author NT.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data are available on reasonable request with the data sharing policy of the institute.

ORCID iDs

Neamin Tesfay http://orcid.org/0000-0002-2348-1199

Fitsum Woldeyohannes http://orcid.org/0000-0003-3440-3855

REFERENCES

1 Graham W, Woodd S, Byass P, *et al*. Diversity and divergence: the dynamic burden of poor maternal health. *Lancet* 2016;388:2164–75.
2 Hogan MC, Foreman KJ, Naghavi M, *et al*. Maternal mortality for 181 countries, 1980-2008: a systematic analysis of progress towards millennium development goal 5. *Lancet* 2010;375:1609–23.
3 Gwatkin DR, Rutstein S, Johnson K, *et al*. *Socio-economic differences in health, nutrition, and population within developing countries*. Washington, DC: World Bank, 2007: 287.
4 Trends in maternal mortality. 1990. Available: https://www.unfpa.org/publications/trends-maternal-mortality-1990-2015 [Accessed 17 Oct 2017].
5 Alkema L, Chou D, Hogan D, *et al*. Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the un maternal mortality estimation inter-agency group. *Lancet* 2016;387:462–74.

6 Hogan MC, Foreman KJ, Naghavi M, *et al*. Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards millennium development goal 5. *The Lancet* 2010;375:1609–23.
7 Oleribe OO, Taylor-Robinson SD. Before sustainable development goals (SDG): why Nigeria failed to achieve the millennium development goals (mdgs). *Pan Afr Med J* 2016;24
8 Women UN. Sustainable development goal 3: good health and well-being. UN Women. Available: https://www.unwomen.org/en/news/in-focus/women-and-the-sdgs/sdg-3-good-health-well-being [Accessed 17 Oct 2017].
9 World Data Atlas. Ethiopia maternal mortality ratio. 1960 to 2020. Available: https://knoema.com//atlas/Ethiopia/Maternal-mortality-ratio [Accessed 17 Oct 2021].
10 Central Statistical Authority [Ethiopia] and ORC Macro. *Ethiopia demographic and health survey 2000*. Addis Ababa, Ethiopia, and Calverton, Maryland, USA: Central Statistical Authority and ORC Macro, 2001.
11 The Federal Democratic Republic. Ethiopia ministry of health health sector transformation plan 2015/16 - 2019/20. Ethiopia.: Available: https://tinyurl.com/33wvh5sh [Accessed 17 Oct 2021].
12 Koblinsky M. Maternal death surveillance and response: a tall order for effectiveness in resource-poor settings. *Glob Health Sci Pract* 2017;5:333–7.
13 World Health Organization. Maternal death surveillance and response: technical guidance. 2021. Available: https://www.who.int/publications-detail-redirect/9789241506083
14 Ethiopian Public Health Institute. NATIONAL TECHNICAL GUIDANCE FOR MATERNAL AND PERINATAL DEATH SURVEILLANCE AND RESPONSE in ethiopia - google search. Available: https://tinyurl.com/736n2fuc [Accessed 17 Oct 2021].
15 Dumont A, Gaye A, de Bernis L, *et al*. Facility-based maternal death reviews: effects on maternal mortality in a district hospital in Senegal. *Bull World Health Organ* 2006;84:218–24.
16 Tesfay N, Tariku R, Zenebe A, *et al*. Critical factors associated with postpartum maternal death in Ethiopia. *PLoS One* 2022;17:e0270495
17 Kaur M, Gupta M, Pandara Purayil V, *et al*. Contribution of social factors to maternal deaths in urban India: use of care pathway and delay models. *PLoS One* 2018;13:e0203209
18 Ameh CA, Kerr R, Madaj B, *et al*. Knowledge and skills of healthcare providers in sub-Saharan Africa and Asia before and after competency-based training in emergency obstetric and early newborn care. *PLoS One* 2016;11:e0167270
19 World. The safe motherhood action agenda: priorities for the next decade. The World Bank; 2021. Available: https://agris.fao.org/agris-search/search.do?recordID=US2012418830
20 Tesfay N, Tariku R, Zenebe A, *et al*. Target areas to reduce the burden of maternal death due to obstetric hemorrhage in Ethiopia. *PLoS One* 2022;17:e0274866
21 Mgawadere F, Unkels R, Kazembe A, *et al*. Factors associated with maternal mortality in malawi: application of the three delays model. *BMC Pregnancy Childbirth* 2017;17:219.
22 Gebreegziabher A, Medhanyie AA, Meressa B, *et al*. Determinants of ambulance service utilization among pregnant women in mekelle city, ethiopia: a case-control study. *East African Journal of Health Sciences* 2019;1:88–9.
23 Legese T, Mulatu K, Kahsay T. Trends and determinants of maternal mortality in mizan-tepi university teaching and bonga general hospital from 2011-2015: A case-control study. *Health Science Journal* 2016;10:1.
24 Mirkuzie AH, Sisay MM, Reta AT, *et al*. Current evidence on basic emergency obstetric and newborn care services in addis ababa, ethiopia; a cross sectional study. *BMC Pregnancy Childbirth* 2014;14:354.
25 Canavan ME, Brault MA, Tatek D, *et al*. Maternal and neonatal services in Ethiopia: measuring and improving quality. *Bull World Health Organ* 2017;95:473–7.
26 Pasha O, Saleem S, Ali S, *et al*. Maternal and newborn outcomes in pakistan compared to other low and middle income countries in the global network's maternal newborn health registry: an active, community-based, pregnancy surveillance mechanism. *Reprod Health* 2015;12 Suppl 2(Suppl 2):S15.
27 Ethiopian Public Health Institute. Ethiopia service availability and readiness assessment (SARA) 2018 final report. Available: https://tinyurl.com/n87e8j6z [Accessed 17 Oct 2021].
28 Somé DT, Sombié I, Meda N. How decision for seeking maternal care is made -- a qualitative study in two rural medical districts of burkina faso. *Reprod Health* 2013;10:1–6.
29 Ethiopian Public Health Institute (EPHI). *Ethiopia mini demographic and health survey 2019: final report*Ethiopia. Rockville, Maryland, USA: EPHI and ICF, 2021.
30 Filippi V, Richard F, Lange I, *et al*. Identifying barriers from home to the appropriate Hospital through near-miss audits in developing countries. *Best Pract Res Clin Obstet Gynaecol* 2009;23:389–400.
31 Lili X, Jian H, Mengjun Z, *et al*. Epidemiological analysis of maternal deaths in Hunan Province in China between 2009 and 2014. *PLoS One* 2018;13:e0207920
32 Gunawardena N, Bishwajit G, Yaya S. Facility-based maternal death in Western Africa: a systematic review. *Front Public Health* 2018;6:48
33 Adegoke AA, Campbell M, Ogundeji MO, *et al*. Place of birth or place of death: an evaluation of 1139 maternal deaths in nigeria. *Midwifery* 2013;29:e115–21.
34 Koirala S, Deuba K, Nampaisan O, *et al*. Facilitators and barriers for retention in HIV care between testing and treatment in asia-a study in bangladesh, indonesia, lao, nepal, pakistan, philippines and vietnam. *PLoS One* 2017;12:e0176914
35 world meter. Ethiopia demographics 2020 (population, age, sex, trends) - world meter. Available: https://tinyurl.com/vfxsjnnv [Accessed 17 Oct 2017].
36 World health Organization. WHO | the WHO application of ICD-10 to deaths during pregnancy, childbirth, and puerperium: ICD MM. Available: https://tinyurl.com/3hd9f645 [Accessed 17 Oct 2017].
37 Karkee R, Tumbahangphe KM, Maharjan N, *et al*. Who are dying and why? A case series study of maternal deaths in Nepal. *BMJ Open* 2021;11:e042840
38 Rane TM, Mahanta TG, Baruah M, *et al*. Epidemiological study of maternal death in Assam. *Clinical Epidemiology and Global Health* 2019;7:634–40.
39 Thaddeus S, Maine D. Too far to walk: maternal mortality in context. *Soc Sci Med* 1994;38:1091–110.
40 Stata Corporation. *Stata survey data reference manual*. Statacorp, 2003.
41 Szumilas M. Explaining odds ratios. *J Can Acad Child Adolesc Psychiatry* 2010;19:227–9.
42 Tesfaye G, Loxton D, Chojenta C, *et al*. Magnitude, trends and causes of maternal mortality among reproductive aged women in kersa health and demographic surveillance system, eastern ethiopia. *BMC Womens Health* 2018;18:198.
43 Central Statistical Agency (CSA). *Ethiopia demographic and health survey 2016*Ethiopia. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF, 2016.
44 Ayele B, Gebretnsae H, Hadgu T, *et al*. Maternal and perinatal death surveillance and response in Ethiopia: achievements, challenges and prospects. *PLoS One* 2019;14:e0223540
45 Melberg A, Mirkuzie AH, Sisay TA, *et al*. " maternal deaths should simply be 0 ": politicization of maternal death reporting and review processes in Ethiopia. *Health Policy Plan* 2019;34:492–8.
46 Zalvand R, Tajvar M, Pourreza A, *et al*. Determinants and causes of maternal mortality in iran based on ICD-MM: a systematic review. *Reprod Health* 2019;16:16.
47 Hanson C, Cox J, Mbaruku G, *et al*. Maternal mortality and distance to facility-based obstetric care in rural southern Tanzania: a secondary analysis of cross-sectional census data in 226 000 households. *Lancet Glob Health* 2015;3:S2214-109X(15)00048-0:e387–95.:
48 Mgawadere F, Unkels R, Adegoke A, *et al*. Measuring maternal mortality using a reproductive age mortality study (Ramos). *BMC Pregnancy Childbirth* 2016;16:291:291.:
49 Khan N, Pradhan MR. Identifying factors associated with maternal deaths in jharkhand, India: a verbal autopsy study. *J Health Popul Nutr* 2013;31:262–71.
50 Okwaraji YB, Webb EL, Edmond KM. Barriers in physical access to maternal health services in rural Ethiopia. *BMC Health Serv Res* 2015;15:493
51 Horwood G, Opondo C, Choudhury SS, *et al*. Risk factors for maternal mortality among 1.9 million women in nine empowered action group states in India: secondary analysis of annual health survey data. *BMJ Open* 2020;10:e038910
52 World Health Organization. Maternal mortality [internet]. 2021. Available: https://tinyurl.com/38jxzxwx
53 Somefun OD, Ibisomi L. Determinants of postnatal care non-utilization among women in nigeria. *BMC Res Notes* 2016;9:21.
54 Sarker BK, Rahman M, Rahman T, *et al*. Reasons for preference of home delivery with traditional birth attendants (tbas) in rural Bangladesh: a qualitative exploration. *PLoS One* 2016;11:e0146161
55 Lisonkova S, Potts J, Muraca GM, *et al*. Maternal age and severe maternal morbidity: a population-based retrospective cohort study. *PLoS Med* 2017;14:e1002307
56 Hoyert DL. Maternal mortality rates in the united states, 2019. *NCHS Health E-Stats* 2021;
57 Hofmeyr GJ, Qureshi Z. Preventing deaths due to haemorrhage. *Best Pract Res Clin Obstet Gynaecol* 2016;36:68–82.

58 Nyfløt LT, Ellingsen L, Yli BM, *et al*. Maternal deaths from hypertensive disorders: lessons learnt. *Acta Obstet Gynecol Scand* 2018;97:976–87.
59 von Dadelszen P, Magee LA. Preventing deaths due to the hypertensive disorders of pregnancy. *Best Practice & Research Clinical Obstetrics & Gynaecology* 2016;36:83–102.
60 Worku AG, Yalew AW, Afework MF. Maternal complications and women's behavior in seeking care from skilled providers in North gondar, Ethiopia. *PLOS ONE* 2013;8:e60171
61 Wanaka S, Hussen S, Alagaw A, *et al*. Maternal delays for institutional delivery and associated factors among postnatal mothers at public health facilities of gamo zone, southern Ethiopia. *Int J Womens Health* 2020;12:127–38.
62 Mrisho M, Schellenberg JA, Mushi AK, *et al*. Factors affecting home delivery in rural Tanzania. *Trop Med Int Health* 2007;12:862–72.
63 Yasin C, Geleto A, Berhane Y. Referral linkage among public health facilities in ethiopia: a qualitative explanatory study of facilitators and barriers for emergency obstetric referral in addis ababa city administration. *Midwifery* 2019;79
64 Miller S, Turan JM, Dau K, *et al*. Use of the non-pneumatic anti-shock garment (NASG) to reduce blood loss and time to recovery from shock for women with obstetric haemorrhage in Egypt. *Glob Public Health* 2007;2:110–24.
65 Bekele G, Terefe G, Sinaga M, *et al*. Utilization of non-pneumatic anti-shock garment and associated factors for postpartum hemorrhage management among health care professionals' in public hospitals of jimma zone, south-west ethiopia, 2019. *Reprod Health* 2020;17:37.
66 McClure EM, Jones B, Rouse DJ, *et al*. Tranexamic acid to reduce postpartum hemorrhage: a mandate systematic review and analyses of impact on maternal mortality. *Am J Perinatol* 2015;32:469–74.
67 Say L, Chou D. Better understanding of maternal deaths -- the new who cause classification system. *BJOG* 2011;118 Suppl 2:15–7.
68 Shikur B, Marye A, Mesfin E. Spinal anesthesia for cesarean delivery at two teaching hospitals in addis ababa, ethiopia. *Ethiop Med J* 2018;56
69 Enohumah KO, Imarengiaye CO. Factors associated with anaesthesia-related maternal mortality in a tertiary hospital in Nigeria. *Acta Anaesthesiol Scand* 2006;50:206–10.
70 Aregawi A, Terefe T, Admasu W, *et al*. Comparing the effect of spinal and general anaesthesia for pre-eclamptic mothers who underwent caesarean delivery in a tertiary, Addis ababa, Ethiopia. *Ethiop J Health Sci* 2018;28:443–50.
71 Hirose A, Borchert M, Cox J, *et al*. Determinants of delays in travelling to an emergency obstetric care facility in herat, afghanistan: an analysis of cross-sectional survey data and spatial modelling. *BMC Pregnancy Childbirth* 2015;15:14.
72 Ayalew Tiruneh G, Melkamu Asaye M, Solomon AA, *et al*. Delays during emergency obstetric care and their determinants among mothers who gave birth in South gondar zone hospitals, Ethiopia. A cross-sectional study design. *Glob Health Action* 2021;14:1953242
73 Tesfay N, Tariku R, Zenebe A, *et al*. Area of focus to handle delays related to maternal death in Ethiopia. *PLoS One* 2022;17:e0274909
74 Knight HE, Self A, Kennedy SH. Why are women dying when they reach Hospital on time? A systematic review of the " third delay. " *PLoS One* 2013;8:e63846