Scientific Research Publishing

Advances in Reproductive Sciences, 2023, 11, 11-22
https://www.scirp.org/journal/arsci
ISSN Online: 2330-0752
ISSN Print: 2330-0744

Circadian Rhythm of Childbirths and Maternal and Neonatal Prognosis at the Yaoundé Central Hospital

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How to cite this paper: Fouelifack, F.Y., Donkeng, J., Takang, W., Mesumbe, E., Fouelifa, L.D., Ofeh, M.A., Ndenkeh, J. and Fouedjio, J.H. (2023) Circadian Rhythm of Childbirths and Maternal and Neonatal Prognosis at the Yaoundé Central Hospital. *Advances in Reproductive Sciences*, **11**, 11-22.
https://doi.org/10.4236/arsci.2023.111002

Received: December 28, 2022
Accepted: February 12, 2023
Published: February 15, 2023

Abstract

Background: The circadian variation of childbirths has been described by several authors around the globe. De Graaf showed that hospital childbirths at night were associated with increased perinatal mortality and adverse perinatal outcome. To improve obstetric care, we carried out this study to evaluate the circadian rhythm of childbirths and to assess the outcome following variations in the time of childbirths during the day. **Methods:** It was a cross-sectional descriptive study at the Yaoundé Central Hospital (YCH), over a two years period. We collected data from files of women who delivered from the 1st of January 2017 to 31st December 2018. We included files of women who delivered at least at 28 weeks of pregnancy. We excluded files of those who delivered by elective caesarean section, those whose hour of delivery was not noted and those who delivered before reaching the hospital. Sociodemographic, obstetrical characteristics, and immediate prognosis were recorded. Data were entered into excel, then analysed with SPSS v23 software. Tools used to appreciate our results were means, median, number, percentage, P, and OR with its 95% confidence interval. The difference in p is significant if p is less than 5%. **Results:** We analyzed 6041 files bearing the time of birth. Childbirths took place at all hours of the day, but the times of the day where the highest

numbers of births were recorded were 10, 11, 12, 13 (that's 1 pm), 14 (that's 2 pm), 15 (that's 3 pm), 16 (that's 4 pm), 17 (that's 5 pm) and 23 (that's 11 pm) hours, with respectively 224 (3.7%), 277 (4.6%), 256 (4.2%), 265 (4.4%), 207 (3.4%), 255 (4.2%), 228 (3.8%), 216 (3.6%) and 226 (3.7%) births. The peak of births was at 11 am while the time of day where the lowest number of births was recorded was 6 pm, with 175 (2.9%) births. The mean age of participants was 27.34 ± 6.03 years with extremes of 13 and 49, with 87.6% between 20 to 39 years. Sociodemographic characteristics of participants, prematurity and bleeding during delivery, had no dependence on the time of delivery. Perineal tear, duration of observation, Apgar score of the newborn, birthweight, delivery mode, health personnel who performed the delivery, and episiotomy seemed to be influenced by the time of delivery. Daily shifts were not independently associated with the poor Apgar score (0 - 6) at 5 mins, when adjusted for all other factors ($p = 0.109$). **Conclusion:** Childbirths were more frequent between 10 am and 5 pm. The period where episiotomy was most performed is the same as when there was macrosomia childbirth. Tears of the perineum are more frequent between 2 pm and 10 pm. There was no independent association between Daily shifts and poor Apgar score. The poor APGAR score would be more related to low birth weight.

