

Delayed Access to Care for Spinal Dysraphism in West Africa: A Median Birth-to-Admission Interval of Eight Months and Associated Factors in an Ivorian Hospital Cohort

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Abstract

Background: The outcome of spinal dysraphism depends on rapid access to a specialised centre, with the 48-hour window after birth serving as the reference in current guidelines. This interval is poorly documented in West Africa. The authors measured it and explored its associated factors in an Ivorian hospital cohort. **Methods:** Single-centre ambispective observational study of the 75 patients operated on for spinal dysraphism at Bouaké Teaching Hospital (data cut-off 30 June 2026); the nine children who were admitted but not operated on were excluded. The primary endpoint was the birth-to-admission interval; the admission-to-surgery interval served as a contrast. Associations with six access factors (referral, antenatal diagnosis, antenatal care visit, distance, financial hardship, prior traditional healer consultation) were assessed by non-parametric methods, with exploratory sensitivity analyses at the 3-, 6- and 12-month thresholds, an exploratory logistic model and a median quantile regression. Odds ratios (ORs) are conditional, with exact confidence intervals (CIs); the thirteen p-values are adjusted by the Benjamini-Hochberg procedure. **Results:** The median birth-to-admission interval was 239 days (≈ 8 months; IQR 148 - 411; range 17 - 1818). No child had reached the centre within 48 hours of birth and 47 (62.7%) were admitted at least 6 months later. The admission-

to-surgery interval was 5 days (IQR 3 - 11), with 69.3% operated on within 7 days; in-hospital time accounted for 2.3% of the total interval. No factor was associated with the interval analysed as a continuous variable. An antenatal care visit was associated with a lower risk of a delay of 6 months or more (conditional OR 0.28; exact 95% CI: 0.09 - 0.82; $p = 0.016$), but this exploratory signal did not remain significant after Benjamini-Hochberg adjustment of the univariate six-month comparisons ($q = 0.097$, univariate Fisher test); an a-posteriori multivariable model gave an adjusted OR of 0.27, not itself subjected to this correction. Present at the 3-month threshold, the signal disappeared at 12 months and was found neither in the continuous analysis nor in the quantile regression. All six odds ratios were below 1. **Conclusions:** The median interval approached eight months, with no child reaching the centre within the recommended window, whereas surgery followed admission by a few days. The delay therefore lies almost entirely before tertiary admission: priorities concern neonatal referral pathways, transport and financial accessibility rather than surgical capacity alone. The observational design permits no causal inference.

Keywords

Spinal Dysraphism, Spina Bifida, Time to Treatment, Access to Care, Paediatric Neurosurgery

1. Introduction

Spinal dysraphism, which results from a defect of neural tube closure, ranks among the most disabling congenital malformations of the central nervous system. Sub-Saharan Africa bears a substantial share of the burden, with high mortality and morbidity before the age of five, often compounded by the conditions of access to care [1] [2]. After birth, rapid access to a neurosurgical centre is a decisive step for prognosis. Yet neurosurgeon density remains low in sub-Saharan Africa [3], and children are frequently admitted late, sometimes in a context of malnutrition or infection; the results of paediatric hydrocephalus surgery there remain inferior to those of high-income countries after adjustment for prognostic factors, a finding that cannot, however, be transposed as such to spinal dysraphism [4].

This delay is not innocuous: it exposes the child to rupture and infection of the sac, with an increased risk of meningitis and ventriculitis, but also to worsening neurological deficits, malnutrition and complicated hydrocephalus [5] [6]. In high-income countries, antenatal diagnosis and, in selected patients, foetal surgery have moved the therapeutic window before birth, and postnatal closure is usually performed within the first days of life [7]. The 48-hour window after birth serves as the reference in North American guidelines, which nonetheless conclude that the level of evidence is insufficient to establish formally its benefit on infec-

tious risk and recommend antibiotic therapy when closure is deferred beyond it [8]. In our setting, the priority remains to shorten access to this postnatal management, the timeliness of which influences infectious complications and outcomes [7] [9].

Several African teams report an age at presentation or at surgery, but the pre-hospital component of the interval is rarely separated from the in-hospital component; in French-speaking West Africa, this interval has not, to our knowledge, been measured directly. It is more often referred to as “late presentation” or approached through indirect markers such as rupture of the sac, and the few studies that have characterised barriers to referral did so in other African settings [10]–[12]. Quantifying it is nevertheless indispensable if the steps of the pathway that could benefit from targeted interventions are to be identified.

