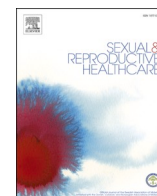


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Scoping maternal care through the lens of maternal deaths: A retrospective analysis of maternal mortality in Georgia

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ABSTRACT

Introduction: Reduction of the maternal mortality ratio (MMR) to 12 per 100,000 live births by 2030 is a priority target in Georgia. This study aims to assess and classify MM in Georgia by direct and indirect causes of death from 2014 to 2017, using data from the national surveillance system and in accordance with internationally approved criteria.

Material and methods: In this secondary study, MM data was retrieved from the Maternal and Children's Health Coordinating Committee and validated with data from the Vital Registry System and the Georgian Birth Registry. The study sample comprised 61 eligible MM cases. Relevant information was transferred to case-report forms to review and classify MM cases by direct and indirect causes of maternal death.

Results: The MMR during the study period was 26.7 per 100,000 live births. The proportion of direct causes of maternal death exceeded that of indirect causes, at 62% and 38%, respectively. The leading direct cause of maternal death was haemorrhage, while infection was the most frequent indirect cause. 52.5% of MM cases had no pre-existing medical condition, 62.3% had frequent adherence to antenatal care, and 52.5% had emergency caesarean sections.

Conclusion: In Georgia, direct causes of maternal death exceed indirect causes in MM cases, with haemorrhage and infections, respectively, being most common. These findings are important to ensure optimal and continuous care and to accelerate progress in the reduction of MM in the country.

Introduction

Maternal mortality ratio (MMR) is an important indicator of maternal health and perinatal care. Although significant progress has been made in the past decade [1–2], the global reduction of MMR remains a critical challenge. Following the United Nation's Millennium Development Goals by 2015, maternal health was also prioritised in the Sustainable Development Goals, with the target to reduce MMR below 70 per 100,000 livebirths by 2030 [2–3]. Recent studies of maternal mortality (MM) have demonstrated that 94% of all maternal deaths

occur in the developing world [4]. According to the WHO, the MMR in low-income countries was 239 per 100,000 live births compared to 12 in the rest of the world in 2015 [5–8]. Direct obstetric causes account for about 86% of all maternal deaths globally, with haemorrhage being the most common cause [7]. However, most MM cases are preventable, and about 50% of cases are avoidable [9,10]. In order to reach the desired reduction in MMR, efforts must focus on the improvement of all parts of the continuum of reproductive healthcare, accurate surveillance, and understanding the causes of maternal death [2,9,10].

Over the last decade, Georgia, a developing lower-middle-income

Abbreviations: MM, maternal mortality; MMR, maternal mortality ratio; WHO, World Health Organisation; ANC, antenatal care; MCHCC, Maternal and Children's Health Coordinating Committee; MoH, Ministry of Internally Displaced Persons from the Occupied Territories, Labour, Health and Social Affairs of Georgia; NCDC, National Center for Disease Control and Public Health; VRS, Vital Registry System; GBR, Georgian Birth Registry; ICD-10, International Classification of Diseases, 10th revision; CI, confidence interval.

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country with a population of 3,719,300 [11], has embraced evidence-based medicine and implemented a health improvement programme with the aim of bettering the quality of health care. State expenses for healthcare increased 2.5 times since 2012, and these expenses currently claim 3.7% of the country's gross domestic product. In 2013, Georgia launched its Universal Health Care Programme, which entitles every citizen to a basic package of health services and is a visible demonstration of the country's commitment to the Sustainable Development Goals. Perinatal services are integrated into this programme, including antenatal care (ANC). According to official statistics, from 2006 to 2016, the MMR fluctuated between 32.1 and 23 per 100,000 live births [11,12,13]. The health improvement programme also sought to implement relevant policy to improve perinatal health and develop national surveillance, reporting, and registration systems and to reduce the MMR to 12 per 100,000 live births by 2030 [13,14].

