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Sociodemographic and Clinical Risk Factors Associated with Mortality in Children with Acute Meningitis Admitted at Lubango Pediatric Hospital – Angola

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

To reach the ambitious target of the UN Sustainable Development Goal (SDG), with countries aiming to end preventable death of newborn and under five children and reduce the mortality rate among children under 5 years to at least 25 per 1000 live birth, we need to understand the principles preventable causes and risk factors leading to child mortality. Among these preventable diseases, meningitis has one of the highest fatality rates and the potential to cause long term disability and devastating epidemics. This study is the first one in trying to identify the risk factors associated in mortality with meningitis in children admitted at luabango pediatric hospital.

We conducted a retrospective cross-sectional study to identify the sociodemographic and clinical risk factors associated with mortality in children admitted with the diagnosis of meningitis at lubango pediatric hospital, Angola. Following approval of the ethics committee at Lubango Pediatric

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Hospital, records of patients diagnosed with acute meningitis between 2020 and 2021 was extracted from infectious ward file record. Data was analyzed using SPSS 23.
20 (26.7%) of children admitted at lubango Pediatric hospital with the diagnosis of meningitis during the period of the study died.
Mother's level of education ((P: 0.000), Vaccination status of the children (P:0.018) and vomiting (P: 0.007) were associated with mortality in a Bivariate analysis.
Lethality rate of children with the diagnosis of meningitis admitted at lubango Pediatric hospital during the period of the study was 26.7%.
mother's level of education, Vaccination status of the children and vomiting were strongly associated with mortality.

Keywords: Children mortality; pediatric; meningitis.

1. INTRODUCTION

Meningitis is an inflammation of the thin membranes (Meningitis) that cover the brain and the spinal cord. Usually, the inflammatory process is not limited to the meninges surrounding the brain but extend to the brain parenchyma (meningoencephalitis), the ventricles (ventriculitis) and spreads along the spinal cord [1].

The World has been able to reduce the under-five mortality from 93 death per 1000 to 43 per 1000 live birth from 1990 to 2015, during the lifetime of the Milenium Development Goal. To reach the ambitious target of the UN Sustainable Development Goal (SDG), with countries aiming to end preventable death of newborn and under five children and reduce the mortality rate among children under 5 years to at least 25 per 1000 live birth [2], we need to understand the principles preventable causes and risk factors leading to child mortality Among these preventable diseases, meningitis has one of the highest fatality rates and the potential to cause long term disability and devastating epidemics.

1.1 Justification

Despite the high burden of infectious disease and the exceptional huge fatality rate as well as the less favorable consequences associated with meningitis in Angolan children, the Clinical presentation and risk factor associated with mortality in children and adolescent admitted with meningitis has not been well described in Angola.

To our knowledge, this study is the first one in trying to identify the risk factors associated in mortality with meningitis in children admitted at luabango pediatric hospital.

1.2 Broad Objective

To identify the sociodemographic and clinical risk factors associated with mortality in children admitted with the diagnosis of meningitis at lubango pediatric hospital- Angola.

1.3 Specific Objectives

1. To describe the sociodemographic and clinical characteristic of meningitis in children admitted at lubango paediatric hospital.
2. To determine the influence of socio-demographic and clinical factors associated with mortality inchildren admitted with meningitis at lubango paediatric hospital.

2. MATRIALS AND METHODS

2.1 Study Site

Lubango pediatric Hospital – Angola.

Lubango Pediatric Hospital is located in LUBANGO/ ZONE HELDER NETO, the core of the city. It has a capacity of 250 beds. The hospital admits about 9783 children annually from which approximately 100 have meningitis (Hospital record) and is the main pediatric referral hospital in the region.

2.2 Study Design

A Retrospective cross-sectional study.

2.3 Inclusion Criteria

- All patients under 14 years of age admitted at the infectious disease ward with the diagnosis of meningitis.
- Whose meningitis had been suspected by clinical sign and symptoms and confirmed by cerebrospinal fluid examination.

