Associated Factors of Neonatal Death at the Yaounde Central Hospital

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Abstract

Purpose: This study was aimed at determining the associated factors of neonatal mortality amongst newborn babies at the Yaounde central hospital (YCH). **Problem:** According to UNICEF (2020), 80% of all newborn deaths result from three preventable and treatable conditions: complications due to prematurity, intra-partum related deaths including birth asphyxia and neonatal infections. However, still 6,700 neonates, babies in their first 28 days of life, the neonatal period, are dying daily around the world. Virtually all (99%) newborn deaths occur in low and middle-income countries. It is especially in Africa and South Asia that the least progress in reducing neonatal deaths has been made [1]. Since 2004, neonatal mortality rate (NMR) in Cameroon only shows a slight insignificant drop and is missing its target for the 2030s sustainable development goal [2]. Most of neonates' death causes get lost as we climb the health pyramid and they remain invisible at the national level. Meanwhile, there is a sudden raise of neonatal death rate since 2019 at the Yaounde Central Hospital.

Methods: We conducted a 1 to 5 matched case-controls study. Using a quota sampling followed by systematic sampling procedures and with the help of Cochran formula for a probabilistic sampling size calculation, a developed questionnaire was addressed to a sample population of 1,428 neonates (cases = 238, controls = 1,190) in the Yaounde central hospital.

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Results: After adjustment, associated factors of neonatal death at the YCH were the absence of placental abnormality (AHR=0.235; P-value =0.016; 95%; CI= [0.072; 0.765]), placenta praevia grade 1 (AHR =1.237; P-value = 0.007; 95%; CI= [1.084; 1.679]), placenta praevia grade 3 (AHR =1.193; P-value = 0.01; 95%; CI= [1.055; 1.679]), placenta abruptio sher 0 (AHR =5.092; P-value = 0.015; 95%; CI= [1.378; 18.820]), placenta abruptio sher 3 (AHR =17.944; P-value = 0.016; CI= [1.728; 186.322]), caesarean delivery (AHR =1.777; P-value = 0.002; 95%; CI= [1.241; 2.545]), the absence of prematurity (AHR =0.376; P-value = 0.0; 95%; CI= [0.274; 0.514]), the odds of not being placed under oxygen (AHR =5.680; P-value = 0.0; 95%; CI= [3.898; 8.275]), and referral after delivery (AHR=11.966; P-value = 0.018; 95%; CI= [1.53; 93.597]).

Conclusion: From the results of our study, the raise of neonatal mortality at the Yaounde Central Hospital was explained at 73.6% by the type of placenta involved in pregnancy (8.3%), the mode of delivery (11.6%), the age of pregnancy at birth (prematurity, 20%), the obvious practice of putting a new-born under oxygen (26.8%), and the referral status of the new-born (6.9%). From this perspective, acting only on the three main preventable and treatable causes of neonatal death revealed by UNICEF (2020) [1], is not sufficient to cause a drop of NMR at the YCH. Particular attention should be paid on cases of pregnancy with placental abnormality and an extra effort should be made. **Significance:** To reduce neonatal mortality when facing placental abnormality, pregnancy should be pushed to at least 37 weeks, late c-section intervention should be avoided and in case of complications, referral should be done before childbirth.

Keywords: associated factors; neonatal death; Cameroon.

1. Introduction

Children are at the greatest risk of dying in their first month of life [1]. Mortality during the neonatal period accounts for a large portion of infant deaths and is considered a useful indicator of maternal and child health and care. Globally, the proportion of neonatal deaths among children who die under five is increasing as countries continue to witness a decline in child mortality. The increase of neonatal mortality is a red flag showing that something must be done to make the neonatal period less fatal for children. In response to this call, WHO is working with ministries of health and partners to improve the survival and well-being of new-borns. WHO program to reduce neonatal mortality has six strategic axes, including a focus on strengthening measurement, program-tracking and accountability to count every newborn death and stillbirth [3]. The sixth pillar of this WHO strategy is to count the number of dead neonates, collect information on where and why these deaths occur and try to understand their underlying causes and preventable factors. This is the responsibility of public health in general and epidemiology in particular.

In Cameroon, there is an unsatisfactory stagnation of neonatal death rate which is a major concern of public health as according to the 2030 SDG agenda concerning good health and well-being, all countries are seeking to reduce neonatal death rate to 12 per 1,000 live births at most by 2030 (SDG 3.2.2) (4,29). From this perspective, there is a need of reducing preventable neonatal deaths in Cameroon. To tackle this issue, it would be beneficial to act on neonate death causes. These causes can be better found where most of neonatal deaths occurred, which is at the health facilities level. If nothing is done, the 80% of preventable neonatal deaths will still occur and

newborns will continue to die while the knowledge behind obstetric and pediatric experience will keep on accumulating in health facilities across the country. It is nevertheless this experience that colleagues need in other health facilities to better manage their daily cases. Moreover, to help Cameroon achieving the goal of ending all preventable neonatal deaths by 2030, recommendations have to be made at the national level for neonate policy adjustment. There is a gap between neonate health policies and their implementation within the operational base of the health system. The central hospital of Yaounde is a perfect example of this gap as evidenced by its neonatal death rates from 2016 to 2020. In this hospital, the lowest peak of neonatal mortality rate (NMR) was reached in 2018 without meeting the SDG 3.2.2 target. Since then, it has steadily increased without ever falling to reach the SDG 3.2.2 target. Having made this observation, how could we explain the sudden raise of NMR in Yaounde Central Hospital (YCH)? This research question had particularly motivated the interest in studying the problem of our study which was the sudden increase of NMR at the Yaounde Central Hospital.