The Maternal and Children's Health Coordinating Committee (MCHCC), part of the Ministry of Internally Displaced Persons from the Occupied Territories, Labour, Health, and Social Affairs of Georgia (MoH), receives notification of each maternal death within 24 h of its occurrence. Reporting of all medical information related to these maternal deaths is also mandatory. The MCHCC is responsible for a national surveillance and response system based on Confidential Enquiries into Maternal Deaths. This entails active tracking and systematic multidisciplinary investigation of all maternal deaths occurring in Georgia, followed by a response that aims to avoid future maternal deaths and improve maternal health care [15,16,17]. In 2012, Georgia implemented the WHO case-report form for death registration and classification. In addition, under the administration of the National Centre for Disease Control and Public Health (NCDC), the country created the Georgian Birth Registry (GBR), enhanced Vital Registry System (VRS), improved follow-up of maternal deaths through the Electronic Integrated Disease Surveillance System, and implemented the verbal autopsy methodology as part of the surveillance of MM. Moreover, specific guidelines, clinical protocols, and tailored courses for the management of common causes of maternal death were created and provided to medical personnel. Details of the surveillance of MM introduced by the MoH and the reporting and registration supported by the NCDC are described elsewhere [13,18].

So far, little attention has been given to surveillance system-based studies. There are few studies that scrutinise persistent causes of MM in developing countries like Georgia, where there are a shortage of appropriate epidemiological reports based on reliable data. No study has yet employed data from the Georgian surveillance system to evaluate whether this data can be used by stakeholders to direct efforts to improve maternal healthcare and thus accelerate progress toward the reduction of MMR in Georgia. Therefore, this study aims to assess and classify MM in Georgia by direct and indirect causes of death from 2014 to 2017, using data from the national surveillance system and in accordance with internationally approved criteria.

Materials and methods

We defined maternal death according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10), i.e., the death of a woman while pregnant or within 42 days of delivery or termination of pregnancy through any causes associated with, or exacerbated by, pregnancy or its management; it did not include deaths from incidental or accidental causes [19].

This study utilised secondary data provided by the MCHCC. All MM cases reported to the MCHCC for the years 2014 through 2017 were collected, reviewed, and validated by the study authors during 2018. The final study sample comprised 61 eligible MM cases, which were registered officially in Georgia as MM cases during the same time period.

Causes of maternal death were classified as direct (obstetric complications of the pregnant state or its management) or indirect (resulting from a previous existing disease or a disease that developed during

pregnancy, and which were not due to a direct obstetric cause), and categorised by ICD-10 code [19]. If both direct and indirect causes of death were recorded, and the starting mechanism for the chain of events was determined to be obstetric, the case was classified as having a direct cause of maternal death. Suicide ($n = 2$) was not included as a direct cause of death in this analysis, contrary to the recommended practice of the ICD-MM [20]. Indeed, ICD-MM recommended practice is not yet accepted worldwide, and Georgia currently follows ICD-10 classifications. Therefore, suicide was defined as an indirect cause of maternal death, following the ICD-10 classification of this term, excluding mental and behavioural disorders associated with the puerperium from direct cause of death. Final diagnoses were validated with autopsy records when available.

Relevant information from MCHCC medical documents was transferred to a standardised case-report form, which was designed for this particular study. The form synthesised data on demographic characteristics, health, perinatal conditions, and other diagnoses (recorded by ICD-10 code) in order to fully ascertain the cascade of events leading to maternal death and establish diagnoses independent of the MCHCC decision. In MM cases with insufficient information in the MCHCC, VRS, and GBR, demographic or obstetric data were acquired from additional NCDC sources (Electronic Integrated Disease Surveillance System; verbal autopsy).

