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Predictors of mortality among children at a tertiary hospital in Tanzania: a cohort study

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Abstract

Background Tanzania is among the countries in sub-Saharan Africa with the highest under-five mortality rate. The leading causes of mortality among these children include vaccine-preventable infections. Strategies for reducing under-five mortality in hospital settings require a good knowledge of driving factors, which are largely unknown in Tanzania. This study was conducted at Muhimbili National Hospital to determine mortality and its predictors among under-five admitted in the general paediatric wards.

Methods We conducted a prospective cohort study among children aged between 1 and 59 months admitted in the paediatric wards at Muhimbili National Hospital from 2nd October 2017 to 13th April 2018. We recruited eligible children consecutively and followed them up until discharge or death. We calculated the mortality rate as the incidence density rate and determined the causes and predictors of mortality. We analyzed data to identify and quantify predictors of deaths and used Kaplan-Meir and Cox regression analyses to determine predictors of survival. A *P*-value of < 0.05 was considered statistically significant.

Results We recruited 925 children aged 1–59 months with a median age of 13 and (IQR) of (20) months, females constituted 40.8%. The overall mortality rate was 12.2% (95% CI: 10.2%-14.5%). We found septicaemia (27%), malnutrition (12%), congenital heart disease (12%), pneumonia (11%), and Human Immunodeficiency Virus infection (9%) to be leading causes of mortality. More deaths were observed at night, during the first 24 h of admission, and on weekends. Independent factors for mortality were found to be low wealth quintiles (lowest quintile (AOR = 4.0; 95% CI: 1.19–13.51), second quintile (AOR = 5.2; 95% CI: 1.65–16.69) and middle quintile (AOR = 3.6; 95% CI: 1.14–11.33), unconsciousness on admission (AOR = 18; 95% CI: 6.70–56.82), inability to feed (AOR = 5.7; 95% CI: 1.97–16.51), lethargy (AOR = 4.9; 95% CI: 2.32–10.40), severe wasting (AOR = 4.5; 95% CI: 2.49–8.10), and respiratory distress (AOR = 2.6; 95% CI: 1.40–4.97).

Conclusion A high mortality rate was noted in this study and low wealth quantile, low parental education, and lack of health insurance were associated with high mortality. Patients had the highest risk of mortality within 24 h of admission, therefore it is important to raise awareness among clinicians regarding the need for improvement in the monitoring of patients, especially within 24 h of admission.

Keywords Under-five mortality, In-hospital mortality, Mortality in children

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Background

The mortality of children aged below 5 years is still high, 5.3 million deaths were reported among children under the age of 5 years in 2019, 50% of which were due to infectious diseases, and 21% were vaccine-preventable [1]. Tanzania has an under-five mortality of 67 out of 1000 live births and it is one of the ten countries with the highest under-five mortality globally. In 2018 deaths among under-five children were reported to be 107,000 in Tanzania [2, 3]. The leading causes of under-five mortality globally were reported to include pneumonia, diarrhoea, malaria, measles, injuries, and congenital abnormalities [1].

Infection is the leading cause of mortality among children aged less than five years in Tanzania, a study conducted by Lugangira et al. among children aged 2–59 months admitted in hospitals in Tanzania noted malaria, diarrhoea, and pneumonia to be the leading causes of mortality [4].

Mortality among children in the sub-Saharan Africa region is driven by several factors including maternal education which may influence health-seeking behaviour with timely presentation to health facilities of sick children. Shortage of personnel and lack of diagnostic equipment in primary care settings in low-income countries contribute to high mortality [5, 6]. Children living in urban areas where more well-equipped health facilities are easily accessible and those from wealthier households were reported to have lower mortality as compared to those in rural settings, which may reflect the quality and access to care [6–8].

Under-five mortality is high in Tanzania and several studies have been carried out to describe the mortality and some of the driving factors, mostly in the primary and secondary level of care. This study was conducted at Muhimbili National Hospital to determine the predictors of mortality among under-five children.

Methods

Study design and setting

This was a prospective cohort study that was conducted among children aged 1–59 months admitted to the general paediatric wards at Muhimbili National Hospital. Muhimbili National Hospital is the national referral hospital and a teaching hospital for Muhimbili University of Health and Allied Sciences and has a bed capacity of 2000 beds. At the time of data collection, the Department of paediatrics had specialized units that included neurology, nephrology, haematology, endocrinology, oncology, gastroenterology, and infectious and malnutrition ward. The general paediatric wards admit children aged 1 month to 14 years with an average daily admission of 3 to 15 children in all units per day. Each unit is staffed with intern doctors, medical officers, residents, and specialists.

Study population

Children aged 1–59 months admitted to general paediatric wards at MNH were eligible for this study. Children admitted with surgical diagnosis/trauma died within 30 min of admission and those whose parents/guardians refused consent were excluded.

Sample size

The sample size for this study was calculated from OpenEpi using Fleiss Methods for Rates and proportions [9]. The death rate due to respiratory tract infection of 2% reported by Ezeonwu et al. [10] was used for estimating sample size, making use of a two-sided confidence level (1-alpha) of 95, power of 80%, ratio of sample size; unexposed/exposed of 4, percentage of exposed population with an outcome (patient who died with respiratory tract infection) of 2%, percentage of unexposed population with an outcome (patient who died with no respiratory tract infection) of 7% and odds ratio of 0.27. Respiratory tract infection was selected because it was presumed to be the leading cause of mortality among children. The exposed and unexposed sample sizes were estimated to be 185 and 737 respectively, making a total sample size of 922. The total sample size was adjusted with an assumption of a 5% non-response rate making the minimum sample size to be 975.