Our main objective was to determine the factors associated with neonatal mortality amongst newborn babies at the Yaounde central hospital. In order to realize this objective, we divided these factors into biological and psychosocial factors according to the biopsychosocial theory of health. It's true that 80% of all newborn deaths result from three preventable and treatable causes, but is this knowledge sufficient enough to cause a drop of NMR at the YCH? This question was still unanswered. Therefore drawing inspiration from the literature review, we formulated the hypothesis that neonatal mortality at the central hospital of Yaoundé is associated with biological factors such as the type of placenta, the mode of childbirth, and neonatal blood level. It is also associated with psychological factors such as maternal death, and toxin consumption, and social factors such as parental relationship, and patient circuit.

2. Materials and methods

2.1. Research type

We conducted a 1 to 5 matched case-control study with 238 cases (dead neonates) and 1,190 controls (neonates alive) which made a total of 1,428 neonates involved. This is a retrospective non-experimental study with analytical aim. In this study, we compare dead neonates (cases) with survivals (controls). Looking back, we measured how often exposure to each maternal, pregnancy, childbirth, and newborn factor is associated with neonatal death. This study helped to measure the strength of relationship between biopsychosocial factors and neonatal death.

2.2. Confounding factors

According to Adere and his colleagues (2020) [5], and Tikkanen (2011) [6], the age of a pregnant woman is a risk factor for placental abnormalities, and placental abnormality is another factor associated of neonatal death. On the other hand, the age of a mother is also a risk factors for neonatal death (Mekonnen and his colleagues, 2013) [7], and neonatal death is the outcome of this study. Therefore to avoid confusion in results interpretation, a match was done in addition to controls based on mother's age. These matched-controls to cases mitigated the effects of confounders.

2.3. Inclusion and Exclusion

Concerned participants were all neonate's life's journey medical records in Yaounde central hospital. These records include all medical file from the mother's arrival at the maternity of the Yaounde Central Hospital until the end of the newborn's journey in this maternity. All stillbirths were not concerned by our study and only live-born children were taken into consideration. All neonates included in this study had their complete file having all needed information to be taken into account. Therefore, incomplete files were excluded.

2.4. Participant Characteristics

Our participants were neonate's medical records from women of childbearing age between 15 to 53 years who delivered at the Yaounde Central Hospital between 2019 and 2020. Those aged 27 were the most represented in our sample. We observed an average age of 27.67 years with a standard deviation of 6.601. Therefore, most of the neonate's mothers participating to the study were aged between 21.02 and 34.22 years old. The odds of being marriage was a key factor for mothers of involved neonates. To mitigate the effect of age in our study, over 30 male neonates involved, 29 female neonates were recruited. Thus, we had a sex-ratio of 29/30 females per males.

2.5. Sampling Procedures

Recruitment method: Participants who met the inclusion criteria were selected at the hospital. To select these participants, we analysed available medical records among the targeted population. In this manual procedure, we started by grouping together all concerned files from different services. These files were grouped per year as per neonate. Finally, files with completed needed information were enrolled in the study.

Sampling methods: We used the quota sampling followed by the systematic sampling method. Since our targeted population were grouped per year, due to the quota sampling procedure, a quota representing the number of dead neonates (cases) per year was calculated and then applied to the entire number of dead neonates (cases) to identify the number of dead neonates (cases) to be included in the study for each year. Subsequently, the systematic sampling procedure permitted us to attribute to each quota a step that gave the road to follow in order to choose cases (dead neonates). Knowing the step to follow, we then navigated in our targeted population sorted in alphabetical order on the name of the survivals to select all those pointed out. When this was completed, the controls (survivals) were selected from the targeted population according to the matching criterion which is the neonate mother's age. For each selected case (dead neonate), we sought for two controls (survivals) among alive neonates whose mother's age was in the same range as that of the mother of the case (dead neonate).

2.6. Sample Size, Power, and Precision

As revealed by Glen (2021) [8], the Cochran formula for sample size calculation given by $n=[z^{2*}p*(1-p)]/e^2$ were used to calculate an ideal sample size based on the 95% desired level of precision, the desired level of confidence with an error margin of (e=0.05), and the given incidence for neonatal death of (p =0.5) revealed in

the literature review by Shah and his colleagues (2015) [9]. With a z value given by the z-table of the reduced centered normal distribution (z=1.96), we found a sample population size of 384 dead neonates to be included in the study.

When proceeding, we adjusted the computed size to our targeted population size as explained by Dessel (2020) with the formula : adjusted sample size=n / (1 + [(n-1)*target population size]) [10]. Statistics recorded in the annual reports of the Yaounde Central Hospital's Health Information and Hospitalization Service showed that between 2019 and 2020, there were 543 newborn deaths among 5,985 live births [11]. With this targeted population size, the adjusted sample population size was computed at the value of 225 newborn deaths that were to be recruited for this study.

Finally on the ground, 238 newborn deaths (cases) were recruited and while using the 1 to 5 coefficient of our cases-controls study, 1,190 alive newborns, survivals (controls) were then added to the sample population thus giving the total 1,428 neonates included in this study.

