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Every maternal near-miss counts: Need for a national audit in South Africa? A mixed-methods study

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Background. To improve maternal health, studies of maternal morbidity are increasingly being used to evaluate the quality of maternity care, in addition to studies of mortality. While South Africa (SA) has a well-established confidential enquiry into maternal deaths, there is currently no structure in place to systematically collect and analyse maternal near-misses (MNM) at national level.

Objectives. To synthesise MNM indicators and causes in SA by performing a systematic literature search, and to investigate perceived needs for data collection related to MNMs and determine whether the MNM tool from the World Health Organization (WHO-MNM) would require adaptations in order to be implemented.

Methods. The study used a mixed-methods approach. A systematic literature search was conducted to find all published data on MNM audits in SA. Semi-structured interviews were conducted virtually with maternal health experts throughout the country who had been involved in studies of MNMs, and main themes arising in the interviews were synthesised. A method for MNM data collection for SA use was discussed with these experts.

Results. The literature search yielded 797 articles, 15 of which met the WHO-MNM or Mantel *et al.* severe acute maternal morbidity criteria. The median (interquartile range) MNM incidence ratio in SA was 8.4/1 000 (5.6 - 8.7) live births, the median maternal mortality ratio was 130/100 000 (71.4 - 226) live births, and the median mortality index was 16.6% (11.7 - 18.8). The main causes of MNMs were hypertensive disorders of pregnancy and obstetric haemorrhage. Eight maternal health experts were interviewed from May 2020 to February 2021. All participants focused on the challenges of implementing a national MNM audit, yet noted the urgent need for one. Recognition of MNMs as an indicator of quality of maternity care was considered to lead to improved management earlier in the chain of events, thereby possibly preventing mortality. Obtaining qualitative information from women with MNMs was perceived as an important opportunity to improve the maternity care system. Participants suggested that the WHO-MNM tool would have to be adapted into a simplified tool with more clearly defined criteria and a number of specific diagnoses relevant to the SA setting. This 'Maternal near-miss: Inclusion criteria and data collection form' is provided as a supplementary file.

Conclusion. Adding MNMs to the existing confidential maternal death enquiry could potentially contribute to a more robust audit with data that may inform health systems planning. This was perceived by SA experts to be valuable, but would require context-specific adaptations to the WHO-MNM tool. The available body of evidence is sufficient to justify moving to implementation.

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Improving maternal and neonatal health is a global health priority. The World Health Organization (WHO) introduced the maternal near-miss (MNM) approach (WHO-MNM) in 2009 to robustly identify maternal morbidities at the severe end of the spectrum of pregnancy-related disease. This approach is increasingly used as an additional tool to monitor and evaluate the quality of maternity care at various levels of the healthcare system.^[1] According to the WHO, an MNM is defined as 'a woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy'.^[1,2]

South Africa (SA) is one of the few countries worldwide where detailed information about maternal deaths is compiled. The National Committee on Confidential Enquiries into Maternal Deaths (NCCEMD) produces triennial reports called 'Saving Mothers', with the aim of identifying lessons learned and improving maternity

care.^[3] While this committee has been systematically reviewing maternal deaths since 1998, in addition to the local reviews carried out by provincial health departments, no such comprehensive audit system for MNMs is currently in place. Before the WHO-MNM criteria were introduced, some regions in SA applied the criteria for severe acute maternal morbidity (SAMM) described by Mantel *et al.*^[4] to assess maternity care.

The primary objective of this mixed-methods study was to quantitatively synthesise MNM indicators and causes from SA publications to describe the burden of MNMs as a potential source for enhanced maternity care review. The secondary objective was to examine perspectives on the need for and methods of data collection pertaining to MNMs, if it were to be implemented in addition to the already existing and well-functioning NCCEMD.

Methods

A systematic literature search was conducted to collect quantitative data from studies of MNMs in SA, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).^[5] We conducted systematic searches in PubMed, Embase, com, Ebsco/CINAHL, Scopus and Google Scholar up to 1 April 2021 with index terms or free-text words 'Pregnancy Complications', 'Maternal Mortality', 'Maternal Morbidity', 'Near Miss', 'South Africa' (PubMed session results, Appendix 1, <https://www.samedical.org/file/1870>). References were searched for relevant publications and duplicate articles were excluded. No language was excluded.