Sampling procedure

We conveniently enrolled all participants meeting inclusion criteria consecutively until the sample size was reached. Information about the study was provided to parents/guardians and informed written consent was sought before recruitment.

Data collection

The principal investigator and two research assistants, who were intern doctors trained in the protocol, collected data for this study using a structured questionnaire starting on 2nd October 2017 and finishing on 13th April 2018. Information collected was filled in the four sections of the questionnaire which included socio-demographic characteristics, clinical presentation, laboratory investigations, and causes of death. Participants were recruited within 24 h of admission. Data was collected from parents/caregivers and participants' case notes. Participants were then followed up every two days until discharge or death, confirmed diagnoses and laboratory findings were recorded on follow-up.

Study variables

Dependent variables (outcome) Death or survival was the primary outcome measured as a binary variable where death = 1, and discharge = 0. Cause of death was defined as the primary underlying illness; for a patient with multiple diagnoses both the underlying cause of death, the immediate cause of death, and co-morbid conditions were recorded. The immediate cause of death was reported as the immediate cause of death as recorded in the patient file after a mortality audit, which is done by more than one clinician in the respective unit. Causes of death were discussed in a review clinical presentation, and any supportive laboratory findings if any as well as circumstances around that death are taken into consideration when reporting the cause of death. Finally, causes of death were documented in the file after a consensus was reached. Mortality audits were done weekly or once in two weeks depending on the unit. Comorbid conditions are those related to the cause of death or complication of underlying disease, for example, malnutrition in a patient with cerebral palsy or congenital heart disease, anaemia, or diarrhoea.

Independent variable Social demographics: Age was recorded in terms of months as a continuous variable. Sex and primary caregiver were recorded as nominal variables. The primary caregiver, occupation, level of education, and wealth quintiles were recorded as ordinal variables. Health insurance and vaccination status were recorded as a dichotomous categorical variable.

The wealth index was generated using 11 items on asset ownership, having a bank account, housing material used to construct roofs, walls, and floors, and the main source of drinking water and cooking fuel. All the items were converted into dichotomous variables 1 = wealth and 0 = poor. (eg housing material floor; made of mud or sand = 0, cement/tile/polished wood = 1). The first factor was then used to construct a household wealth index that was summarized as quintiles – highest, rich, middle, poor, and lowest quintiles.

Clinical features: cough, fever, convulsion, vomiting, diarrhoea, inability to feed, reduced urine output, lethargy, unconscious and respiratory distress was recorded as a dichotomous variable.

Biochemical markers relevant to the diagnosis recorded included white blood cell count, haemoglobin level, platelet counts, C – reactive protein, electrolyte, serum creatinine recorded as a continuous variable, and blood culture as a nominal variable.

Nutrition status: assessment was done on admission; weight was measured using a weighing scale (Seca beam balance) calibrated before measurement and weight recorded to the nearest 10gm. The length was taken for children who were not able to stand using the length board while the child was lying supine on a flat surface with the head touching the top board and the soles of the feet touching the footboard. Children who were able to stand had their height measured using a height board while the child was standing and the head touching the top board. Weight for height was calculated and interpreted using WHO standard growth chart Z scores where moderate wasting was defined as weight for height between (-2SD to -3SD) and severe wasting (< -3SD).

Human Immunodeficiency Virus infection (HIV)status was extracted from the patient file. Every child's HIV status was checked on admission as per local paediatric protocol. HIV exposure was defined as children below 18 months born with HIV positive mother but had a DNA PCR negative test at 6 weeks of life and the child was still breastfeeding. HIV infection was defined as children confirmed HIV positive by DNA PCR if they were below 18 months. Children above 18 months of HIV infection were diagnosed using two rapid tests; Bioline then confirmed by Unigold test, manufacture of these tests are Standard Diagnostic, Inc., 65, Borahagal-ro, Giheung-gu, Yongin-si, Gyeonggi-do, Republic of Korea.

Respiratory distress: These are children presented with higher respiratory rate than normal for age, lower chest wall in drawing, nasal flaring, or grunting.

Anaemia: This study categorizes anaemia into very severe anaemia – Hb < 5 g/dl, severe anaemia – Hb 5.0–6.9 g/dl, moderate anaemia Hb 7.0–9.0 g/dl, mild anaemia- Hb 9.1–11.0 g/dl and normal is > 11.0 g/dl.

Fever was defined as a temperature above 37.5 °C.

Admission diagnosis: This was a confirmed diagnosis after being reviewed by the team of the unit either resident or specialist or both with laboratory and radiological confirmation as per protocol. The provisional diagnosis was used if a child died before the diagnosis was confirmed.

Data management and analysis

Questionnaires were manually checked for completion daily by Principal Investigator and were entered into the computer system using Statistical Package for Social Sciences version 16 (SPSS Inc., Chicago, IL, USA). Data was cleaned before the analysis and all analyses were done using SPSS.

The mortality rate was calculated as the cumulative proportion of the total number of deaths divided by the total number of admissions during the study period. Kaplan–Meier curves are presented showing the overall mortality rate and by select characteristics. Mean ± SD and median (IQR) were calculated for continuous normally distributed and skewed variables, respectively. The wealth index was constructed after component factor analysis (data reduction procedure).

Bivariate analysis was done to determine the association between patient characteristics and mortality. Statistical significance was assessed using chi-square tests and Fisher's exact test for categorical variables. Differences between continuous (normally distributed) variables were analyzed using an independent sample t-test. A variable was considered statistically significant if the *p*-value was < 0.05.