2.7. Data Collection

Data collection was carried out with the help of five (05) investigators for a period of one month from December 8th, 2021 at the Yaounde central hospital. To achieve this, a structured questionnaire was developed by the researcher and validated by key resource people. Once validated, the questionnaire was integrated into the Open data Kit (odk) – "Kobo-Collect" smartphone data collection tool.

Our questionnaire was structured according to the three (03) main hypotheses of our research study. It had four (04) main sections: a section on neonatal death, a section on biological factors, a section on psychological factors, and a section on social factors.

3. Results
3.1. Biological factors associated with neonatal death at the YCH

Table 1: Biological factors independently associated with neonatal death.

	Bivariate analysis	Multivariate analysis		
Independent Variable	**P-value**	**P-value**	**Adjusted hazard-ratio**	**Confidence interval [95%]**
Placenta type	0.042[*]	0.016[*]	-	-
Normal Placenta Yes No	0.4	0.016[*]	0.235	[0.072;0.765]

	Bivariate analysis	Multivariate analysis		
Independent Variable	**P-value**	**P-value**	**Adjusted hazard-ratio**	**Confidence interval [95%]**
Placenta praevia	0.012*			
Placenta praevia - grade 1 (Marginal placenta Praevia)	0.079	0.007*	1.237	[1.084;1.679]
Placenta praevia - grade 2 (Lateral placenta Praevia)	0.865	0.4	-	-
Placenta praevia - grade 3 (Partial placenta Praevia)	0.015*	0.01*	1.193	[1.055;1.679]
Placenta praevia - grade 4 (Complete placenta Praevia)	0.631	0.73	-	-
Abruptio placenta	0.338	0.05*	-	-
Sher 0	0.962	0.015*	5.092	[1.378;18.820]
Sher 1	0.253	0.134	-	-
Sher 2	0.886	0.062	-	-
Sher 3	0.068	0.016*	17.944	[1.728;186.322]
Delivery mode C-section Vaginal	0.0*	0.002*	1.777	[1.241;2.545]
Neonatal blood level				
Prematurity No Yes	0.0*	0.0*	0.376	[0.274;0.514]
Placed under oxygen No Yes	0.0*	0.0*	5.680	[3.898;8.275]
*= Significant at 5%				

N.B: No association found between Placenta accreta Spectrum, Vasa praevia and neonatal death.

3.1.1. Type of placenta

As shown in Table 1, placenta type (P-value = 0.016) was independently associated with neonatal death in YCH at 5% confidence level. More precisely, the odds of having a normal placenta (AHR=0.235; P-value =0.016; 95%; CI= [0.072; 0.765]) was protective against neonatal death. Newborns with a normal placenta have 76.5 % more survival chance during neonatal period.

Therefore, a newborn with an abnormally inserted placenta had a 23.5% increased risk of neonatal death. However, the risk of dying during neonatal period could be narrowed to 19.3% for Placenta praevia - grade 3

(Partial placenta Praevia) (AHR =1.193; P-value = 0.01; 95%; CI= [1.055; 1.679]).

In a case of Placenta praevia - grade 1 (Marginal placenta Praevia) (AHR =1.237; P-value = 0.007; 95%; CI= [1.084; 1.679]), the risk of neonatal death was raised at 23.7%. Placental abruptio had a peculiarity.

Though it was associated with neonatal mortality (P-value = 0.05), newborns with a placenta abruptio sher 0 (AHR =5.092; P-value = 0.015; 95%; CI= [1.378; 18.820]) had a risk of dying during neonatal period multiplies by 5.092. In addition, newborns who survived to a placenta abruptio sher 3 (AHR =17.944; P-value = 0.016; 95%; CI= [1.728; 186.322]) had a risk of dying during neonatal period multiplied by 17.944.

3.1.2. Mode of childbirth

Concerning the delivery mode, table 1 shows that caesarean section (AHR =1.777; P-value = 0.002; 95%; CI= [1.241; 2.545]) was found to be an independent risk factor of neonatal death. Compared to survival, newborns through c-section have a 77.7% increased risk of dying during neonatal period.

3.1.3. Neonatal blood level

Neonatal blood level represented in this study by anaemia (P-value = 0.849) and Blood transfusion (P-value = 0.255) was not associated with neonatal death. However, the absence of prematurity (AHR =0.376; P-value = 0.0; 95%; CI= [0.274; 0.514]) and the odds of not being placed under oxygen (AHR =5.680; P-value = 0.0; 95%; CI= [3.898; 8.275]) were two other correlated factors independently associated with neonatal death. In fact, the odds of not being premature was most likely to be found among survivals compared to death cases. Babies born full term had 62% more chances of survival during neonatal period.

Also, not being placed under oxygen had increased by 5.680 times the risk of dying during neonatal period.

3.2. Psychological factors associated with neonatal death at the YCH
3.2.1. Maternal death

Table 2 reveals that at a crude effect analysis level, maternal death (P-value = 0.401) was not statistically associated with neonatal death.

3.2.2. Toxin consumption

According to table 2, toxin consumption represented by alcohol intake during pregnancy (P-value = 0.899), and smoking during pregnancy (P-value = 0.585), was not statistically associated with neonatal death.

Table 2: Psychosocial factors table of contingency.