2.4 Exclusion Criteria

I. Patient with systematic disease which affect clinical symptom and CSF analysis, such as:

i. vascular collagen diseases,
ii. AIDS
iii. Cancers

2.5 Sample Size

Sample size was calculated using the Kish Leslie formula (1965) with previously known prevalence of meningitis in African children of 13 % as per Kanani Sh at al.

$$n = \frac{z^2 p (100-p)}{\varepsilon^2}$$

Where:

z= level of confidence (1.96 for 95% confidence level)
p = expected proportion =13%.
ε = margin of error = 10%
$n= [1.96^2* 13 (100-13)]/ 10^2 = 44$

2.6 Sampling Method

Recruitment of participants was conducted by peaking files from the infectious diseases ward which is located in the main hospital building.

The record of children lees than 14 years diagnosed and treated for Meningitis at lubango pediatric hospital, were reviewed in a retrospective manner.

A diagnosis of meningitis was based on clinical signs and symptoms of meningitis, positive result on direct examination of the cerebrospinal fluid, changes in the cerebrospinal fluid (cerebrospinal fluid pleocytosis (>10 cells/mm^3, protein), positive polymerase chain reaction (PCR) results in the cerebrospinal fluid or rarely a confirmed bacterial etiology on a positive cerebrospinal fluid culture.

All children who meet the inclusion criteria was sampled in a systematic consecutive way until a sample size of 75 children was met.

2.7 Data Collection Tools

Data was collected using a structured questionnaire.

Important socio-demographic factors was retrieved from the record/ the file and Clinical Determinant such duration of illness and categorizing symptoms such as fever and cough among others was noted.

2.8 Variables

The dependent variable was child mortality, where there was those who died and those who did not die.

While the independent variables used to determine association included: demographic information (level of education, occupation, residence, number of children in the family, age of the children, gender, weight, and vaccination status.) and clinical manifestations (fever, headache, vomiting, convulsion, diarrhea, cough, dyspnea, budging fontanelle, irritability and positive kerning sign).

2.9 Data Management and Analysis

Data was analyzed using SPSS 23. Descriptive statistics is reported to describe the variables. Categorical variables were compared using Chi square test.

Continuous variables that had normal distribution (care takers age, number of children) was categorized based on the mean into two categories while skewed variables (child age) was categorized based on the median.

Bivariate statistics (chi-square and logistic regression Analysis) was used to establish association between meningitis and the explanatory factors using a chi-square while logistic regression was used to determine the predictors of Meningitis. Variables with $P < 0.05$ in the logistic regression was considered to have a significant association with mortality. Logistic regression was performed on multiple variables hypothesized to explain association between risk factors and mortality from meningitis.

3. RESULTS

3.1 Demographic Characteristics

Between December 2021 and February 2022, a total of 75 participants (caregiver-child pair) were recruited into the study. The majority of the mother had at most secondary school 32 (42.7%), lived in the suburban area surrounding the hospital 46 (61.3%) and had at least 6 children 42 (56%), while the majority of the fathers were employed but with no fixed salary 61 (81.3%).

Table 1. Caregiver's characteristics (n=75)

Characteristics	Number (N)	Percentage (%
Level of education of the mother		
None	22	29.3
Primary	9	12
Secondary	32	42.7
Tertiary	12	16
Occupation of caretaker		
Unemployed	6	8
Employed with no fixed salary	61	81.3
Employed with fixed salary	8	10.7
Residence		
Rural	22	29.3
Suburban	46	61.3
Urban	7	9.3
Number of children in the family		
Less than 4	2	2.7
4 – 6 children	31	41.3
More than 6 children	42	56

Table 2. Children's socio-demographic characteristics

Characteristics	Number (N)	Percentage (%)
Gender of the child		
Male	52	69.3
Female	23	30.7
Weight		
1 - 10	41	54.7
11- 14	11	14.7
15 – 18	9	12
➢ 18	14	18.7
Age of the child (months)		
1 – 12	30	40
13 - 36	15	20
37 – 60	8	10.7
>60	22	29.3
Vaccination state		
None	1	1.3
Incomplete	48	64
Complete	26	34.7

The majority of children were male 52 (69.3%), aged between 1 and 12 months 30 (40%), with a mean age of 46.6 months and a medium age of 24 months, while most of them had a body weight of less than 10 kg 41 (54.7%).