The MMR for the study period was defined as the number of eligible MM cases per 100,000 live births. The confidence interval (CI) was estimated as a Wald Interval. All analyses were performed using STATA 15 (StataCorp LLC, College Station, TX, USA). In analyses of direct and indirect causes of maternal death, MM cases that occurred outside of medical facilities with no autopsy or verbal autopsy could not be classified and were excluded.

Ethical consideration

The Institutional Review Board of NCDC approved the legal aspects of the study (IRB #2017-009). In addition, regional Committees for Medical and Health Research Ethics (REC North) approved the protocol (Ref: 2017/404/REK nord). Personal identification remained hidden to the investigator at all times and the data are free from personal identifiers.

Results

Over the 4-year study period (2014–2017), there were 228,300 live births in Georgia [11] with an MMR of 26.7 per 100,000 live births. All MM cases reported to the MCHCC during the study period ($n = 84$) were identified (including incidental, accidental, and late maternal deaths), reviewed, and validated against MM cases in the GBR and VRS using the unique personal identification number assigned to Georgian residents/citizens. Pregnancy-related ICD-10 codes (O00-O95 and 98-99, A34, B20-B24, C58, X60-X84) were used for additional validation of MM cases or identification of possible misclassified MM cases in both registries [19], but this process did not reveal any additional MM cases for this period in Georgia. Following the maternal death definition in the ICD-10, and after validation in the VRS and GBR, 23 MM cases were excluded by the study authors (12 due to late maternal death, 9 due to accidental death, and 2 due to occurrence in occupied territories in Georgia with lack of information). Thus, 61 eligible MM cases comprised the study sample (Table 1). The majority of MM cases were 25–34 years old (44.3%), married (77%), and lived in rural areas (55.7%). Medical facilities could not be classified by the level of provided services (primary, secondary, and tertiary) during the study period, as this classification was only completed after 2017 in Georgia. A large proportion of MM cases were multiparous (49.9%), had no pre-existing medical conditions (52.5%), and had low-risk pregnancies (73.8%). Moreover, 62.3% of MM cases adhered to obligatory ANC, 42.6% had preterm deliveries (between 22 and 36 weeks of gestation), and 52.5% had an

Table 1
Selection of maternal mortality cases. Georgia, 2014–2017.

	2014	2015	2016	2017	Total
Total cases	26	24	17	17	84
<i>Excluded cases</i>					
Late maternal death	5	3	1	3	
Accidental death	–	1	4	4	
De facto territories	–	–	1	1	
Final study sample	21	20	11	9	61

emergency caesarean section (CS) (Table 2).

Thirty-six (62%) MM cases were due to direct causes of maternal death, and 22 were due to indirect causes (38%). Three MM cases were unclassifiable, as the death occurred outside medical facilities with limited medical data. Due to this issue, these cases were excluded from the further analysis. Two of the unclassifiable cases died during

Table 2
Demographic and prenatal characteristics associated with maternal mortality. Georgia, 2014–2017.

	Total n = 61 n (%)
<i>Age groups</i>	
18–24	14 (22.9)
25–34	27 (44.3)
35–47	19 (31.2)
Unknown ^b	1 (1.6)
<i>Marital status</i>	
Married	47 (77)
Never married	9 (14.75)
Unknown	5 (8.25)
<i>Parity</i>	
Primiparous	27 (44.3)
Multiparous	30 (49.4)
Missing ^c	4 (6.6)
<i>Residency</i>	
Rural	34 (55.7)
Urban	27 (44.3)
<i>Pre-existing medical condition</i>	
Yes	15 (24.6)
No	32 (52.5)
Unknown	14 (22.9)
<i>Adherence to antenatal care</i>	
No care	6 (9.8)
1–4	28 (45.9)
>4	10 (16.4)
Missing	17 (27.9)
<i>High-risk pregnancy</i>	
Yes	16 (26.2)
No	45 (73.8)
<i>Gestational age</i>	
<22 weeks	5 (8.2)
Preterm (22–36 weeks)	26 (42.6)
Early term (37–38 weeks)	10 (16.4)
Full term (39–40 weeks)	12 (19.7)
Late term (41–42 weeks)	3 (4.9)
Unknown	5 (8.2)
<i>Mode of delivery</i>	
Normal vaginal	15 (24.6)
Planned CS ^a	3 (4.9)
Emergency CS ^a	32 (52.5)
Died during pregnancy	11 (18)

^a Caesarean section.

