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Factors Associated with Maternal Mortality at the Gyneco-Obstetric and Pediatric Hospital of Yaounde

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Abstract

Purpose: Our study aims at analyzing the factors associated with maternal mortality that occurred at the Gyneco-Obstetric and Pediatric Hospital of Yaounde (YGOPH) from the 1st January 2018 to the 31st December 2021.

Problem: WHO and UNICEF estimate that around half millions of women die every year, that is more than one woman die every minute from complications of pregnancy and delivery; almost 99% of these deaths occurred in developing countries [1]. Their statistics reveals that, the average risk for a woman of dying from complications linked to pregnancy and delivery is 300 times higher in developing countries than those in developed countries [1]. Out of Asia, Sub-Saharan Africa is the region of the world which scores the high rates of maternal deaths. These staggering figures show that maternal mortality is an urgent problem of public health in developing countries. Cameroon is one of the developing country who moved forwards in the fight against maternal deaths, but he still so far in the achievement of the Sustainable Development Goals (SDGs) which stipulate that the global maternal mortality ratio should be less than 70 per 100000 live births by 2030. For instance, the maternal mortality rate has dropped by 40% after 7 years, that was from 782 /100000 live births in 2011 to 406/100000 live births in 2018 [2]. Looking onto it, we realize unfortunately that 8 years are remaining to reach 2030, but yet the mortality rate is still far away to reach this target.

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Moreover, a rapid evaluation of epidemiological progress in the Center region, specifically at YGOPH, a tertiary hospital and a reference center for maternal and child care showed a sudden rise in the maternal mortality ratio, that is from 6/100000 live births in 2018 to 7/100000 live births in 2021. This prompted the researcher to investigate on the situation in this heath institution.

Methods: We conducted an analytical case control study with a retrospective data collection, using medical files of 210 participants (for 1 case, 2 survivors, totally 70 cases and 140 survivors). Data were collected using a questionnaire and analyzed with SPSS 25.0. A multivariate analysis was done to determine the independent factors associated with maternal mortality at YGOPH.

Results: Maternal mortality at YGOPH was explained by the followings: Hypertensive disorders (AHR=3.304; P-value=0.019; 95%; CI=[1.401; 5.020]), Co-morbidities (AHR=3.01; P-value = 0.003; 95%; CI= [2.059; 3.900]), mode of delivery (AHR=2.900; P-value=0.002; 95%; CI=[4.652; 8.549]), Postpartum hemorrhage (AHR=3.700; P-value = 0.011; 95%; CI= [1.730; 4.002]), Infections (AHR=9.489; P-value=0.004; 95%; CI=[3.552; 12.519]), Maternal cardiac arrest (AHR=16.000; P-value = 0.000; 95%; CI= [8.039; 79.510]), delay in decision making (AHR=3.015; P-value = 0.009; 95%; CI= [1.506; 7.010]), delay in reaching the heath facility (AHR=2.417; P-value = 0.009; 95%; CI= [1.152; 5.147]), delay in receiving treatment (AHR=2.931; P-value = 0.016; 95%; CI= [1.245; 3.538]), in-hospital patient circuit (AHR=1.710; P-value = 0.044; 95%; CI= [1.005; 3.455])) and health care management (AHR=4.810; P-value = 0.002; 95%; CI= [2.148; 10.043]).

Conclusion: The above results suggest the importance of adequate provision of care and proper follow-up of women by the qualified health professionals from pregnancy till the postpartum period. All these thanks to the harmonization in the health care system: that is through both an effective communication inside (in between services) and outside (in between health facilities) and a strong collaboration in between health professionals and their patients. This should be done consistently for a sustained effect.

Keywords: Factors associated; maternal mortality; Hospital; Cameroon..

1. Introduction

Maternal mortality continues to claim the lives of women of childbearing age worldwide. This problem remains a challenge for many countries that still struggle to prevent it. Over half a million annual maternal deaths propelled maternal mortality onto the international stage, where it became a global priority and the chosen outcome to assess progress on maternal health. Still, an estimated 810 maternal deaths occur each day in the world [3]. The Millennium Development Goal (MDG) 5 to reduce the global burden of maternal death by 75% by 2015, and the recent Sustainable Development Goal (SDG) 3, which seeks to significantly cut the number of deaths to 70 per 100,000 live births by 2030, led to the implementation of interventions to reduce the global burden of maternal mortality. Many countries over the last three decades have reduced their maternal mortality levels and contributed to the global decline of maternal deaths. However, in sub-Saharan Africa, where over 50% of all maternal deaths occur, maternal mortality rates have largely stagnated.

In Cameroon, in order to reduce the maternal mortality rates, several national strategies have been put in place

to subsidize obstetric care. For targeted and direct actions, Maternal and Perinatal Death Surveillance and Response (MPDSR) was implemented in many regions of the country. MPDSR is a form of continuous surveillance that bridges the health information system and quality of care improvement processes from the local to the national level. This system helps to provide information on how, where and why women died following complications due to pregnancy and delivery. So, circumstances around these maternal deaths are known even not deeply.

It is true that, the causes and risk factors of maternal mortality are known, strategies have been developed to reduce it and there is a slight decrease in the maternal mortality rate between 2011 (782 /100000 live births) and 2018 (406/100000 live births) in Cameroon according to the National Demographic Health Survey results of 2018 but it is not enough to explain the occurrence of maternal mortality in health facilities, many questions remain unanswered. It is therefore incumbent upon both the Cameroonian government and the managers of health facilities to contextualize maternal mortality as a phenomenon resulting from the interaction of many factors. Hence, our research study with the aim of analyzing the factors associated with maternal mortality is undertaken at the Gyneco-Obstetrics and Pediatric hospital of Yaounde. Our general population for the study consists of all women admitted between the 1st January 2018 and the 31st December 2021, in YGOPH for any reason related to pregnancy or childbirth.