The present study belongs to a series based on a single cohort, the first part of which described the epidemiological, clinical and surgical profile of 75 patients operated on for spinal dysraphism at Bouaké Teaching Hospital, a tertiary centre serving a large part of Côte d’Ivoire (Teti *et al.*, unpublished data). The primary objective was to describe the distribution of the birth-to-admission interval; the secondary objective was to explore its associations with six preselected factors. We hypothesised that most of the delay occurred before admission to the tertiary centre and reflected health-system obstacles rather than isolated individual determinants.

2. Patients and Methods

2.1. Study Design, Setting and Population

We conducted a single-centre ambispective analytical observational study in the Department of Neurosurgery of Bouaké Teaching Hospital (Côte d’Ivoire), using the analytical database of the first part of the series: standardised REDCap data collection from 2024 onwards, supplemented by a retrospective review of earlier records. The inclusion period ran from 2017 to 2026, with collection being prospective from 2024 (72 of the 75 patients). The manuscript was prepared in accordance with the STROBE recommendations [13]. The analysis cut-off date was 30 June 2026.

The analysis included the 75 patients operated on for spinal dysraphism (open or closed forms) or for cranial dysraphism (encephalocele), the cranial forms being few (**Figure 1**); the subgroup sizes preclude a separate inferential analysis by lesion type, and the 48-hour benchmark is most relevant to the open spinal forms. Of the 84 children managed during the period, 9 were not operated on—3 pre-operative deaths, 2 discharges against medical advice or parental refusal, 2 transfers, 1 temporary deferral for major infection and 1 loss to follow-up before scheduling—and are not included, in order to preserve the denominators of the first part. These 9 children had nonetheless been admitted to the hospital and their birth-to-admission interval is measurable; the consequences of their exclusion are examined among the limitations.

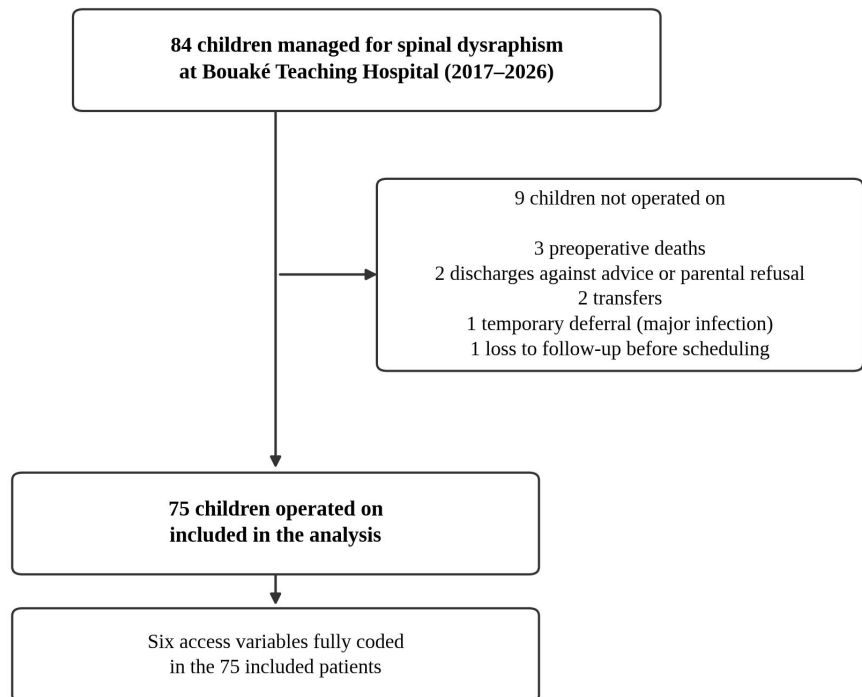


Figure 1. STROBE flow diagram of patient selection. Of 84 children managed for spinal dysraphism at Bouaké Teaching Hospital, 9 were not operated on and 75 were included. The six access variables were fully coded in all 75 included patients.