Independent Variable	P-value	Pattern of similarities	Strength of association
Maternal death Yes No	0.401	none	N/A
Alcohol intake Yes No	0.899	none	N/A
Smoking Yes No	0.585	none	N/A
Marital status Married Single Divorced Widow	0.456	none	N/A
Referral number after delivery None One	0.009*	 a b	6.9%
Referral number before delivery None One Two Three	0.929	none	N/A

*= Significant at 5%

3.3. Social factors associated with neonatal death at the YCH

Table 3: Social factors independently associated with neonatal death.

	Bivariate analysis	Multivariate analysis		
Independent Variable	**P-value**	**P-value**	**Adjusted hazard-ratio**	**Confidence interval [95%]**
Patient circuit				
Referral number after delivery One None	**0.009***	**0.018***	11.966	[1.53;93.597]

*= Significant at 5%

3.3.1. Parental relationship

Table 2 shows that Marital status (P-value = 0.456) was not statistically associated with neonatal death.

Table 4: Correlation of marriage and neonatal death.

Variables	Mother's age groups		
	15-19 years	20-34 years	35 years and above
	Frequency (n=151)	Frequency (n=1,022)	Frequency (n=255)
Neonatal death			
Yes	20	174	44
No	131	848	211
Death proportion per group	13.25%	17.03%	17.25%
Marriage			
Yes	11	254	113
No	140	768	142
Marriage proportion per group	7.28%	24.85%	44.31%

Table 4 reveals that neonatal mortality among newborn babies at the YCH had evolved in an increasing way across social classes represented here by maternal age groups as mothers of the newborns recruited in this study were classified in three categories: Adolescent mothers (15-19 years), Young adult mothers (20-34 years), Advanced Maternal Age (AMA) mothers (35 years and above). Thus, while passing from adolescent mother's group to young mothers' group, neonatal mortality had increased by 3.78% and while passing from young mothers' group to that of AMA mothers, neonatal mortality had increased further by 0.22%. There have been therefore a progressive pattern of neonatal death within the study population across maternal age social groups.

Aligned with neonatal death, when we studied marriage, which is a social fact in the same social classes as adolescent mothers (15-19 years), young adult mothers (20-34 years), AMA mothers (35 and over), we discovered that marriage had followed the same ascending order as that of neonatal death in these groups. Thus, passing from the group of teenage mothers to the group of young mothers, marriage proportion had increased by 17.57% and passing from the group of young adult mothers to that of AMA mothers, we noticed a further increase of 19.46% for marriage proportion. There have been therefore a model of progressive marriage within the study population through the social group of maternal age. Finally, marriage and neonatal mortality were correlated according to the direction of the gradient within the study population through the social group of maternal age.

3.3.2. Patient circuit

Patient circuit was classified into two groups: referral during labour and referral after childbirth. Among neonates mothers recruited in our study, 17.9% were referred once (17.2%), twice (0.6%) and thrice (0.1%) before arriving to YCH. Finally, very few babies (0.4%), coming from another health center were referred to the NICU of YCH.

Table 3 shows that neonate referral status (AHR=11.966; P-value = 0.018; 95%; CI= [1.53; 93.597]) was a risk

factor, independently associated with neonatal death at 5% confidence level. The odds of being referred was more likely to be found on death cases than survival. Therefore, newborns referred to YCH had an 11.966 times increased risk of death.

4. Discussion

4.1. Association of placenta type with neonatal death

Placenta type (P-value = 0.042) was associated at 8.3% to neonatal death. This confirmed that placenta type had a small to moderate effect on neonatal death. Precisely, the behaviour of neonates born with a placenta praevia while facing death was statistically different from others. Given this reason, placenta praevia (P-value = 0.012) was a crude dependent factor of neonatal death with a strength of 6.7%. So then, placenta praevia had a small to moderate effect on neonatal death. A look was given to Placenta praevia - grade 3 (Partial placenta Praevia) which supported this association with a P-value of 0.015 at the strength of 6.5%.

Al-Sheyab and his colleagues (2020) in their study, revealed that the most common reported condition associated with neonatal death was complication of placenta, cord, and membrane which contributed to 55% of the 31 deaths that had maternal causes. Our results aligned with this study while adding that neonatal death can be explained at 8.3% by placental complication.

4.1.1. Normal placenta and neonatal death

After adjustment, the odds of having a normal placenta (AHR=0.235; P-value =0.016; 95%; CI= [0.072; 0.765]) was protective again neonatal death. Newborns with a normal placenta had 76.5 % more survival chances during neonatal period. Therefore, a newborn with an abnormally inserted placenta had a 23.5% increased risk of neonatal death. However, the risk of dying during neonatal period was narrowed to 19.3% for Placenta praevia - grade 3 (Partial placenta Praevia) (AHR =1.193; P-value = 0.01; 95%; CI= [1.055; 1.679]). In a case of Placenta praevia - grade 1 (Marginal placenta Praevia) (AHR =1.237; P-value = 0.007; 95%; CI= [1.084; 1.679]), this risk of neonatal death was raised at 23.7%.

4.1.2. Placenta praevia and neonatal death

According to the clinical signs, placenta praevia - grade 1 (Marginal placenta Praevia) may present a lower pregnancy risk than placenta praevia - grade 3 (Partial placenta Praevia). A case of placenta praevia - grade 1 (Marginal placenta Praevia), is associated with multiple episodes of mild to moderate vaginal bleeding meanwhile a case of placenta praevia - grade 3 (Partial placenta Praevia) comes with one episode of very heavy vaginal bleeding. In YCH, when placenta praevia - grade 3 (Partial placenta Praevia) is diagnosed in the third trimester of pregnancy, a planned c-section delivery with a counselling protocol to the family is followed to avoid delay in carrying out the c-section.