Table 3. Children's Age distribution

Age distribution	
Minimum	1
Maximum	168
Mean	46.6
Median	24

Table 4. Children's clinical characteristics

Characteristics	Number (N)	Percentage (%)
Fever		
Yes	60	80
No	15	20
Headache		
Yes	8	10.7
No	67	89.3
Vomiting		
Yes	14	18.7
No	61	81.3
Convulsion		
Yes	54	72
No	21	28
Diarrhea		
Yes	2	2.7
No	73	97.3
Cough		
Yes	3	4
No	72	96
Dyspnea		
Yes	1	1.3
No	74	98.7
Budging fontanelle		
Yes	3	4
No	72	96
Irritability		
Yes	4	5.3
No	71	94.7
Kerning		
Positive	11	14.7
Negative	64	85.3

Table 5. Children' mortality

Mortality	Number (N)	Percentage (%)
Yes	20	26.7
No	55	73.3

Signs and symptoms most presented were fever 60 (80%) and convulsion 54 (72%), and the least presented were diarrhea 2(2.7%) and dyspnea com only 1 child (1.3%).

3.2 Mortality Rate

20 (26.7%) children admitted at lubango Pediatric hospital with the diagnosis of meningitis during the period of the study died.

3.3 Bivariate Logistic Regression for Caregiver's Characteristics Associated with Mortality

Among the caretaker's socio-demographic characteristic studied, only the mother's primary and secondary level of education were associated with mortality in a Bivariate analysis (P: 0.000).

Table 6. Bivariate logistic regression for Caregiver's characteristics associated with Mortality

Characteristic	OR (95% CI)	P value
Level of education of the mother		
None	1.00	
Primary	19.190 (2.522 - 220.326)	0.000
Secondary	7.679 (0.494 – 65.162)	0.006
Tertiary	1.827 (0.020- 6.171)	0.177
Occupation of caretaker		
Unemployed	1.00	0.134
Employed with no fixed salary	2.243 (0.102- 1.357)	0.956
Employed with fixed salary		
Residence		
Rural	1.737	0.188
Suburban	1.764 (0.221 – 1.344)	0.184
Urban		
Number of children in the family		
Less than 4	2.083 (0.212 – 1.265)	0.149
4 – 6 children	0/005	0.942
More than 6 children		

3.4 Bivariate Logistic Children's Socio-demographic Characteristics Associated with Mortality

Vaccination status of the children were strongly associated with mortality in a bivariate model (P:0.018).

3.5 Bivariate Logistic Children's Clinical Characteristics Associated with Mortality

Children who presented vomiting as a symptom had more risk of dying than the ones who did not have vomiting in our bivariate analysis (P: 0.007).

Table 7. Bivariate logistic Children's socio-demographic characteristics associated with Mortality

Characteristic	OR (95% CI)	P value
Gender of the child		
Male	0.006 (0.314 – 2.919)	0.959
Female		
Weight		
1 - 10	0.051	0.643
11- 14	1.115(0.274 – 5.104)	0.822
15 – 18	1.325 (0.218 - 8.669)	0.735
➢ 18	3.397 (0.469 – 18.333)	0.250
Age of the child (months)		
0 – 12	0.164	0.686
13 - 36	0.113 (0.233– 2.608)	0.737
37 – 60	1.036(0.282 -3.336)	0.309
>60	2.772 (0.031 – 2.991)	0.467
Vaccination state		
None	0.000	**0.018**
Incomplete	5.610 (1.384 – 31.287)	**0.001**
Complete		

Table 8. Bivariate logistic Children's clinical characteristics associated with Mortality

Characteristic	OR (95% CI)	P value
Fever		
Yes	0.423 (0.442 – 5.092)	0.516
No		
Headache		
Yes	0.013 (0.204 – 5.967)	0.910
No		
Vomiting		
Yes	7.263 (1.587- 18.672)	0.007
No		
Convulsion		
Yes	2.166 (0.714 – 10.639)	0.141
No		
Diarrhea	0.527 (0.169- 47.714)	0.468
Yes		
No		
Cough	0.070 (0.120 – 16.276)	0.791
Yes		
No		
Dyspnea	0.000 (0.000-)	1.000
Yes		
No		
Budging fontanelle	0.070 (0.120 – 16.276)	0.791
Yes		
No		
Irritability	0.006 (0.089 – 9.314)	0.938
Yes		
No		
Kerning	0.002 (0.246 – 4.368)	0.961
Positive		
Negative		

