Table 3: Univariate analysis of laboratory parameters

CSF exam	Categories	Cases (32)		Controls (64)		P	OR	IC à 95%
		n	%	n	%			
Germs/ Organisms	*N. meningitidis*	11	34.38	1	1.56	<0.001*	33	3.00- 361.95
	*S.pneumoniae and others***	21	65.63	63	98.44			
CSF glucose	> 20 mg/dl	16	50	39	60.94	0.307		
	≤ 20 mg/dl	16	50	25	39.06			
CSF protein	≤ 400 mg/l	9	28.13	10	15.63	0.147		
	> 400 mg/l	23	71.88	54	84.38			

*Fisher exact test

**Only *Streptococcus pneumoniae* and *Neisseira meningitidis* were found in the cases, other germs are *Streptococcus B*, *Staphylococcus aureus* and *E. coli, no Haemophilius was found.*

Table 4: Adjusted odds ratio of factors associated with BM death

Variables	P	Adjusted OR	95% CI
Age	-		
Sibling	0,003	14,48	2,53- 82,95
Crowding	0,021	9,31	1,39- 62,29
Time before hospitalisation	0,023	9,26	1,36 – 62,92
Altered consciousness	<0,001	47,74	6,24- 364,96
Organism : *Neisseria Meningitidis*	0,017	36,68	1,90 – 704,97

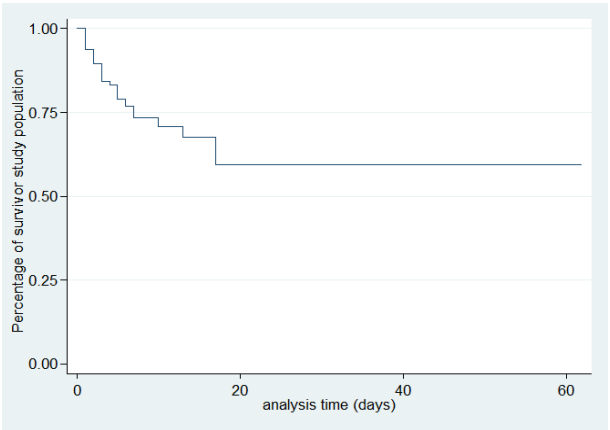

Figure 1: Survival analysis curve of Kaplan-Meier

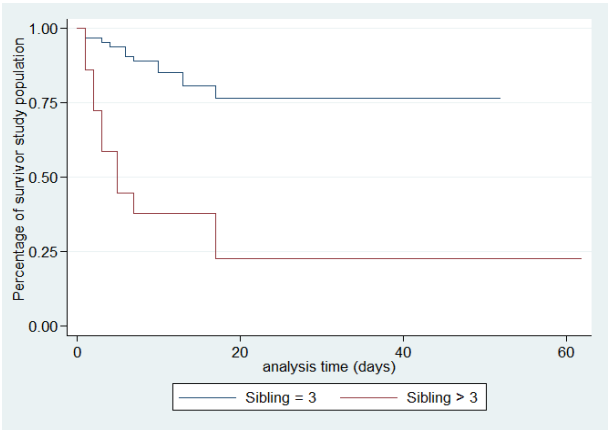

Figure 2: Survival analysis curves according to sibling

Survival Analysis

In our series, the median duration of hospitalization was 11 days with a maximum of 62 days. For the cases, this median duration is 4, 5 days versus 14 days for the controls. There was a gradual decrease in the survival curve; the decline is most important during the first 5 days (Figure 1)

According to the existence of factors associated with death, survival is shorter if the number of siblings is more than three, with crowding, altered consciousness, and when the causative organism is meningococcal meningitis (Figures 2-6).