In the case of placenta praevia - grade 1 (Marginal placenta Praevia), vaginal delivery is still possible but if the pregnancy is not well followed, complications might lead to caesarean delivery. Most of these cases are usually referred to the YCH. The delay in fund raising, and the delay in caesarean kit gathering might lead to a delay in

c-section intervention which put the baby more at risk. These results are aligned with the findings of Salihu and his colleagues (2003) [13] who demonstrated that the adjusted relative risk of death was three times higher among placenta praevia neonates (hazard ratio, 3.06; 95% CI, 2.40-3.94).

4.1.3. Placenta abruption and neonatal death

Placenta abruptio had a peculiarity. Though it was associated with neonatal mortality (P-value = 0.05), newborns with a placenta abruptio sher 0 (AHR =5.092; P-value = 0.015; 95%; CI= [1.378; 18.820]) had a risk of dying during neonatal period multiplied by 5.092. In addition, neonate born with a placenta abruptio sher 3 (AHR =17.944; P-value = 0.016; 95%; CI= [1.728; 186.322]) had a risk of dying during neonatal period multiplied by 17.944. This result agrees with Downes and his colleagues (2017) [14] who showed that neonates born with a placenta abruptio were 7.6 times more at risk of neonatal death (RR = 7.6, 99% CI: 5.2, 10.1).

At this stage of our study, our results showed that placenta praevia reduces by 80% the odds of being alive among neonate, placenta abruptio multiplies the risk of dying during neonatal period by 5 and 17 times. On the other hand, a child born with a normal placenta is at 80% protected against neonatal death.

4.2. Association of delivery mode with neonatal death

Delivery mode was also associated with neonatal death (P-value = 0.0) at the strength of 11.6%. This revealed that neonatal death could be explained at 11.6 percent by the delivery mode of the baby. More again, the behaviour towards death of neonate born through the vaginal was different from those born by caesarean. Our results concerning delivery mode were in agreement with authors like Bakalar (2006) [15], Varela and his colleagues (2019) [16], Tadesse and his colleagues (2021) [17] , and Chiabi and his colleagues, (2014) [18] who all found that delivery mode was associated to neonatal death.

Caesarean section (AHR =1.777; P-value = 0.002; 95%; CI= [1.241; 2.545]) was found after adjustment to be an independent risk factor of neonatal death. Compared to survival, newborns through c-section had a 77.7% increased risk of dying during neonatal period. This results aligned with Varela and his colleagues (2019) [16] study which revealed that infants born in a C-section delivery had 3.71 increased odds of post-neonatal death. Tadesse and his colleagues, (2021) [17] with a logistic regression confirmed that giving birth through cesarean section [AOR 3.59, 95%CI (1.22, 10.55)] were significantly associated with a risk of neonatal mortality with an adjusted odd ratio of 3.59. Our results revealed that c-section was associated with an increased risk of neonatal death because of delay in practice.

Upon 10 women to undergo surgery, 8 may be taking to the theatre room lately because of the unavailability of the cesarean kit. Late c-section intervention may lead to acute fetal distress and exposes the newborn to a risk of neonatal death. The issue is that, women come to the hospital without money, by the time they put their financial resources together to get the caesarean kit which is also incomplete, and they have to struggle by their own to complete it. All these cause a delay in carrying out c-section intervention which increases the risk of neonatal death.

4.3. Non-association of neonatal blood level with neonatal death

We found that, anaemia (P-value = 0.849) and blood transfusion (P-value = 0.255) representing neonatal blood level, were not statistically associated with neonatal death.

Going further, our results revealed that prematurity does not mean systematic anaemia. In fact, those who were premature and anaemic (43.6%) were even lesser than those who were anaemic and not premature. Anaemia in prematurity was not statistically established within the population of the study. This is to say anaemia in neonatology was not statistically associated with prematurity (P-value = 0.723). Although anaemia in prematurity was not associated with neonatal death at the YCH, the absence of prematurity (AHR =0.376; P-value = 0.0; 95%; CI= [0.274; 0.514]) and the odds of not being placed under oxygen (AHR =5.680; P-value = 0.0; 95%; CI= [3.898; 8.275]) were two major factors associated with neonatal death.

Finally, prematurity (P-value = 0.0) and oxygen intake (P-value = 0.0) were two independent factors strongly associated with neonatal death at 26.8% and 20% respectively. These two factors related to neonatal blood level had a high effect on neonatal death and can explain together at a crude level, almost 46.8% of neonatal death at the YCH.