2.2. Variables and Definitions

The primary endpoint was the birth-to-admission interval, defined as the number of days between the date of birth and the date of admission to the hospital. The admission-to-surgery interval was analysed as a contrast variable in order to locate the delay upstream or downstream of the hospital. The factors studied a priori were referral from another hospital, antenatal diagnosis, attendance at at least one antenatal care visit, home-to-hospital distance, financial hardship and prior consultation of a traditional healer. Each factor was recorded by the admitting neurosurgical team at admission, from the standardised admission form (prospective records, 2024 onwards) or from the inpatient chart (the three records predating 2024). Referral was coded as present when the admission documents indicated a transfer or referral from another health facility, and as absent when the child had presented directly; antenatal diagnosis as present when an obstetric ultrasound performed during pregnancy had identified a compatible abnormality before birth, and as absent otherwise; attendance at at least one antenatal care visit as present when at least one visit was reported or documented, and as absent when the record indicated that none had taken place. Financial hardship was coded as present when the parents or guardians explicitly reported a financial difficulty that had delayed or prevented transfer, and as absent when this was explicitly denied or when no financial obstacle was reported at the standardised assessment; prior consultation of a traditional healer as present when a consultation or treatment before admission was reported, and as absent when this was explicitly denied. The

parent-reported items (financial hardship, prior traditional-healer consultation) were obtained from the parent or legal guardian during the admission interview. A variable was not coded as absent merely because it was not mentioned: the absent category required an explicit negative answer or source information allowing absence to be concluded, whereas a non-documented or non-reported item was treated as missing data. The geographical variable was the distance between the home and the hospital, not between the place of birth and the hospital: the origin was the place of residence reported at admission, as documented in the clinical or administrative record, and the distance was estimated along the shortest available road route to Bouaké Teaching Hospital, not as a straight-line or geodesic distance; it therefore coincides with the maternity-to-hospital distance only when the reported residence and the place of birth are identical. Place of birth was analysed as a distinct supplementary variable.

2.3. Statistical Analysis

The analysis plan was defined a priori, with the exception of the multivariable model specified below. Categorical variables are presented as counts and percentages, quantitative variables as median and interquartile range (IQR). As the interval was not censored and its distribution was markedly skewed in a limited sample, non-parametric methods were preferred and no survival model was required. Between-group comparisons used the Mann-Whitney test with estimation of the Hodges-Lehmann shift; the association with distance was assessed with the Spearman coefficient.

A sensitivity analysis dichotomised the interval at 6 months (≥ 183 days), a threshold defined a priori as a marker of major delay within the cohort; it does not correspond to the 48-hour window adopted by the guidelines, which no patient in the series met and which would therefore have discriminated no subgroup. Associations were then examined with Fisher's exact test; odds ratios (ORs) are estimated by conditional maximum likelihood and accompanied by exact 95% confidence intervals (CIs), consistent with Fisher's test. Thirteen tests in all were performed on the interval: five Mann-Whitney comparisons on the preselected binary factors, a sixth on place of birth, a Spearman correlation for distance, and six Fisher exact tests on the interval dichotomised at the six-month threshold. Their p-values were adjusted by the Benjamini-Hochberg procedure and are reported as q-values, computed both on the six dichotomous comparisons and on the thirteen tests as a whole. Dichotomisation was repeated at the 3- and 12-month thresholds in order to assess the dependence of the associations on the cut-point; their q values were computed separately, within the six tests of each threshold. The correction therefore covers neither these sensitivity analyses, nor the logistic model, nor the quantile regression.

An exploratory multivariable logistic model was fitted on the three factors with sufficient exposure numbers (antenatal care visit, referral, distance > 220 km; 9.3 observations per variable when taking the less frequent category of the endpoint, that is, the 28 children admitted before six months). Since the choice of these fac-

tors and the distance cut-point, set at the observed median, were made after inspection of the distribution of exposures, this model cannot be regarded as pre-specified. A median quantile regression was used to estimate adjusted differences in the interval, including antenatal care visit, mode of referral and distance expressed per 100 km; the rarest exposures were not entered, their estimates being unstable at this sample size. The 95% CIs were obtained by bootstrap (10,000 replications). Durations expressed in months are based on the conversion 1 month = 30.44 days. All tests were two-sided, with $\alpha = 0.05$. Analyses were performed with Python 3.12 (pandas, SciPy, statsmodels).

2.4. Missing Data and Control of Bias

The six selected access variables were fully coded in the internal database for all 75 included patients; analyses therefore relied on complete cases, without imputation. This completeness concerns the coding of these six variables and not the exhaustiveness of the determinants of the access pathway: several of them—parental education, household income, actual travel time, health literacy—are not documented in the database and are discussed among the limitations. Despite definitions established before the analyses and standardised collection, a selection bias linked to hospital recruitment and residual confounding cannot be excluded.