The interest of this study lies in the fact that, we want to propose to the government and health policy makers the strategies they can implement to boost the effectiveness of the actions taken for the reduction of this mortality rate in YGOPH. The main objective is to analyze the factors associated with maternal mortality in a tertiary hospital. In order to achieve our goal, we divided those factors into individual and environmental factors.

Indeed, to understand the occurrence of maternal mortality in health facilities and the slow decrease of its rate, brainstorming and expertise are required, but also the involvement of an adapted theoretical approach. Thus, a multidimensional approach in this management system is required. For this reason, we have mobilized the General system theory knowing that general observations raise questions whose answers will lead to the achievement of our set objectives.

2. Materials and methods

2.1. Study designs

To reach our objectives, an unmatched analytical case control study covering a period of 4 years from January 1, 2018 to December 31, 2021 was undertaken at YGOPH in a retrospective phase of data collection.

In this study, we compared maternal death (cases) with survivors (controls) during the study period. So, we measured how often exposure to maternal deaths was associated with each individual and environmental factor in each group. This study helped to measure the strength of the relationship between individual and environmental factors with adverse maternal outcome.

2.2. Inclusion and Exclusion

2.2.1. Inclusion criteria

Case: Any woman admitted in YGOPH for any reason related to pregnancy or childbirth, who died according to WHO definition of maternal death and has been registered

Control: Any woman who survived after being admitted for any reason related to pregnancy or childbirth.

2.2.2. Exclusion criteria

All cases and controls with incomplete data.

2.3. Sampling procedures

Recruitment method: Eligible population was identified from the various registers of services concerned, that is Emergencies, Gynecology, Maternity and Rea/Theatre services. Their respective files were explored to ensure the completeness of information needed. Participants who met our inclusion criteria were recruited for our study.

Sampling methods: A non-probability purposive sampling technique was used to select the accessible population.

2.4. Sample Size

The estimated sample size of the target population was calculated based on Lorentz formula given by $\boldsymbol{n} = \frac{\boldsymbol{Z^2pq}}{\boldsymbol{e^2}}$ where **e** is the margin of error related to the desired level of precision, **p** is the prevalence of maternal mortality rate in a previous study carried out in 2017 at YGOPH, **q** is equal to **1 - p** and **Z** is the given Z-table value of the reduced centered normal distribution (typical value 1.96).

In 2017, Owono E. et al., in a retrospective and descriptive study of Epidemiology, diagnosis and evolution of obstetrical complications in two ICU in Cameroon, at YCH and YGOPH had a maternal mortality rate of 9.4% at YGOPH. So, two (2) controls per case and a mortality rate of 9.4% in 2017 were used as the basis for the calculation. This allows us to obtain a minimum sample size of 210 participants: 70 cases and 140 controls.

2.5. Data collection

Data was collected during a period of one month at the YGOPH (from April to May). To achieve this, a survey sheet was developed by the researcher and validated by the resource people.Once on the field, the concerned registers including individual medical files were gathered for data collection. This involved the review of individual medical files of the eligible population after being identified from the various registers. This helped us to collect all the information needed in our extraction grid.

3. Results

3.1. Individual factors associated with maternal mortality

Table 1: Individuals factors independently associated with maternal mortality (1/2).

	Bivariate analysis			**Multivariate analysis**		
Independent Variable	**P-value**	**Crude hazard-ratio**	**Confidence interval [95%]**	**P-value**	**Adjusted hazard-ratio**	**Confidence interval [95%]**
Hypertensive disorders in pregnancy						
Eclampsia	**0.009***	2.325	[1.221;4.429]	**0.019***	3.304	[1.401;5.020]
HELLP syndrome	**0.035***	2.433	[1.046;5.660]	**0.025***	2.263	[1.027;2.598]
Comorbidities in pregnancy						
Severe anemia	**0.004***	3.121	[2.558;3.808]	**0.003***	3.01	[2.059;3.900]
Diabetis	**0.044***	3.059	[2.517;3.717]	**0.078***	3.550	[2.817;4.019]
Encephalopathy	**0.044***	3.059	[2.517;3.717]	**0.064***	4.007	[3.511;5.907]
Kidney failure	**0.014***	3.090	[2.537;3.762]	**0.035***	4.090	[1.907;5.002]
Mode of delivery						
C/S	**0.001***	2.771	[1.531;5.014]	**0.002***	2.900	[4.652;8.549]
Dilation & Curettage	**0.014***	0.324	[0.266;0.394]	**0.003***	0.525	[0.296;0.804]
Vaginal delivery	**0.024***	0.479	[0.252;0.913]	**0.017***	0.627	[0.199;0.954]
***= Significant at 5%**						

According to the table above, the following factors were found after adjustment, as independently associated to maternal mortality in YGOPH:

Women presenting **Eclampsia during pregnancy** (AHR=3.304; P-value = 0.019; 95%; CI= [1.401; 5.020]) had a risk of dying during pregnancy, childbirth or postpartum period multiplies by 3.304. **HELLP syndrome in pregnancy** (AHR=2.263; P-value = 0.025; 95%; CI= [1.027; 2.598]) was seen in women as increasing the risk of maternal mortality by 2.263. Mothers manifesting **Severe anemia during pregnancy** (AHR=3.01; P-value = 0.003; 95%; CI= [2.059; 3.900]) had 3.01 times, the risk of dying during pregnancy, childbirth or postpartum period. For women diagnosed with **Diabetis in pregnancy** (AHR=3.550; P-value = 0.078; 95%; CI= [2.817; 4.019]), the risk of maternal mortality was multiplied by 3.550.