Keywords

Circadian Rhythm, Childbirth, Maternal, Neonatal, Prognosis

1. Introduction

Mankind has done its possible best to explain the physiology of childbearing: from conception to delivery. There are several questions that still remain unanswered. Several authors have studied the variation in births over the year, month, week, and day, with rather mixed results. The circadian variation of childbirths has been described by several authors around the globe. Vercoustre in France 1995 found that from the 24th week till term, there is an increase in uterine activity during the night [1]. According to Enid, this increase in uterine activity leads to an increased number of births at night [2]. Pasche *et al.* observed 685 low-risk pregnant women consecutively admitted at an early stage of labor to six maternity units, and showed the hourly variations in the birth rate and circadian variations in obstetric practices that might explain the hourly pattern observed for the birth rate. By contrast, the frequency of a positive neonatal risk indicator was uniform across all time categories in this population at low obstetric risk [3]. Goldstick *et al.* in Israel following a retrospective study from 1990-1998, observed a marked diurnal variation in urgent operative childbirths [4]. De Graaf *et al.* showed that hospital childbirths at night were associated with increased perinatal mortality and adverse perinatal outcome [5].

In Cameroon, the health system is pyramidally consisting of three levels: primary, secondary, and tertiary. Emergency obstetric care also follows the same

strata, but very few hospitals are capable of carrying out secondary and tertiary emergency obstetric care. There is an increase in maternal and perinatal mortalities due to the absence of hospital personnel and delayed onset of management at certain hours of the day [6]. It is, therefore, important to know the circadian variation of childbirths in our community, to help to improve our emergency obstetric care. Our general objective was to evaluate the circadian rhythm of childbirths and to assess the outcome following variations in the time of delivery during the day.

2. Methods

We carried out a cross-sectional descriptive study at the Yaoundé Central Hospital (YCH), over a two years period. We collected files of women who delivered from 1st January 2017 to 31st December 2018. Sampling was consecutive and exhaustive. The minimal size of the sample was obtained using the Lorentz formula [7]: $N = t^2 \times p(1-p)/m^2$, with N = minimal size of the sample, t = level of confidence at 95% (value 1.96), p = prevalence of delivery in our context (50% if unknown), m = error 0.05). After application, N = 400 participants. But to increase the reliability of our results, we recruited the files of all women who fulfilled our selection criteria.

We included files of all women who delivered at the YCH with gestational age of at least 28 weeks. We excluded files of those who delivered by elective caesarean section and those whose hour of delivery was not mentioned in the delivery register or in their files. Those who delivered before reaching the hospital (at home or in the taxi) were not included. Sociodemographic characteristics (age, gravidity, parity, ethnic origin, marital status, profession), obstetrical characteristics (gestational age at delivery, time of onset of labour, time of delivery, duration of active phase of labour, mode of delivery) and immediate prognosis (episiotomy, perineal tear, sex of newborn, birth weight, Apgar score in the 5th minute) were recorded in a pretested data sheet.

3. Data Analysis

Data collected with the data sheet were entered into an excel spreadsheet then transferred to and analysed in the SPSS v23 software. The results were presented in means or medians for continuous variables depending on their distribution. Their comparisons were done using unpaired t-test or Man Whitney test depending on their skewness. Also, categorical variables were presented in proportions which were compared amongst them using the chi-square test. The unadjusted effect of daily shifts (the main factor) on risk of having a child with poor prognosis (having an Apgar score at 5 mins of 0 - 6) [5] was identified using a bivariate logistic regression which was also used to identify other potential risk factors of poor prognosis. All the above identified factors were then adjusted for each other's effect in a multivariate logistic regression where focus was kept on the main factor to know if it remained independently associated to risk of poor

prognosis in a newborn upon adjustment for the other factors. Significance for all above tests was set at 5%.

4. Results

During the study period, 6065 births were recorded, of which 6041 bearing the time of birth were included and analyzed. Some variables were not filled in the files, resulting in variation in size of the studied characteristic.

4.1. Variation of the Number of Childbirths throughout the 24-Hour Period

During the study period, childbirths took place at all hours of the day, but the times of the day when the highest numbers of births were recorded were 10, 11, 12, 13 (that's 1 pm), 14 (that's 2 pm), 15 (that's 3 pm), 16 (that's 4 pm), 17 (that's 5 pm) and 23 (that's 11 pm) hours, with respectively 224 (3.7%), 277 (4.6 %), 256 (4.2%), 265 (4.4%), 207 (3.4%), 255 (4.2%), 228 (3.8%), 216 (3.6%) and 226 (3.7%) births. The peak of births was at 11 am while the time of day when the lowest number of births was recorded was 6 pm, with 175 (2.9%) births (see Figure 1).

