Scientific Research Publishing

Advances in Reproductive Sciences, 2026, 14(1), 18-26
https://www.scirp.org/journal/arsci
ISSN Online: 2330-0752
ISSN Print: 2330-0744

Survival Analysis and Factors Influencing Time to Onset of Anemia among Pregnant Women in Parakou in 2025

Roger Klikpezo[1,2,3*], Awade Afoukou Achille Obossou[1,2], Beaudouin Jean-de-Dieu Edayé[3,4], Maurice Togbédji Agonnoudé[5], Sabine Amouzoun[3,4], Mahugnon Boris Philippe Ezinmegnon[4,5], Nouéssewa Fanny Maryline Hounkponou Ahouingnan[1,2], Kabibou Salifou[1,2]

[1]Departmental University Hospital Center of Borgou and Alibori, Parakou, Benin
[2]Faculty of Medicine of the University of Parakou, Parakou, Benin
[3]Armed Forces Teaching Hospital—University Hospital Center of Parakou, Parakou, Benin
[4]Research Office in Epidemiology and Population Health (CaRESaP), Parakou, Benin
[5]National School for Training Higher Technicians in Public Health and Epidemiological Surveillance (ENATSE)—University of Parakou, Parakou, Benin
Email: *Kliroger@yahoo.fr, amouzounsabine40@gmail.com, pezinmegnon@gmail.com

How to cite this paper: Klikpezo, R., Obossou, A.A.A., Edayé, B.J.D., Agonnoudé, M.T., Amouzoun, S., Ezinmegnon, M.B.P., Ahouingnan, N.F.M.H. and Salifou, K. (2026) Survival Analysis and Factors Influencing Time to Onset of Anemia among Pregnant Women in Parakou in 2025. *Advances in Reproductive Sciences*, **14**, 18-26.
https://doi.org/10.4236/arsci.2026.141003

Received: October 25, 2025
Accepted: January 19, 2026
Published: January 22, 2026

Abstract

Introduction: Gestational anemia remains a major public health concern. This study aimed to identify factors influencing the time to onset of anemia among pregnant women in Parakou in 2025. **Methods:** A prospective, descriptive, and analytical prospective cohort study was conducted from June to July 2025 among 366 pregnant women attending nine public maternity centers in Parakou. Data were collected through questionnaires and blood tests. Kaplan-Meier survival analysis and Cox regression were used to identify determinants of the time to anemia onset. **Results:** The mean age of participants was 26.46 ± 5.39 years. The prevalence of anemia was 35.25%. Pregnancy type did not significantly affect the time to onset ($p = 0.645$). Lack of iron/folic acid supplementation significantly increased the risk (HR = 2.97; $p < 0.0001$). Urinary tract infections were also associated with earlier anemia onset ($p = 0.025$). **Conclusion**: Gestational anemia remains common. Iron/folic acid supplementation and infection prevention are essential to delay its occurrence.

Keywords

Anemia, Pregnancy, Survival Analysis, Parakou

1. Introduction

Anemia during pregnancy remains one of the most serious public health problems worldwide [1] [2]. According to estimates from the World Health Organization, nearly 40% of pregnant women are anemic, with more than half of cases occurring in sub-Saharan Africa [3]. This condition is associated with an increased risk of maternal mortality, preterm birth, intrauterine growth restriction, and low birth weight—outcomes consistently confirmed in recent African studies [4]-[6]. In 2022, Langam M. *et al.* [7] in Burkina Faso reported an anemia prevalence of approximately 60%. In a meta-analysis conducted between 2010 and 2025, Magnus Michael Sichalwe *et al.* [8] found anemia prevalence ranging from 20% to 83.5%, with an overall estimate of 51.5% (95% CI: 43.1% - 61.6%).

In low-resource settings, the causes of anemia are multifactorial. Nutritional deficiencies, particularly iron and folic acid, remain predominant, but chronic infections (malaria, helminthiasis, urinary tract infections) and comorbidities such as hypertension or previous anemia also play significant roles [6] [9]-[11]. Biological and behavioral factors, including maternal age, hypertension, and the use of potentially hematotoxic medications, significantly influence hematologic imbalances [11]-[14]. These observations underscore that maternal health results from a complex interaction between physiological conditions, lifestyle behaviors, and access to prenatal care.