Articles were uploaded to the online software Rayyan QCRI (<https://rayyan.qcri.org>), where identification of duplicates took place, followed by screening of titles and abstracts by two authors (JS and AH).

Included were SA studies using either the WHO-MNM or Mantel *et al.*^[4] SAMM criteria (both methods described in Table 1), and studies that provided quantitative statistics on the MNM incidence ratio (MNM-IR), maternal mortality ratio (MMR) and mortality index (MI). Articles were excluded if there was no clear use of either the WHO-MNM or Mantel *et al.*^[4] SAMM criteria, or if the study was a secondary analysis of previously published data.

The MNM-IR is expressed as the number of MNMs per 1 000 live births, the MMR as the number of maternal deaths per 100 000 live births, and the MI as the number of maternal deaths divided by the number of women who sustained an MNM + maternal deaths, expressed as a percentage. The MI is an indicator of the quality of maternity care for women with an MNM.^[1,2]

Full-text articles were found for the remaining studies, and those not fulfilling the inclusion criteria were independently excluded by two researchers (AH and JS). Selected articles were then exported to Endnote for referencing purposes and their study characteristics, including descriptive MNM statistics, settings and their methodologies specific to using the Mantel *et al.*^[4] SAMM or WHO-MNM criteria, were extracted. The literature selection flow chart is presented in Fig. 1.

To investigate the need for and methods of data collection of MNM in SA, the present study was conducted as a pilot using interviews to assess whether this topic has priority according to healthcare workers. Healthcare workers from various clinical professions who worked with clinical data of maternal morbidity in SA were recruited through convenience sampling.

Semi-structured interviews were conducted virtually by Zoom after informed consent had been obtained by the research student (JS), as part of a master's thesis in global health from the Vrije Universiteit Amsterdam (VU), supervised by AH and TvDA. The review was conducted according to the VU Faculty of Social Science Research Ethics Review Committee's ethical guidelines. This conforms to the ethical guidelines for 'standard' research and does not require further ethical review.

For this qualitative study, an interview guide was created (interview guide, Appendix 2, <https://www.samedical.org/file/1870>). The purpose of the sampling was to include a small number of diverse caregivers as a pilot study. Eleven individuals were approached for the interviews, all of whom had experience with MNM data collection and audit. All who participated signed an informed consent form beforehand.

The main themes of the interviews focused on experiences with MNM audits, including recollection of the process of collecting information on MNMs and any perceived difficulties of or benefits from the audits. Interviewees were also asked whether a national MNM audit was needed or would be wanted for SA to improve maternal health, and whether the WHO-

MNM tool was suitable for that purpose. Interviews were transcribed, and any personal information that could be used for identification was removed to preserve anonymity. A 'code book' was developed in order to organise relevant quotes by theme, and ATLAS.ti software, version 22.0.5 (ATLAS.ti Scientific Software Development GmbH, Germany), was used to extract quotes from the transcripts (qualitative code book, Appendix 3, <https://www.samedical.org/file/1870>).

The method of auditing MNMs can differ between institutions and between interviewed persons. In 2018, we discussed the data collection form used for MNMs in the Metro East health district, Western Cape Province, SA,^[6] with the authors of articles on the Metro West district^[7] and Pretoria,^[8] who are also participants in the NCCEMD (see acknowledgement). Adjustments were based on the knowledge of the setting together with the Haydom criteria^[9] from the literature and outcomes of a Delphi study for low-income countries.^[10] This process led to some modifications of the WHO-MNM tool for South Africa: a reduction in administering blood products from ≥ 5 to ≥ 4 U and an additional list of diagnoses. The 'Maternal-near miss: Inclusion criteria and data collection form' is provided as a