As complications of HIV, women who developped **Encephalopathy during pregnancy** (AHR=4.007; P-value = 0.064; 95%; CI= [3.511; 5.907]) were found to have a 4.007 times increase risk of maternal death. **Kidney failure** (AHR=4.090; P-value = 0.035; 95%; CI= [1.907; 5.002]) was observed as a factor multiplying the risk of maternal mortality by 4.090.

For those who underwent **Ceserean Section** (AHR=2.900; P-value = 0.002; 95%; CI= [4.652; 8.549]), it appeared that their risk of dying during childbirth or postpartum period was increased by 2.900. Unlike the others variables, the followings were showed as a protective factor for maternal mortality: **the practice of Dilatation and Curettage** (AHR=0.525; P-value = 0.003; 95%; CI= [0.296; 0.804]) reduced the risk of maternal mortality and therefore, increased the survival rate of women at 47.5%. It was revealed that **Vaginal delivery** (AHR=0.627; P-value = 0.017; 95%; CI= [0.199; 0.954]) was a protective factor that narrowed exposal to maternal mortality and increased survival by 37.3%.

Table 2: Individuals factors independently associated with maternal mortality (2/2).

	Bivariate analysis			**Multivariate analysis**		
Independent Variable	**P-value**	**Crude hazard-ratio**	**Confidence interval [95%]**	**P-value**	**Adjusted hazard-ratio**	**Confidence interval [95%]**
Postpartum hemorrhage	**0.014***	**3.090**	**[2.537;3.762]**	**0.011***	**3.700**	**[1.730;4.002]**
PPH due to DIC	0.000*	7.599	[3.842;15.030]	0.000*	5.169	[2.340;14.500]
PPH due to abortion	0.023*	3.295	[1.123;9.668]	0.043*	5.169	[2.225;11.007]
Infections	**0.000***	**5.482**	**[2.440;12.316]**	**0.004***	**9.489**	**[3.552;12.519]**
Puerperal sepsis	0.029*	2.442	[1.078;5.533]	0.035*	4.781	[2.708;7.033]
Septic abortion	0.004*	4.500	[1.474;13.733]	0.019*	8.077	[2.504;12.033]
Thromboembolic diseases	**0.007***	**2.895**	**[1.303;6.430]**	**0.044***	**7.221**	**[3.003;12.900]**
Pulmonary embolism	0.000*	15.103	[6.174;36.942]	0.004*	8.077	[7.501;48.040]
Venous thrombosis	0.044*	3.059	[2.517;3.717]	0.040*	4.038	[2.709;5.009]
Maternal shock	**0.000***	**18.000**	**[6.539;49.551]**	**0.000***	**16.000**	**[8.039;79.510]**
***= Significant at 5%**						

The table above reveals the followings:

Postpartum hemorrhage (AHR=3.700; P-value = 0.011; 95%; CI= [1.730; 4.002]) was found as a factor raising times 3.700 maternal mortality. When occuring to mothers, **PPH due to DIC** (AHR=5.169; P-value = 0.000; 95%; CI= [2.340; 14.500]) multiplied by 5.169 the risk of maternal death. Women who had a **history of PPH due to abortions** (AHR=5.169; P-value = 0.043; 95%; CI= [2.225; 11.007]) were found 5.169 times at risk of dying in the postpartum period.

Infections (AHR=9.489; P-value = 0.004; 95%; CI= [3.552; 12.519]) was found to be increasing by 9.489 times maternal mortality. **Puerperal sepsis** (AHR=4.781; P-value = 0.035; 95%; CI= [2.708; 7.033]), when occuring in postpartum, was found to be multiplying by 4.781 the risk of dying during this period. In regards to **Septic abortions** (AHR=8.077; P-value = 0.019; 95%; CI= [2.504; 12.033]), it was revealed as a risk factor multiplying maternal mortality by 8.077.

Thromboembolic diseases (AHR=7.221; P-value = 0.044; 95%; CI= [3.003; 12.900]) was observed as raising times 7.221 the risk of maternal deaths for those having the disease.

We could also identify that **Pulmonary embolism** (AHR=8.077; P-value = 0.004; 95%; CI= [7.501; 48.040]) was one of the risk factor multiplying maternal death by 8.077 in women presenting this complication. There was a tendency of increased maternal mortality risk for those having a **Venous thrombosis** (AHR=4.038; P-value = 0.040; 95%; CI= [2.709; 5.009]) and this risk was multiplied by 4.038.

For women who experienced the **Maternal shock** (AHR=16.000; P-value = 0.000; 95%; CI= [8.039; 79.510]), they were at 16.000 times at risk of dying during pospartum period.

3.2. Environmental factors associated with maternal mortality

The table below reveals that some environmental factors were found independently associated at 5% threshold with maternal death. Among them, some were revealed as risk factors while others were protective against maternal mortality.

Table 2: Environmental factors independently associated with maternal mortality.