Despite the existence of national policies for systematic iron and folic acid supplementation, adherence remains low: several African studies report that fewer than 60% of pregnant women consistently take IFA tablets, often due to side effects, stockouts, or lack of information [15]-[17]. This poor adherence contributes to persistently high anemia prevalence, often ranging from 30% to 45% among pregnant women according to local reports.

However, most available studies are limited to cross-sectional analyses measuring prevalence at a single time point [11]-[14]. Pregnancy-related anemia is a dynamic phenomenon, with onset depending on gestational timing, prior nutritional status, infectious exposures, and the effectiveness of prenatal follow-up. Very few studies have explored the time to anemia occurrence—that is, the rate at which a pregnant woman becomes anemic according to her clinical or behavioral characteristics. This temporal approach is crucial, as it allows identification not only of factors associated with anemia but also of when they accelerate its onset.

The objective of this study was to determine the rate of anemia onset during pregnancy and to identify factors associated with its early occurrence, in order to contribute to improved prenatal monitoring and prevention of maternal anemia in public maternity facilities in Benin.

2. Study Methods

We conducted a prospective cohort study with an analytical approach in the nine

public maternity facilities of Parakou (Benin) between January and July 2025, aiming to analyze factors influencing the time to onset of anemia in pregnant women. The study included 366 pregnant women aged 18 to 45 years, residing in Parakou for at least six months, followed for at least two consecutive prenatal visits, and who provided written informed consent. Exclusion criteria were women with chronic conditions (sickle cell disease, HIV, renal insufficiency) or those who discontinued follow-up before the second trimester.

Sampling was proportionally stratified according to the volume of prenatal consultations in each maternity, followed by systematic selection. Data were collected using a semi-structured questionnaire and complemented by hemoglobin measurements performed in the first, second, and third trimesters of pregnancy according to WHO standards (anemia defined as Hb < 11 g/dL).

The dependent variable was the time (in weeks) from the first prenatal consultation to the occurrence of anemia. The independent variables analyzed in this study included: history of gestational anemia, lack of iron/folic acid supplementation, presence of urinary tract infection or sexually transmitted infection (STI), calcium intake, fruit and vegetable intake, meat/egg/fish intake, pregnancy bleeding, meal frequency (≥3 meals per day), and malaria. Data on supplementation, dietary habits, and meal frequency were obtained through self-report during individual interviews using a semi-structured questionnaire and coded as dichotomous variables (yes/no). Information on obstetric history, bleeding episodes, and malaria infection was extracted from antenatal care records and consultation registries. Urinary tract infections or STIs were confirmed through urinalysis results from maternity laboratory records. These variables were selected based on their clinical relevance as identified in the literature and their statistical association with anemia onset ($p < 0.20$) in bivariate analysis prior to inclusion in the Cox regression model. Statistical analyses were performed using MedCalc®, including descriptive statistics, estimation of Kaplan-Meier survival curves to determine the median time to anemia onset, group comparisons using the log-rank test, and multivariate Cox regression to identify independent factors associated with anemia onset, after verifying the proportional hazards assumption. A significance level of $p < 0.05$ was applied.

The study was conducted in accordance with the principles of the Declaration of Helsinki (2013). Confidentiality was ensured through data coding and secure file storage, and anemic participants were referred to healthcare services for appropriate management.

3. Results

3.1. Sociodemographic Data

A total of 366 pregnant women were included in this study. Their ages ranged from 18 to 45 years, with a mean age of 26.46 ± 5.39 years. The modal age was 25 years. The vast majority of women were married (94.26%) (**Table 1**).

Table 1. Distribution of pregnant women attending prenatal consultations in public maternity facilities in Parakou in 2025, by age and marital status (n = 366).

Anemia	Count (n = 366)	Frequency (%)
Age (Years)		
▪ <20	32	08.74
▪ [20 - 30[	227	62.02
▪ [30 - 40[	100	27.32
▪ ≥40	07	01.91
Marital status		
▪ Single	04	01.09
▪ Married	345	94.26
▪ Widowed	01	0.27
▪ Cohabiting	16	04.37

3.2. Prevalence of Anemia during Pregnancy

Table 2 below shows the prevalence of anemia among the pregnant women included in the study in Parakou in 2025, along with the corresponding 95% confidence intervals.

Table 2. Prevalence of anemia among pregnant women attending prenatal consultations in public maternity facilities in Parakou in 2025 (n = 366).

Anemia	Prevalence	95% CI
▪ **Yes**	**129 (35.25)**	**30.53 - 40.27**
▪ **No**	237 (64.75)	59.73 - 69.47

The occurrence of anemia among pregnant women in Parakou in 2025 progressively increased with advancing gestation. Comparison between singleton and twin pregnancies showed that the type of pregnancy did not significantly influence the time to onset of anemia (log-rank test, p = 0.645; HR = 1.19 [95% CI: 0.57 - 2.45]), although a slight tendency toward earlier onset was observed in twin pregnancies (Figure 1).

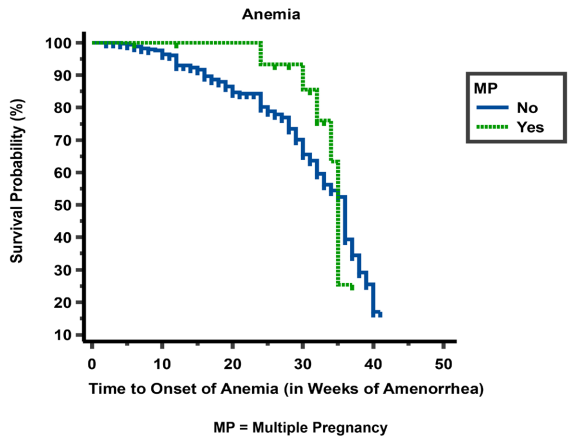

Figure 1. Kaplan-Meier survival curves for time to onset of anemia according to pregnancy type among pregnant women attending prenatal consultations in Parakou, 2025.

Despite the increased physiological demands of twin pregnancies, the time to develop anemia during pregnancy was not statistically different from that of singleton pregnancies (Table 3).

Table 3. Distribution of pregnant women according to pregnancy type and mean time to anemia onset during prenatal follow-up in public health centers of Parakou in 2025.

Pregnancy type	N	Events	Censored	Mean survival (weeks)
▪ Singleton	349	122 (34.96)	227 (65.04)	31.998 ± 0.585
▪ Twin	17	7 (41.18)	10 (58.82)	33.973 ± 0.915
Overall	366	129 (35.25)	237 (64.75)	32.125 ± 0.560

3.3. Overall Model Fit

The Cox proportional hazards regression model, adjusted for five covariates, showed a significant improvement over the null model (−2 log-likelihood: 1249.150 vs 1279.234; $\chi^2 = 30.084$; df = 15; p = 0.0116). This indicates that the included factors collectively contribute significantly to explaining the time to anemia onset among pregnant women. Therefore, the selected covariates provide meaningful explanatory value regarding the risk of developing anemia during pregnancy.

3.4. Cox Regression Model

Among the included covariates, some were statistically significantly associated with a faster onset of anemia.

Lack of iron or folate supplementation was identified as a major risk factor: non-supplemented women developed anemia more rapidly, with nearly three times higher risk (HR = 2.97; 95% CI: 1.77 - 4.96; p < 0.0001). The presence of a urinary tract infection was significantly associated with a faster onset of anemia during pregnancy (HR = 2.48; 95% CI: 1.47 - 4.07; p = 0.01). In other words, women with urinary tract infections were about two and a half times more likely to develop anemia earlier than those without infection. The following Table 4 presents these results.

Table 4. Multivariate Cox regression results for factors associated with risk of anemia onset among pregnant women attending public maternity centers in Parakou, 2025.

Covariate	Wald	P-Value	HR	95% CI HR
▪ History of gestational anemia	0.959	0.328	1.44	0.70 - 2.96
▪ Lack of iron/folate supplementation	17.18	<0.0001	2.97	1.77 - 4.96
▪ Urinary tract infection/STI	15.45	0.001	2.48	1.47 - 4.07
▪ Calcium intake	0.138	0.710	1.09	0.70 - 1.69
▪ Fruit/vegetable intake	2.23	0.135	1.40	0.90 - 2.19
▪ Meat/egg/fish intake	1.86	0.173	0.53	0.22 - 1.32
▪ Pregnancy bleeding	0.301	0.583	1.19	0.64 - 2.21
▪ ≥3 meals per day	0.0001	0.978	1.01	0.69 - 1.46
▪ Malaria	0.374	0.541	1.15	0.73 - 1.82

4. Discussion

In this study conducted in Parakou in 2025, the overall prevalence of anemia among pregnant women was 35.25%, which falls within the higher range of estimates reported in similar low- and middle-income country settings. This prevalence is comparable to that reported in certain African studies, although it is slightly higher than rates observed in European countries, where Levi *et al.* in 2016 reported annual incidences ranging from 7.2 to 13.96 per 1000 person-years among pregnant women and the general population [18]. This difference may be explained by disparities in access to prenatal care, iron supplementation, nutritional preventive measures, and a higher infectious burden in our context.

Time-to-event analysis showed that the type of pregnancy (singleton vs. twin) did not significantly influence the onset of anemia (HR = 1.19; p = 0.645), although a trend toward earlier onset was observed in twin pregnancies. This finding is consistent with the literature indicating that, despite the increased physiological load in multiple pregnancies, the relative risk of anemia does not always significantly rise when adequate prenatal care is provided. Although Alcalay *et al.* in 2023 focused on the respiratory consequences of maternal anemia, their study highlights the importance of maternal anemia as an independent clinical determinant of neonatal and pediatric outcomes, supporting the relevance of our Cox regression approach to identify predictive factors [19].

In our cohort, the absence of iron/folate supplementation emerged as a major risk factor for rapid anemia onset (HR = 2.97; p < 0.0001), underscoring the critical role of prenatal nutritional interventions. This finding aligns with observations by Levi *et al.* in 2019, who demonstrated that pregnancy, maternal age, and a history of blood loss-related disorders were significant determinants of iron-deficiency anemia among women of reproductive age in Europe [20]. The consistency of these results across high- and low-income settings suggests a universal effect of iron supplementation and prenatal care, although the overall incidence remains higher in resource-limited contexts.

Furthermore, the presence of urinary tract infections or STIs was associated with an accelerated onset of anemia, highlighting the role of infectious factors in the pathogenesis of gestational anemia. These results are echoed in Berhan's 2014 study, where maternal anemia, often exacerbated by infections and obstetric complications, was an independent predictor of perinatal mortality in a low-income setting [21].

Based on these findings, targeted public health actions are warranted. Strengthening adherence to iron/folic acid supplementation and implementing systematic screening for urinary tract infections during prenatal visits could significantly reduce the risk and delay the onset of gestational anemia in Parakou.

5. Limitation of the Study

This study has certain limitations that should be acknowledged, though they do not undermine the robustness of its conclusions. First, some variables, such as

iron/folic acid supplementation and dietary habits, were based on participants' self-reports, which may be subject to recall or social desirability bias. Nevertheless, this approach is standard in population-based studies and remains the most feasible method in resource-limited settings. Second, the research was conducted exclusively in the city of Parakou, which may limit the generalizability of the findings to other regions of Benin. However, Parakou serves as a major referral center with a socio-demographically diverse population, providing reasonable representativeness for urban areas of the country. Lastly, although the follow-up period was relatively short, the use of survival analysis methods (Kaplan-Meier and Cox regression) enhanced the analytical value of the data collected. These limitations, therefore, do not compromise the internal validity of the study, which contributes valuable insights for the prevention of gestational anemia in African contexts.