Factors associated with mortality in bivariate analysis with a *p*-value < 0.1 were entered in the multivariable logistic regression model to identify and quantify predictors of deaths while controlling for potential confounders. Crude and adjusted odds ratio with 95% confidence intervals were calculated and factors with *P*-value < 0.05 were considered significant after analysis.

Results

A total of 975 children aged 1–59 months were admitted during the study period. Out of that 925(94.9%) children participated in the study. A total of 50 (5.1%) children were excluded as indicated in the study flow diagram (Fig. 1).

Baseline characteristics of study participants

The median age (Interquartile range) of participants was 13 (20) months. In Table 1, nearly half of all participants 46.8% (433) were infants. Male children accounted for 59.2% (548) of the study population. Fathers were the main source of income in most of the families 72.9% (674) and a little over a third 39.6% (366) of the caregivers had primary education followed by a quarter with secondary 25.3% (234) and a college level of education 26.9% (249) while only 8.2% (76) had no formal education. One out of three of the caregivers was a petty trader 36.6% (339) or employed 31.8% (294). Only a quarter of the children 27.1%; (251) had health insurance. Half of the admissions were referred from district hospitals 50.9% (471), and one-third from home 35.6% (329).

Admission diagnosis, and causes of mortality

Most patients had more than one admission diagnosis, the reported admission diagnoses included pneumonia

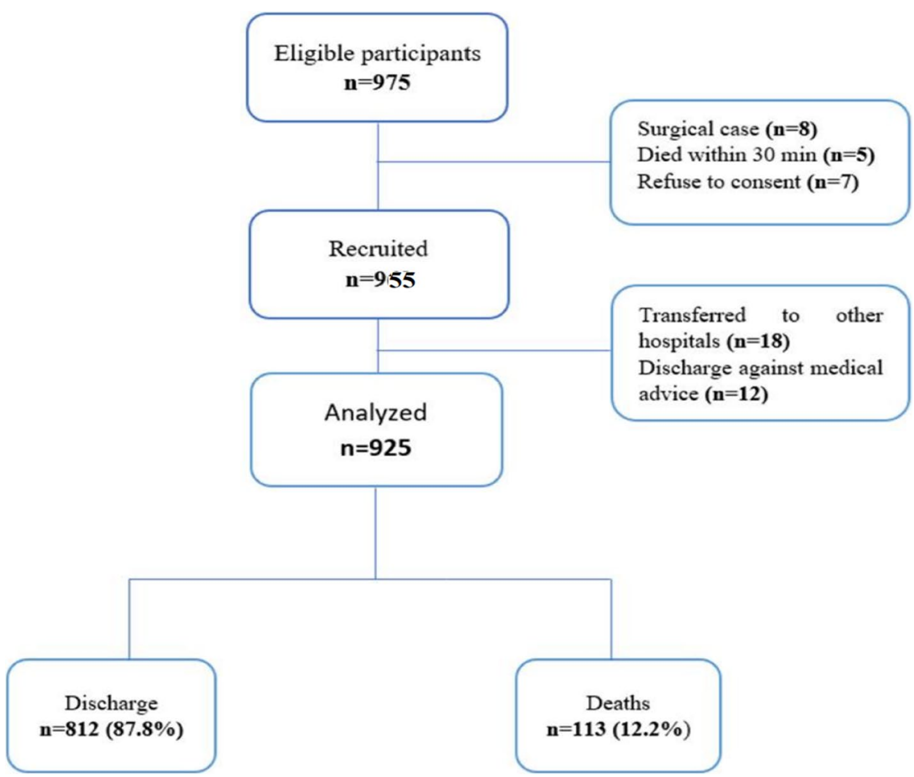

Fig. 1 Flow chart showing enrollment of study participants

Table 1 Baseline and socio-demographic characteristics of study participants

Variables	Categories	n (%)
Age of the children (months)	Median (IQR)	13 (20)
	1–11	433 (46.8)
	12–23	233 (25.2)
	24–59	259 (28.0)
Sex of participant		
	Male	548 (59.2)
	Female	377 (40.8)
Primary caregiver		
	Father	674 (72.9)
	Mother	173 (18.7)
	Others	78 (8.4)
Maternal age (years)		
	< 20	57 (6.2)
	20–34	668 (72.6)
	≥ 35	195 (21.2)
Education level		
	No formal education	76 (8.2)
	Primary	366 (39.6)
	Secondary	234 (25.3)
	College level	249 (26.9)
Occupation of caregiver		
	Employed	294 (31.8)
	Peasant	109 (11.8)
	Petty trader	339 (36.6)
	Unemployed	183 (19.8)
Health insurance		
	Insured	251 (27.1)
	Not insured	674 (72.9)
Origin of referral		
	Home	329 (35.6)
	District Facility	471 (50.9)
	Private facility	81 (8.8)
	Other health facilities	44 (4.8)
Wealth index (quintiles)		
	Lowest (poor)	184 (19.9)
	Second	186 (20.1)
	Middle	184 (19.9)
	Fourth	207 (22.4)
	Highest (rich)	164 (17.7)

28% (260), septicemia 25% (228), malnutrition 23% (211), and gastroenteritis 17% (152), Fig. 2. Immediate causes of death in this study were septicemia (26%), pneumonia (12%), heart failure (10%), multi-organ failure (8%), and hypoglycemia (6%), Fig. 3. The most commonly reported underlying causes of death were septicemia (27%), malnutrition (12%), congenital heart disease (12%), pneumonia (11%), and HIV (9%) as shown in Fig. 4. Among children who died 75.2% (85/113) had multiple diagnoses, the predominant co-morbid conditions were malnutrition (39%; 33/85), anemia (38%; 32/85), septicemia (24%; 20/85) and gastroenteritis (22%; 19/85) as shown in Fig. 5.