	Bivariate analysis			**Multivariate analysis**		
Independent Variable	**P-value**	**Crude hazard-ratio**	**Confidence interval [95%]**	**P-value**	**Adjusted hazard-ratio**	**Confidence interval [95%]**
Time elapsed from maternal symptoms to admission into a health facility						
One day or less	0.005*	0.347	[0.162;0.740]	0.007*	0.440	[0.170;0.890]
2-7 days	0.007*	2.895	[1.303;6.430]	0.009*	3.015	[1.506;7.010]
Number of health facilities visited before admission to YGOPH						
Three	0.044*	3.059	[2.517;3.717]	0.072*	3.568	[2.624;4.018]
Difficulties related to referral application						
Lack of finances	0.008*	2.683	[1.271;5.664]	0.009*	2.417	[1.152;5.147]
Inappropriate health care as cause of disharmony out of YGOPH						
Yes	0.013*	2.162	[1.165;4.007]	0.016*	2.931	[1.245;3.538]
Pre-transfert preparation						
No	0.008*	0.417	[0.216;0.803]	0.008*	0.417	[0.216;0.803]
Average Length of Hospital Stay						
One day and less	0.000*	3.726	[2.876;4.828]	0.001*	3.016	[2.055;4.029]
2-9 days	0.000*	0.149	[0.070;0.320]	0.001*	0.540	[0.024;0.899]
Number of services visited						
One	0.043*	0.155	[0.020;1.214]	0.049*	0.205	[0.150;1.305]
GYNECOLOGY Service						
Not visited	0.015*	2.081	[1.151;3.763]	0.020*	2.504	[1.540;4.030]
REA/THEATRE Service						
First service visited	0.043*	0.220	[0.033;1.158]	0.049*	0.274	[0.064;1.507]
Service of admission	0.058*					
Rea/Theatre service	0.043*	0.155	[0.020;1.214]	0.000*	0.175	[0.039;1.401]
Gaenycology service	0.045*	1.971	[1.009;3.851]	0.044*	1.710	[1.005;3.455]
Insufficient health care as cause of disharmony in YGOPH						
Yes	0.000*	4.571	[2.091;9.992]	0.002*	4.810	[2.148;10.043]
***= Significant at 5%**						

According to the **time elapsed from maternal symptoms to admission into a health facility**, those who made one day or less (AHR=0.440; P-value = 0.007; 95%; CI= [0.170; 0.890]) had 56% more chance of survival, so protected against maternal mortality. However, women who did 2- 7 days (AHR=3.015; P-value = 0.009; 95%; CI= [1.506; 7.010]) were 3.015 times at increased risk of dying during childbirth or postpartum period. The fact of **visiting three health facilities before admission in YGOPH** (AHR=3.568; P-value = 0.072; 95%; CI= [2.624; 4.018]) multiplied by 3.568 the risk of maternal mortality. Among difficulties related to referral application, the **lack of finances** (AHR=2.417; P-value = 0.009; 95%; CI= [1.152; 5.147]) increased by 2.417 times the occurrence of maternal mortality. **Inappropriate care causing disharmony between diagnosis, prescription and care received out of YGOPH** (AHR=2.931; P-value = 0.016; 95%; CI= [1.245; 3.538]) was found to be an increasing factor of maternal mortality as it multiplied the risk by 2.931. When done, **pre-transfert preparation** (AHR=0.417; P-value = 0.008; 95%; CI= [0.216; 0.803]) protected women from maternal death at 58.3%.

We could notice that an Average Length Of hospital Stay (**ALOS) for one day and less** (AHR=3.016; P-value = 0.001; 95%; CI= [2.055; 4.029]) multiplied by 3.016 times the occurrence of maternal mortality amongst participants. Whereas, an **ALOS of 2-9 days** (AHR=0.540; P-value = 0.001; 95%; CI= [0.024; 0.899]) reduced by 46%, the risk of dying during postpartum period. We also found that, the fact of **visiting one service** (AHR=0.205; P-value = 0.049; 95%; CI= [0.150; 1.305]) was protective against maternal mortality at 79.5%. When women were not passing through the **GYNECOLOGY service** (AHR=2.504; P-value = 0.020; 95%; CI= [1.540; 4.030]), they were at 2.504 times exposed to maternal mortality. From another side, the passage to the **REA/THEATRE service** as a first service visited (AHR=0.274; P-value = 0.049; 95%; CI= [0.064; 1.507]) was protective against maternal mortality at 72.6%. Similarly, when **REA/THEATRE** (AHR=0.175; P-value = 0.000; 95%; CI= [0.039; 1.401]) was recorded as the service of admission, participants had 82.5% increased chance of survival and 17.5% less risk of maternal mortality. Whereas, when admission was recorded by the **GYNECOLOGY service** (AHR=1.710; P-value = 0.044; 95%; CI= [1.005; 3.455]), the risk of maternal mortality was multiplied by 1.710. **Insufficient care causing disharmony between diagnosis, prescription and care received in YGOPH** (AHR=4.810; P-value = 0.002; 95%; CI= [2.148; 10.043]) was identified as a risk factor multiplying maternal mortality by 4.810.

4. Discussion

4.1. Association of Hypertensive disorders in pregnancy with maternal mortality

Hypertensive disorders in pregnancy (Eclampsia and HELLP syndrome in pregnancy) were found independently associated with maternal mortality. In fact, Eclampsia in pregnancy (AHR=3.304; P-value = 0.019; 95%; CI= [1.401; 5.020]) was significantly associated at 17.9%, followed by HELLP syndrome in pregnancy (AHR=2.263; P-value = 0.025; 95%; CI= [1.027; 2.598]) also significantly associated with a strength of 14.6%, all at 5% threshold. This result goes in ligne with Bauserman et al (2020) findings who demonstrated in their study entitled "Maternal mortality in six low and lower middle income countries from 2010 to 2018: risk factors and trends", a significant relationship between hypertensive disorders (p=0.001) and maternal mortality. On the same vein, Kamga et al (2021) found in their study on "Maternal Mortality in Two Reference Hospitals in the City of Yaounde (Cameroon)" that mostly Eclampsia and HELLP syndrome, among hypertensive disorders increased maternal mortality. We can therefore conclude that Eclampsia and HELLP syndrome, highly expose women to maternal death **if not well managed on time**. History on hypertensive disorders is more common and seriously affects women during pregnancy or after childbirth. There is **a need of improving the quality of care** rendered to women of this condition.