4.4. Association between prematurity and neonatal death

The odds of not being premature was most likely to be found among survival compared to death neonates. Babies born full term have 62% more chances of survival during neonatal period. Most cases of neonates born from an abnormally inserted placenta were delivered prematurely to avoid delivery complications. This was one of the reason why abnormal placentae were highly correlated with preterm birth. In their study, Vahanian and his colleagues (2015) [19, p. S80] showed that placenta praevia was significantly associated with preterm delivery and their study equally showed that placenta accreta cases had a significantly shorter duration of pregnancy by 1.50 weeks and decreased birthweight by approximately 240g. According to Hadgu and his colleagues (2020) [20], gestational age was significantly associated with neonatal mortality. For Dhaded and his colleagues (2020) [21] a one-week decrease in gestational age at delivery was associated with a higher risk of neonate mortality. In his study, Lona Reyes and his colleagues (2018) [22] demonstrated that the conditions associated with death was gestational age < 37 weeks. Weddih and his colleagues (2019) [23] showed that low gestational age was significantly associated with neonatal death. Varela and his colleagues (2019) [16] added that neonatal deaths was 14.09 times more likely to occur in a preterm compared to live infants. For Yego, and his colleagues, (2014) [24], the odds of gestational age < 37 weeks and > 42 weeks, compared to 37-42 weeks, was higher for deaths neonates relative to alive neonates. Our results on preterm birth revealed that health practitioners should do their best to carry pregnancies to term (between 37 to 42 weeks). But our experience in the hospital shows that when a woman is diagnosed with an abnormal placenta, she is given hospital bed rest at 28 or 32 weeks. Within this period, she has to feed and continue to follow her ANC. For pregnancy to mature, she has to stay for about two months in the hospital. This woman will then face the stress of abandoning the family and also the stress of bills. Because of psychosocial stress, she may find herself bleeding on the cause of hospitalization. This bleeding will then push health practitioners to terminate her pregnancy before term. We

think that if health insurance is put in place, it will be easy for this woman to follow prescription and protocols. Also, it will be possible to avoid sudden bleeding in case of abnormal placenta. This will help to push the pregnancy as much as possible to it full term (at least 37 weeks) which will be protective for the baby. Although premature babies were not dominating our sample population (45.4%), premature newborns represented the majority of dead cases (67.6%). Also, the behavior of premature newborns concerning death was statistically different from those who were not premature. Since prematurity is birth at gestational age < 37 weeks, our findings correlated with the results of authors like Weddih and his colleagues (2019) [23], Varela and his colleagues (2019) [16], and Lona Reyes and his colleagues (2018) [22] who demonstrated that a condition associated with neonatal death was gestational age < 37 weeks.

4.5. Association between oxygen intake and neonatal death

The behaviour of neonates who were anaemic and placed under oxygen was statistically different from those who were anaemic and were not placed under oxygen while facing death. From the overall 11.3% of neonates placed under oxygen in our sample population, 18.1% of anaemic babies were placed under oxygen meanwhile the rest of 81.9% were never placed under oxygen. Added to that, our sample population presented 10.8% of non-anaemic babies placed under oxygen. Finally, placing a neonate under oxygen (P-value = 0.031) was found statistically associated with anaemia in newborn at 5.7% which revealed that oxygen intake had a small to moderate effect on anaemic babies. In addition, not being placed under oxygen increased by 5.680 times the risk of dying during neonatal period. In fact, the neonatology service of YCH has four functional spots of oxygen, 4 functional incubators, and one functional hitting table. These are all methods of reanimation which are really helpful in case of prematurity. Our experience in this hospital showed that up to 5 preterm babies can be admitted in this service daily. A baby may stay under oxygen for three days depending on the severity of symptoms. However, other babies in the service may need to be replaced under oxygen again. Because of limited number of oxygen spots, some babies may not be place under oxygen on time. It could equally happen that during the weekend the oxygen bottles are out of stock. All of these create a gap in oxygen supply which can easily lead to neonatal death. On the other hand, the behaviour of neonates placed under oxygen was statistically different from those who were not placed under oxygen when facing death. The overall percentage of neonates placed under oxygen in our sample study population was 11.3. Among them, 7.5% of all the babies who survived where placed under oxygen. However, 30.3% of all neonates who died had been placed under oxygen and the rest of 60.9% were not placed under oxygen in time or delay on arrival.

4.6. Non-association between maternal death and neonatal death

Very few mothers of neonates involved in this study died during the neonatal period (2.9%). Moreover, maternal death occurring during pregnancy and after neonatal period was not our concern. However, maternal death (P-value = 0.401) was not associated with neonatal death. In fact, babies whose mothers died during neonatal period were generally well prepared before delivery. For instance, mothers who died during neonatal period are usually diagnosed with a disease during the third trimester of their pregnancy. In general, this disease complicates the pregnancy which often ends in a c-section resulting in the death of the mother which might occur during neonatal period. The disease usually puts the foetus in a chaotic environment that allows it to

rapidly mature its organs to survive. After birth, such a child is better equipped to face the neonatal period, hence its high survival rate. If for example, a pregnant woman has ecclampsia in the third trimester of her pregnancy, the lungs of her foetus will rapidly mature unlike a woman who has a premature rupture of the membrane where the child is not yet prepared. This mother must then take corticosteroids to help mature the lungs of the foetus (lung immaturity being a major problem for premature babies). For this reason, maternal death during pregnancy was not associated with neonatal death in our study.

4.7. Non-association between toxin consumption and neonatal death

Very few mothers of babies recruited for this study drank alcohol during pregnancy (8.6%). Moreover, only 1.2% of baby's mothers presented in the population of the study were smoking during pregnancy. Finally, toxin consumption divided into alcohol intake during pregnancy (P-value = 0.899), and smoking during pregnancy (P-value = 0.585) was not associated with neonatal death. In fact, in our African culture when a woman becomes pregnant, she will tend to stop her habit of drinking or smoking if any. This will then cause a moderation in her consumption rate of toxins. Therefore, even if it can be difficult to maintain this behaviour, the quantity consumed and the frequency of consumption, may not be enough to affect baby life outcome during the neonatal period.