4.2. Sociodemographic and Obstetrical Characteristics of Participants with Respect to Daily Shifts

The mean age was 27.34 ± 6030 years with extremes of 13 and 49, with 87.6% between 20 to 39 years. Sociodemographic and Obstetrical characteristics of participants with respect to daily shifts are presented in Table 1.

There was no dependence between sociodemographic characteristics of participants and the time of delivery.

4.3. Mother and Child Prognosis with Respect to Daily Shifts

Apart the prematurity and the bleeding during delivery who have no relation

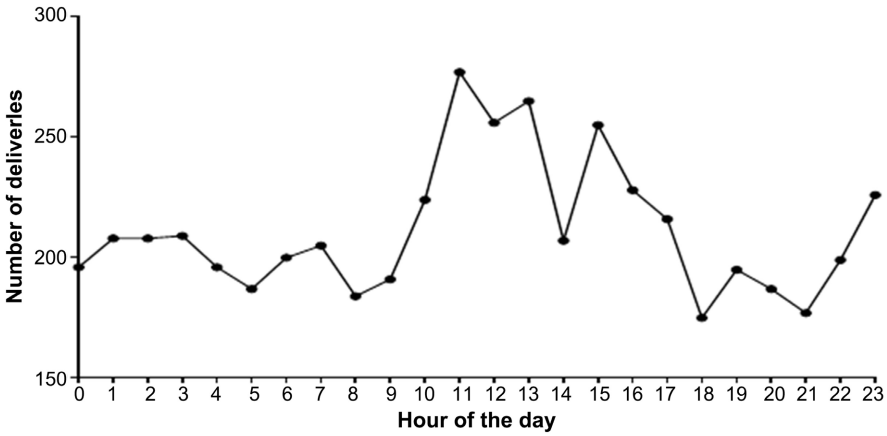

Figure 1. Hourly evolution of the frequency of childbirths during 24 hours. (NB: 0 corresponds to might night and 13, 14, 15, 16, 17, 18, 18, 20, 21, 22, 23 corresponds respectively to 1 pm, 2 pm, 3 pm, 4 pm, 5 pm, 6 pm, 7 pm, 8 pm, 9 pm, 10 pm and 11 pm.)

Table 1. Sociodemographic and obstetrical characteristics of participants with respect to daily shifts.

Characteristics	Total n (%)	6 – 14 H n (%)	14 – 22 H n (%)	22 – 6 H n (%)	P-value
Age Group (Years)	5039	1786	1629	1624	0.41
<20	478 (9.5)	150 (8.4)	164 (10.1)	164 (10.1)	
20 - 39	4414 (87.6)	1582 (88.6)	1420 (87.2)	1412 (86.9)	
>39	147 (2.9)	54 (3.0)	45 (2.8)	48 (3.0)	
Profession	4969	1761	1603	1605	0.668
Unemployed	1854 (37.3)	652 (37.0)	585 (36.5)	617 (38.4)	
Student	1184 (23.8)	411 (23.3)	383 (23.9)	390 (24.3)	
Informal Sector	1033 (20.8)	370 (21.0)	351 (21.9)	312 (19.4)	
Formal Sector	898 (18.1)	328 (18.6)	284 (17.7)	286 (17.8)	
Marital Status	4979	1771	1608	1600	0.168
Single	2342 (47.0)	861 (48.6)	758 (47.1)	723 (45.2)	
Married	2614 (52.5)	901 (50.9)	846 (52.6)	867 (54.2)	
Other	23 (0.5)	9 (0.5)	4 (0.2)	10 (0.6)	
Sex of Baby	5336	1890	1748	1698	0.656
Male	2790 (52.3)	989 (52.3)	927 (53.0)	874 (51.5)	
Female	2546 (47.7)	901 (47.7)	821 (47.0)	824 (48.5)	
Gravidity	*4648*	*1556*	*1528*	*1564*	*0.849*
Mono-gravid	1337 (28.8)	433 (27.8)	451 (29.5)	453 (29.0)	
Multigravida	2444 (52.6)	827 (53.1)	791 (51.8)	826 (52.8)	
Grand Multigravida	867 (18.7)	296 (19.0)	286 (18.7)	285 (18.2)	
Parity	*4627*	*1548*	*1522*	*1557*	*0.142*
Nulliparous	141 (3.0)	46 (3.0)	56 (3.7)	39 (2.5)	
Pauciparous	2920 (63.1)	954 (61.6)	964 (63.3)	1002 (64.4)	
Multiparous	1165 (25.2)	422 (27.3)	362 (28.3)	381 (24.5)	
Grand Multiparous	401 (8.7)	126 (8.1)	140 (9.2)	135 (8.7)	
Pregnancy Type	*5069*	*1802*	*1639*	*1628*	*0.105*
Monofoetal	4799 (94.7)	1711 (95.0)	1534 (93.6)	1554 (95.5)	
Multiple	270 (5.3)	91 (5.0)	105 (6.4)	74 (4.5)	

NB: 6041 mothers giving birth to 6376 newborns.

with the time of delivery, all others studied characteristics (tear, duration of observation, Apgar score of the newborn, birthweight, delivery mode, Health personnel who performed the delivery, and episiotomy) seemed to be influenced by the time of delivery (Table 2).

4.4. Logistic Regressions

To look for associations, we used all variables that seemed to be influenced by

Table 2. Mother and child prognosis with respect to daily shifts.

Characteristics	Total n (%)	6 – 14 H n (%)	14 – 22 H n (%)	22 – 6 H n (%)	P-value
Premature Baby	3984	1314	1333	1337	0.302
No	3306 (83.0)	1093 (83.2)	1090 (81.8)	1123 (84.0)	
Yes	678 (17.0)	221 (16.8)	243 (18.2)	214 (16.0)	
Bleeding (Median)	500	500	500	500	0.996
Perineal Tear	4136	1802	1053	1281	<0.001
No	3481 (84.2)	1802 (100)	394 (37.8)	1281 (100)	
Yes	655 (15.8)	0 (0)	655 (62.2)	0 (0)	
Duration of Observation	241	106	25	110	<0.001
2 Days or Less	88 (36.5)	0 (0)	4 (16.0)	84 (76.4)	
More than 2 Days	153 (63.5)	106 (100)	21 (84.0)	26 (23.6)	
Apgar at 5 Mins	4933	1624	1644	1665	0.012
0 - 3	329 (6.7)	101 (6.2)	136 (8.3)	92 (5.5)	
4 - 6	69 (1.4)	21 (1.3)	19 (1.2)	29 (1.7)	
7 - 10	4535 (91.9)	1502 (92.5)	1489 (90.6)	1544 (92.7)	
Birth Weight	5332	1884	1745	1703	0.011
Underweight	837 (15.7)	255 (13.5)	308 (17.7)	274 (16.1)	
Normal Weight	4084 (76.6)	1470 (78.0)	1312 (75.2)	1302 (76.5)	
Macrosomia	411 (7.7)	159 (8.4)	125 (7.2)	127 (7.5)	
Delivery Mode	4945	1750	1597	1598	<0.001
Vaginal	4204 (85.0)	1710 (97.7)	1118 (70.0)	1376 (86.1)	
Caesarian Section	741 (15.0)	40 (2.3)	479 (30.0)	222 (13.9)	
Health Personnel	4928	1795	1624	1509	<0.001
Specialist	1135 (23.0)	247 (13.8)	603 (37.1)	285 (18.9)	
Nurse	3793 (77.0)	1548 (86.2)	1021 (62.9)	1224 (81.1)	
Episiotomy	4136	1802	1053	1281	<0.001
No	3803 (91.9)	1685 (93.5)	939 (89.2)	1179 (92.0)	
Yes	333 (8.1)	117 (6.5)	114 (10.8)	102 (8.0)	
AMTPL	3936	1246	1273	1417	0.405
No	3812 (96.8)	1200 (96.3)	1235 (97.0)	1377 (97.2)	
Yes	124 (3.2)	46 (3.7)	38 (3.0)	40 (2.8)	

AMTPL: Active Management of the Third Phase of Labour.

delivery time (Table 1 and Table 2) to perform bivariate and multivariate logistic regressions to find independent associations between delivery time and prognosis of delivery (Table 3).

Daily shifts were not independently associated to the above poor Apgar score (0 - 6) at 5 mins, when adjusted for all other factors (p = 0.109).

Table 3. Multivariate analysis of associated factors.

Characteristics	Total Newborns (N = 6376)	Newborns Apgar 0 - 6 (N = 457)	Bivariate Logistic Regression		Multivariate Logistic Regression	
	n (%)	n (%)	OR (95% CI)	aP	aOR (95% CI)	aP
Mother's Age Group (Years)				0.002		0.365
Adolescent (<20 Years)	534 (9.9)	64 (12.0)	1.6 (1.2 - 2.1)		1.2 (0.8 - 2.0)	
Adult	4876 (90.1)	389 (8.0)	1		1	
Profession				<0.001		0.014
Unemployed	2089 (39.3)	227 (10.9)	2.3 (1.7 - 3.2)		1.8 (1.1 - 2.9)	
Student	1232 (23.2)	84 (6.8)	1.4 (1.0 - 2.0)		1.2 (0.7 - 2.0)	
Informal Sector	1083 (20.4)	80 (7.4)	1.5 (1.0 - 2.2)		1.2 (0.7 - 2.0)	
Formal Sector	913 (17.2)	46 (5.0)	1		1	
Marital Status				<0.001		0.006
Single	2467 (46.6)	161 (6.5)	0.6 (0.5 - 0.8)		0.6 (0.4 - 0.8)	
Other	27 (0.5)	3 (0.7)	1.2 (0.3 - 3.9)		0.9 (0.1 - 8.3)	
Married	2796 (52.9)	273 (9.8)	1		1	
Gravidity				0.011		0.198
Mono-gravid	1488 (28.1)	132 (8.9)	0.8 (0.6 - 1.1)		0.7 (0.5 - 1.2)	
Multigravida	2786 (52.7)	206 (7.4)	0.7 (0.5 - 0.9)		0.7 (0.5 - 1.0)	
Grand multigravida	1017 (19.2)	105 (10.3)	1		1	
Premature Baby				<0.001		<0.001
No	3436 (81.0)	198 (5.8)	0.3 (0.2 - 0.3)		0.4 (0.3 - 0.6)	
Yes	804 (19.0)	153 (19.0)	1		1	
Daily Shift*				0.045		0.109
6 – 14 H	1624 (32.9)	122 (7.5)	1.0 (0.8 - 1.3)		1.3 (0.9 - 1.9)	
14 – 22 H	1644 (33.3)	155 (9.4)	1.3 (1.0 - 1.7)		1.4 (1.0 - 2.1)	
22 – 6 H	1665 (33.8)	121 (7.3)	1		1	
AMTPL				<0.001		0.002
No	4107 (96.6)	296 (7.2)	0.4 (0.3 - 0.7)		0.4 (0.2 - 0.7)	
Yes	143 (3.4)	22 (15.4)	1		1	
Health Personnel				0.013		0.141
Specialist	1292 (25.3)	131 (10.1)	1.3 (1.1 - 1.6)		1.3 (0.9 - 1.9)	
Nurse	3820 (74.7)	302 (7.9)	1		1	
Birth Weight				<0.001		<0.001
Underweight	865 (15.9)	174 (20.1)	2.2 (1.5 - 3.1)		1.8 (0.9 - 3.6)	
Normal Weight	4147 (76.4)	235 (5.7)	0.5 (0.4 - 0.7)		0.6 (0.3 - 1.0)	
Macrosomia	414 (7.6)	43 (10.4)	1		1	

Daily shift* is the main factor of interest adjusted for other potential factors. AMTPL: Active Management of the Third Phase of Labour.