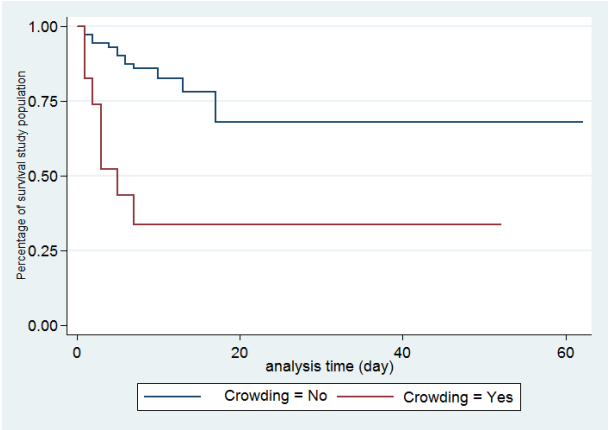

Figure 3: Survival analysis curves according to crowding

Discussion

The mean childhood BM mortality is around 5%

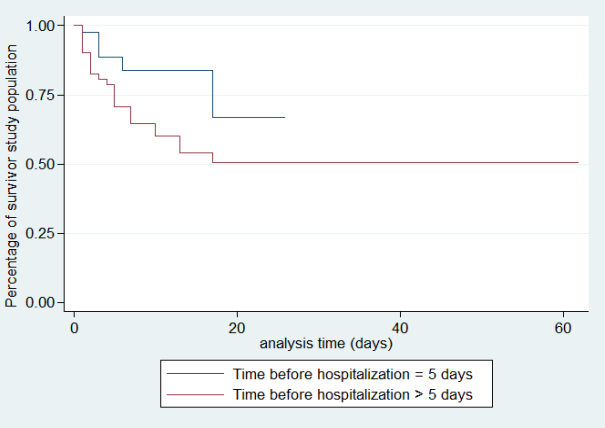

Figure 4: Survival analysis curves according to time before hospitalization

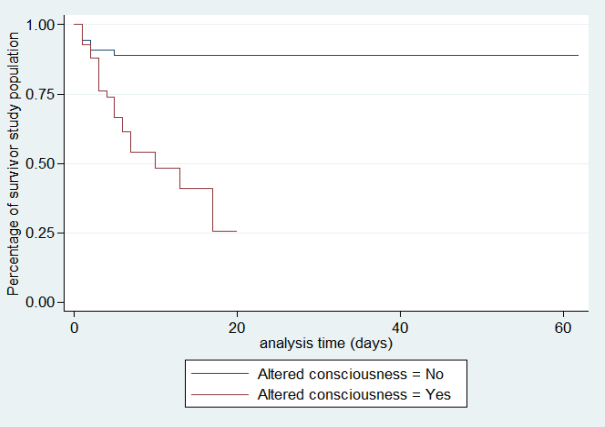

Figure 5: Survival analysis curves according to altered consciousness

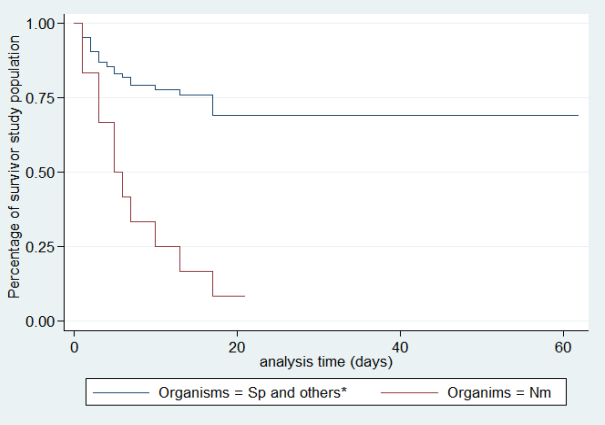

Figure 6: Survival analysis curves according to organisms
*Only Streptococcus pneumoniae and Nesseira meningitidis were found in the cases, other germs are Streptococcus B, Staphylococcus aureus and E. coli, no Haemophilius was found.

worldwide[1-4] with differences depending on the country and study site. For example it was reported as 28.7% in Malawi, 33% in Angola, and up to 37% in Latin America[7-10]. In developed countries, this value is much lower as for example in France with a death rate ranging from 5.9 % to 10.2% over the past decade[11].

The mortality in our study was 17, 71%, which is lower than for the other African countries, but it could be revised upwards due to the relatively small sample size as a result of exclusion of children with missing data. Also one retrospective study such as ours cannot provide an accurate estimation of the mortality due to BM in Madagascar.

In France, Nigeria, Guatemala and Malaysia, the category mainly affected by BM is children less than 12 months[11-14]. Basri in Malaysia shows that children less than 12 months are at increased risk of death due to BM (OR = 3.13 [1.33 to 7.24])[14]. These results are in agreements with our study, children suffering from BM and less than six months of age have twice the risk of death. Young infants are a population at risk for BM death and may require a more tailored support.

The majority of BM impact studies found a male predominance of 50 to 60%, as MacCormick in Malawi[8], Kuti in Nigeria[12], and Basri in Malaysia[14] have reported. The sex ratio depends on the socio-demographic breakdown of each country. However, sex is not a death risk factor related to BM.

Our study found a strong association between the number of siblings and death among children with BM. Our findings thus confirmed what the literature clearly established and reported, an association between the risk of developing BM and the number of siblings[15, 16]. However, no study has shown the effect of siblings on the survival of children with BM. In our study, the effect of the number of siblings on the survival of children with BM could be explained by the assumption of difficulty of a hospitalized child from a large family in a developing country. It's very difficult for parents devoting time because of economic difficulties to take care all their children.

The same applies to overcrowding. Huljer highlights that children staying in a nursery have twice the risk of acquiring BM, but the association with death has not been established. Overcrowding exposes the child to more virulent organisms, and once again, the large family cannot cope with the hospital charge or fee due to demands of the family. This may explain the strong association of deaths and number of of siblings or overcrowding in our study.

In several countries in Latin America, Garcia and his team have demonstrated the protective effect of the haemophilus vaccine on the risk of meningitis, with a relative risk ranging from 0.07 to 0.21[17]. Suarez demonstrates that the efficacy of pneumococcal vaccine on mortality in pneumococcal diseases including meningitis

from admission. Further studies are necessary, given the limitations of the present study, among other things, the establishment of the childhood BM severity score, and the assessment of care in emergency is particularly essential.

Competing interests

SAM, RMRR, RM and ALR are in the Faculty of Medicine of Antananarivo, Madagascar. The authors declare no financial competing interests.

Authors' contributions

SAM wrote the first draft of the study and conceived the study with ALR. SAM, RMRR and RM contributed the data. SAM, RMRR, RM and ALR were responsible for data interpretation. All authors edited the final version of the manuscript and approved its submission for publication.

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ALR is director of the CHUMET of Madagascar

Acknowledgements

WHO-DPEV Madagascar

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