Mortality and associated factors

The overall mortality rate was 12.2% (113/725), and most deaths 66.4% (75/113) occurred during the night shift. As indicated in Fig. 6, in all age groups, mortality was high in the first 25 days of admission, and more deaths were observed in children aged less than two years as compared to those aged above two years (13.9% vs 8.7%) but this difference was not statistically significant ($p = 0.059$). No difference was noted in mortality between females and males (13.8% vs 11.1%, $p = 0.220$). Mortality was higher for children admitted from district hospitals and homes, and in the first 10 days of admission mortality rate was higher for children from district hospitals ($p = 0.003$).

Socio-demographic factors

Children whose caregivers had higher level of education had lower mortality compared to those with secondary, primary, and no education (8% vs 9.8% vs 14.8% vs 21.1%, $p = 0.005$). There was a trend in the decline of mortality as the level of parent education increased ($p < 0.001$). We observed that patients with no health insurance had significantly higher mortality compared to those with health insurance (14.4% vs. 6.4% $p = 0.001$). More deaths were observed in children whose caregivers were petty traders (17.7%) compared to the peasant (11%), unemployed (9.4%), and employed (8.4%) caregivers and the difference was statistically significant ($p = 0.001$). Children from households in the lowest, second, and middle wealth quintiles had more deaths compared to the highest wealth quintiles (15.8%, 18.8%, and 13.0%, respectively vs. 3.7%; $p < 0.001$). Deaths decreased with an increase in household wealth (p for trend < 0.001), Table 2.

Clinical and laboratory factors

Children referred from district hospitals had significantly higher mortality (16.1%) compared to admissions from home (8.2%), private hospitals (7.4%), and other health facilities (9.1%) ($p = 003$). More deaths occurred on weekends compared to weekdays (19.4% vs. 10.4%; $p = 0.001$) and the risk of death was highest within 24 h of hospital stay ($p < 0.001$). Clinical features associated with mortality in the bivariate analysis were convulsions ($p = 0.015$), unconsciousness ($p < 0.001$), lethargy ($p < 0.001$),), diarrhoea ($p = 0.001$), inability to feed or breastfeed ($p = 0.001$), respiratory distress ($p = < 0.001$) and HIV

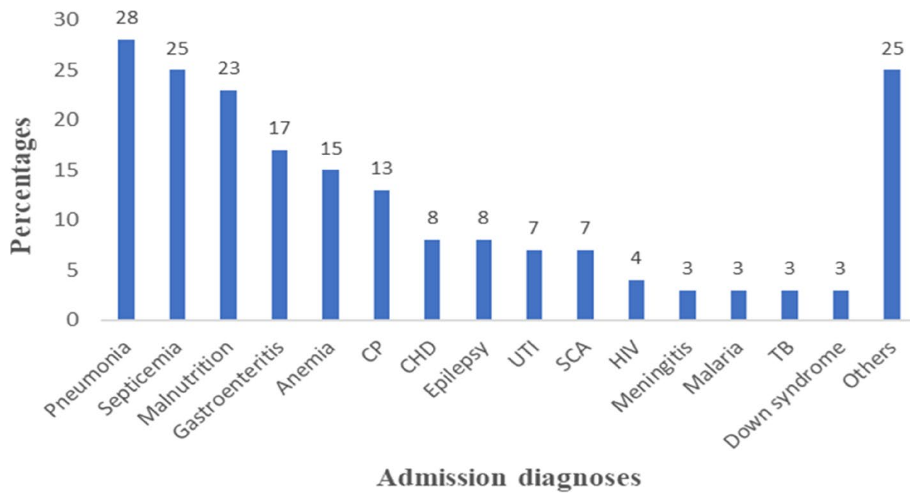

Fig. 2 Admission diagnosis of study participants. CHD: Congenital heart disease, CP: Cerebral palsy, HIV: Human Immunodeficiency Virus, SCA: Sickle cell disease, TB: Tuberculosis, UTI: Urinary tract infection

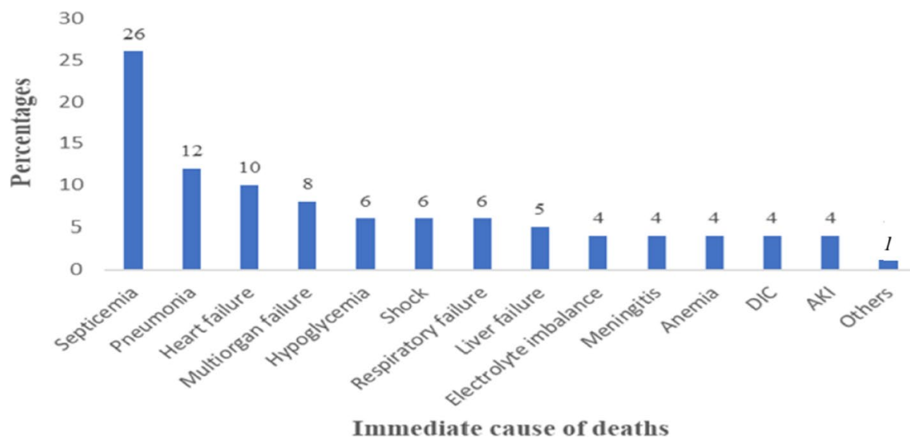

Fig. 3 Immediate causes of deaths. AKI: Acute kidney injury, DIC: Disseminated intravascular coagulopathy