Table 9. Multivariate model for significant predictors of death from meningitis

Characteristic	OR (95% CI)	P value
Level of education of the mother		
None		
Primary	7.042 (2.356 -298.590)	0.008
Secondary	0.917 (0.253 – 54.716)	0.338
Tertiary	0.301(0.022- 8.508)	0.583
Vomiting		
Yes	3.731 (0.030 – 1.026)	0.053
No		
Vaccination state		
None	0.000	1.000
Incomplete	3.326 (1.871 – 46.901)	0.048
Complete		

3.6 Multivariate Model for Significant Predictors of Death from Meningitis

After successful iterations at the multivariable modeling, the significant predictors for death in meningitis in children are mother level of education (at least primary level of education) and vaccination status (a complete vaccination) in the child. Although not highly significant, there was evidence for an association of clinical symptom of vomiting with death from meningitis in children admitted at lubango pediatric hospital)

after adjusting for all factors in the multivariable model.

4. DISCUSSION

Meningitis is a serious illness resulting in almost 170,000 deaths each year, around the world [3]. It is really a deadly infection and potentially disabling.

The impact of pediatric meningitis is serious as it includes a range of developmental and functioning Sequelae such as hearing loss, vision loss, cognitive delay, speech/language disorder, behavioral problems, motor delay/impairment, and seizures [4]. This can impact on the long-term family life, principally for parent with resources limited to take care of a disabled child.

We conducted this retrospective, facility-based study to access fatality rate as well as the socio-demographics and clinical characteristic associated with mortality among children admitted with Meningitis at Lubango pediatric Hospital.

It is known that all people are at the risk of acquiring meningitis , but it is the highest in people living in Africa where we find the region known as the African Meningitis Belt , who are much specifically at high risk of meningococcal but also of pneumococcal epidemics. To identify the risk factors for death in child with meningitis is then of special interesse in this region in general and in Angola in particular.

In our study, the majority of the mother lived in the suburban area surrounding the hospital 46 (61.3%) and had at least 6 children 42 (56%). This confirm finding by Abdel Moat Al JAROUSHA and Ahmed. Al AFIFI who found more case of meningitis in children living in crowded areas and relatively low income family, in a cross sectional study conducted in Gaza [5]. Similar from finding by WHO [6]. The risk of meningitis is Higher in people living in close proximity and overcrowded household such as refugee camps and student setting. Increased number of household, principally if it include adult smoker may disturb the respiratory epitalial defense and expose the child to more risk of infection, apart from increasing the number of heathy carrier of the potentially infective pathogen. This fact put the child from big family at a particular risk of any infectious disease, including meningitis.

The majority of children in our study were male 52 (69.3%), aged between 1 and 12 months, while most of them had a body weight of less than 10 kg 41 (54.7%) . similar data were shown by Abdel Moat Al JAROUSHA and Ahmed. Al AFIFI who find more children with bacteria meningitis to be younger in three hospitals in Gaza and by uganariu G, Miftode E, Teodor D, Leca D and Dorobăţ in 2012 who had more participant less than 1 year in their series of children dignosed with meningitis [5,7]. Confirming the fact that young children in their development process are more exposed and immunologically susceptible to infection. Meningitis in this age group usually results from the respiratory infection or infection of the bloodstream, two of the commonest infections in younger children.

In term of clinical presentation, more children in our study presented with fever 60 (80%) and /or convulsion 54 (72%). similar symptoms were recorded in a report Gudina EK el al in 2016 and Geteneh A et al in 2020 [8,9]. Although a few participants had no fever in our study, the majority presented with fever as it is the manifestation of an inflammatory process and one of the most frequent signs of any infection.

The fatality rate of children with meningitis at lubango pediatric hospital was 26,7%. This rate is similar to the one of 10-25% in infants reported by Durand ML et al in 1993 [10]. This high rate is not unusual and among the preventable diseases, meningitis has one of the highest fatality rates. African children have some of the highest rates of bacterial meningitis in the world, which usually lead to serious neuropsychological sequelae or child mortality [11]. Africa has one of the high rate of Unfavorable outcomes in the world following meningitis infection and this can be among other factor, associated to the unfavored living condition. This rate is slightly lower than findings by Heikki Peltola, Irmeli Roine, Markku Kallio & Tuula Pelkonen in 2021 where fatality rates were 38 % in Angola [12]. This may be explained by the fact that our study was retrospective study and including only patient admitted to the infectious disease unit and missing patient who were admitted in ICU. The fact that Lubango pediatric hosptal is a teaching and referral hospital, with rigorous diagnosed and treatment guidelines may probably as well impact on this relatively low mortality rate.