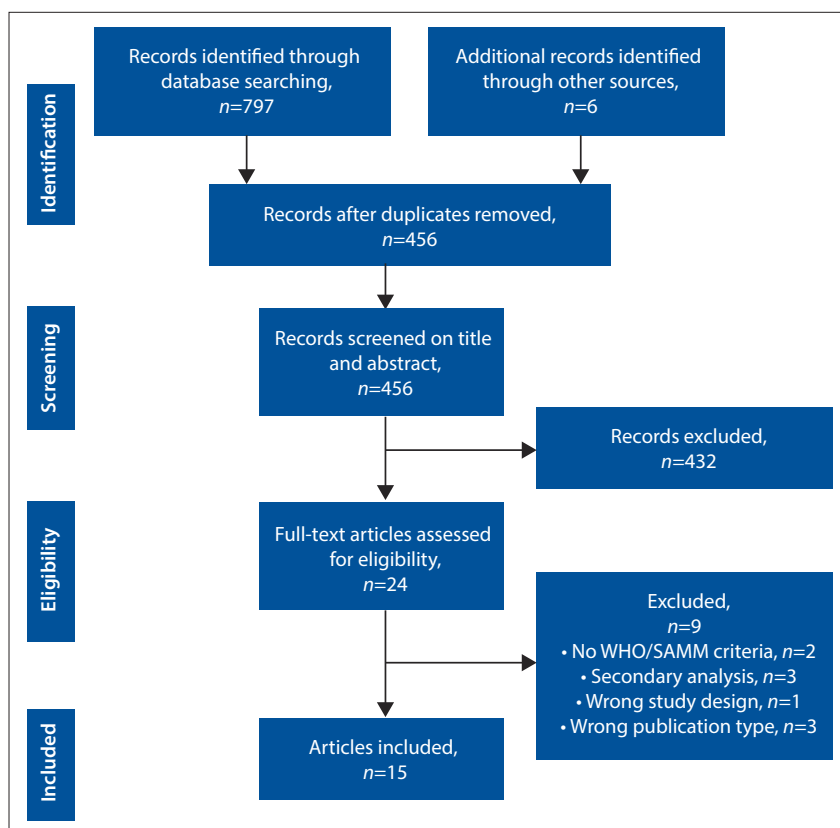


Fig. 1. Systematic literature search, flowchart of selection procedure. (WHO/SAMM = World Health Organization/severe acute maternal morbidity.)

supplementary file (<https://www.samedical.org/file/1871>) depicting the criteria for MNMs, underlying complications, details of women with an MNM and the assessment of avoidable factors, also used in our study in the Metro East district.^[6]

Results

Quantitative

The search yielded a total of 797 results. Inclusion criteria were met by 15 articles^[4,6-8,11-21] (Supplementary Table 1, <https://www.samedical.org/file/1872>). We found eight studies that applied the Mantel *et al.*^[4] SAMM criteria,^[4,11-17] one of which did so in a slightly adapted form.^[15] The other seven studies used the WHO-MNM criteria,^[6-8,18-21] two of which made adaptations to arrive at criteria relying on clinical assessment only and by adding diagnoses that are relatively frequent in SA^[13,14] (Supplementary Table 1, <https://www.samedical.org/file/1872>).

The quantitative aspect of the study is briefly presented in the text, but more extensively depicted in Table 2. This table lists MNM and mortality statistics for the nine studies that focused on MNM and mortality

comprehensively rather than from a single cause.^[4,6-8,11-14,21] The median MNM-IR in the nine studies was 8.4/1 000 (5.6 - 8.7) live births, the median MMR 130/100 000 (71.4 - 226.0) live births, and the median MI 16.6% (11.7 - 18.8). The main causes of MNMs were hypertensive disorders of pregnancy and obstetric haemorrhage..

Qualitative

Of the 11 maternal health experts who were approached, 8 (P1 - P8) responded and were interviewed between May 2020 and February 2021. The participants' professions were as follows: 1 nurse-midwife, 6 consultant obstetricians and gynaecologists, and 1 academic physician who also worked as a policymaker. All the participants were maternity care workers or policymakers who were not active as care workers any longer, who had been involved in auditing maternal morbidity in various capacities.