4.2. Association of Co-morbidities in pregnancy with maternal mortality

Co-morbidities in pregnancy were revealed as independent factors of maternal mortality. Indeed, the following factors were identified as statistically significantly associated to maternal mortality at their respective strength of association: **Severe anaemia** (AHR=3.01; P-value = 0.003; 95%; CI= [2.059; 3.900]) at 19.7%, **Diabetes** (AHR=3.550; P-value = 0.078; 95%; CI= [2.817; 4.019]), **Encephalopathy** (AHR=4.007; P-value = 0.064; 95%; CI= [3.511; 5.907]) at both 13.9%, and **Kidney failure** (AHR=4.090; P-value = 0.035; 95%; CI= [1.907; 5.002]) at 17%. Thus, the existence of co-morbidities during pregnancy increased the odds of maternal deaths.

This result is in line with the findings of McCall et al (2016) which revealed that medical co-morbidities (OR 5.92, 95% CI 3.56–9.86) were strongly associated with maternal mortality, specifically, Diabetes and Encephalopathy. Added to it, Yego et al (2014) came to the same conclusion, when in their study they demonstrated that pre-existing illnesses such as Malaria, HIV and its related complications during pregnancy adversely impact maternal prognoses.

On the contrary, Saintrain et al (2016) opposed our result and instead proved that the presence of comorbidities did not have a statistically significant effect on maternal mortality. This difference can be explained by the types of illness in presence and the stage at which it was managed. Therefore, if **patients with co-morbidities in pregnancy are carefully handled and followed-up**, complications that led to death can be avoided.

4.3. Association of Mode of delivery with maternal mortality

Mode of delivery was found fully associated with maternal mortality after bivariate and multivariate analyses. In fact, **Cesarean Section** (AHR=2.900; P-value = 0.002; 95%; CI= [4.652; 8.549]), **vaginal delivery** (AHR=0.627; P-value = 0.017; 95%; CI= [0.199; 0.954]), **Dilatation and Curettage** (AHR=0.525; P-value = 0.003; 95%; CI= [0.296; 0.804]) were showed statistically significant at 5% threshold and independently associated with maternal mortality respectively at 23.6%, 15.6% and 17%. The logistic regression analysis helps us to conclude that women who underwent Ceserean Section increased their risk of maternal death by 2.900. Meanwhile, those who passed through Vaginal delivery increased their chance of survival by 37.3% and those to whom Dilatation and Curettage was done, had an increase chance of survival of 47.5%. These results explain how the mode of delivery especially C/S highly exposed women to maternal deaths.

In line with our study, Boafor et al (2021) and Bauserman et al (2020) found an association between the mode of delivery and maternal mortality. Particularly, they demonstrated an increased risk between C/S and maternal mortality. This can be attributed to the fact that women who undergo C/S are usually in the critical conditions.

Opposed to our study, Saintrain et al (2016) found that vaginal delivery (5.47-fold higher risk of death) was associated with higher mortality compared to C/S. This is probably because the majority of their patients had hemorrhagic disorders following a vaginal delivery compared to C/S. These differences can be explained by the lack of professionalism and technical platform. Finally, **delivery procedures should be handled by a team of competent professionals who can manage appropriately critical situations**.

4.4. Association of PPH with maternal mortality

PPH (AHR=3.700; P-value = 0.011; 95%; CI= [1.730; 4.002]) was found statistically significantly associated, after adjustment at 5% threshold (p=0.014) as being an independent risk factor of maternal mortality at 17% level of association. Furthermore, **PPH due to DIC** (AHR=5.169; P-value = 0.000; 95%; CI= [2.340; 14.500]) and **PPH due to abortions** (AHR=5.169; P-value = 0.043; 95%; CI= [2.225; 11.007]) were statistically significantly associated to maternal death respectively at the strength of 42.9% and 15.7%. These results after adjustment suggest a multiplication of maternal mortality risk by 3.700 times for PPH, by 5.169 times for PPH due to DIC and by 5.169 for PPH due to abortions. We can then conclude that the risk of maternal death

increases with PPH caused by DIC and abortions.

Our result goes along with the studies conducted on "Estimating the Risk of Maternal Death at Admission: A Predictive Model from a 5-Year Case Reference Study in Northern Uganda" by Alobo et al (2022) which revealed that PPH was the second leading cause of maternal mortality. Moreover, Saintrain et al (2016) observed that a large proportion of death cases had PPH due to DIC.

We found no study in contrast to our result, which shows how PPH is associated with a higher maternal mortality. Therefore, there is a need for permanent availability of blood when dealing with a patient in critical conditions.

4.5. Association of Infections with maternal mortality

Infections (AHR=9.489; P-value = 0.004; 95%; CI= [3.552; 12.519]) were found as an independent factor of maternal mortality with a strong level of association of 30.5%. Specifically, **Puerperal sepsis** (AHR=4.781; P-value = 0.035; 95%; CI= [2.708; 7.033]) and **Septic abortion** (AHR=8.077; P-value = 0.019; 95%; CI= [2.504; 12.033]) were found statistically significantly associated with maternal mortality respectively at 15.1% and 19.6%. From the obtained results, we can conclude that Infections multiplied by 9.489 times the risk of maternal mortality, Puerperal sepsis did multiply by 4.781 times maternal mortality risk and Septic abortions did multiply maternal mortality risk by 8.077 times. Finally, Infections or Sepsis are significant contributors of maternal mortality.