2.5. Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki. No constituted ethics committee existed at Bouaké Teaching Hospital during the study period; the protocol was authorised by the Head of the Department of Neurosurgery and by the hospital management. Written informed consent was obtained from the parents or legal guardians of all patients, including for the three records predating 2024 that were collected retrospectively; data were anonymised before analysis. Dates of birth and admission were verified individually against the admission registers and the inpatient records; discrepancies were resolved by returning to source documents and corrections were entered in a control log.

3. Results

3.1. Access Characteristics and Geographical Origin

The cohort comprised 75 patients, of whom 50 (66.7%) were referred from another hospital. An antenatal diagnosis had been made in 5 patients (6.7%), while 39 (52.0%) had attended at least one antenatal care visit. A financial difficulty reported as a cause of delay concerned 30 patients (40.0%), and 9 (12.0%) had consulted a traditional healer before admission (**Table 1**). The median home-to-hospital distance was 220 km (IQR 44 - 350; maximum 420 km). Patients came from ten regions; although Vallée du Bandama, where the hospital is located, supplied the largest share (28; 37.3%), nearly two-thirds came from more distant regions, notably Abidjan (15; 20.0%), Savanes (11; 14.7%) and Montagnes (10; 13.3%), reflecting a wide referral territory.

Table 1. Access characteristics of the cohort (n = 75).

Characteristic	n (%)
Referral from another hospital	50 (66.7)
Antenatal diagnosis	5 (6.7)
At least one antenatal care visit	39 (52.0)
Financial difficulty reported as a cause of delay	30 (40.0)
Traditional healer consulted before admission	9 (12.0)
Birth in a maternity unit	51 (68.0)
Home-to-hospital distance, median (IQR; maximum)	220 km (44 - 350; 420)
Regions of origin	10

IQR = interquartile range. The six access variables were fully coded in all 75 included patients.

3.2. Distribution of the Birth-to-Admission Interval

The median birth-to-admission interval was 239 days, that is about 8 months (IQR 148 - 411). The mean was 358 ± 374 days and values ranged from 17 to 1818 days, close to 5 years (Figure 2). No child had reached the centre within 48 hours of birth: the shortest interval observed was 17 days and only 3 children (4.0%) were admitted before one month of age. Forty-seven patients (62.7%) were admitted at least 6 months after birth; 24 (32.0%) between 6 and 12 months and 23 (30.7%) beyond one year (Table 2).

Table 2. Distribution of the birth-to-admission interval (n = 75).

Interval category	n (%)
<1 month	3 (4.0)
1 to 3 months	9 (12.0)
3 to 6 months	16 (21.3)
6 to 12 months	24 (32.0)
12 to 24 months	17 (22.7)
≥ 24 months	6 (8.0)
Median (IQR)	239 days (148 - 411)
Mean $\pm$ standard deviation	358 ± 374 days
Range	17 - 1818 days
Interval ≥ 6 months	47 (62.7)

Conversion used: 1 month = 30.44 days. No child reached the centre within 48 hours of birth.

3.3. Comparison of the Prehospital and In-Hospital Intervals

The admission-to-surgery interval was markedly shorter. After arrival at the hospital, the operation was performed after a median of 5 days (IQR 3 - 11; maximum

44 days) and 52 patients (69.3%) were operated on within 7 days. The birth-to-admission interval was thus about 48 times longer than the admission-to-surgery interval (**Figure 3**). Related to the total birth-to-surgery interval, in-hospital time accounted for a median of 2.3% (IQR 1.0 - 6.1), that is, a median prehospital share of 97.7%.