Two of the 8 interviewed participants used the MNM inclusion criteria and data collection form. Table 3 shows the items addressed in the interviews. When prompted to reflect on a national MNM audit, all the participants saw benefits or noted an urgent need for establishing

Table 1. Methods for identifying maternal morbidity

	Mantel <i>et al.</i> ^[4] SAMM criteria	WHO-MNM criteria ^[3]
Organ dysfunction		
Cardiovascular	Cardiac: Pulmonary oedema: a clinical diagnosis necessitating intravenous furosemide or intubation and ventilation Cardiac arrest Vascular: Hypovolaemia requiring ≥ 5 U whole blood or packed cells for resuscitation	Shock, use of continuous vasoactive drugs, cardiac arrest, CPR, severe hypoperfusion (lactate >5 mmol/L or >45 mg/dL or severe acidosis, pH <7.1)
Respiratory	Intubation and ventilation for >60 min for any reason other than for a general anaesthetic Oxygen saturation on pulse oximetry $<90\%$ lasting more than 60 min $\text{PaO}_2/\text{FiO}_2 \leq 3$	Acute cyanosis, gasping, respiratory rate >40 or <6 /min, severe hypoxaemia (oxygen saturation $<90\%$ for ≥ 60 min or $\text{PaO}_2/\text{FiO}_2 <200$), or intubation and ventilation not related to anaesthesia
Renal	Oliguria (defined as <400 mL/24 h) that does not respond to either careful adequate intravascular rehydration or attempts at inducing diuresis with furosemide or dopamine Acute deterioration of urea to >15 mmol/L or creatinine to >400 mmol/L	Oliguria non-responsive to fluids or diuretics, dialysis for acute renal failure Creatinine ≥ 300 $\mu\text{mol/mL}$ or ≥ 3.5 mg/dL
Coagulation/haematological	Acute thrombocytopenia requiring platelet transfusion	Failure to form clots, massive transfusion ≥ 5 U blood or red cells, platelets <50 000/mL
Hepatic	Jaundice in the presence of pre-eclampsia (pre-eclampsia defined as blood pressure $\geq 140/90$ mmHg together with $\geq 1+$ proteinuria)	Jaundice in the presence of pre-eclampsia, bilirubin >100 $\mu\text{mol/L}$ or >6.0 mg/dL
Neurological	Coma lasting >12 h Subarachnoid or intracerebral haemorrhage	Prolonged unconsciousness/coma (>12 h), stroke, status epilepticus or uncontrollable fits
Uterine dysfunction/hysterectomy	For any reason	Haemorrhage or infection leading to hysterectomy
Immunological dysfunction	Intensive care admission for sepsis Emergency hysterectomy for sepsis	-
Metabolic	Diabetic ketoacidosis Thyroid crisis	-
Management based		
Intensive care admission	For any reason	-
Anaesthetic accidents	Severe hypotension associated with spinal or epidural analgesia (hypotension defined as systolic blood pressure <90 mmHg lasting >60 min) Failed tracheal intubation requiring anaesthetic reversal	-

SAMM = severe acute maternal morbidity; WHO-MNM = World Health Organization maternal near-miss; CPR = cardiopulmonary resuscitation; $\text{PaO}_2/\text{FiO}_2$ = ratio of the partial pressure of oxygen in arterial blood to the percentage of oxygen in inspired air.

