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Maternal health in Namibia: Lessons learned from obstetric surveillance

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Chapter 1.

General introduction

Personal justification

The story of Selma

In 2017 Selma entered the labour ward of the Windhoek Hospital Complex around 4:00 AM. As the medical officer on call, I was responsible for her care. Selma was bleeding, had a high blood pressure and severe abdominal pain. On examination I felt that her womb was as hard as a rock. Her baby was still alive but the heartbeat very slow. I suspected that Selma had an abruption of the placenta, meaning that her baby was in immediate danger. Her cervix was dilated to one centimetre only, so to expedite birth we rushed her to the operating room for a caesarean section. I had a quick look on Selma's health passport and saw it was her fifth pregnancy: she had had four stillborn babies from pregnancies complicated by high blood pressure. I realized how long Selma had been hoping to become a mother of a live baby. Fortunately, the staff of the operating room was readily available and within a few minutes we could start the operation. Nevertheless, we were too late to save Selma's baby. Moreover, the operation was complicated by massive blood loss. After placing a B-lynch suture, a technique to compress the uterus, the bleeding finally stopped, just before we would have had to resort to the last option: removing her uterus. Selma is an example of a so-called 'maternal near-miss', meaning that she nearly died but survived a severe complication of pregnancy.

Selma's complication could possibly have been prevented with better care. In her current pregnancy, Selma was seen weekly by one of the doctors in the antenatal care clinic. Her blood pressure was carefully managed with medication. She reached a gestation of 32 weeks, already one month further than the term at which she lost her previous babies. During her most recent visit she had been seen by an intern, a medical doctor with limited clinical experience who had recently graduated from medical school. Interns are not supposed to work unsupervised, but an obstetrician-gynaecologist, or even a medical officer with basic clinical experience, had not been available that day due to staff shortages. The intern had not realized that the blood pressure of Selma had been too high and had sent her home.

After the operation, I had to tell Selma she had lost yet another baby. I was sad and angry. Sad that this death could potentially have been prevented and unlikely would have happened in a Dutch health facility. And angry at those in power. Why is there still so much inequity in this world in the 21st century? How can it be that in high-income settings there are so many resources that expensive robots can assist doctors with operations, whilst we cannot even ensure that in this part of the world a woman simply sees an appropriately trained health worker when she needs one?

It was during my final year of medical school that I had made up my mind that I wanted to work where there was a shortage of doctors. My final rotation was at the obstetric department in a Dutch hospital. On the labour ward, it happened more than once that, on a quiet day, the obstetrician, obstetrician-in-training, midwife, midwife-in-training, and one or two medical students were waiting for women in need of a skilled birth attendant. The contrast with my previous internship in a rural hospital in Zambia could not be more harrowing. There, I had been impressed by the overwhelming challenges confronting health workers, including lack of staff at all levels resulting in permanently overburdened personnel.

After my specialization as a medical doctor in Tropical Medicine & International Health, I had started as a medical officer in the department of obstetrics and gynaecology at the national referral hospital of Namibia. There was a shortage of doctors in the country, as only in 2010 the first medical school had opened its doors. Until then, doctors working in Namibia were either Namibians trained elsewhere, or foreigners. At the hospital, my colleagues and I were confronted with the death of one or two women every month. Many women probably would have survived with better care. Maternal near-misses occurred nearly every day. On the night Selma lost her baby and nearly lost her life, I realized that simply having more doctors, midwives and nurses is not the silver bullet. Only when health workers are working in a functioning system, they can deliver good care. I started questioning myself: what is needed to achieve a better functioning maternity care system in Namibia to ensure that women like Selma have a pregnancy without severe adverse outcomes?

If this were an easy question to answer, there would have been no need to raise it. One important realisation was that, in my quest for an answer, I was not alone. Many devoted colleagues were similarly looking for ways to make things better: in the department and the hospital at large, as well as in other public hospitals in Namibia. Motivated to improve maternal health, we started several initiatives and tried to improve existing ones, such as the confidential enquiry into maternal deaths. This thesis describes the outcomes of our joint efforts, and I feel grateful with this opportunity to share our journey. I am hopeful that some of the lessons learned along our journey may be helpful to colleagues who are seeking to develop similar initiatives elsewhere.

Background

Maternal health, the global numbers

It is rather confronting that still in 2023, I have to include in the introduction of my thesis, like many others before me, the following sentence: it is estimated that globally each year 295 000 women die from complications of pregnancy and childbirth.[1] More than two out of three deaths occur in sub-Saharan Africa and the overwhelming majority could have been prevented with better care.[2] It is estimated that for each maternal death there are five maternal near-misses.[2,3] This means that globally, every day, there are 5000 women like Selma with severe maternal outcome, which is the term applied for the combination of maternal near-miss and maternal death. So why is this tragedy still continuing? One would expect that focus and resources go where the need is highest. But the distribution of COVID-vaccines painfully illustrates how the real world works: rich countries first ensure their own health facilities are sufficiently stocked to be able to more than double vaccinate their entire population, before they share the left-overs of less effective vaccines with poor countries.[4,5] The rich come first and the poor last.

In the past decades there has been increasing attention to improve the health of pregnant women around the world, especially from the year 2000 onwards, when improving maternal health became one of the eight Millennium Development Goals. This may have contributed to the overall reduction in the number of maternal deaths globally: the maternal mortality ratio (MMR), a ratio commonly used to monitor maternal deaths, reduced from 385 deaths in 1990 to 216 per 100 000 live births in 2015.[6] Nevertheless, gross inequity persists: the regional MMR of sub-Saharan Africa is still 45 times higher compared to the average MMR of all high-income countries combined. It is obvious that further reductions are urgently needed, particularly among the poor and the vulnerable.

Learning from success stories

In several countries, the number of maternal deaths has been going down considerably in the course of centuries or decades. By analysing the progress in countries that went from high to low maternal mortality, a common pathway was identified. Based on this common pathway, the World Health Organization designed the five-stage 'obstetric transition' model.[7] Policymakers aiming to reduce maternal mortality are advised to first determine in which stage of the model their country is, since in each stage different strategies are recommended to further improve maternal outcome. In this model, countries that are in stage 1 hardly have a functioning health system and the MMR is above 1000 deaths per 100 000 live births. In countries in stage 2, women are trying to reach health facilities but lack of access still plays an

important role, as well as marked weaknesses within the health system. For countries in both stage 1 and 2, it is recommended by the World Health Organization to improve infrastructure to increase access to maternity care, and simultaneously invest in basic preventive measures, such as family planning, infection prevention and iron supplementation.[7] In stage 3 the MMR is still high, 50-299 deaths per 100 000 live births. Women are reaching the formal health system, often leading to overburdened facilities, and improving quality of care is the core determinant to further reduce mortality in this stage. As obstetric care is improving, some obstetric deaths are reduced and the impact of deaths due to pre-existing medical conditions starts to increase. In countries in stage 4, nearly all obstetric deaths are avoided and mainly deaths due to pre-existing medical conditions are seen. With an MMR below 50 deaths per 100 000 live births, the occurrence of maternal deaths will be rare in most health facilities and, as a result, in this stage health workers are predominantly confronted with maternal near-miss complications.[8] In stage 5 all avoidable maternal deaths are indeed avoided.

Namibia

Namibia had an MMR estimated at 195/100,000 live births in 2017.[9] In 2015, the commonest causes of maternal death were obstetric haemorrhage, hypertension-related complications, tuberculosis and cardiac disease.[10] Key indicators suggest high access to maternity care, with 97% of women having at least one antenatal visit and 88% giving birth in a health facility in 2013.[11] In line with the obstetric transition, Namibia can therefore be situated in stage 3, whereby many women are reaching health facilities and, as a result, improving quality of care at the facility level becomes key to further improve maternal outcome.

Although globally the MMR nearly halved between 1990 and 2015, in Namibia this reduction was less than 25%.[6] Such insufficient progress was seen in most countries in southern sub-Saharan Africa, the high burden of HIV in this region being an important determinant.[12] The high impact of HIV was a result of both the severe complications directly caused by the virus, such as the rise in opportunistic infections and severe anaemia, and the indirect mechanisms taking place at the health system level, such as resources being diverted away from maternity to HIV care.[12] The impact of HIV is compounded by a high prevalence of tuberculosis. Namibia has one of the highest tuberculosis/HIV co-infection rates in the world: in 2017, an estimated 36% of the newly diagnosed tuberculosis cases were also HIV positive. The HIV prevalence was estimated at 15.7% among women aged 15-64 years in 2017.[13] In comparison to neighbouring countries, Namibia performs well with regard to the implementation of HIV treatment services: in 2017, 97.1% of HIV-infected females were on treatment, of whom 92.2% were virally suppressed.[13]

Another important determinant of the poor progress in reducing maternal mortality in Namibia can be found in the presence of extreme socioeconomic inequalities.[14] At the end of apartheid, Namibia inherited these when it gained independence from South Africa in 1990.[15] Since independence, there has been peace and political stability and from 2008 Namibia has been classified by the World Bank as an upper middle-income country. Nevertheless, even in 2015, Namibia was one of the countries with the highest income disparities in the world, with over 60 percent of the population living of less than $5.5 per day, the poverty line for an upper middle-income country.[14]

Considering gender equity, there is a discrepancy between various indicators. The literacy rate is relatively high at 88.7% in 2016, with hardly any differences between men and women.[16] Completion of secondary school is comparable for both men and women.[16] After the elections in 2020, women took the seats of nearly half of the parliament.[17] At the same time, there is a high teenage pregnancy rate of nearly 20%. One in three married women has experienced gender-based domestic violence, and over 1000 cases of rape are reported to the police every year.[11] Namibia ranks 106th out of 189 countries based on the Gender Inequality Index.[18]

The Namibian health system consists of both private and public health facilities. Private facilities are well-equipped and staffed, employing 72% of the doctors in Namibia.[19] Nevertheless, access to private health facilities is limited to a small proportion of the population, with only 18% of the population covered by medical aid.[19] Moreover, a significant proportion of the people covered by medical aid also makes use of public health facilities, as most medical aid programs do not fully cover all care expenses provided in private health facilities, such as surgery or admission. Many cannot afford the additional fees. There are 35 public hospitals: the national referral hospital, four regional hospitals and 30 district hospitals, Figure 1. In public health facilities, patients pay a small fee (about US$ 0.65) for each health visit. No additional costs are paid for diagnostics or management options including clinical admissions and surgery. All reproductive health related services, including contraception, are provided free-of-charge. In 2017, there were about ten consultant obstetrician-gynaecologists working at public hospitals, of whom more than half were employed by the hospital in the capital. Nurses follow a four-year training, whereby they can specialize in midwifery in their final year, in order to qualify as nurse-midwives. Besides these specialized nurses, there is no post-graduate midwifery training within Namibia, such as there is in, for instance, neighbouring South Africa. There is a national midwifery association for those trained abroad. There is no national association for obstetricians and gynaecologists.

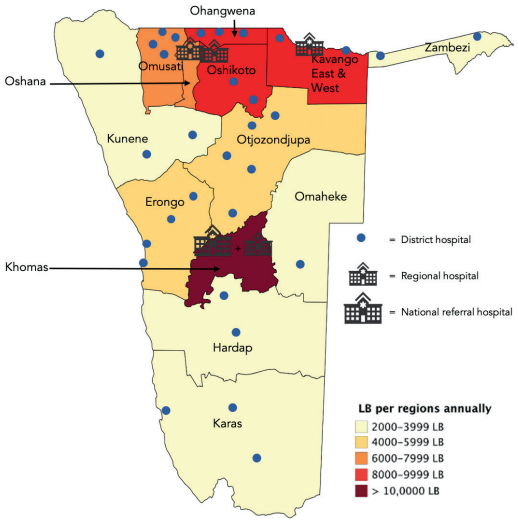

Figure 1. Map of Namibia with its 14 regions. Number of live births (LB) annually and location of public hospitals are shown. The distance between the three regional hospitals outside Khomas region and the national referral hospital are 678, 722 and 714 kilometre respectively. The longest distance between a district hospital and the national referral hospital is 1227 kilometre (this district hospital being located in Zambezi region).

The impact of cardiac disease and hepatitis E

During my employment as a medical officer in the capital of Namibia, both cardiac disease and hepatitis E were common causes of maternal death. Before coming to Namibia, I had not expected to be confronted with the considerable impact of particularly these two conditions in pregnancy, since these are relatively rarely discussed in reports on maternal health in low- and middle-income countries. Several challenges were encountered to provide good care to women affected by either condition.

For hepatitis E in pregnancy there was very limited data on outcome, so we did not know which women were at risk of severe maternal outcome. No curative treatment was available. For cardiac disease in pregnancy, quite some data was available on outcome, as well as clinical guidance for managing these high-risk pregnancies. However, data and guidance were mainly available from high-income settings. To give better insight into the complexity of caring for pregnant women with cardiac disease in a middle-income setting like Namibia, and explain why outcome data and guidelines from high-income settings may not be applicable to this setting, I present the story of two women.

The story of Esperance and Martha

On a regular antenatal care morning I met Esperance, a Congolese woman, pregnant for the third time. She had rheumatic heart disease complicated by mitral valve stenosis. This means that due to her cardiac condition she was at high risk of a complicated course of pregnancy. Her previous two pregnancies had been complicated by severe heart failure, early in the third trimester. As a result, she had to give birth by emergency caesarean section twice. Nevertheless, both of her babies had died soon after birth due neonatal asphyxia caused by her own poor condition. Esperance herself also nearly died during the last pregnancy. When I met her she was twelve weeks pregnant and determined to keep this pregnancy, despite being well aware of its risks. She explained that she wanted to have a large family or rather die if she would not be able to have living children.

On the same day I met Martha. Martha had been admitted into the cardiology department and was in poor condition. Two years ago, after her first pregnancy, she had developed heart failure due to peripartum cardiomyopathy. Her heart never fully recovered and she had been started on chronic heart medication. She was told she should not become pregnant due to her condition and while using heart failure medication, since these posed markedly increased risks for the baby. Interrupted supplies of contraceptives at the local clinic contributed to her becoming pregnant unintentionally. When she realized she was pregnant, she stopped taking all pills, being under the impression that this would be better for her baby. She decided not to go back to the hospital, out of fear for the doctor's opinion about her getting pregnant. When she was six months into the pregnancy, she developed severe heart failure and was brought to the hospital by her relatives.

For both women, doctors of the obstetric and cardiology departments worked closely together to prevent and manage any cardiac, maternal or fetal complications. Both women gave birth to healthy boys and after birth, both women were observed in the ICU department for two days. They recovered without any complications. After counselling, they both received long-acting reversible contraceptives before being discharged.

These stories show that management of these high-risk pregnancies requires a multidisciplinary approach, with involvement of -at the very least- doctors of the cardiac and obstetric departments, ideally starting before pregnancy with preconception counselling. However, for accurate counselling, more data on maternal

and perinatal outcomes were needed, specified to the Namibian setting. Also, given the differences in diagnostic and therapeutic options between high- and middle-income countries, it was unclear whether it was possible to implement the available guidelines in the Namibian setting.

Hepatitis E only started having an impact on maternal outcome in Namibia in 2017, when the first case was reported. The number of infections rapidly increased among the entire population. As it is transmitted via contaminated drinking water, the infection was mainly seen in areas with poor sanitation. Usually, hepatitis E infection is self-limiting with a low mortality rate. However, during pregnancy, a severe clinical course is frequently seen, the pathogenesis of which being poorly understood. The nationwide outbreak, therefore, had a devastating impact on maternal and fetal health, and in 2018-2019 hepatitis E even became the leading cause of maternal death.

Several barriers to good care were encountered. First, it was unclear which women were at risk of severe maternal outcome. The outbreak in Namibia concerned hepatitis E genotype 2. Adverse outcomes had previously been described in areas where genotype 1 is endemic, and, although these previously appeared to be confirmed in reports from genotype 2 endemic areas, the latter type is far less prevalent leading to paucity of data. Another concern was the high HIV prevalence in Namibia. As with most infections among HIV-infected individuals, a more severe outcome of the course of hepatitis E was anticipated. However, there were no reports available reporting outcomes of pregnant women co-infected with HIV and acute hepatitis E. Second, most health workers were not familiar with diagnosis and management of hepatitis E, since the most recent previous outbreak in Namibia had taken place in 1995. Many women presented in a confused state caused by hepatic encephalopathy, and especially in the beginning of the outbreak, women were misdiagnosed to have alcohol intoxication. Third, no curative treatment was available. In case of liver failure, only supportive care could be provided.

Problem statement and aims of thesis

It has been obvious for a considerable time that Namibia's high burden of severe maternal outcome must be addressed. However, it was unclear how a significant reduction could be achieved. The double burden of both direct obstetric causes as well as medical conditions suggested to our group of researchers that a set of diverse interventions would be needed. Improved basic obstetric care was needed for women like Selma, whereas more complex care was needed for women with medical

conditions like Esperance and Martha. Even though indicators suggested that women were reaching the health facilities, this did not mean that women had *timely* access, or access to high-quality care.

For the development of applicable and effective interventions, a better understanding was needed of the drivers of severe maternal outcome and current challenges present in the maternity care system. These insights can be obtained through obstetric surveillance.[20] Until 2017, assessment of the maternity care system was mainly done through review of maternal deaths, using the confidential enquiry into maternal deaths methodology. However, successful implementation was hampered by a blame culture that allegedly made clinicians refrain from reporting cases to the enquiry committee.[21] Committee members of the national confidential enquiry gradually became aware that not all deaths were reported or found that, in case a death was reported, not all medical notes were submitted for review. Moreover, review of maternal deaths mainly provided insight into functioning of the larger hospitals. Due to Namibia's small population of 2.5 million there were about 70 000 births per annum and the absolute number of maternal deaths was low. Maternal deaths seldom occurred in district hospitals, as the majority of these facilities had less than 1500 births per annum and the most critically ill women were transferred to higher level facilities. There was no system in place to monitor other severe complications such as maternal near-misses, which are more frequent, also at lower level facilities.

The first aim of this thesis was to enhance implementation of a national obstetric surveillance system to enable a better understanding of the underlying causes of the high burden of severe maternal outcome and the second aim was to come up with recommendations on how to improve maternal health in Namibia.

Research questions

- What are facilitators and barriers of successful implementation of obstetric surveillance in Namibia?
- What are the main maternal health problems in Namibia?
- What are recommended interventions to improve maternal outcome given the Namibian context?

Obstetric surveillance

The enhanced implementation of obstetric surveillance in Namibia was based on three components. The first was improved implementation of the confidential enquiry into maternal deaths. Secondly, a maternal near-miss approach was added

to the national obstetric surveillance system. This approach was chosen as, besides maternal near-misses occurring in larger numbers, review of these complications is probably less threatening to health workers as the focus is on women who survived rather than those who were lost.[22,23] Although the maternal near-miss approach is recommended by the World Health Organization, implementation in low-and middle-income countries has been hampered by several challenges.[24] For example, the near-miss identification criteria appeared to be less suitable for lower-income settings, due to limited availability of diagnostics and therapeutic options, leading to underreporting.[25-28] Before implementation, suitable near-miss criteria were identified for the Namibian setting. And third, two facility-based studies were performed in the national referral hospital to assess in greater detail the outcomes of pregnant women with cardiac disease and hepatitis E and explore options to reduce the risk of severe maternal outcome in these women.

Conceptual framework

A conceptual framework was developed, to place into perspective the requirements to reduce severe maternal outcome in Namibia (Figure 2). In general, to achieve favourable maternal outcome and avoid and manage severe complications women should have access to health workers who are providing good care. For a functioning health system, each element has to function. This means that women need to have timely access to the health system, as good care can only be 'delivered' to a woman when she is there and when she is there in time. This requires a supportive system around the woman to ensure that she is only pregnant when she chooses to be (**choice**), is able to access care when she needs it (**ability**) and is in good health (**women's health status**) when she becomes pregnant to reduce the risk of severe maternal outcome. On the other hand, health workers must be enabled to 'deliver' good care: they need to have **knowledge and skills**, have access to sufficient **supplies**, such as medication or medical equipment, and they need to be with enough (**human resources**).

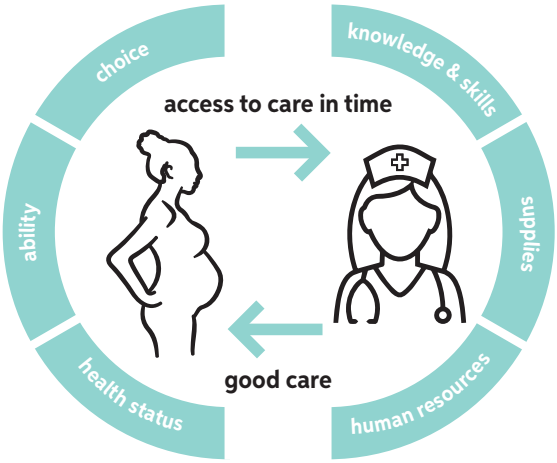

Figure 2. Framework used for this thesis to map the requirements identified through obstetric surveillance to improve maternal health in Namibia.

Thesis outline

Part I of this thesis describes both the implementation and findings of maternal death and near-miss surveillance. Chapter 2 describes the process of improving implementation of the confidential enquiry into maternal deaths by focussing on attempts to increase trust among health workers in the enquiry process. Chapter 3 presents the findings of a pilot study to identify suitable maternal near-miss criteria for a middle-income country like Namibia. Chapter 2 assesses why women die during pregnancy, birth or the postpartum period in Namibia, and chapter 4 shows why women nearly die. Lastly, based on findings of the national maternal death and near-miss surveillance studies, chapters 2 and 4 present recommendations for improvement of the maternity care system in Namibia.

Part II focuses on the impact of cardiac disease and hepatitis E. Chapter 5 explores the burden of maternal mortality due to cardiac disease in low- and middle-income countries. Chapter 6 assesses the maternal and fetal outcomes of women with cardiac disease in Namibia. A multidisciplinary approach providing care from preconception up to postpartum for women with cardiac disease was implemented in the national referral hospital of Namibia, and chapter 6 describes the challenges and benefits of such approach. Chapter 7 describes the maternal and fetal outcomes of pregnancies complicated by acute hepatitis E and whether or not the HIV status of the woman had an impact on outcome.

References

1. World Health Organization. Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. World Health Organization: Geneva, 2019.
2. Graham W, Woodd S, Byass P, et al. Diversity and divergence: the dynamic burden of poor maternal health. Lancet. 2016;388(10056):2164-2175.
3. Souza JP, Gulmezoglu AM, Vogel J, et al. Moving beyond essential interventions for reduction of maternal mortality (the WHO Multicountry Survey on Maternal and Newborn Health): a cross-sectional study. Lancet. 2013;381(9879):1747-1755.
4. Reuters. African Union drops AstraZeneca vaccine, which COVAX will supply; 2021. (Available from: https://www.reuters.com/article/uk-health-coronavirus-africa-idUSKBN2BV19H) [25-06-2022]
5. BBC News Peter Mwai. Covid-19 vaccines: Why some African states can't use their vaccines; 2021. (Available from: https://www.bbc.com/news/56940657) [25-06-2022]
6. 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(10017):462-474.
7. Souza JP, Tuncalp O, Vogel JP, et al. Obstetric transition: the pathway towards ending preventable maternal deaths. BJOG. 2014;121(Suppl 1):1-4.
8. Heitkamp A, Meulenbroek A, van Roosmalen J, et al. Maternal mortality: near-miss events in middle-income countries, a systematic review. Bull World Health Organ. 2021;99(10):693-707F.
9. Maternal Mortality Estimation Inter-Agency Group. Maternal mortality in 2000-2017. Internationally comparable MMR estimates by the Maternal Mortality Estimation Inter-Agency Group (MMEIG), Namibia. World Health Organisation: Geneva, 2017.
10. Stillbirth and Neonatal Death Review National Committee for Maternal Death. Maternal and perinatal death review, 2012-2015: Second Report. Namibia Ministry of Health and Social Services: Unpublished.
11. Ministry of Health and Social Services. Demographic and Health Survey Namibia 2013. Ministry of Health and Social Services: Windhoek, 2014.
12. Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, et al. Global, regional, and national levels and causes of maternal mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014;384(9947):980-1004.
13. Ministry of Health and Social Services. Namibia Population-Based HIV impact assessment NAMPHIA 2017. Ministry of Health and Social Services: WIndhoek, 2019.
14. World Bank Data. Country statistics Namibia; 2017. (Available from: https://data.worldbank.org/country/NA) [1-4-2019]
15. TRP Associates. 1995 Residents Survey. Municipality of Windhoek: Windhoek, 1996.
16. Namibia Statistics Agency. Namibia Inter-censal Demographic Survey 2016. Namibia Statistics Agency: Windhoek, 2017.
17. Sampaya F. Namibia narrowly misses 50% women in parliament; 2020. (Available from: https://genderlinks.org.za/news/namibia-narrowly-misses-50-mark-after-special-appointments/) [12-08-2021]
18. Human Development Reports United Nations Development Programme. Gender Inequality Index; 2019. (Available from: http://hdr.undp.org/en/content/gender-inequality-index-gii) [26-10-2021]
19. Ministry of Health and Social Services. Namibia 2014/15 Health Accounts Report. Ministry of Health and Social Services: Windhoek, 2017.
20. World Health Organization. Beyond the Numbers. Reviewing maternal deaths and complications to make pregnancy safer. World Health Organization: Geneva, 2004.
21. Ministry of Health and Social Services. Report of the Prevalence and Contributing Factors of Facility-Based Maternal and Neonatal Deaths in Five Regions of Namibia (Erongo, Hardap, //Karas, Khomas, Omaheke) during 2010–2012. Hardap Regional Health Directorate: Mariental, 2014.
22. Bakker W, van den Akker T, Mwagomba B, Khukulu R, van Elteren M, van Roosmalen J. Health workers' perceptions of obstetric critical incident audit in Thyolo District, Malawi. Trop Med Int Health. 2011;16(10):1243-1250.
23. Cecatti JG, Souza JP, Parpinelli MA, de Sousa MH, Amaral E. Research on severe maternal morbidities and near-misses in Brazil: what we have learned. Reprod Health Matters. 2007;15(30):125-133.
24. World Health Organization. Evaluating the quality of care for severe pregnancy complications. The WHO near-miss approach for maternal health. World Health Organization: Geneva, 2011.

25. Nelissen E, Mduma E, Broerse J, et al. Applicability of the WHO maternal near miss criteria in a low-resource setting. PLoS One. 2013;8(4):e61248.
26. van den Akker T, Beltman J, Leyten J, et al. The WHO maternal near miss approach: consequences at Malawian District level. PLoS One. 2013;8(1):e54805.
27. Tura AK, Trang TL, van den Akker T, et al. Applicability of the WHO maternal near miss tool in sub-Saharan Africa: a systematic review. BMC Pregnancy Childbirth. 2019;19(1):79.
28. Verschueren KJ, Kodan LR, Paidin RR, et al. Applicability of the WHO maternal near-miss tool: A nationwide surveillance study in Suriname. J Glob Health. 2020;10(2):020429.