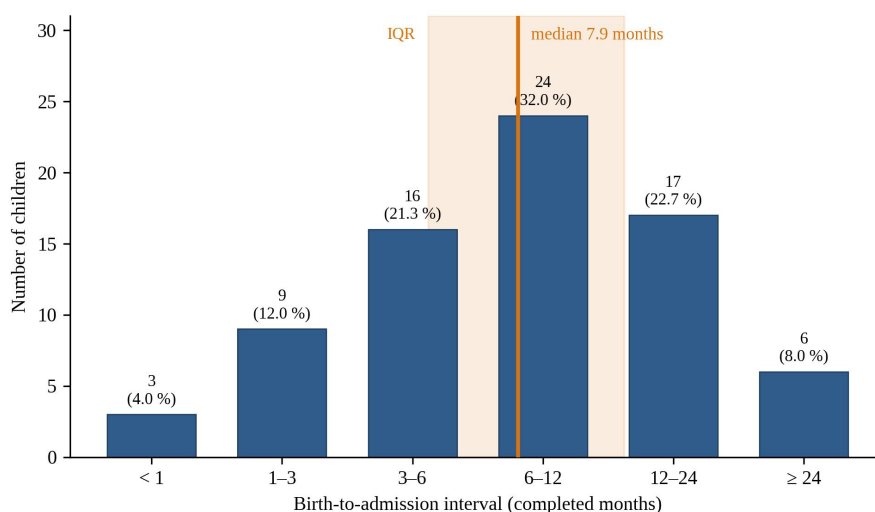


Figure 2. Distribution of the birth-to-admission interval ($n = 75$). Orange line: median (7.9 months); shaded band: interquartile range.

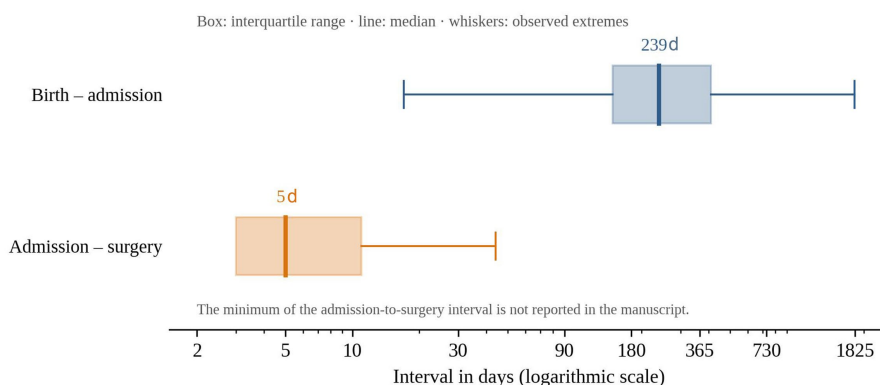


Figure 3. Comparison of the birth-to-admission and admission-to-surgery intervals (logarithmic scale). Elapsed time is concentrated before admission; surgical management is rapid once the child has been admitted.

3.4. Associations with Access Factors

None of the factors studied was significantly associated with the interval analysed as a continuous variable (**Table 3**). The medians observed according to mode of referral, antenatal diagnosis, antenatal care visit, financial hardship, traditional consultation and place of birth remained close to the overall median, and distance was not correlated with the interval (Spearman $\rho = -0.13$; $p = 0.28$). After Benjamini-Hochberg adjustment across the thirteen tests, the smallest q value observed

among these comparisons was 0.39. In median quantile regression adjusted for antenatal care visit, mode of referral and distance, no factor was associated in a statistically demonstrated manner with the median of the continuous interval: antenatal care visit –65 days (95% CI: –179 to +48; $p = 0.26$), referral –3 days (–171 to +88; $p = 0.73$), distance –26 days per 100 km (–56 to +13; $p = 0.22$).

Table 3. Associations with the birth-to-admission interval analysed as a continuous variable ($n = 75$).

Factor	Test	p
Referral from another hospital	Mann-Whitney	0.160
Antenatal diagnosis	Mann-Whitney	0.181
Antenatal care visit	Mann-Whitney	0.140
Reported financial hardship	Mann-Whitney	0.146
Traditional healer consulted	Mann-Whitney	0.244
Place of birth	Mann-Whitney	0.561
Home-to-hospital distance	Spearman ($\rho = -0.13$)	0.278

After Benjamini-Hochberg adjustment across the thirteen tests, the smallest q value observed among these comparisons was 0.39.