Our result is aligned with Boafor et al (2021) findings who demonstrated that Sepsis at 54.76%, most puerperal was one of the conditions with the highest case fatality rate. In the same vein, Saintrain et al (2016) concluded that puerperal infection predominates among the direct pregnancy-related causes of death. These results highlight how infections are one of the leading causes of maternal death. It can be attributed to the lack or malpractice of septic techniques during delivery. Therefore, **the quality of the care provided might be a decisive factor**.

4.6. Association of Thromboembolic diseases with maternal mortality

Thromboembolic diseases (AHR=7.221; P-value = 0.044; 95%; CI= [3.003; 12.900]) were found from a multivariate analysis as one of the independent factors associated with maternal mortality at 18.5%. Particularly, **Pulmonary embolism** (AHR=8.077; P-value = 0.004; 95%; CI= [7.501; 48.040]) and **Venous thrombosis** (AHR=4.038; P-value = 0.040; 95%; CI= [2.709; 5.009]) were statistically significantly associated at 5% threshold with maternal mortality at the respective strength of 48.1% and 13.9%. These results showed that Thromboembolic diseases increased by 7.221 times the risk of maternal death, Pulmonary embolism by 8.077 times and Venous thrombosis by 4.038 times. Our results show that Thromboembolic conditions are malignant for postpartum mothers as they expose them to maternal deaths. More specifically, Pulmonary embolism (48.1%) appears as extremely dangerous being the major contributor to maternal death.

Converging to our result, Boafor et al (2021) demonstrated that Pulmonary embolism (61.11%) was among the

conditions with the highest case fatality rate. This may be due to the lack of thrombo-prophylaxis protocols or low effectiveness of these protocols. Therefore, **there is a need of establishing thrombo-prophylaxis protocols or reviewing the pre-existing one**.

4.7. Association of Maternal shock with maternal mortality

Maternal shock (AHR=16.000; P-value = 0.000; 95%; CI= [8.039; 79.510]) has a great role to play in maternal mortality as shown from analyses, there is a statistical significance association with a strong adherence level of 47.2% with maternal mortality. In fact, women who passed through Maternal shock had 16.000 times the risk of dying. Maternal shock is a deterioration that may occurs at any time to women with life threatening conditions. This emergency situation can cause death if prompt actions are not taken. Mawarti et al (2017) supported this conclusion and agreed that successful resuscitation following maternal shock requires an integrated set of coordinated actions between health workers. In addition, Saintrain et al (2016) concluded that 100% of the women who died had been subjected to mechanical ventilation following a maternal shock, whereas 77.9% of the discharged ones had been not. Thus, once a shock is diagnosed, a team should be mobilized for a better management, as quick actions are required.

4.8. Time elapsed from maternal symptoms to admission into a health facility associated with maternal mortality

Time elapsed from maternal symptoms to admission into a health facility (p=0.024) was found statistically significantly associated with maternal mortality at the strength of 21.2%. Specifically, the proportion of **those who made one day or less before deciding to seek care** (p=0.005) and **those who delayed from 2- 7 days before seeking care** (p=0.007) showed also a statistical significance association with maternal mortality, respectively at 19.4% and 18.5%. Bilinear logistic regression shows that, those who made one day or less (AHR=0.440; P-value = 0.007; 95%; CI= [0.170; 0.890]) had 56% more chance of survival, while those who did 2- 7 days (AHR=3.015; P-value = 0.009; 95%; CI= [1.506; 7.010]) were 3.015 times at increased risk of dying.

Thus, **delay in decision making** was significant for maternal mortality and, it was pronounced **above one day** from the onset of maternal symptoms and admission to a health facility. Aboubakar et al (2021) agreed with our results as they proved maternal deaths associated with delays in decision making to seek care. On the same line, Ramazani et al (2022) revealed that 46% of maternal deaths were related to a parturient' delayed decision in seeking healthcare in time (first delay).

4.9. The visit of three health facilities before admission associated with maternal mortality

The visit of three health facilities before admission to YGOPH (AHR=3.568; P-value = 0.072; 95%; CI= [2.624; 4.018]), was at 5% threshold significantly and independently associated with maternal mortality at 13.9% of strength of association. In fact; the fact of visiting three health facilities before admission in YGOPH multiplied by 3.568 the risk of maternal mortality. Definitively, the visit of many health facilities was a form of delay in taking the right decision and a risk for maternal mortality. Our study agreed with Ajavon et al (2022) who observed that delay to support decision making, that is visiting many health facilities, especially with

obstetrical complications was reducing maternal prognosis and increasing the risk of maternal death. This might be due to socioeconomic conditions or lack of satisfaction in care rendered by health professionals. Therefore, **the quality of maternal care needs to be improved**.

4.10. Difficulties related to referral application associated with maternal mortality

Difficulties related to referral application particularly, **the lack of finances** (AHR=2.417; P-value = 0.009; 95%; CI= [1.152; 5.147]) was showed to be statistically significantly associated at 18.3% with maternal mortality. This result demonstrates that delay in referral response due to lack of finance multiplied by 2.417 times the occurrence of maternal mortality. So, lack of financial means being the reason for the second delay or delay in transportation, contribute to maternal mortality. Our finding is aligned with the one of Aboubakar et al (2021) who demonstrated that maternal deaths were associated with delays in reaching health facilities. In addition, Ajavon et al (2022) emphasized that the delay of evacuation during an application of referred cases, is usually due to difficulties in getting transport, and associated cost. These conclusions can be explained by depletion of financial resources during health care management or simply low socioeconomic status. So, it is crucial to **implement an in-hospital social insurance for desperate cases**.