6. Conclusion

Gestational anemia remains a major public health issue in Parakou. The absence of iron and folate supplementation, as well as urinary tract infections, are key factors accelerating its onset. Targeted interventions focusing on supplementation and infection prevention could effectively delay its development. Strengthening prenatal care is essential to improve maternal and fetal outcomes.

Acknowledgements

The authors express their sincere gratitude to the Cabinet of Research in Epidemiology and Population Health—CaRESaP (http://www.caresap.org/) for their methodological, statistical, and logistical support throughout this study. Their contribution was instrumental in ensuring the scientific rigor and quality of the analyses presented.

Conflicts of Interest

The authors declare no conflicts of interest related to the conduct of this study, the data analysis, or the writing of this manuscript.

References

[1] Abdilahi, M.M., Kiruja, J., Farah, B.O., Abdirahman, F.M., Mohamed, A.I., Mohamed, J., *et al.* (2024) Prevalence of Anemia and Associated Factors among Pregnant Women at Hargeisa Group Hospital, Somaliland. *BMC Pregnancy and Childbirth*, **24**, Article No. 332. https://doi.org/10.1186/s12884-024-06539-3

[2] Abneh, A.A., Kassie, T.D. and Gelaw, S.S. (2024) The Magnitude and Associated Factors of Immediate Postpartum Anemia among Women Who Gave Birth in Ethiopia: Systematic Review and Meta-Analysis, 2023. *BMC Pregnancy and Childbirth*, **24**, Article No. 317. https://doi.org/10.1186/s12884-024-06495-y

[3] WHO (2015) Estimates of the Global Burden of Foodborne Diseases. World Health Organization. https://apps.who.int/iris/bitstream/handle/10665/199350/9789241565165_eng.pdf

[4] Nambuya, M. and Mayanja-Kizza, H. (2024) A Case Report: Recurrent Anemia Re-

lated to Long Term Acyclovir Use in a Pregnant HIV Infected Ugandan. *African Health Sciences*, **24**, 91-93. https://doi.org/10.4314/ahs.v24i1.11

[5] Debella, A., Dheresa, M., Geda, B., Tiruye, G. and Fage, S.G. (2021) A Third of Pregnant Women Are Affected by Anemia in Eastern Ethiopia: A Facility-Based Study. *Journal of Blood Medicine*, **12**, 299-306. https://doi.org/10.2147/jbm.s305567

[6] Chilot, D., Aragaw, F.M., Belay, D.G., Asratie, M.H., Bicha, M.M. and Alem, A.Z. (2023) Anaemia among Lactating and Non-Lactating Women in Low-Income and Middle-Income Countries: A Comparative Cross-Sectional Study. *BMJ Open*, **13**, e069851. https://doi.org/10.1136/bmjopen-2022-069851

[7] Langam, M., Nikiema, P.A., Kassinga, V., Sondo, M., Djigma, W.F. and Simpore, J. (2025) Prevalence and Determinants of Anaemia during Pregnancy in the Central Region of Burkina Faso: Case of the Malaria Peak and Harvesting Period. *Food and Nutrition Sciences*, **16**, 374-394. https://doi.org/10.4236/fns.2025.164021

[8] Sichalwe, M.M., Charles, D.E., Kimaro, R.R., Basit, A., Tavengana, G. and Behera, M.R. (2025) Anaemia in Pregnancy across Tanzania: A Comprehensive Review of Prevalence, Risk Factors, and Birth Outcomes. *Clinical Epidemiology and Global Health*, **36**, Article 102219. https://doi.org/10.1016/j.cegh.2025.102219

[9] Ngozi Eze, S., Nwanneka Ani, P. and Onyinyechukwu Anoshirike, C. (2024) Anaemia in Pregnancy: Prevalence and Associated Socio-Demographic and Obstetric Factors in Urban and Rural Communities in Nsukka Area of Enugu State, Nigeria. *African Health Sciences*, **24**, 194-202. https://doi.org/10.4314/ahs.v24i2.22