^b Supporting medical document or data was lacking in the data source.

^c Empty box or insufficient information in the respective data source.

pregnancy, and one in the late postpartum period. When considering direct causes of maternal death, three MM cases (8.3%) died from anaesthetic complications, two during childbirth, and one 7–42 days postpartum after oesophageal haemorrhage and sepsis caused by a misplaced tube during intubation. Two deaths (5.5%) were related to ectopic pregnancies, three to amniotic fluid embolism (8%), and six to venous thromboses (18%). Four MM cases (11.1%) were attributed to eclampsia and the haemolysis, elevated liver enzymes, and a low platelet count (HELLP) syndrome (Table 3).

Among all direct causes, haemorrhage was the “initiating” event in the cascade of complications, which represented 29.5% (95% CI: 19.4–41.9) of all MM cases in our study. Nine MM cases died within 24 h, six died 2–6 days postpartum, and three died 7–42 days postpartum. Nine of these 18 cases had neither severe maternal diseases nor any severe pregnancy-related conditions. Fourteen of these cases had CS and died from postpartum bleeding. Seven of those 14 had no serious maternal- or pregnancy-related diseases recorded in their medical file. Only one MM case was attributed to uterine rupture, whereas six cases experienced placental abruption. Extensive blood loss was reported in seven MM cases (≥ 1500 ml); blood transfusion was provided in 11 cases (Table 4).

Hysterectomy was performed in 13 MM cases, among whom nine ended up with disseminated intravascular coagulation. Post-caesarean laparotomy was performed in five cases that suffered haemorrhage, but none of these cases received uterine artery embolisation as an alternative treatment. Pre-eclampsia was the dominant pregnancy-related disease associated with haemorrhage, mainly in combination with severe obesity and emergency CS. Moreover, severe obesity was observed in five out of 18 haemorrhage cases, anaesthesia complications in two of three, venous thromboembolism in four of six, and ectopic pregnancy one of two MM cases (Tables 3 and 4).

Of all 22 MM cases attributed to indirect causes of maternal death, seven died during pregnancy, three died 2–6 days postpartum, and 12 died 7–42 days postpartum (Table 5). The leading cause of indirect maternal death was infection (10 cases, comprising 45.5%); among them were leptospirosis (2 cases), pneumonia (2 cases), tuberculosis (2 cases), meningitis (2 cases), and hepatitis (1 case). Three became pregnant after a cancer diagnosis (acute leukaemia) and two had a diagnosis of malformations. Of those, four died during pregnancy and the fifth a few days after childbirth. Three MM cases died from complications of cardiovascular disease, three from suicide, and one case from complications due to a cholecystectomy in the postpartum period (Table 5).

Thirty-one percent of MM cases had incomplete medical records, i.e., missing ANC related data, autopsy data, and histology reports.

Discussion

This is the first study of MM that has been performed after the creation of the MCHCC in Georgia. We found that the share of direct causes of maternal death exceeded that of indirect causes of maternal death. Haemorrhage was the leading direct cause of maternal death, and infection was the most common indirect cause. The estimated MMR during our study period was 26.7 per 100,000 live births. This number confirms the relatively stable MMR reported by the country’s official national statistics office for the last decade [11,13]. Moreover, it reflects the same level of MM recently reported from middle-income countries in Europe (Romania, Russian Federation, and Turkey), Central and East Asia (Armenia, Azerbaijan, Turkmenistan, and Uzbekistan), and Latin America (Costa Rica) [7,10,21,22,23]. However, the observed MMR in Georgia is double that of most high-income countries [1,24,25] and far from the ratio being targeted for 2030 in Georgia [13,14]. Obviously, some actions have already been taken to change the current MMR; although, tailored solutions based on evidence should be initiated to reach the desired goal before the deadline.