4.11. Inappropriate care as cause of disharmony associated with maternal mortality

Inappropriate care as cause of disharmony out of YGOPH (AHR=2.931; P-value = 0.016; 95%; CI= [1.245; 3.538]) was found to be an independent factor of maternal mortality at 17.1%. This result demonstrates how women who visited other health facilities before admission to YGOPH and had gone inappropriate care, had a 2.931 multiplied risk of dying. Our result is approved by Aboubakar et al (2021) who found that maternal deaths were associated with delays in receiving adequate treatment in health care facility: he noticed a higher rate with 74.4% of patients among death cases not having received adequate treatment before referral. In the same vein, Mgawadere et al (2017) also support our result as they found among death cases in their study that 51.1% had a wrong assessment of risk, wrong diagnosis, wrong treatment and 35% received inappropriate treatment due to the lack of treatment guidelines.

Insufficient care as cause of disharmony in YGOPH (AHR=4.810; P-value = 0.002; 95%; CI= [2.148; 10.043]) was statistically significantly associated with Maternal Mortality at 27.8% strength of association. Therefore, insufficient care caused by disharmony within the hospital multiplied by 4.810 times the risk of maternal mortality.

Once in the hospital, an observation was made on this tendency of disharmony causing insufficient care and poor adequacy of treatment, thus exposing women to maternal death. Our result goes in line with Aboubakar et al (2021) who observed that 25.6% cases of deaths were due to poor adequacy of treatment. In addition, Mgawadere et al (2017) observed that unavailability of drugs was one of the main causes of care insufficiency among referred cases. These findings highlight the importance of a better inter-service communication and appropriate institutional policies put in place in hospitals.

4.12. Pre-transfer preparation associated with maternal mortality

Pre-transfer preparation (AHR=0.417; P-value = 0.008; 95%; CI= [0.216; 0.803]) was statistically significantly associated with maternal mortality at the strength of 18.3%. Therefore this result shows that when it is well done, pre-transfer preparation is protective for 58.3% against maternal death.

Aligned with this finding, Kamga et al (2021), demonstrated that deceased patients had been evacuated, in most cases without accompanying measures and this worsens the prognosis for the survival of these women. In addition, Aboubakar et al (2021) in their study went beyond and found that the existence of a reliable intravenous catheter is an important element in the management of vital distress for example. Thus, when done before referral, it increases the chance of survival of a patient. This example demonstrates the importance of pre-transfer preparation in the survival of women while fighting against maternal mortality. A gap in pre-transfer preparation might lead to loss the golden minute which is vital to save a life.

4.13. Average Length of hospital Stay (ALOS) associated with maternal mortality

ALOS (p=0.000) was listed among independent factors of maternal mortality with a statistical significance at 5% threshold and a strength of association of 46.5%. Particularly, spending one day and less in the hospital i.e an **ALOS of one day and less** (AHR=3.016; P-value = 0.001; 95%; CI= [2.055; 4.029]) was associated with Maternal Mortality at 46.4%; while spending 2 – 9 days i.e an **ALOS of 2-9 days** (AHR=0.540; P-value = 0.001; 95%; CI= [0.024; 0.899]) was associated at 36.4%. These results show that spending one day and less in the hospital multiplied the risk maternal death by 3.016 meanwhile spending 2 – 9 days in the hospital protected for 46% against maternal death. We noticed during our journey in the hospital that the more patients stay in hospital, the more they receive care accordingly and increase their chance of survival.

Our findings opposed those of Ikeda et al (2021), who demonstrated that mothers did not always receive adequate care at proper timing, even if they stayed for more than the recommended 24 hours. Probably due to the lack of close monitoring in the postpartum period. These differences can be attributed to the patient's follow-up protocol in hospitals.

4.14. Patient circuit associated with maternal mortality

Patient circuit (number of service visited: service of admission, Emergencies service, Gynecology service, Maternity service and REA/THEATRE service) was found to be an independent factor of maternal mortality: **Having visited one service** (AHR=0.205; P-value = 0.049; 95%; CI= [0.150; 1.305]), and particularly **REA/THEATRE as a first service visited** (AHR=0.274; P-value = 0.049; 95%; CI= [0.064; 1.507]) was found statistically significantly associated with maternal mortality at both at 14%. Also, **the absence of visit into the GYNECOLOGY service** (AHR=2.504; P-value = 0.020; 95%; CI= [1.540; 4.030]) or **having visited the GYNECOLOGY as the first service** (AHR=1.710; P-value = 0.044; 95%; CI= [1.005; 3.455]) was statistically significantly associated with maternal mortality, respectively at 16.9% and 13.8%.

Our above findings suggest that women who did not visit the GYNECOLOGY service had a risk of maternal death multiplied by 2.504, and when their first admission was recorded at the GYNECOLOGY service, they had an increased risk of maternal death of 71%. Moreover, the fact of visiting one service, increased the chance of

women for survival by 79.5% and the passage to the REA/THEATRE as the first service visited was also protective at 72.6% against maternal mortality. These results reflect institutional policies concerning patient's circuit in hospitals which influences their prognosis on discharge (being death or alive). The fact is that YGOPH being a hospital of reference received referral cases most of the time. Most of these cases upon arrival are in critical conditions. Therefore it is vital that the patient circuit within the hospital allow the Rea/Theatre service as the first service of admission for those cases which made the majority of death cases recorded in this hospital. The service of admission for patient in critical condition (being the majority of cases treated in the hospital as a reference hospital) must not be the Gynecology service. If the journey of such women is successful therefore they will only end up having visited one service as revealed by our results. But on the contrary, it might be important to guarantee their survival by sending then to the Gynecology service after having handled the critical aspect of their health for better monitoring purposes. In their study; Ajavon et al (2022) found that poor organization of services and lack of inter-communication between health professional of different service was one of the factor increasing the maternal mortality. This should be avoided and better institutional policies put in place in hospitals.