[10] Azzam, A., Khaled, H., Alrefaey, A.K., Basil, A., Ibrahim, S., Elsayed, M.S., *et al.* (2025) Anemia in Pregnancy: A Systematic Review and Meta-Analysis of Prevalence, Determinants, and Health Impacts in Egypt. *BMC Pregnancy and Childbirth*, **25**, Article No. 29. https://doi.org/10.1186/s12884-024-07111-9

[11] Bongomin, F., Kibone, W., Nantale, R., Lebu, S., Awekonimungu, B., Musoke, P., *et al.* (2025) Anemia Prevalence and Severity among Pregnant Refugee Women Settled in the West Nile Region, Uganda. *PLOS One*, **20**, e0329970. https://doi.org/10.1371/journal.pone.0329970

[12] Arsenault, C., Mfeka-Nkabinde, N.G., Chaudhry, M., Jarhyan, P., Taddele, T., Mugenya, I., *et al.* (2024) Antenatal Care Quality and Detection of Risk among Pregnant Women: An Observational Study in Ethiopia, India, Kenya, and South Africa. *PLOS Medicine*, **21**, e1004446. https://doi.org/10.1371/journal.pmed.1004446

[13] Nxele, X. and Symington, E. (2024) Associations of Anaemia with Blood Pressure in Women of Reproductive Age: A Cross-Sectional Study in Johannesburg, South Africa. *The Pan African Medical Journal*, **48**, Article 99. https://doi.org/10.11604/pamj.2024.48.99.43763

[14] Aweke, M.N., Yitageasu, G., Agimas, M.C., Yismaw, G.A., Baffa, L.D. and Alemu, G.G. (2025) Co-Occurrence of Maternal Anemia and Child Undernutrition in Ethiopia: Multilevel Analysis of Analysis of EDHS Data (2005-2016). *BMC Public Health*, **25**, Article No. 2722. https://doi.org/10.1186/s12889-025-23961-0

[15] Soda, M.A., Hamuli, E.K., Batina, S.A. and Kandala, N. (2024) Determinants and Spatial Factors of Anemia in Women of Reproductive Age in Democratic Republic of Congo (DRC): A Bayesian Multilevel Ordinal Logistic Regression Model Approach. *BMC Public Health*, **24**, Article No. 202. https://doi.org/10.1186/s12889-023-17554-y

[16] Obeagu, G.U. and Obeagu, E.I. (2025) Complications of Anemia in Pregnancy: An Updated Overview for Healthcare Professionals. *Medicine*, **104**, e44246. https://doi.org/10.1097/md.0000000000044246

[17] Tamirat, K.S., Tesema, G.A. and Tessema, Z.T. (2021) Determinants of Maternal High-Risk Fertility Behaviors and Its Correlation with Child Stunting and Anemia in the East Africa Region: A Pooled Analysis of Nine East African Countries. *PLOS ONE*, **16**, e0253736. https://doi.org/10.1371/journal.pone.0253736

[18] Levi, M., Rosselli, M., Simonetti, M., Brignoli, O., Cancian, M., Masotti, A., *et al.* (2016) Epidemiology of Iron Deficiency Anaemia in Four European Countries: A Population-Based Study in Primary Care. *European Journal of Haematology*, **97**, 583-593. https://doi.org/10.1111/ejh.12776

[19] Alcalay, I., Wainstock, T. and Sheiner, E. (2022) Maternal Anemia and Long-Term Respiratory Morbidity of the Offspring—Results of a Population-Based Cohort. *Archives of Gynecology and Obstetrics*, **308**, 1189-1195. https://doi.org/10.1007/s00404-022-06780-1

[20] Levi, M., Simonetti, M., Marconi, E., Brignoli, O., Cancian, M., Masotti, A., *et al.* (2019) Gender Differences in Determinants of Iron-Deficiency Anemia: A Population-Based Study Conducted in Four European Countries. *Annals of Hematology*, **98**, 1573-1582. https://doi.org/10.1007/s00277-019-03707-w

[21] Berhan, Y. (2014) Predictors of Perinatal Mortality Associated with Placenta Previa and Placental Abruption: An Experience from a Low Income Country. *Journal of Pregnancy*, **2014**, Article ID: 307043. https://doi.org/10.1155/2014/307043