Table 2. SAMM/MNM outcomes, primary causes and substandard care factors

Author	Year*	Study setting	Live births	MNM-IR	MMR	MI	Primary cause MNM	Substandard care
Mantel <i>et al.</i> ^[4]	1998	Urban – Kalafong and Pretoria Academic hospitals, catering for deliveries of indigent women in the Pretoria health region	13 429†	10.9*	233.4*	16.9*	Hypertension Obstetric haemorrhage Sepsis	50% of the near-misses and deaths could have been avoided Patient related, initial assessment, lack of recognition n/a
Vandecruys <i>et al.</i> ^[11]	2002	Urban – Pretoria Academic Complex: four hospitals, two of which received tertiary referrals from outside Gauteng Province	26 152† (1997 - 1999); 13 854 (2000)	11.7 (1997 - 1999); 8.7 (2000)*	226 (1997 - 1999); 188 (2000)	16.2 (1997 - 1999); 17.7 (2000)*	Hypertension Abortion Postpartum haemorrhage (1997 - 1999); Hypertension Postpartum haemorrhage Abortion (2000)	n/a
Cochet <i>et al.</i> ^[12]	2003	Urban – Pretoria Academic Complex: Kalafong Hospital and Pretoria Academic Hospital	13 854 (2000); 15 978 (2001)	5.5 (2000); 8.2 (2001)	130 (2000); 100 (2001)	19.1 (2000); 10.9 (2001)*	Obstetric haemorrhage Hypertension Abortion	n/a
Pattinson <i>et al.</i> ^[13]	2003	Rural and urban – Free State provincial regions A and B and the Pretoria and Greater Soweto areas of Gauteng Province	NR	NR	NR	23.2	Hypertension Obstetric haemorrhage Abortion	Patient orientated (35.5%) Administrative (24.3%) Medical staff (51.8%): management plan, problem recognition
Ghandi <i>et al.</i> ^[14]	2004	Rural – all four primary hospitals in the rural Jozini health district of KwaZulu-Natal Province	5 728†	5.41	NR	NR	Hypertension Obstetric haemorrhage	20 of 31 SAMM cases (65%) Delays in diagnosis, treatment, referral, and monitoring, no hospital transport was available (ambulances were out on calls or out of order), where essential drugs were out of stock, difficulties in recruiting and retaining experienced staff In two cases, staff acted to the best of their ability but did not have the skills to achieve a satisfactory outcome
Soma-Pillay <i>et al.</i> ^[8]	2015	Urban – Pretoria Academic Complex: Steve Biko Academic Hospital (level 3), Kalafong Provincial Tertiary Hospital (level 3), Mamelodi Hospital (level 2), Tshwane District Hospital (level 1), Pretoria West Hospital (level 1), Laudium CHC with MOU, Eersterust MOU, Stanza Bopape and Dark City clinics (CHCs)	26 614†	4.4*	71.4*	14.0	Obstetric haemorrhage Hypertension Non-pregnancy-related infections	Delay 83%: lack of knowledge (40%), inadequate ANC (37%), delay admission, referral, treatment (37%)

continued...

Table 2. (continued) SAMM/MNM outcomes, primary causes and substandard care factors

Author	Year*	Study setting	Live births	MNM-IR	MMR	MI	Primary cause MNM	Substandard care
Iwuh <i>et al.</i> ^[7]	2018	Urban – nine primary care maternity facilities (MOUs), which refer all complicated maternal cases to two secondary hospitals, New Somerset Hospital and Mowbray Maternity Hospital, or to the maternity centre at the tertiary hospital, Groote Schuur Hospital	19 524† (19 222 live births)	5.83	67.6	10.4	Hypertension Obstetric haemorrhage Pregnancy-related sepsis	Analysis of avoidable factors identified lack of antenatal clinic attendance (11.6%), inter-facility transport problems (6.3%) and health provider-related factors (25.9% at the primary level of care, 38.2% at secondary level and 7.1% at tertiary level)
Hlabisa ^[21]	2019	Urban – King Edward VIII tertiary hospital in Durban	6 253	8.6	255.9	22.8	Obstetric haemorrhage Hypertensive disorders	n/a
Heitkamp <i>et al.</i> ^[6]	2021	Urban – Tygerberg Hospital, Metro East region, Cape Town	32 161	8.6	49.7	6.9	Hypertension Obstetric haemorrhage Non-pregnancy-related infections	n/a
Median (IQR)	-	-	-	8.4 (5.6 - 8.7)	130.0 (71.4 - 226)	16.6 (11.7 - 18.8)	-	-

SAMM = severe acute maternal morbidity; MNM = maternal near-miss; MNM-IR = SAMM/MNM incidence ratio (MNM incidence/1 000 live births); MMR = maternal mortality ratio (maternal deaths/100 000 live births); MI = mortality index (maternal deaths/(maternal deaths + MNM incidence) × 100%); n/a = not applicable; NR = no result; ANC = antenatal care; CHC = community health centre; MOU = midwife obstetric unit; IQR = interquartile range.
 *By year ascending.
 †Total births (not live births).
 ‡Calculated by author.

such a system, even when they considered potential difficulties with implementation.

Discussion

The overall MNM-IR in SA was comparable with other middle-income countries,^[22] but varied according to region. Within SA, outcomes varied as a result of differing study methods and settings. The main causes of MNMs in SA were found to be consistent, with little variation: hypertensive disorders of pregnancy and obstetric haemorrhage. The main causes of maternal deaths according to the NCCEMD (2017 - 2019) were non-pregnancy-related infections (mostly advanced tuberculosis (TB) and HIV-related illness); hypertensive disorders of pregnancy and obstetric haemorrhage were the second and third important causes.^[3] This difference could be explained by the fact that most severely ill pregnant women with HIV/TB are managed by physicians in medical wards, and only referred to obstetric wards if their pregnancy is advanced. They would not be identified by an MNM audit in an obstetric setting unless they were in late pregnancy, in labour or postpartum.