5. Conclusion

The aim of our study was to analyze the factors associated with maternal mortality at the Gyneco-Obstetrics and Pediatrics Hospital of Yaounde. For this purpose, due to literature review and the General System Theory, we had to search for any possible association of individual factors such as hypertensive disorders during pregnancy, comorbidities during pregnancy, mode of delivery, postpartum hemorrhage, infections, thromboembolic diseases and maternal shock with maternal mortality. In addition, we had to check for possible associations of maternal mortality with environmental factors such as time elapsed between maternal symptoms and admission to a health facility, the number of health facilities visited before admission to YGOPH, difficulties related to referral application, inappropriate health care conditions as a cause of disharmony out of YGOPH and in YGOPH, pre-transfer preparation, the number of services visited, the fact of visiting GYNECOLOGY service, the fact of visiting the REA/THEATER service, and the service of admission.

To achieve this objective, we formulated the question of what are the factors associated with maternal mortality at the Gyneco-Obstetrics and Pediatrics Hospital of Yaounde. In order to analyze these factors, each phenomenon was broken down into its different elements according to the General System Theory. This model of health conceptualized by Ludwig von Bertalanffy in 1968 in his postulate, suggested that systems cannot be reduced to a series of parts functioning in isolation, but, to understand the whole, we must understand the interrelationships between these parts. The interaction of these parts, both individual and environmental, have guided the analyzes of this study. Regarding individual factors, mother's history, pregnancy related factors, labor related factors and delivery related factors were all explored and we had the following results: Pregnancy related factors had two independent variables, showed as increasing factors for maternal mortality after a multivariate analysis: Hypertensive disorders (with Eclampsia (AHR=3.304; P-value=0.019; 95%; CI=[1.401; 5.020]), and HELLP syndrome (AHR=2.263; P-value = 0.025; 95%; CI= [1.027; 2.598])) and Co-morbidities (with Severe anaemia (AHR=3.01; P-value = 0.003; 95%; CI= [2.059; 3.900]), Diabetes (AHR=3.550; P-value = 0.078; 95%; CI= [2.817; 4.019]), Encephalopathy (AHR=4.007; P-value = 0.064; 95%; CI= [3.511; 5.907])

and Kidney failure (AHR=4.090; P-value = 0.035; 95%; CI= [1.907; 5.002]). Delivery related factors had five independent variables, which reveals two protective factors under the variable mode of delivery: Vaginal delivery (AHR=0.627; P-value = 0.017; 95%; CI= [0.199; 0.954]) and D/C (AHR=0.525; P-value = 0.003; 95%; CI= [0.296; 0.804]). The remaining variables were found as increasing factors for maternal mortality: mode of delivery (with C/S (AHR=2.900; P-value=0.002; 95%; CI=[4.652; 8.549]), PPH (AHR=3.700; P-value = 0.011; 95%; CI= [1.730; 4.002]) mainly due to DIC and abortions), Infections (AHR=9.489; P-value=0.004; 95%; CI=[3.552; 12.519]), due to puerperal and septic abortion), Thromboembolic diseases (AHR=7.221; P-value = 0.044; 95%; CI= [3.003; 12.900]) mainly Pulmonary embolism and Venous thrombosis) and Maternal shock (AHR=16.000; P-value = 0.000; 95%; CI= [8.039; 79.510]).

Concerning the environmental factors, health system related factors and institutional factors were analysed using bivariate and multivariate analysis, we got the following results: From the health system related factors, four variables were observed as independent factors of maternal mortality among which two were seen as protective factor against maternal mortality: no pre-transfer preparation (AHR=0.417; P-value = 0.008; 95%; CI= [0.216; 0.803]), one day or less elapsed from maternal symptoms to admission into a health facility (AHR=0.440; P-value = 0.007; 95%; CI= [0.170; 0.890]) while those of 2-7 days (AHR=3.015; P-value = 0.009; 95%; CI= [1.506; 7.010]) were found as increasing the risk of maternal mortality. The remaining variables were all increasing factors: visit of three health facilities before admission in YGOPH (AHR=3.568; P-value = 0.072; 95%; CI= [2.624; 4.018]), the lack of finances as difficulties related to referral application, (AHR=2.417; P-value = 0.009; 95%; CI= [1.152; 5.147]) and inappropriate care as cause of disharmony out of YGOPH (AHR=2.931; P-value = 0.016; 95%; CI= [1.245; 3.538]). We could notice from the institutional factors, that three variables were seen independent factors of maternal mortality, with more protective factors: an ALOS of 2-9 days (AHR=0.540; P-value = 0.001; 95%; CI= [0.024; 0.899]), visiting one service (AHR=0.205; P-value = 0.049; 95%; CI= [0.150; 1.305]) and REA/THEATRE as service of admission (AHR=0.274; P-value = 0.049; 95%; CI= [0.064; 1.507]). Unlike these above, the following were all increasing factors of maternal mortality: an ALOS for one day and less (AHR=3.016; P-value = 0.001; 95%; CI= [2.055; 4.029]), patient circuit in YGOPH (with not passing through the GYNECOLOGY service (AHR=2.504; P-value = 0.020; 95%; CI= [1.540; 4.030]), GYNECOLOGY as service of admission service (AHR=1.710; P-value = 0.044; 95%; CI= [1.005; 3.455])) and insufficient health care as cause of disharmony in YGOPH (AHR=4.810; P-value = 0.002; 95%; CI= [2.148; 10.043]).

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