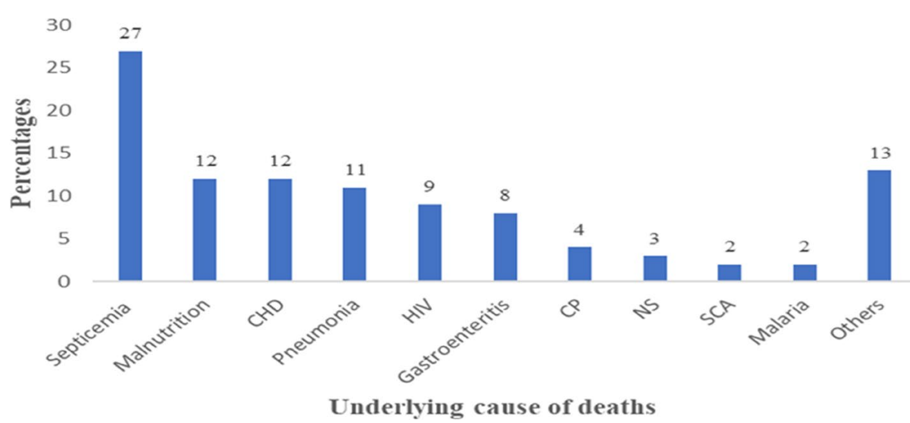

Fig. 4 Underlying causes of deaths among study participants. CHD: congenital heart disease, CP: cerebral palsy, HIV: Human Immunodeficiency Virus, NS: nephrotic syndrome, SCA: sickle cell anaemia

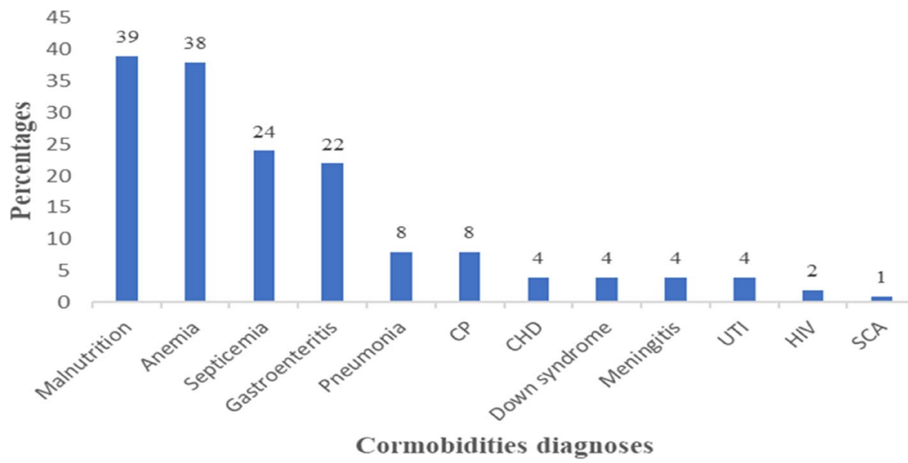

Fig. 5 Co-morbidity conditions among study participants who died with multiple diagnoses

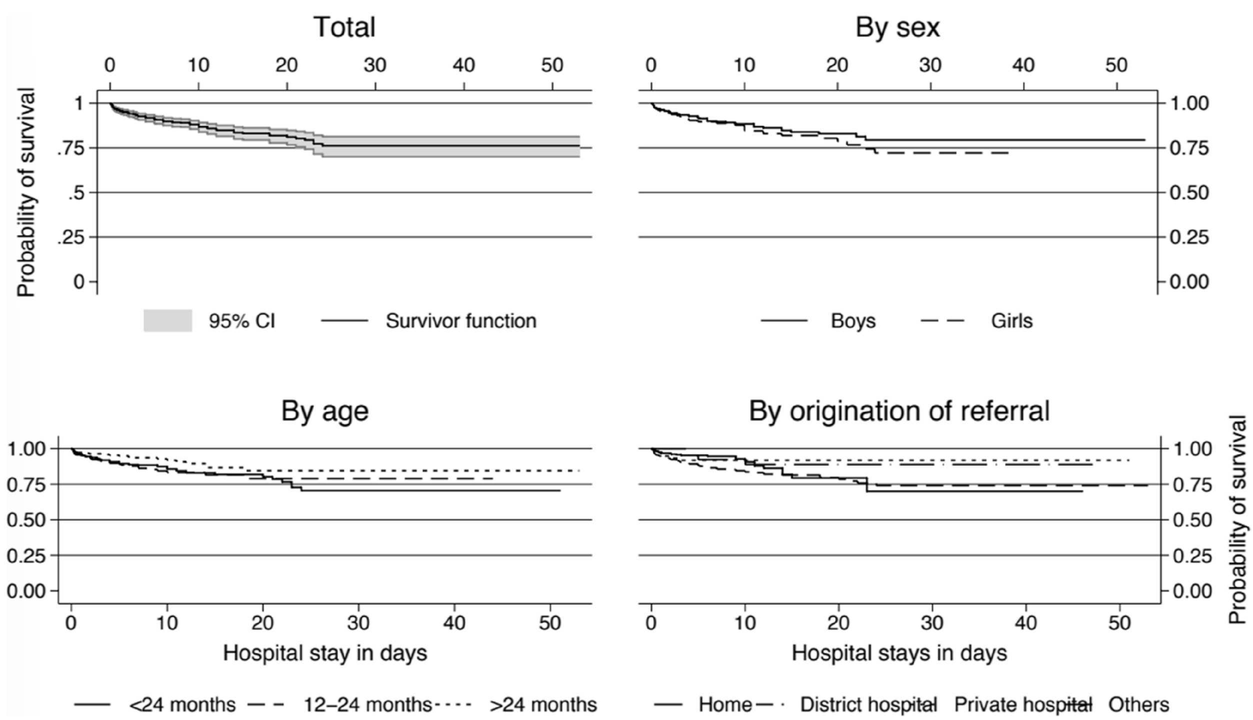

Fig. 6 Kaplan Meir Survival estimates for study participants

infection or exposure ($p = 0.001$). Children with severe wasting had higher mortality compared to those with moderate wasting and mild or normal nutritional status (24.4% vs. 10.8% vs. 9.0; $p = < 0.001$), Table 3.

Children with very severe anaemia (18.2%), severe anaemia (16.2%) and moderate anaemia (15.8%) had higher mortality compared to children with mild or no anaemia (8.5%) ($p = 0.007$). More deaths were observed in children with leucopenia (20.0%) and leukocytosis (14.9%) compared to those with normal white cell count (7.9%) ($p = 0.002$). More deaths were noted among children with high serum creatinine compared to those with normal values (45.2% vs. 12.5%; $p < 0.001$). Children with hypernatremia ($p < 0.001$) and hypokalemia ($p < 0.001$) were noted to have higher deaths, Table 4.

Table 2 Socio-demographic characteristics associated with mortality among study participants

Variables	Death n (%)	Survival n (%)	*P*-value
Age (months)			
01–11	60 (13.9)	373 (86.1)	
12–23	32 (13.7)	201 (86.3)	
24–59	21 (8.7)	238 (91.9)	0.059
Sex			
Male	61 (11.1)	487 (88.9)	
Female	52 (13.8)	325 (86.2)	0.220
Caregiver			
Father	86 (12.8)	588 (87.2)	
Mother	22 (12.7)	151 (87.3)	
Others	5 (6.4)	73 (93.6)	0.270
Maternal age			
< 20	7 (12.3)	50 (87.7)	
20–34	90 (13.5)	578 (86.5)	
≥ 35	16 (8.2)	179 (91.8)	0.143
Education level			
No formal education	16 (21.1)	60 (78.9)	
Primary	54 (14.8)	312 (85.2)	
Secondary	23 (9.8)	211 (90.2)	
College/ University	20 (8.0)	299 (92.0)	0.005
Occupation of caregiver			
Employed	24 (8.4)	270 (91.8)	
Peasant	12 (11.0)	97 (89.0)	
Petty trader	60 (17.7)	279 (82.3)	
Unemployed	17 (9.3)	166 (90.7)	0.001
Health insurance			
Insured	16 (6.4)	235 (93.6)	
No insurance	97 (14.4)	577 (85.6)	0.001
Wealth quintiles			
Lowest (poorest)	29 (15.8)	155 (84.2)	
Second	35 (18.8)	151 (81.2)	
Middle	24 (13.0)	160 (87.0)	
Fourth	19 (9.2)	188 (90.8)	
Highest (Richest)	6 (3.7)	158 (96.3)	< 0.001

Independent risk factors for mortality

Table 5 describes the Multivariable logistic regression model for independent factors for mortality among study participants, household wealth, duration of hospital stay, clinical characteristics, nutritional status, and HIV status were noted to be independent factors for mortality. Children from households with a low income had a 4–sixfold increase in the risk of dying compared to children from households in the highest wealth quintile. Clinical characteristic that significantly predict mortality were unconsciousness (AOR = 19.3; 95%CI: 5.58–63.03),

Table 3 Clinical characteristics associated with mortality among study participants

Clinical characteristics	Death n (%)	Survival n (%)	*P*-value
Origin of referral			
Home	27 (8.2)	302 (91.8)	
District hospital	76 (16.1)	395 (83.9)	
Private hospital	6 (7.4)	75 (92.6)	
Other health facilities	4 (9.1)	40 (90.9)	0.003*
Day of death occurrence			
Weekdays	76 (10.4)	658 (88.6)	
Weekends	37 (19.4)	154 (80.6)	0.001
Duration of hospital stay (hours)			
< 24	36 (38.7)	57 (61.3)	
24–72	24 (16.8)	119 (83.2)	
> 72	53 (7.7)	636 (92.3)	< 0.001
Clinical features			
Convulsion			
Yes	33 (17.4)	157 (82.6)	
No	80 (10.9)	655 (89.1)	0.015
Unconscious			
Yes	18 (64.3)	10 (35.7)	
No	95 (9.5)	651 (90.3)	< 0.001
Lethargy			
Yes	26 (38.8)	41 (61.2)	
No	87 (10.7)	771 (89.9)	< 0.001
Cough			
Yes	29 (9.7)	270 (90.3)	
No	84 (13.4)	542 (86.6)	0.100
Diarrhoea			
Yes	33 (22.8)	112 (17.2)	
No	80 (10.3)	70 (89.7)	< 0.001
Vomiting			
Yes	19 (12.8)	129 (87.2)	
No	94 (12.1)	683 (87.9)	0.800
Inability to feed			
Yes	9 (33.3)	18 (66.7)	
No	104 (11.6)	794 (88.4)	0.001
Respiratory distress			
Yes	35 (26.9)	95 (73.1)	
No	78 (9.8)	717 (90.2)	< 0.001
Fever (temperature)			
< 37.5⁰C	55 (10.5)	468 (89.5)	
> 37.5⁰C	58 (14.4)	344 (85.6)	0.072
Nutritional status (weight/height)			
Normal	52 (9.0)	525 (91.0)	
Moderate wasting	19 (10.8)	157 (89.6)	
Severe wasting	42 (24.4)	130 (75.6)	< 0.001

* Fisher exact test

Table 4 Biochemical markers associated with mortality among study participants

Biochemical markers	Died n (%)	Survival n (%)	*P* value
Hb (g/dl)			
< 5.0	8 (18.2)	36 (81.8)	
5.0–6.9	18 (16.2)	86 (82.7)	
7.0–9.0	41 (16.3)	210 (83.7)	
9.1–11.0	31 (9.9)	282 (90.1)	
> 11.0	8 (5.9)	127 (94.1)	0.007
WBC ($\times 10^3$/l)			
< 4	7 (20.0)	28 (80.0)	
4–11	30 (7.8)	355 (92.2)	
> 11	67 (14.9)	383 (85.1)	0.002
Platelets ($\times 10^3$/l)			
< 150	35 (16.7)	175 (83.3)	
150–450	52 (10.7)	435 (89.3)	
> 450	17 (9.8)	156 (90.2)	0.052
Serum creatinine (mmol/l)			
< 88	50 (12.5)	351 (87.5)	
> 88	14 (45.2)	17 (54.8)	< 0.001
CRP (mg/l)			
< 10	26 (8.20	290 (91.8)	
> 10	38 (13.0)	254 (87.0)	0.055
Serum sodium (mmol/l)			
< 125	14 (33.3)	28 (66.7)	
125–135	39 (16.2)	201 (83.8)	
136–145	28 (10.3)	245 (89.7)	
> 145	5 (38.8)	8 (61.5)	< 0.001
Serum Potassium (mmol/l)			
< 2.5	25 (52.1)	23 (47.9)	
2.5–3.5	11 (9.6)	104 (90.4)	
3.5–5.0	41 (12.7)	282 (87.3)	
> 5.0	7 (9.2)	69 (90.8)	< 0.001
Blood culture			
Gram positive cocci	6 (9.7)	56 (90.3)	
Gram negative bacilli	2 (14.2)	12 (85.7)	
No growth	26 (20.2)	103 (98.8)	0.200*

Hb Hemoglobin, *WBC* White blood cell count, *CRP* C-reactive protein

* Fisher's exact test

inability to feed (AOR = 5.9; 95%CI: 1.99–17.87), lethargy (AOR = 5.5; 955%CI: 2.50–11.95), severe wasting (AOR = 4, 95%CI: 2.15–7.38), HIV infection or exposure (AOR = 3.5, 95%CI: 1.47–8.47), respiratory distress (AOR = 2.5; 95%CI: 1.33–4.84) and diarrhoea (AOR = 1.9; 95%CI: 1.04–3.62). There was an eight-fold high risk of dying within 24 h for admitted children (AOR = 7.9; CI: 4.05–15.25). Children who were severely wasted had four-fold odds (AOR = 4.5, 95%CI: 2.49 – 8.10) of death compared to children categorized as having normal nutritional status ($p < 0.001$).

Table 5 Multivariable logistic regression of mortality in relation to socio-demographic and clinical characteristics among study participants

Variables	Crude OR (95%CI)	Adjusted OR (95%CI)	*P*-value
Sex			
Male	1.0	1.0	
Female	1.28 (0.86–1.90)	1.10 (0.67–1.82)	0.698
Age (months)			
1–11	1.8 (1.08–3.08)	2.1 (1.03–4.19)	0.042
12–23	1.8 (1.01–3.23)	1.9 (0.91–4.07)	0.089
24–59	1.0	1.0	
Level of education of caregivers			
No formal education	3.05 (1.50–6.25)	1.27 (0.38–4.22)	0.695
Primary	1.98 (1.15–3.40)	0.84 (0.33–2.10)	0.704
Secondary	1.25 (0.67–2.34)	0.66 (0.28–1.55)	0.338
Higher level	1.0	1.0	
Occupation of caregiver			
Employed	1.0	1.0	
Peasant	1.39 (0.67–2.89)	0.53 (0.17–1.60)	0.258
Petty trader	2.42 (1.46–3.99)	1.26 (0.59–2.68)	0.550
Unemployed	1.15 (0.60–2.21)	0.69 (0.27–1.74)	0.430
Health insurance			
Yes	1.0	1.0	
No	2.47 (1.42–4.29)	1.40 (0.65–2.98)	0.389
Wealth quintiles			
Lowest (poorest)	4.9 (1.99–12.20)	4.0 (1.19–13.51)	0.025
Second	6.1 (2.50–14-93)	5.2 (1.65–16.69)	0.005
Middle	4.0 (1.57–9.92)	3.6 (1.14–11.33)	0.029
Fourth	2.7 (1.04–6.83)	2.4 (0.82–7.16)	0.111
Highest (richest)	1.0	1.0	
Origin of referral			
Home	1.0	1.0	
District hospitals	2.15 (1.35–3.42)	1.3 (0.69–2.25)	0.424
Private	0.89 (0.36–2.25)	1.3 (0.42–3.81)	0.680
Others	1.19 (0.37–3.36)	1.4 (0.40–5.07)	0.580
Day of death occurrence			
Weekdays	1.0	1.0	
Weekends	2.1 (1.35–3.20)	1.9 (1.07–3.30)	0.028
Hospital stay (hours)			
< 24	7.6 (4.58–12.52)	7.9 (4.05–15.25)	< 0.001
24–72	4.1 (2.06–8.06)	3.7 (1.95–7.18)	< 0.001
> 72	1.0	1.0	
Clinical features, (%Yes)			
Inability to feed	3.8 (1.67–8.70)	5.7 (1.97–16.51)	0.001
Respiratory distress	3.4 (2.15–5.23)	2.6 (1.40–4.97)	0.003
Convulsion	1.72 (1.11–2.67)	0.9 (0.44–1.79)	0.728
Lethargy	5.6 (3.20–9.64)	4.9 (2.32–10.40)	< 0.001
Diarrhea	2.6 (1.64–4.05)	1.7 (0.89–3.07)	0.108
Unconscious	15.2 (6.8–33.9)	18 (6.70–56.82)	< 0.001