4.8. Non-association of parental relationship with neonatal death

Among neonates mothers recruited for this study, 26.5% were married. However, Marital status (P-value = 0.456) was not associated with neonatal death. But from a social epidemiology point of view, marriage and neonatal mortality were positively correlated according to the direction of the gradient within the population studied through the social group of maternal age. A social analysis of marriage and neonatal death had revealed a growing chain linking neonatal death to marriage across maternal age group. Our findings agreed with Bennett (1992) [25] who demonstrated that the relationship between marital status and birth outcomes varies by maternal race and age. Therefore to reverse this phenomenon, encouraging marriage at the age range of 20-34 years is protective against neonatal death.

4.9. Association of patient circuit with neonatal death

Only reference after delivery (P-value = 0.009) was a factor of neonatal death with a strength of 6.9%. Therefore, referral after birth had a small to moderate crude effect on neonatal death. This is to say, neonatal death at the YCH can be explained at 6.9% with the referral status of the baby. In fact, the behaviour towards neonatal death of babies that were referred was found statistically different from those that were not referred. Referral after birth (AHR=11.966; P-value = 0.018; 95%; CI= [1.53; 93.597]) was a risk factor independently associated with neonatal death at 5% confidence level. The odds of being referred was more likely to be found on death cases than survival. Therefore, newborns referred to the YCH had an 11.966 times increased risk of neonatal death. This result is in agreement with the effect of "Golden Minute" which refers to the first 60 seconds of an infant's life. Within these limited seconds, the infant should begin breathing on his or her own, or interventions must be started. In each case, steps taken to treat an infant must be precise and timely [26]. From

the above points of view, moving from one spot to another in search of neonatal treatment is time and life costly. Referral mechanisms towards admission to a neonatal intensive care unit therefore appear here as a strong determinant of neonatal life outcome. The time spent between when a neonate health problem is diagnosed and its access to treatment determine if this child will live or die.

4.10. Limitations and Strengths of the study

The main limitation of our study is that it is a single-center study. However, the results obtained can still be generalized as they describe similar etiologies of neonatal hospital mortality observed in different areas in Cameroon (1,38,39) and abroad (33,40,41) The neonatal mortality factors studied in this research were not yet thoroughly addressed or were remained ambiguous in the literature. Their combination in this study makes them the main strength which lifts this veil and thus awakens new angles to fight more effectively against neonatal mortality. Moreover, the merits of this study include its matched case-controls design and robust statistical methods to make a level III contribution of scientific evidence [42, p. 8] to the paucity of neonatal hospital mortality data in Sub-Saharan settings. Our results can be generalized since the sampling selection processes were well-designed and the sample population was representative. A case-control method performed for our study proved effective since we studied a health outcome (neonatal death) with a long latency period between exposure beginning with pregnancy and manifestation in the neonatal period. Also, having pushed the controls-to-case ratio to the maximum of (1:5) as explained by Hennessy and his colleagues (1999) permitted to stratify the study population [43]. In fact, the concern of additional controls per case in this study was needed to carry out a social stratified analyses in which each case together with its matched controls constitutes a distinct stratum of maternal age. In addition, matching performed in our case-control study had mitigated the confounding effect of the matching factor (maternal age).

4.11. Study Implications: explanation of the raise of NMR at the YCH

From the results of our study, the raise of neonatal mortality at the Yaounde Central Hospital was explained at 73.6% by the type of placenta involved in pregnancy (8.3%), the mode of delivery (11.6%), the age of pregnancy at birth (prematurity, 20%), the practice of putting a newborn under oxygen (26.8%), and its referral status (6.9%). From this perspective, acting only on the three main preventable and treatable causes of neonatal death revealed by UNICEF (2020) [1], is not sufficient to cause a drop of MNR at the YCH. Particular attention should be paid on cases of pregnancy with placental abnormality and an extra effort should be made. To reduce neonatal mortality when facing placental abnormality, pregnancy should be pushed to at least 37 weeks, late c-section intervention should be avoided and in case of complications, referral should be done before childbirth.

Acknowledgments

5. Conclusion

The aim of our study was to determine associated factors of neonatal mortality amongst newborn babies at the