A notable finding was the proportion of direct and indirect causes of

Table 3

Direct causes of maternal death - major maternal, pregnancy, and delivery related events, excluding haemorrhage. Georgia, 2014–2017.

Time of death	Maternal condition	Pregnancy-related condition	Mode of delivery	Delivery-related condition	Postpartum events
In pregnancy	Obesity	Ectopic pregnancy	Not applicable	Not applicable	Not applicable
In pregnancy	None	Ectopic pregnancy	Not applicable	Not applicable	Not applicable
Delivery	None	Preeclampsia	Emergency CS ^b	Anaesthesia complications	Not applicable
Delivery	Obesity	None	Emergency CS ^b	Anaesthesia complications	Not applicable
7–42 days	Obesity	Preeclampsia	Emergency CS ^b	Anaesthesia complications	Oesophageal haemorrhage, sepsis
1st 24 h	None	None	Emergency CS ^b	Amniotic fluid embolism	Hysterectomy
1st 24 h	None	Preeclampsia	Emergency CS ^b	Amniotic fluid embolism	None
2–6 days	Anaemia	None	Vaginal	Amniotic fluid embolism	HELLP ^a , DIC ^c
1st 24 h	None	None	Vaginal	None	Venous thromboembolism
2–6 days	Obesity	None	Emergency CS ^b	None	Venous thromboembolism
2–6 days	Obesity	None	Emergency CS ^b	None	Venous thromboembolism
7–42 days	Obesity	Preeclampsia	Emergency CS ^b	None	Venous thromboembolism
7–42 days	Obesity	None	Planned CS ^b	None	Venous thromboembolism
7–42 days	None	None	Emergency CS ^b	None	Venous thromboembolism
1st 24 h	None	Preeclampsia	Vaginal	Eclampsia	None
7–42 days	None	Eclampsia	Emergency CS ^b	None	HUS ^d , hysterectomy, DIC ^c
7–42 days	None	HELLP ^a	Vaginal	Haemorrhage	Septic shock
7–42 days	None	HELLP ^a	Vaginal	None	Septic shock

^a Haemolysis, elevated liver enzymes, and a low platelet count.

^b Caesarean section.

^c Disseminated intravascular coagulation.

^d Haemolytic-Uremic Syndrome.

Table 4

Direct causes of maternal death - major maternal, pregnancy and delivery related events, cases with haemorrhage. Georgia 2014–17.

Time of death	Maternal condition	Pregnancy-related condition	Mode of delivery	Delivery-related condition	Blood loss (ml)	Postpartum events
1st 24 h	None	None	Emergency CS ^a	Haemorrhage	1300 ^b	Hysterectomy
1st 24 h	None	None	Emergency CS ^a	Haemorrhage	Unknown	Hysterectomy, DIC ^c
1st 24 h	None	None	Emergency CS ^a	Haemorrhage, uterine rupture	Unknown ^b	None
1st 24 h	None	None	Vaginal	Haemorrhage, deep laceration	2500 ^b	Laparotomy
1st 24 h	None	Preeclampsia	Emergency CS ^a	Haemorrhage, atony	Unknown	Hysterectomy, DIC ^c
1st 24 h	None	Preeclampsia /eclampsia	Vaginal	Haemorrhage	1800 ^b	Hysterectomy
1st 24 h	Obesity	Preeclampsia	Emergency CS ^a	Haemorrhage, abruptio placenta	1200 ^b	Hysterectomy, DIC
1st 24 h	Obesity	Cervical cerclage, preeclampsia	Emergency CS ^a	Haemorrhage	600	None
1st 24 h	Obesity	Placenta praevia	Emergency CS ^a	Haemorrhage, abruptio placenta	2200 ^b	Hysterectomy
2–6 days	None	None	Emergency CS ^a	Haemorrhage, abruptio placenta	2000 ^b	DIC ^c
2–6 days	None	None	Emergency CS ^a	Haemorrhage, atony	2100 ^b	Hysterectomy, DIC ^c
2–6 days	None	None	Vaginal	Haemorrhage, deep laceration	Unknown ^b	Hysterectomy, DIC ^c
2–6 days	None	None	Emergency CS ^a	Haemorrhage, atony	800	None
2–6 days	Obesity	None	Emergency CS ^a	Haemorrhage, abruptio placenta	3500 ^a	Hysterectomy, DIC ^c
2–6 days	Obesity	Preeclampsia	Emergency CS ^a	Haemorrhage, abruptio placenta	2500 ^a	Hysterectomy, DIC ^c
7–42 days	None	None	Vaginal	Retained products	Unknown ^b	Haemorrhage, hysterectomy
7–42 days	None	Preeclampsia	Planned CS ^a	None	Unknown ^b	HELLP ^d , haemorrhage, hysterectomy
7–42 days	Anaemia	Preeclampsia	Emergency CS ^a	Haemorrhage, abruptio placenta	Unknown	Haemorrhage, hysterectomy

^a Caesarean section.

^b Blood transfusion.

^c Disseminated intravascular coagulation.

^d Haemolysis, elevated liver enzymes, and a low platelet count.

maternal death (62% and 38%, respectively). It is important to analyse the distribution of these causes, as it gives an indication of the quality of antenatal, perinatal, postpartum, and continuum of care. When direct causes of maternal death exceed indirect causes, it suggests that obstetric care is substandard [26]. The study of global causes of maternal death and other retrospective studies have shown results similar to ours in other developing countries, where direct causes of maternal death account for around 70% of MM [5,22]. The proportions we report differ from the previous Georgian study, in which direct causes of maternal deaths accounted for 77% of MM cases and indirect causes accounted for

23% [18]. Our results indicate that Georgia is making progress in decreasing the MMR due to direct causes of maternal death; however, some aspects still need attention. The notably low number of high-risk pregnancies and co-morbidities we observed in MM cases are another indicator of substandard care, especially on an ANC level. Timely recognition of complications is important for correct diagnosis and treatment, which are important if MM is to be prevented [10,27]. To accelerate progress in the prevention of MM, Georgia should enhance optimal obstetric care, improve ANC guidelines to detect high-risk pregnancies and co-morbidities, and ensure that midwives and

Table 5
Indirect causes of maternal death - major maternal, pregnancy and delivery related events. Georgia 2014–17.

Time of death	Maternal condition	Pregnancy-related condition	Mode of delivery	Delivery-related condition	Postpartum events
In pregnancy	Acute leukaemia	None	Not applicable	Not applicable	Not applicable
In pregnancy	Ovarian cancer	None	Not applicable	Not applicable	Not applicable
In pregnancy	Cerebral malformation	None	Not applicable	Not applicable	Not applicable
2–6 days	Acute leukaemia	None	Emergency CS ^c	None	Cachexia
7–42 days	Cerebral malformation	None	Emergency CS ^c	None	Cerebral haemorrhage
In pregnancy	None	Pneumonia	Not applicable	Not applicable	Not applicable
In pregnancy	None	Leptospirosis, pneumonia, sepsis	Not applicable	Not applicable	Not applicable
In pregnancy	None	Leptospirosis, chorioamnionitis, sepsis	Not applicable	Not applicable	Not applicable
2–6 days	Multi resistant TB ^a	None	Vaginal	None	Acute respiratory distress
2–6 days	None	TB, preeclampsia	Emergency CS ^c	None	Acute respiratory distress
7–42 days	None	Pneumonia	Emergency CS ^c	None	Acute respiratory distress
7–42 days	None	Pneumonia	Emergency CS ^c	None	Acute respiratory distress
7–42 days	None	None	Vaginal	None	Meningitis
7–42 days	None	None	Unknown	None	Bacterial meningitis
7–42 days	Chronic hepatitis	None	Emergency CS ^c	None	Acute liver failure, sepsis
7–42 days	None	None	Emergency CS ^c	None	Complicated cholecystitis
7–42 days	CVD ^b	None	Emergency CS ^c	None	Cardiomyopathy
7–42 days	CVD ^b	None	Emergency CS ^c	None	Severe cardiac failure
7–42 days	Cardiomyopathy	None	Vaginal	None	Severe cardiac failure
In pregnancy	Mental disorder, suicide	None	Not applicable	Not applicable	Not applicable
7–42 days	None	None	Planned CS ^c	None	Mental disease, suicide
7–42 days	None	None	Vaginal	Retained products	Haemorrhage, sepsis, hysterectomy, suicide

^a Tuberculosis.

^b Cardiovascular disease.

^c Caesarean section.

obstetricians complete special courses within the framework of their Continuous Medical Education. These measures could lower the proportion of MM due to direct causes of maternal death, and hence decrease the MMR.

Haemorrhage was the foremost direct cause of maternal death in our study. The latest study of global causes of maternal death showed that haemorrhage accounted for 27.1% of MM cases and represented the leading cause of maternal death worldwide [7]. In the present study, maternal death due to haemorrhage represented 29.5% of all MM cases, which is a common number in countries with a similar socio-development index [5]. Our findings correspond to previous information about leading causes of maternal death in Georgia, which also cited haemorrhage as the most common cause of death [13,18]. The majority of these cases occurred in low-risk pregnancies with no severe pregnancy-related conditions. However, the main mode of childbirth for these cases was emergency CS, and the indication for CS was lacking. Indeed, CS has intrinsic risks that can lead to a cascade of complications in both non-risk and high-risk pregnancies [28]. Therefore, the high fatality rate in these cases suggests inappropriate indications for CS, poor diagnostic skills, and lack of follow-up by responsible medical personnel during the post-operative period, which indicates necessity for future studies. Our results also suggest that there is a lack of active management in the third stage of labour to prevent haemorrhage, and that artery embolization is under-used as an alternative treatment for haemorrhage [28]. In general, haemorrhage is a preventable cause of maternal death, and recent studies have outlined ways to optimise the outcome of this condition. These publications promote a multidisciplinary team approach and the application of checklist-based protocols for the timely management of haemorrhage [13,28], neither of which was evidenced in our data. Additionally, the volume of blood lost or other justifications for such treatment did not consistently accompany reports of blood transfusion in our study. Nonetheless, study findings on haemorrhage are an additional indication of substandard care at all levels of reproductive services, including the inappropriate evaluation of risks, justification for blood transfusion, detection of co-morbidities, and lack of knowledge-based performance during obstetric emergencies. In order to further reduce the MMR, is it important to equip medical

personnel with current knowledge and approaches to managing life-threatening conditions. These steps must be taken if we are to improve the quality of medical care for pregnant women and prevent haemorrhage as a major direct cause of maternal death.

Our study identified infection as the leading cause of indirect maternal death. Contrary to national improvements in access to antibiotic treatment, preventive vaccination, and advanced diagnostic and laboratory services, our results show a noticeably high proportion of MM attributable to infections [13,18]. Thus it may be possible to prevent mortality through more appropriate clinical solutions. However, our results lead us to believe that there is a fragmentation in continuous obstetric care, low quality of ANC, a lack of either continuous care or communication with sub specialists, and weak multidisciplinary approaches, all of which suggest substandard care. In their study of barriers to accessing adequate maternal care in Georgia, Miteniece et al. also indicated substandard care, along with gaps in clinical quality and staff skills, poor communication, and lack of continuous education programmes in the Georgian health care system [29]. After all, if a country is looking to accelerate its progress in preventing maternal death, it is not sufficient to improve ANC coverage; it is also necessary to ensure high quality and continuous care. Better medical performance and updated guidelines for provided services are needed, along with improved collaboration with specialists and timely referrals [10,15,23,30].