3.5. Sensitivity Analyses

The dichotomous analysis at the 6-month threshold produced broadly concordant results (**Table 4, Figure 4**). Only the antenatal care visit was associated with a lower probability of a delay of 6 months or more (19/39 versus 28/36; conditional OR 0.28; exact 95% CI: 0.09 - 0.82; $p = 0.016$). In an exploratory multivariable logistic model adjusted for referral and distance, this association persisted (adjusted OR 0.27; 95% CI: 0.10 - 0.75; $p = 0.012$), whereas referral (0.43; 95% CI: 0.14 - 1.36) and distance > 220 km (0.78; 95% CI: 0.28 - 2.19) were not significant. The association did not, however, remain significant after Benjamini-Hochberg adjustment of the univariate Fisher comparisons at the six-month threshold ($q = 0.097$ across the six dichotomous comparisons, $q = 0.21$ across the thirteen tests); this q value refers to that univariate six-month analysis and not to the a-posteriori multivariable logistic model, which was not corrected for multiplicity. The signal was not found on the continuous interval ($p = 0.14$) and must be regarded as exploratory, to be confirmed. All six odds ratios of this analysis were below 1, including those for traditional consultation (0.43) and for a distance greater than 220 km (0.68), whose direction is counter-intuitive. At the alternative thresholds, the association with the antenatal care visit was more marked at 3 months (63 delays; OR 0.17; $p = 0.026$) than at 6 months and disappeared at 12 months (23 delays; OR 0.79; $p = 0.80$); none of these associations withstood correction for multiple comparisons ($q = 0.16$, 0.097 and 1.00, respectively).

Table 4. Dichotomous analysis: factors associated with a delay of 6 months or more (183 days), n = 75.

Factor	Exposed	Unexposed	Conditional OR (exact 95% CI)	p	q
Antenatal care visit	19/39	28/36	0.28 (0.09 - 0.82)	0.016	0.097
Referral from another hospital	28/50	19/25	0.41 (0.11 - 1.29)	0.129	0.388
Antenatal diagnosis	2/5	45/70	0.38 (0.03 - 3.51)	0.356	0.533
Traditional healer consulted	4/9	43/66	0.43 (0.08 - 2.23)	0.281	0.533
Distance > 220 km	19/33	28/42	0.68 (0.24 - 1.94)	0.476	0.571
Reported financial hardship	18/30	29/45	0.83 (0.29 - 2.40)	0.809	0.809

Number of children admitted at least 6 months after birth, related to the size of each category. Fisher's exact test; odds ratios (ORs) estimated by conditional maximum likelihood, exact confidence intervals (CIs). The q values are those of the Benjamini-Hochberg procedure applied to the six dichotomous comparisons.

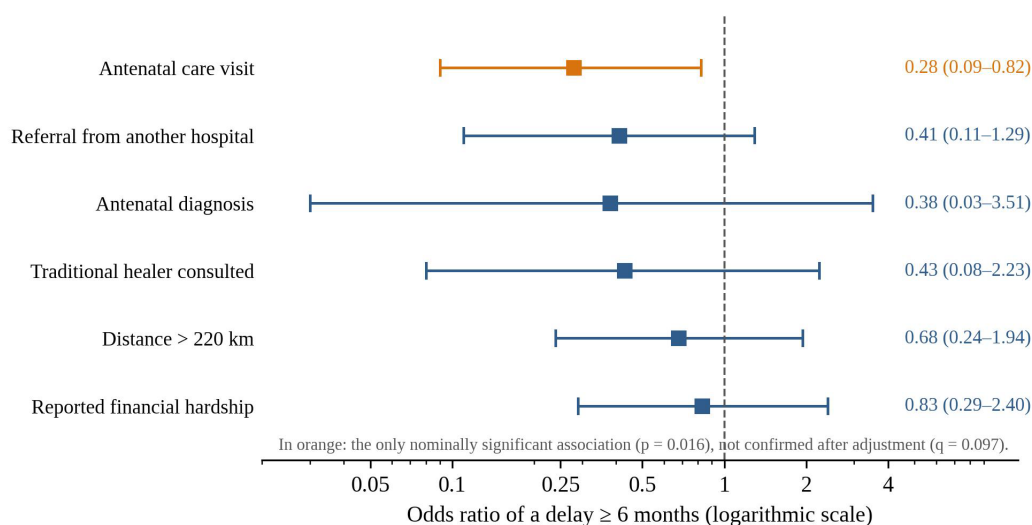


Figure 4. Odds ratios of a delay of 6 months or more according to access factors (Fisher's exact test; ORs estimated by conditional maximum likelihood, exact 95% CIs, logarithmic scale). An OR < 1 indicates a lower risk of delay. In orange: the only nominally significant association (antenatal care visit), which does not remain significant after Benjamini-Hochberg adjustment ($q = 0.097$).