Yaounde central hospital. Giving this purpose, due to the literature review and the biopsychosocial theory of health, we had to seek for any possible association of biological factors like placenta type, delivery mode, and neonatal blood level with neonatal death. Added to this, we had to check for possible associations of psychological factors like maternal death, and toxin consumption with neonatal death. And finally, we were to design any association of neonatal death with social factors like parental relationship, and patient circuit at the Yaounde central Hospital. To reach this target, we formulated the question of what are the associated factors of neonatal mortality amongst newborn babies at the Yaounde central hospital. In order to analyse these factors, each phenomenon was broken down into its different elements following the biopsychosocial theory. This model of health conceptualized by George Engel in 1977 in his postulate, suggested that in order to understand a person's medical condition, not only biological factors are to be considered, but also psychological and social factors. These factors, both biological and psychosocial, are indeed those analysed in this study. Our study revealed for biological factors that placenta type (P-value = 0.042) and delivery mode (P-value = 0.042) were biological factors associated with neonatal death at the YCH respectively 8.3% and 11.6%. In fact, after adjustment, placenta praevia grade 1 (AHR =1.237; P-value = 0.007; 95%; CI= [1.084; 1.679]), placenta praevia grade 3 (AHR =1.193; P-value = 0.01; 95%; CI= [1.055; 1.679]), placenta abruptio sher 0 (AHR =5.092; P-value = 0.015; 95%; CI= [1.378; 18.820]), placenta abruptio sher 3 (AHR =17.944; P-value = 0.016; CI= [1.728; 186.322]), caesarean delivery (AHR =1.777; P-value = 0.002; 95%; CI= [1.241; 2.545]) were found to be risk factors meanwhile the absence of placental abnormality (AHR=0.235; P-value =0.016; 95%; CI= [0.072; 0.765]), and the absence of prematurity (AHR =0.376; P-value = 0.0; 95%; CI= [0.274; 0.514]) were protective. Neonatal blood level represented in this study by anaemia (P-value = 0.849) and Blood transfusion (P-value = 0.255) was not associated with neonatal death. However, two other biological factors related to neonatal blood level were found dependently associated with neonatal death. These factors were prematurity (P-value = 0.0) and oxygen intake (P-value = 0.0) respectively associated to neonatal death at 20% and 26.8%. After adjustment, the odds of not being placed under oxygen (AHR =5.680; P-value = 0.0; 95%; CI= [3.898; 8.275]) was a risk factors. For psychological factors, neither maternal death (P-value = 0.401), nor toxin consumption divided into alcohol intake during pregnancy (P-value = 0.899), and smoking during pregnancy (P-value = 0.585) were associated with neonatal death. For social factors, only referral after delivery (P-value = 0.009) which is part of the patient circuit was associated with neonatal death at 6.9%. After adjustment, referral after delivery (AHR=11.966; P-value = 0.018; 95%; CI= [1.53; 93.597]). To reduce neonatal mortality when facing placental abnormality, pregnancy should be pushed to at least 37 weeks, late c-section intervention should be avoided and in case of complications, referral should be done before childbirth.

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Appendices

Questionnaire for data collection

1. INVESTIGATIOR IDENTIFICATION	ANSWER

1.1. Investigator id

1.2. Date of the day (dd/mm/yyyy)

2. MOTHER IDENTIFICATION	ANSWER

2.1. Mother's id (from the childbirth register)

2.2. Mother's name (first names & last names)

2.3. Mother's phone number (9 digits nber starting with 6)

2.4. Contact person phone (9 digits nber starting with 6)

2.5. Mother's address or quarter

2.6. Gestational age (per weeks)

2.7. Delivery date (dd/mm/yyyy)

2.8. Delivery place

    1. Hospital

    2. Community

3. CHILD IDENTIFICATION	ANSWER

3.1. Child's id (from the neonatal register)

3.2. Child's name (first names & last names)

3.3. Child's sex

    1. Female

    2. Male

4. SOCIAL FACTORS	ANSWER

4.1. Mother's age

4.2. Marital status

    1. Single

    2. Married

    3. Divorced

    4. Widow

4.3. Number of Referral (during labour, zero if none)

    1. Zero

    2. One

    2. Two

    3. Three

4.4. Number of Referral (After delivery, zero if none)

    1. Zero

2. One

2. Two

3. Three

5. MATERNAL BEHAVIORAL FACTORS   ANSWER

5.1. Alcohol intake during pregnancy

1. No

2. Yes

5.2. Smoking during pregnancy

1. No

2. Yes

6. PREGNANCY-RELATED FACTORS   ANSWER

6.1. Normal Placenta (Mandatory, if yes go to next session)

1. No

2. Yes

6.2. Placenta Praevia (Not mandatory, if answered go to next session)

1. Grade 1 : Marginal placenta praevia

2. Grade 2 : Lateral placenta praevia

3. Grade 3 : Partial placenta praevia

4. Grade 4 : Complete placenta praevia

6.3. Placenta Accreta spectrum (Not mandatory, if answered go to next session)

1. placenta accreta

2. Placenta Increta

3. placenta Percreta

6.4. Vasa praevia (Mandatory, if yes go to next session)

1. No

2. Yes

6.5. Abruptio Placenta (Not mandatory)

1. Sher 0

2. Sher 1

3. Sher 2

4. Sher 3

7. DELIVERY FACTORS   ANSWER

7.1. Delivery mode

1. Vaginal delivery

2. Cesarean delivery

8. MATERNAL LIFE OUTCOME   ANSWER

8.1. Is the baby's mother alive?

      1. Yes

      2. No

8.2. If no, indicate the date of mother's death (dd/mm/yyyy)

8.3. Mother's Place of death (if applicable)

      1. Hospital

      2. Community

8.4. Mother's Period of death (if applicable)

      1. During pregnancy

      2. During Delivery

      3. After Delivery

9.   NEONATE LIFE OUTCOME   ANSWER

9.1. Is the baby alive?

      1. Yes

      2. No

9.2. If no, indicate the date of the baby's death (dd/mm/yyyy)

9.3. Baby's death Place (if applicable)

      1. Hospital

      2. Community

9.4. Baby's death Period (if applicable)

      1. Within 24 hours after birth

      2. Within 48 hours after birth

      3. During the 1st week of life

      4. After the first weeks of live

10. NEONATAL FACTORS   ANSWER

10.1.   Neonatal anaemia status (based on child's hemoglobin level)

      1. Positive

      2. Negative

10.2.   Blood transfusion (number of units, zero if none)

      1. Zero

      2. One

      3. Two

10.3.   Placed under oxygen?

      1. No

      2. Yes