5. Discussion

5.1. Limiting and Confounding Factors of the Study

Since not all the variables were noted in the files, the size differed according to the characteristic studied, thus causing information bias. This is an inherent disadvantage of retrospective studies in our context where archiving is not computerized. Also, as we used hospital and monocentric data, results cannot be generalized to the entire population. However, we believe that our results are reliable because the number of each valid variable was greater than the minimum sample size.

5.2. Hourly Variation of the Number of Childbirths

During the study period, childbirths took place at all times of the day, but women gave birth more between 10 am and 5 pm and lesser in the early hours of the night. The lowest number of births was at 6 pm with 175 births (**Figure 1**). Our frequency polygon leads us to think that childbirths take place more during the day than at night.

Enid already mentioned in 1953 [3], a high occurrence of labor and consequently a high number of births during the night. Vercoustre in 1997 [1], Nathanielsz [8], Pasche *et al.* [4] in 1998, and Roizen *et al.* in 2007 explained that, this was due to the circadian secretion of oxytocin. In Iran, Pooya and Abadi [9] found in 2001, the peak of delivery at 3:00 am. Based on research, out of 39628 recorded contractions, 67% of them happened between 8:00 pm and 8:00 am. Probably, this circadian rhythm of uterine contractions, which can be responsible of more childbirths during the night, is due to estrogen and oxytocin secretions [7] [8]. Several other hormones in maternal and fetal circulation, as melatonin, maternal cortisol, fetal dehydroepiandrosterone, and progesterone, have also been shown to demonstrate 24 hours rhythms [10].

In the Roberto study [11], the majority of sexual encounters took place at bedtime (11 pm to 1 am). The most common explanations for this temporal pattern were the rigidity of the professional work schedule and family obligations and the availability of the partner, which reduced the opportunity for sexual encounters at other times of the day. We have not found in literature any relationship between the time of sexual encounters and the time of delivery, and also, we did not assess this aspect in our study.

In 1959, Gauquelin, after analyzing hospital statistics, then civil status statistics in Paris, already showed how with the evolution of medicine, medical intervention tended to modify the primitive "physiological curve", shifting the daily maximum from the end of the night towards "working hours", which are more conducive to good supervision of childbirth [12]. We have not found any literature in Africa in this area. But we think as Gauquelin [12] and Toulemon in 1986 [13] that this rhythm could have been modified by the improvement of techniques and the increasing number of interventions during childbirth, indeed the medical rhythm would have shifted the maximum number of births around the

middle of the day. For these same reasons, childbirths today take place more often during working days than during the week.

5.3. Sociodemographic and Obstetrical Characteristics of Participants with Respect to Daily Shifts

According to our allotment of the day, there was no dependence between sociodemographic characteristics of participants and the time of delivery: age group ($p = 0.41$), profession (0.668), marital status ($p = 0.168$), and sex of the baby ($p = 0.656$) (**Table 1**). According to Angeloa [14] the diurnal rhythms of labor and delivery in women were modulated by parity and seasons. In our study, we did not study the season, but the parity had no dependence with the time of delivery ($p = 0.142$). One might think that the time of delivery is not related to demographic and obstetrical parameters, or that the factor influencing this periodicity may not have been analyzed in our study.

5.4. Mother and Child Prognosis with Respect to Daily Shifts

Apart from the prematurity and the bleeding during delivery which have no relation with the time of delivery, all other studied characteristics (tear, duration of observation, Apgar score of the newborn, birth weight, delivery mode, health personnel who performed the delivery, and episiotomy) seemed to be influenced by the time of delivery (**Table 2**).