Table 5 (continued)

Variables	Crude OR (95%CI)	Adjusted OR (95%CI)	*P*-value
Fever	1.43 (0.90–2.10)	1.4 (0.80–2.27)	0.258
Cough	0.7 (0.44–1.08)	0.6 (0.35–1.15)	0.135
Nutritional status			
Normal	1.0	1.0	
Moderate wasting	1.22 (0.70–2.12)	1.6 (0.78–3.14)	0.210
Severe wasting	3.26 (2.08–5.11)	4.5 (2.49–8.10)	< 0.001

Discussion

This study was conducted to determine mortality among under-five admitted in the paediatric wards at Muhimbili National Hospital and 925 children were followed from admission to discharge between October 2017 and April 2018. The predominant admission diagnoses in this study were pneumonia, septicaemia, malnutrition, and gastroenteritis, which are among the reported leading causes of under-five mortality in sub-Saharan Africa and globally [4, 11, 12]. A high mortality of 12.2% was noted in this study and several clinical and socio-demographic factors were noted to influence mortality.

Highest mortality was noted within 24 h of admission, in this study, this is consistent with reports by Samantha et al. and Remtullah et al. in studies conducted at Muhimbili National Hospital in South Africa and Tanzania respectively [4, 5, 13]. More than half of the children in this study were referred from district hospitals, reflecting a critical state at the time of referral which could have contributed to high mortality within 24 h. This finding highlights the need to build capacity at the primary level facility in managing critically ill children and ensuring timely referral to high-level facilities.

The risk of death among admitted children was two folds during the weekends as compared to weekdays, the weekend effect on mortality has been widely investigated globally and patients admitted on weekends have been reported to have higher mortality [14, 15]. Barwise-Munro et al. did not observe a difference in mortality among children admitted during weekends as compared to weekdays [16]. In a systematic review and meta-analysis by Honeyford et al., the weekend effect was noted with more than half of all included 43 articles indicating worse outcome for patients who were either undergoing surgery or admitted on weekend [17]. Our study focused on the day of occurrence of deaths, the effect noted in our study may be attributed to various factors including low staffing during weekends leading to inadequate monitoring of critically ill children and limiting other vital services including laboratory services [18]. This observation calls for the assessment and reorganization of services during weekends in our setting.

Severely ill children which were characterized by an inability to feed, altered level of consciousness, severely wasted and inability to feed increased the likelihood of dying in this study, this is consistent with other reports of under-five mortality in the region [15, 19]. Caring for critically ill children is challenging in many resource-limited setting and high mortality among these children is contributed by inadequate facilities. A study which was conducted at this hospital revealed limitations in the form of trained healthcare providers, equipment, and guidelines to support the care of these children [5].

Education of parents and guardians is reported to be an important factor in under-five mortality and several studies have shown lower mortality with high education [20, 21], this was also noted in our study in which parents with high education had lower mortality. Parents with high education are more likely to have high incomes and also they are likely to utilize health interventions for protecting children. In this study also children who were from wealthier households were less likely to die.

Children with health insurance have improved access to care, and in this study, these children were two times less likely to die as compared to those without. In Tanzania, children can be insured by paying the equivalent of 20 US dollars. The country is also in the process of adopting universal health coverage through the universal health coverage legislature. This process will possibly improve access to care and is expected to reduce under-five mortality [22].

Strengths and limitations

The cohort study design enabled the determination of predictors of mortality in this study, and the cause of death collected in this study was obtained from mortality audit meetings and not taken from the death certification which is provided by different clinicians and might result in inter-observer bias.

Limitations in this study include the exclusion of patients who died within 30 min of admission, which may have resulted in an underestimation of the mortality rate, and the challenge of accurately identifying the primary cause of death for children with multiple diagnoses.

Conclusion

High under-five mortality which was associated with critical illness, caregiver education and employment, household wealth, and having health insurance was noted in the present study. Concerted efforts are required to address this high mortality including focusing on enhanced monitoring of patients within 24 h of admission. Increasing coverage of health insurance will improve access to care and timely health-seeking behaviour. There is a need for further study to explore in-depth factors which were associated with under-five mortality.

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Authors' contributions
DD, FF, and GL designed the study. DD carried out data collection, analysis and wrote the initial report, FF participated in the initial report writing. FF and DD contributed equally to this work and are joint first authors. GL assisted in data analysis and critically reviewed the manuscript. All authors have read and approved this manuscript.

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Availability of data and material
Materials analysed for this study will be provided upon reasonable request to the corresponding author.

Declarations

Ethics approval and consent to participate
This study was approved by Muhimbili University of Health and Allied Sciences Institutional Review Board and permission to conduct this study at Muhimbili National Hospital was granted by hospital management. Parents/guradians of children were requested to consent for this study by signing written forms prior to recruitment of their children.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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