It is helpful to try to reach consensus regarding which methodology would be best suited for collecting data on MNMs in SA, and the gap that exists in knowledge about countrywide differences in MNM statistics should be addressed. A national audit with a standardised data collection tool may fill that gap.

The lower the MI, the more women with an MNM survive. An MNM audit could result in important positive messages, boosting health worker morale, as opposed to only performing death reviews. Comparing these outcomes and differences between provinces may highlight possible lessons learned. The added value of auditing MNMs is regarded as useful, illustrated by P7's words: 'If you recognise severe morbidity, in time you are able to prevent mortality.' An MNM (avoiding mortality) can be seen as a positive outcome, supporting health workers who are often working under difficult conditions.

Included retrospective studies have reported common limitations inherently resulting from study design: incomplete data for reported cases, different applied definitions of maternal morbidity, and the possibility of under-reporting.^[7,8] However, none of the seven prospective reports mentioned limitations of their study designs. Most studies did not discuss their methodology extensively on their audit methods, making it difficult to determine which design may be better suited for an MNM audit.

Nevertheless, a national MNM audit would be similar to the ongoing death reviews of the NCCEMD, where information is gathered soon after the event. By applying standardised criteria and definitions, the above challenges and limitations could be mitigated. The fact that adaptations had to be made to the WHO-MNM tool for use in urban settings even in our middle-income country, compared with use in high-income settings, supports the opinion of the interviewees that applicability of the tool could even be lower in rural areas. The difference between settings would make it harder to identify appropriate criteria for use across the entire country. Of interest is that the literature search did not find any studies in SA where the WHO-MNM tool was used in rural areas or more under-resourced facilities. This is a limitation of our study. As we know from low-income settings, challenges in applying the WHO-MNM tool might be more pressing and under-reporting higher as a result of lack of equipment in such settings.^[23] Interviewees were nearly unanimous in pushing for a

Table 3. Qualitative outcomes (number of comments, some of the quotes that reflect the item)

Item	n	Quotes
Implementation		
Data collection process	12	'In terms of process, there are district clinical specialists who oversee a district, some provinces have regional specialists, who could do it, because there is a tradition in all maternities to have "morbidity and mortality" and "perinatal mortality" meetings. In these facilities, they always discuss many perinatal deaths, but maternal deaths are very rare. But if they started to discuss near-misses, a lot of facilities would like to do that, it would just need guidance and setting up with the district specialists. So I think it is feasible in South Africa, I think actually might be quite welcomed.' (P5) 'In my experience with these type of things, the more complicated you make it, the less likely you're going to get people filling out the forms. The moment you have to use your own intuition to fill out a form, you're going to get such varied answers, it's not going to be useful for research.' (P8) 'I think it's feasible, and I think it has to be done that way, that it's standardised for everyone. The question will just be "Do we leave it as it is or do we modify it for everyone?", that's the thing.' (P2)
Feasibility of database	5	'Obviously it's going to take some work, and I think the benefits far outweigh the difficulties that we would have.' (P3) 'If you were trained in identifying near-misses – which is what you're trained for when you reach specialist level – to identify severe cases that may end up as mortalities, whereas a junior might not identify it as being serious enough, until they experience a demise. It is very important, especially in a training setting, to have that audit of near-misses, and realise that this could happen if we don't do x, y and z.' (P7)
High income v. low income	6	The fact that adaptations had to be made in urban settings supports the opinion of the interviewees that applicability of the WHO-MNM tool would be even lower in rural areas.
Implementation strategy	6	Four participants stressed the need of a top-down implementation strategy. (P3, P5, P6, P7) 'If it was a perfect world and you could have all that you need; a computer that's being updated and working, the internet, a properly working database and somebody that can import the data, someone to identify the cases, access the files, at every facility, then obviously it would be very good, and we would be able to learn a lot from it, and you would have a better idea of the needs assessment of the country or of specific facilities and provinces, and know what the underlying problems are.' (P8)
Modifications	10	'You may have to tweak the criteria a bit, because someone might have severe morbidity of postpartum haemorrhage in a district hospital, which has only 2 units of blood in the fridge.' (P5) 'There existed only one category for "sepsis", while we distinguish sepsis that is related to the genital tract, puerperal sepsis, which is very different from HIV infection or now, COVID-19. I also think they didn't have anything for pulmonary embolism. All I know is that we added into the category of pregnancy complications. We also made minor adjustments on other parameters, and another big thing that we added was a quality of care assessment at the end. So you have to identify whether there was any substandard care, or if the woman had problems arriving, or if she had any problems at community level; we go through various health system factors to see if there was substandard care in any way.' (P5)
Experience		
Experience with MNM data collection	8	Four participants preferred an adapted version of the WHO-MNM tool to be used nationally. P4 and P7, however, considered the Mantel SAMM criteria to be more practical, less complex and therefore easier to implement and more applicable in rural areas. That being said, four participants said that when the WHO-MNM tool is used without any adaptation, a large portion of women with MNM are likely to go unidentified. (P2, P3, P5, P7) 'Whereas when we modified it and just used the intervention criteria, you would find the sick patients very easy and measurable. You knew that "Ok, blood transfusion, ventilation" – it was easy to identify who the near-miss patients were.' (P2) 'Our criteria for calling something a renal failure, would not meet the WHO-MNM criteria; our criteria is much lower. So, we'll regard someone with organ dysfunction when levels of creatine are much lower than WHO says. So we include a lot more patients into our near-miss than the strict WHO-MNM criteria.' (P3)
Experience with SAMM	3	P4 mentioned that maternal morbidities are already discussed, but there needed to be more routine data collection.
Experience with WHO tool	5	When it came to the applicability of the WHO-MNM tool for a national audit, all four participants who had experience using this tool in their facilities claimed they had to adapt the criteria in order to fit availability of resources and skills of staff. All participants agreed that realistically, the WHO-MNM tool will have to be adapted or the SAMM criteria should be used instead – for example: 'the more complicated you make it, the less likely you're going to get data collected.' (P7)

(continued)

Table 3. (continued) Qualitative outcomes (number of comments, some of the quotes that reflect the item)

Item	n	Quotes
Advantages		
Pros of MNM data collection	5	'Every near-miss counts.' (P6) 'Every patient from every province should be treated equally.' (P7) 'It's good to have a standardised thing, when you communicate between facilities about patients, that they also realise the seriousness of whatever the underlying condition is. Also for the patients themselves, afterwards, when you counsel the patient, you can look at all the qualitative aspects of their experience, and seeing a patient that experienced a near-miss, which has some implications for the rest of their psychological wellbeing.' (P8)
Pros of WHO-MNMM tool	3	P2 liked 'the fact of having a standardised, international tool, because up till then, anyone was using what they preferred.' 'WHO-MNMM criteria is probably something that we should all use in collecting data and doing studies that should be interpreted everywhere in the world.' (P3) 'WHO criteria is much better' compared with the Mantel SAMMM criteria, as it is 'much more applicable to our situation.' (P5)
Reasoning: need for national database	9	To look at trends over time. (P5) 'We use the data to motivate for things, and the unit has progressed from 2 beds to 4 beds. From just a face-mask oxygen, to 4 ventilators. From sisters who didn't know how to do ventilation to sisters who now know how to do ventilation. Even registrars who can do ventilations. So, it just shows how much we can gain from just collecting data and using it.' (P3)
Challenges		
Challenges of maternal care	6	'[The] reason why we're not collecting this data is because of staffing shortages, we are ill-equipped.' (P3) 'There's no time, if you do take the time to do data collection, that's time taken away from your clinical job.' (P4) 'Adding more paperwork won't necessarily be to the benefit of the care of patients.' (P6)
Challenges: coronavirus/timing	3	When considering the feasibility of implementing a national audit, COVID-19 was mentioned as both a roadblock and as a catalyst. P5 believed it is not the right time for a national MNM audit, as the health system is already overstretched by the pandemic. In contrast, P1 noted how her workplace was able to take advantage of the extra funds being made available due to the crisis and try to obtain more equipment. P3 saw the crisis from a broader perspective, believing that 'COVID-19 highlighted the importance of social development and more importantly, health as a social problem' and therefore could serve as a catalyst for a national health insurance scheme. Introduction of this survey would 'level the medical playing field', increase equity in accessing healthcare and ultimately improve maternal health outcomes.
Challenges: lack of resources	13	'Administering five units of blood for one is already difficult in well-resourced tertiary hospitals in large South African cities and thus much less realistic at lower levels of the referral system.' (P5) 'We are fully trained, but the thing is that there's a lack of interest from the management side, from nursing management side, the support is very little.' (P1)
Challenges: rural v. urban	5	'You have to go physically to those rural areas, if you want to implement a national programme, it means everybody in the whole country needs to be informed. In order to get to those places, it's not going to be easy.' (P7)
Cons of WHO tool	10	Feasibility of a national MNM database was felt to be poor despite potential benefits (P8), and this underlined current struggles to keep up with the national maternal mortality database on top of overloaded clinical work. Four participants preferred an adapted version of the WHO-MNMM tool to be used nationally.
Subjectivity	4	Difficulty in defining the problem of MNM, related to the subjectivity of identifying women with MNM in general: 'What is a near-miss? Because a lot of people will just say "severe haemorrhage" but not know how much [blood] loss makes it a near-miss,' (P5), because an MNM was perceived not to be as clear-cut as maternal death: 'it's left to the registrar to decide whether they meet the criteria.' (P3)

WHO = World Health Organization; MNM = maternal near-miss; SAMMM = severe acute maternal morbidity.

national MNM audit in SA, even though they felt that implementing such a national audit would involve logistical challenges, mainly because of lack of resources, staffing and time that might hinder implementation. SA has the largest wealth inequity in the world (Gini index 63 in 2014), so finding a standardised tool that works in both poor and rich communities served by the public and private healthcare systems is a significant hurdle to overcome.^[24] Interviewees felt that such challenges need to be faced, because having an MNM audit in place would allow participants to use data for learning lessons and motivate medical leaders to improve maternity care.

Added benefits of a national MNM audit may include identification and subsequent improvement of health system deficits. Another benefit would be the opportunity to compare data on national and international levels and participate in a database, such as the International Network of Obstetric Survey Systems (INOSS).^[25] A national database with a robust registration system could also be a valuable contribution to identifying complications of new health threats in pregnancy, including pandemics such as COVID-19.

Overall, the consensus was that if the WHO-MNM criteria were to be used for a nationwide standardised audit, they would have to be adapted in order to capture as many women with MNMs in the country as possible. This would, however, affect comparability with other countries and settings where the WHO-MNM criteria are also used. Nevertheless, accurate identification of women with MNMs was prioritised over the importance of having internationally comparable data. Much debate centres on the applicability of MNM criteria in SA as a whole. Even though funding in the public health services does provide for an equal distribution of resources within the country, owing to different management and different allocation of funds at provincial and local levels, some hospitals and clinics are under-resourced to a larger extent than others.^[26] The large disparities between the public and private health sectors must also be kept in mind.

Opinions from interviewed participants differed when it came to which criteria would work best, and additional efforts are needed to achieve consensus in this regard.

This study was set up as a pilot study to identify whether there was interest in and a need for further research on a national MNM audit. The available body of evidence (the publications from SA and the findings reported in this article) is sufficient to justify moving to implementation, with a stepped-wedge approach providing more information as implementation progresses. Moreover, with the present knowledge, more items can be applied in optimising and implementing the MNM inclusion criteria and data collection form.

Conclusion

MNM-IRs in SA are similar to those in other middle-income countries. MMRs and MIs, however, varied considerably between the different regions, possibly being influenced by lack of methodological consistency, high variability in study designs or differences in quality of maternity care. A national MNM audit was recommended by the interviewees to evaluate causes and improve maternal health. In their perspective, simplification of the WHO-MNM tool could be helpful, with inclusion of additional clinical criteria and context-specific diagnoses. There is a need for simplified methods of identification that would be applicable and acceptable to healthcare workers in under-resourced clinical settings, and a tool for implementation is added as a supplementary file. The recognition of early signs of maternal morbidity by healthcare workers, and their response, will result in a reduction of maternal morbidity and mortality.

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