The way of childbirth was related to the period when it occurred. It has thus been observed that vaginal childbirths mainly take place between 6 am and 2 pm (**Table 2**). This observation is somewhat similar to that of Mancuso *et al.* [15] who had described more normal births between 1 pm and 2 pm. This trend could be justified by hospital attendance, which is much higher during the day than at night. The motivations of patients to go mainly to the maternity ward in the morning despite the symptoms which have sometimes been present since the night [16] could be found in reasons which have not been analyzed here, such as insecurity and the availability of means of accompaniment.

Cesarean childbirths were more frequent between 2 pm and 10 pm (**Table 2**). This observation is somewhat similar to that of Goldstick *et al.* in Israel where they had more caesareans between 4 pm and 8 am [4]. Moreover, the period when more caesarean sections are performed corresponds to when the specialist performs the most childbirths. One might think that there is a link between the presence of the specialist and the mode of delivery.

Most episiotomies were performed between 6 am and 2 pm (**Table 2**). We also observed that during this time slot, there were more macrosomia childbirths. Macrosomia is recognized as a factor increasing the risk of episiotomy. These two events can be associated [17]. We had more tearing of the perineum between 10 pm and 2 pm. This period coincides with when the midwife performs the most childbirths. However, the majority of childbirths took place between 2 pm and 10 pm. One would think that the staff is more alert during the period of the day when there are more childbirths and a little less between 10 pm and 2 pm. when

there are fewer childbirths.

5.5. Daily Shifts Independently Associated to Child's Poor Prognosis

Daily shifts were not independently associated to the poor APGAR score (0 - 6) at 5 mins, when adjusted for all other factors (p = 0.109) (**Table 3**). Pasche *et al.* in their study found that the frequency of a positive neonatal risk was uniform across all time categories in this population at low obstetric risk [3]. But De Graaf *et al.* found that hospital childbirths at night were associated with increased perinatal mortality and adverse perinatal outcome [5]. The time of delivery and other organisational features representing experience (seniority of staff, volume) may explain hospital-to-hospital variation.

Our results showed that profession, marital status, prematurity, performance of AMTPL, and birth weight of newborn were independently associated to poor Apgar score (0 - 6) at 5 mins (**Table 3**). Taking into consideration the fact that when profession, marital status, prematurity and AMTPL were compared with respect to daily shifts gave p values that were not significant (as shown in tables 1 - 3) and the fact that comparing birth weight with respect to daily shift gave a p value = 0.011 (**Table 3**), we can thus think that the virtual association between daily shift and poor Apgar score was due to the apparent difference in birth weights within those different daily shifts.

Low birth weight was associated with poor APGAR score. This association is often found in [18]. We can therefore think that it is the low birth weight in this time slot that could increase the frequency of poor APGAR scores.

6. Conclusion

At the YCH, vaginal childbirths were more frequent between 10 am and 5 pm. There were no independent associations between daily shifts and poor Apgar score. The period when the most episiotomy was performed was the same as when there was the most macrosomia delivery. Tears of the perineum are more frequent between 6 pm and 2 pm. The poor APGAR score would be more related to low birth weight. We can say, from our results, that it is essential that specialists or highly qualified personnel should always be present in the hospital at these time intervals.

Authors' Contributions

Fouelifack Ymele designed the study, recruited, analyzed the data and wrote the manuscript. Donkeng, Takang, Mesumbe, Dongmo Fouelifa and Ofeh wrote the manuscript, Ndenkeh designed and analyzed data and Fouedjio supervised the process until manuscript submission.

Acknowledgements

We thank the administrations of Yaoundé Central Hospital for facilitating the realization of this study, as well as the personnel of the gynecology and obstetrics

unit.

Ethical Considerations

Ethical clearance N˚15526 CEI-UDO/04/2018/T was obtained from the Ethical Committee of the University of Douala. We also obtained permission from the administrations of the YCH to undertake this study. Data collected were confidential and reserved only for science.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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