The major strength of this paper is the use of data from the MCHCC, along with validation from and enrichment with register-based data. In MM studies, Confidential Enquiries into Maternal Deaths and registries give researchers a great advantage, as they allow them to obtain information, analyse non-aggregated and consistency data, validate cases, and understand the full cascade of events [10,27]. Some of the limitations of this study include the primary data source, which was hospital records. Because of this, some problems arose in deciphering handwriting. Additionally, 31% of our MM cases had medical records with incomplete or missing information, which could have led to under-reporting; thus our results should be interpreted with caution. Moreover, our results showed that autopsy and forensic service are infrequent in Georgia, which is not unique, as many other developing countries face a

similar problem, especially for ANC [31,32]. However, given the importance of decreasing the MMR, it is vital to have detailed, quality information on this topic [25]. Under the circumstances, insufficient medical files cannot guarantee a high-quality enquiry using MCHCC data. Indeed, this insufficiency led to the exclusion of 3 unclassifiable cases from our analyses as well. Furthermore, in-depth future studies on the quality of reproductive healthcare should address some specific questions (e.g. skills and competencies of medical personnel, quality of care at any level, provision and access to family planning, high proportion of CS and consistent of their indications). Limitation of the present study includes a small study sample with low MM in absolute numbers. Thus, results cannot fully address failure of reproductive healthcare system in specific health-related conditions (tuberculosis, hepatitis, and leukaemia). However, provided results are important to prioritize methodology for future studies and enhance them with the “near-miss” approach - identification and additional assessment of cases in which pregnant women survive certain complications [2,16].

Overall, our findings indicate the challenges Georgia faces in accelerating the reduction of MM. This evaluation of the causes of MM and classification of cases by direct and indirect causes of death with the use of national surveillance data may be used to generate new recommendations for clinical practice and policy improvement. This study has important implications for the quality enhancement of reproductive healthcare in Georgia. The present findings indicate the existence of weaknesses and gaps in the healthcare system that can only be improved through the collaboration of different stakeholders. Regular and systematic analyses, transparency, and involvement of professional associations, main decision makers, and healthcare authorities will strengthen reproductive healthcare and accelerate Georgia’s progress to decrease MM. Moreover, austerity measures should be considered to ensure optimal obstetric care and family planning, to launch country-wide Continuous Medical Education for obstetricians, and to tailor trainings for midwives to tackle the knowledge gap. Measures should also be taken to trigger timely treatment or referral for multidisciplinary care and the establishment of routine autopsies in MM cases should be considered.

Conclusion

In Georgia, contrary to high-income countries, direct causes of death exceed indirect causes of death in MM cases, with haemorrhage and infections, respectively, being most common. The results suggest increasing efforts toward decreasing the MMR, where high-quality MM-related medical data and data completeness applications are crucial to obtain best medical measures and policies. The study findings are important to guide stakeholders and ensure that they implement optimal, continuous care and effective follow-up, and to accelerate progress in the reduction of MM in the country.

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Authors’ contributions

NS co-developed the core idea and study design, collected data, reviewed all cases, conducted analyses, interpreted results, and wrote the article. EEA co-developed the core idea, participated in study design, in the interpretations of results, and in the revision of draft version of the article. NK collected data, reviewed all cases, interpreted results, and revised the draft version of the article. TB participated in the interpretations of results and in the revision of the draft version of the article. AG co-developed the core idea, developed study design, and

participated in the interpretation of results and in the revision of the draft version of the article. All authors approved and agreed on the final version of the article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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