4. Discussion

In this West African cohort, most of the interval to care lay before arrival at the tertiary centre: children were referred a median of nearly eight months after birth but operated on a median of five days after admission, in-hospital time accounting for a median of only 2.3% of the total interval. This delay was moreover relatively homogeneous across subgroups. These observations locate the main lengthening of the pathway upstream of the hospital and suggest that increasing surgical capacity alone will have a limited effect on the overall interval as long as referral pathways are not strengthened at the same time.

4.1. Interpretation

This profile is interpreted within the framework of the “three delays” model: delay

in deciding to seek care, delay in reaching an adequate facility, and delay in receiving care once there [14]. In our cohort, this third delay was minimal, most of the time falling within the first two. The absence of a reproducible association with the individual factors measured must not be read as an absence of effect: given the limited sample size, power remained moderate, and the delay appears to be related to the cumulative effect of multiple barriers—geographical, financial, organisational and informational—rather than to a single determinant. This reading directs action towards the whole pathway rather than towards the targeting of a subgroup.

Two observations deserve mention. First, all six odds ratios of the dichotomous analysis are below 1; under the hypothesis of independent and random directions, a concordance of this kind—all six oriented the same way—would have a probability of about 1 in 32. These exposures are not, however, independent and share a common component of contact with the formal health system, an explanation more economical than an effect specific to each. Second, the association with distance runs counter to the expected direction and to that reported in Zambia, where facilities furthest from the tertiary centre referred children later [12]. The most plausible explanation is a selection bias: among the most distant families, only those who rapidly overcame the obstacles reach the centre, the others never doing so.

The antenatal care visit is associated with a lower probability of accumulating delay during the early part of the pathway, mainly before three to six months, but it no longer distinguishes children when the extreme delays of at least twelve months are considered. This profile does not appear to be confined to the six-month threshold alone, but remains dependent on the categorisation of the interval, since it is found neither in the continuous analysis nor in the quantile regression. It cannot therefore be read as a protective effect of antenatal care on delay; at most it suggests that early contact with the formal health system would deserve to be evaluated as a lever for orientation, within a study designed for that purpose.

4.2. Comparison with the Literature

Late presentation of spinal dysraphism is frequently reported in sub-Saharan Africa, but it is most often described qualitatively and the published intervals concern heterogeneous quantities. The available benchmarks nevertheless situate our cohort. In Zambia, the median age at presentation to the tertiary centre is 7.5 days [12], and a Lusaka series of 75 children—the same sample size as ours—reports 9 days to first evaluation and 21 days to surgery [15]. In Ghana, myelomeningocele repair is performed at a median of 33 days [6], and in Nigeria the age at surgery is 11 days [5]. Our median of 239 days is thus an order of magnitude higher than in these series. It relates to admission, whereas several of these benchmarks are ages at surgery; the gap remains of the same order, the admission-to-surgery interval being only five days. It is not isolated for all that: the same Zambian synthesis reports, for age at surgery in Africa, a range from 11 days in Ethiopia to 274 days in Sudan [12], an interval within which our cohort lies at the late end without falling outside

it. This dispersion, by a factor greater than twenty between centres of the same continent, is itself an argument: it indicates that access delay depends on the organisation of pathways far more than on a regional determinant.

Antenatal indicators must be compared with caution, as the available measures are not equivalent. The Zambian series reports antenatal ultrasound coverage (77% of mothers having had at least one obstetric ultrasound) alongside a 3% rate of antenatal diagnosis [12]; our cohort documents attendance at at least one antenatal care visit (52%) and a 6.7% rate of antenatal diagnosis. Only the antenatal-diagnosis rates refer to the same quantity and are directly comparable; the ultrasound coverage of the Zambian study and the antenatal-visit attendance of ours measure different exposures and are reported here side by side, without inferring any difference in diagnostic yield between the two settings. In Ghana, ruptured or infected sacs testify to difficulties of access [6]. The Nigerian experience showed the value of early repair in reducing infectious complications [5], and the importance of surgical timing has been underlined in other resource-limited settings, where 29% of children died before the operation [9]. A systematic review with geospatial mapping confirms, on a global scale, the uneven availability of therapeutic services for neural tube defects [16], and the recent literature underlines the heterogeneity of presentations and follow-up [17]. The contrast with high-income countries, where closure is usually performed within the first days of life, highlights the extent of the inequalities [7]. These findings echo the Lancet Commission on Global Surgery, which makes timely access to essential surgical care an indicator of health-system performance [18].