Meningitis develops after the pathogen invades the CNS either through hematogenous route (bacteremia) or by direct extension secondary to sinusitis or mastoiditis and multiplies in the subarachnoid space resulting in a severe inflammatory process. This persistent inflammatory process subsequently leads to decreased cerebral perfusion, cerebral edema, raised intracranial pressure, metabolic disturbances, and vasculitis, all contributing to neuronal injury and ischemia [12]. Brandt CT in 2010 showed clearly that meningitis continue to be a very serious disease with high risk of death from these serious complication which can be local or systemic such as shock, multi/organ failure the intracranial complications stroke, seizures, increase intracranial pressure or brain herniation [13].

In our bivariate analysis as well as after adjusting for all factors in the multivariable model, Level of education of the mother was strongly associated with death in children admitted with the diagnosis of meningitis at Lubango Pediatric Hospital, as children of mother who have never been to school are at higher risk of dying from meningitis as compared to children of mother who have done at least primary level education.

This could be attributed to the fact that people who are generally more educated are more knowledgeable about prevention and the need to seek medical care at the early stage of the disease. Further, educated people are more often recipients of mass media campaigns regarding prevention and early seek of medical care, which more often are concentrated in urban areas. A we know, the golden rule of early diagnosis and treatment to achieve a good outcome has not yet been challenged by any other strategy.

In our study, vaccination status was statistically associated with mortality in a bivariate model and continue to be so after successful iterations at the multivariate modeling. There was an increased risk of dying in children with incomplete vaccine dose as compare to children with complete vaccine dose as per the Angolan immunization schedule. Similar found were seen by Gudina EK el al in resource limited settings in 2016 and by Geteneh A el al in 2020 in Ethiopia [8,9]. Meningitis continue to be a deadly disease in most cases but routine childhood immunization has significantly decreased the number of serious infections as well as the case fatality rate.

The current study finds evidence of an association of clinical symptom of vomiting with death from meningitis in children admitted at lubango pediatric hospital.

It is well known that meningitis developed as a complication for initial infection like pneumonia, sepsis, and otitis, which may present with vomiting and affect the child nutritional and immune status. Further, as a Symptoms suggestive of raised intracranial pressure, vomiting is frequently the initial features of bacterial or viral meningitis and may put the patient at risk of bulbar herniation and death.

Our findings show no significant association between age of the participant and the risk of death, different to the report by Wall EC el al who found a strong association between age and mortality in children admitted for meningitis in a study in Malawi [14]. This may be explained by the fact that almost 40% of the patient in our study had less than 12 month and very few in the remaining age group.

A unique finding was the lack of a significant relationship between convulsion and mortality, as this was found in a number of studies [15,16]. This lack of association in this study may be explain by the fact that a great majority (72%) of participant presented with convulsion, causing a dilution of a probable association [17].

5. CONCLUSION

Lethality rate of children with the diagnosis of meningitis admitted at lubango Pediatric hospital during the period of the study was 26.7%.

Among the caretaker's socio-demographic characteristic studied, only the mother's level of education was associated with mortality in a Bivariate analysis (P: 0.000).

Vaccination status of the children were strongly associated with mortality in a bivariate model (P:0.018).

Children who presented vomiting as a symptom had more risk of dying than the ones who did not have vomiting in our bivariate analysis (P: 0.007).

In a multivariate model, only level of education of the mother and vaccination state continue to be associate with the risk of death.

6. RECOMMENDATIONS

- With a lethality rate of 26.7%, meningitis continue to be one the major contributors of child mortality in patient admitted at Lubango Paediatric Hospital and require more attention in it management and guidelines revision.
- Sensitization on importance routine and campaign immunization activity.
- Efforts to make basic education available will go a long way in improving knowledge on immunization and reduce common preventable diseases.
- Prospective study to determine factors associated with morbi-mortality of meningitis in children at lubango pediatric hospital is needed.

CONSENT

It is not applicable.

ETHICAL APPROVAL

This is a retrospective descriptive study using existing data. Following approval of the ethics committee at Lubango Pediatric Hospital, records of patients diagnosed with acute meningitis between 2020 and 2021 was extracted from infectious ward file record. After hospital ethical committee approval, data were collected.

Obtaining study records was handled with a high level of confidentiality and privacy and all identifying data was removed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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