4.3. Implications for Health Systems

Whereas rupture of the sac can serve only as an indirect marker of late access, the present work provides a direct measurement of the interval itself. Distinguishing the prehospital component from the in-hospital component is methodologically useful: a global “time to surgery” indicator would aggregate these two periods and mask the bottleneck. The birth-to-admission interval, or the proportion of children admitted beyond 6 months, could constitute a quality indicator for referral pathways, complementary to surgical outcome indicators, subject to external validation; the Lancet Commission moreover stresses that no single indicator accounts on its own for access to surgical care and that these measures must be interpreted jointly [18]. Interventions can be ranked: in the short term, neonatal referral protocols, awareness-raising in maternity units and priority transfer; in the medium term, regional networks, telemedicine between peripheral maternity units and neurosurgeons, support for medical transport and financial coverage of transfer; in the long term, primary prevention by periconceptional folic acid supplementation, whose efficacy in preventing recurrence of neural tube defects has been established since the Medical Research Council trial [19], antenatal screening, a national dysraphism registry and strengthening of paediatric neurosurgery. Maintaining rapid surgical management after admission is a strength of the centre.

4.4. Strengths and Limitations

The strengths of this study lie in a homogeneous cohort, in the completeness of the coding of access variables, in the direct measurement of the birth-to-admission interval and its comparison with the admission-to-surgery interval, and in a methodology suited to the skewed distribution. Several limitations must be acknowledged. The sample of 75 patients reduces power, particularly for rare exposures. Nine children admitted to the hospital but not operated on were excluded in order to preserve the denominators of the series, although their birth-to-admission interval was measurable; three of them died before the operation and one was temporarily deferred for major infection, so that this exclusion preferentially concerns degraded pathways and probably leads to an underestimation of the true interval. An analysis covering the 84 children managed is the verification to be undertaken as a priority.

Some variables—financial hardship, traditional consultation—were self-reported and exposed to recall or desirability bias, and distance did not reflect actual travel time. The signal observed for the antenatal care visit is not uniform across the distribution of the interval: present at the 3- and 6-month thresholds, it disappears at 12 months and appears neither in the continuous analysis nor in the quantile regression; it remains dependent on the categorisation adopted and cannot be extrapolated to the longest delays, which are precisely those the study seeks to reduce. The interval between diagnosis and referral was not measured separately. Residual confounding cannot be excluded, several relevant determinants were not available in the database. The single-centre design may limit generalisability, although the centre serves ten Ivorian regions. Finally, recruitment concerned only children who reached the hospital: patients never referred or who died before transfer were not represented, which probably leads to an underestimation of the true extent of access difficulties, and these results do not allow any causal relationship to be established.

4.5. Perspectives

Three lines of work emerge: multicentre validation using harmonised definitions; pathway studies including, as far as possible, children who were never referred; and prospective evaluation of organisational interventions, examining not only the interval but also infections, neurological outcomes and mortality. Such work will determine whether the birth-to-admission interval can serve as an indicator applicable to other urgent paediatric neurosurgical conditions.

5. Conclusion

In this cohort, nearly 98% of the total interval to care preceded arrival at the tertiary centre and no child reached the centre within the 48-hour window adopted by the guidelines, the shortest interval being 17 days; once admitted, children were operated on rapidly. Priorities for improvement therefore concern neonatal referral, medical transport and financial accessibility rather than operative capacity alone.

The birth-to-admission interval could serve as a simple, reproducible indicator for evaluating future interventions on referral pathways in resource-limited settings.

Funding

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Availability of Data and Materials

The data and analyses are available from the corresponding author on reasonable request.

Prior Presentation

No part of this work has been presented or published previously.

Related Publications

This study concerns the same institutional cohort as the other parts of the series, devoted to the epidemiological, clinical, surgical and outcome profile of spinal dysraphism and to early postoperative outcome of spinal forms. The studies share the patients but rely on different endpoints.

Consent to Publish

The written consent of parents or legal guardians covers publication of the anonymised data; no figure or table allows a patient to be identified.

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Author Contributions

The study was designed collectively. Data collection: Teti. Analysis: Fionko. Drafting of the first version: Dongo. All authors commented on the successive versions and approved the submitted version.

Conflicts of Interest

The authors declare no conflict of interest concerning the materials or methods used in this study or the findings reported herein.

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List of Abbreviations

CI: confidence interval;

IQR: interquartile range;

OR: odds ratio;

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology.