World Journal of Pediatric Surgery

Factors associated with mortality in congenital malformations of the gastrointestinal tract in a tertiary center in Senegal

Florent Tshibwid A Zeng ,[1] Papa Alassane Mbaye,[1] Doudou Gueye,[1] Ndèye Fatou Seck,[1] Ibrahima Bocar Wellé,[1] Rosalie Niang,[1] Youssouph Diedhiou,[1] Mbaye Fall,[2] Ndèye Aby Ndoye,[1] Aloïse Sagna,[1] Oumar Ndour,[2] Gabriel Ngom[1]

To cite: Zeng FTA, Mbaye PA, Gueye D, *et al*. Factors associated with mortality in congenital malformations of the gastrointestinal tract in a tertiary center in Senegal. *World Jnl Ped Surgery* 2023;**6**:e000463. doi:10.1136/wjps-2022-000463

Received 16 June 2022
Accepted 5 January 2023

[1]Department of Pediatric Surgery, Albert Royer National Children's Hospital Center, Université Cheikh Anta Diop Faculté de Medecine Pharmacie d'Odonto-Stomatologie, Dakar, Senegal
[2]Department of Pediatric Surgery, Aristide Le Dantec University Teaching Hospital, Université Cheikh Anta Diop Faculté de Medecine Pharmacie d'Odonto-Stomatologie, Dakar, Senegal

Correspondence to
Dr Florent Tshibwid A Zeng; tshibwidflo@gmail.com

ABSTRACT

Objective Patients with congenital malformations (CMs) of the gastrointestinal tract (GIT) have a very high mortality. However, the literature on the factors associated with mortality in these patients is scarce in sub-Saharan Africa. The aim of this study is to identify independent risk factors for mortality in patients with CMs of the GIT at our pediatric surgical department.

Methods We conducted a retrospective analysis of cases with CMs of the GIT managed at a tertiary center from 2018 to 2021. Patients were subdivided into two groups based on the outcomes, and variables with a significant difference were analyzed by logistic regression.

Results Our review included 226 patients, 63 of whom died (27.88%). Patient age ranged from 0 to 15 years. Taking into account statistical significance, mortality was more frequent in neonates than in older patients (57.30% vs 6.15%), in patients coming out of the Dakar area than in those from the Dakar area (43.75% vs 19.18%), in patients with abnormal prenatal ultrasound than in those with normal ultrasound (100% vs 26.67%), in premature children than in those born at term (78.57% vs 21.87%), in patients with an additional malformation than in those with an isolated malformation (69.23% vs 25.35%), and in those with intestinal, esophageal, duodenal and colonic atresia than in those with other diagnoses (100%, 89%, 56.25% and 50%, respectively). Referred patients died more than those who changed hospitals or came from home (55.29% vs 25% and 9.09%, respectively). On multivariable logistic regression, two independent factors of mortality were identified: presence of associated malformation [odds ratio (OR)=13.299; 95% Confidence interval (CI) 1.370 to 129.137] and diagnosis of esophageal atresia (OR=46.529; 95% CI 5.828 to 371.425).

Conclusion The presence of an associated malformation or diagnosis of esophageal atresia increases mortality in patients with CMs of the GIT in our environment.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Perioperative mortality of congenital gastrointestinal malformation is very high in low and middle-income countries. However, local studies of its risk factors are scarce.

WHAT THIS STUDY ADDS

⇒ In Senegalese children, esophageal atresia and associated malformation multiply the risk of mortality in congenital gastrointestinal malformations by 46 and 13, respectively.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Early diagnosis and management of esophageal atresia and management of polymalformation in well-equipped neonatal intensive care units should be attempted.

INTRODUCTION

Congenital malformations (CMs) represent a large burden of pediatric surgical disease in African tertiary centers.[1 2] CMs are the third leading cause of death among children aged less than 5 years worldwide.[3] Malformations of the gastrointestinal tract (GIT) are the third most common CM.[4] In high-income countries (HICs), these malformations are more frequently diagnosed prenatally or during the neonatal period with early management in dedicated centers and with improved survival during the last decades.[5 6] However, prenatal diagnosis of GIT malformations is rare in low and middle-income countries (LMICs).[5 6] Postnatal diagnosis is often delayed, and the resulting mortality is very high compared with HICs.[6]

The global mortality of CMs of the GIT in LMICs is 39.8%, while it is only 5.6% in HICs.[6] However, some conditions have a very high contrast in mortality rate. This is the case for esophageal atresia (EA), for which mortality is 85.7% in LMICs versus 7.2% in HICs.[6] Many reasons have been advocated to justify this difference. However, in sub-Saharan Africa, studies on risk factors for mortality from GIT malformations are scarce.[7] In Senegal, the

Table 1 Characteristics of patients by survival status and analysis of differences

	All patients (n=226)	Mortality		P value
		Yes (n=63)	No (n=163)	
Neonate				**< 0.001***
Yes	96	55 (57.3)	41 (42.7)	
No	130	8 (6.15)	122 (93.85)	
Sex				0.449*
Males	136	37 (27.21)	99 (72.79)	
Females	90	26 (28.89)	64 (71.11)	
Origin				**< 0.001***
Dakar	146	28 (19.18)	118 (80.82)	
Other	80	35 (43.75)	45 (56.25)	
Prenatal ultrasound				**0.002†**
Abnormal	6	6 (100)	0	
Not done	9	4 (44.44)	5 (55.56)	
Normal	30	8 (26.67)	22 (73.33)	
Not reported	181	45 (24.84)	136 (75.14)	
Gestational age at birth				**0.002†**
Prematurity	14	11 (78.57)	3 (21.43)	
Postmaturity	2	1 (50)	1 (50)	
Not reported	178	44 (24.72)	134 (75.28)	
Normal	32	7 (21.87)	25 (78.13)	
Associated malformation				**0.002‡**
Yes	13	9 (69.23)	4 (30.77)	
No	213	54 (25.35)	159 (74.65)	
Diagnosis				**< 0.001†**
Intestinal atresia	5	5 (100)	0	
Esophageal atresia	37	33 (89.19)	4 (10.81)	
Duodenal atresia	16	9 (56.25)	7 (43.75)	
Colonic atresia	2	1 (50)	1 (50)	
Anorectal malformation	69	9 (13.04)	60 (86.96)	
Malrotation	29	3 (13.04)	26 (86.96)	
Hirschsprung's disease	64	3 (4.69)	61 (95.31)	
Congenital esophageal stenosis	4	0	4 (100)	
Year of admission				0.064*
2018	53	9 (16.98)	44 (83.02)	
2019	72	19 (26.39)	53 (73.61)	
2020	101	35 (34.65)	66 (65.35)	
Mode of admission				**< 0.001***
Referral	45	47 (55.29)	38 (44.71)	
Mutation	20	5 (25)	15 (75)	
Home	121	11 (9.09)	110 (90.91)	
Parental consanguinity				0.098*
Yes	21	9 (42.86)	12 (57.14)	
No	64	21 (32.81)	43 (67.19)	
Not reported	141	33 (23.4)	108 (76.6)	

Bold denotes statistically significant difference.
Data were presented as number (percentage).
*Pearson's χ^2 test.
†Monte Carlo's exact test.
‡Fisher's exact test.

Table 2 Logistic regression analysis for risk factors of mortality in patients with CMs of the GIT

Variable	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Neonate				
No	Ref		Ref	
Yes	20.457 (8.995 to 46.528)	< 0.001*	1.353 (0.340 to 5.382)	0.668
Dakar				
Yes	Ref		Ref	
No	3.278 (1.792 to 5.997)	< 0.001*	2.347 (0.820 to 6.717)	0.112
Prenatal ultrasound				
Not reported	Ref		Ref	
Normal	1.099 (0.457 to 2.641)	0.833	0.713 (0.045 to 11.401)	0.811
Abnormal	4.8E9 (0.000)	0.999	6.580E9 (0.000)	0.999
Not done	2.418 (0.622 to 9.395)	0.202	1.237 (0.132 to 11.639)	0.852
Gestational age at birth				
Normal	Ref			
Prematurity	13.095 (2.844 to 60.303)	0.001*	17.151 (0.946 to 310.999)	0.055
Postmaturity	3.571 (0.197 to 64.632)	0.389	1.420 (0.005 to 427.706)	0.904
Not reported	1.173 (0.475 to 2.898)	0.730	5.208 (0.300 to 90.537)	0.257
Associated malformation				
No	Ref		Ref	
Yes	6.625 (1.961 to 22.386)	0.002*	**13.299 (1.370 to 129.137)**	**0.026**
Hirschsprung's disease				
No	Ref			
Yes	0.084 (0.025 to 0.278)	< 0.001*	0.881 (0.133 to 5.831)	0.896
CES				
No	Ref			
Yes	0.999 (0.000)	< 0.001*	0.000 (0.000)	0.999
Anorectal malformation				
No	Ref			
Yes	0.286 (0.132 to 0.620)	0.002*	1.238 (0.240 to 6.387)	0.798
Duodenal atresia				
No	Ref			
Yes	3.714 (1.319 to 10.457)	0.013*	3.274 (0.446 to 24.028)	0.243
Intestinal atresia				
No	Ref			
Yes	45E7 (0.000)	0.999	66E8 (0.000)	0.999
Colonic atresia				
No				
Yes	2.613 (0.161 to 42.423)	0.499	7.689 (0.179 to 329.362)	0.287
Malrotation				
No				
Yes	0.263 (0.077 to 0.904)	0.034*	1.003 (0.101 to 5.342)	0.920
Esophageal atresia				
No				
Yes	43.725 (14.430 to 132.491)	< 0.001*	**46.529 (5.828 to 371.425)**	**< 0.001**
Admission mode				
Home	Ref			

Continued

Table 2 Continued

Variable	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Referral	12.368 (5.825 to 26.262)	< 0.001*	3.387 (0.858 to 13.369)	0.082
Mutation	3.333 (1.017 to 10.922)	0.047*	0.866 (0.115 to 6.544)	0.899

*Statistically significant on unadjusted (univariate) logistic regression. Bold denotes statistically significant on adjusted (multivariate) logistic regression.
CES, congenital esophageal stenosis; CI, confidence interval; OR, odds ratio; Ref, reference.

mortality of several GIT malformations was reported to be very high.[8–12] We assume that the identification of independent factors of mortality in patients with CMs of the GIT will allow a better understanding of mortality in this group of children and therefore lead to the improvement of care for better survival. With this review, our aim was to identify risk factors for mortality in patients with CMs of the GIT admitted at our University Teaching Hospital (UTH), Albert Royer National Children's Hospital Center in Dakar, the capital city of Senegal.

METHODS

Study design

We conducted a retrospective review at the pediatric surgery department of our UTH, Albert Royer National Children's Hospital Center in Dakar, Senegal. With two other tertiary hospitals, our department is the main pediatric surgical unit of Senegal, providing surgical care to Senegalese children, as well as those from neighboring countries (Gambia, Guinea and Mauritania).

Study participants

We considered patients admitted for CM of the GIT between 1 January 2018 and 1 January 2021. Patients whose medical records could not be retrieved or were referred to another hospital for management were excluded from this review. Patients' medical records were retrieved from patients' medical files, operating room registers, and the hospital's informatics services.

Collected data were sociodemographic (age at diagnosis, sex, geographic origin), diagnostic (prenatal ultrasound (US), gestational age at birth, type of CM of the GIT), and associated malformation, which was defined as presence of additional malformation to the digestive one. In case the associated malformation is digestive too, the most life threatening was considered as the diagnosed malformation, and the less threatening malformation is considered as the associated malformation or outcome (mortality). They were first registered on a predesigned printed sheet before being encoded using an Excel spreadsheet (Microsoft Office 2019).

Among the 242 patients, 16 were excluded from the present study: 10 due to lack of pathology results in suspected Hirschsprung's disease (HD), 5 for missing information about patients' age at diagnosis, sex and outcome, and 1 for missing information about the patient's sex.

Statistical analysis

Patients were divided into two groups according to the outcome: mortality and survival group. Qualitative data were expressed as frequencies when the mean and Standard deviation (SD) were calculated for quantitative data. Differences between the two groups were analyzed for significance using Pearson's χ^2 test, Monte Carlo's exact test or Fisher's exact test. Statistically significant variables were analyzed in logistic regression model with unadjusted and adjusted odds ratios (ORs) calculated. The level of significance was set at p value <0.05. Data were analyzed with SPSS V.26.0 (IBM SPSS Statistics V.26). Factors studied included being a neonate, originating out of Dakar, having abnormal prenatal US, prematurity, having an associated malformation, diagnosis, and previously leaving a hospital against medical advice.

RESULTS

From 2018 to 2021, among 3667 patients admitted to our department, 242 had CM of the GIT, implying a frequency of 6.6% at our institution. Among the 242 patients, 16 were excluded from the present study.

In this study, the patients' ages ranged from 0 to 15 years; neonates represented 42.48%, and males represented 60.18%, with a sex ratio of 1.5:1. Concerning the origin of patients, 64.60% of them were from Dakar and its neighborhood. Parental consanguinity status was reported in 85 cases (37.61%), of whom 24.71% of patients were issued from a consanguineous marriage. Status of prenatal US was reported in 19.91% of cases, of which 13.33% were abnormal, 20% were not done and 66.67% were normal. The gestational age at birth was reported in 48 patients (20.24%), of whom 29.17% noted prematurity, 4.17% noted postmaturity, and 66.66% noted normal gestational age at birth. CMs of the GIT were isolated in 94.25% of cases. Malformations encountered included anorectal malformation in 30.53%, HD in 27.88%, EA in 16.37%, malrotation in 12.83%, duodenal atresia (DA) in 7.08%, intestinal atresia in 2.21%, congenital esophageal stenosis in 1.77%, and colonic atresia (CA) in 0.88%. The admission rate progressively increased from 2018 to 2020 with 53, 72, and 101 cases, respectively. A total of 85 patients (37.61%) were referred, 53.54% came from home, and 8.85% changed the hospital based on parental decisions, that is, self-referral.

Among our population study, 63 deaths (27.88%) were registered. Analysis of differences between the mortality

and survival groups showed no significance for sex, parental consanguinity or year of admission. The variables between the two groups that were statistically significant included being a neonate (p < 0.001), geographical origin (p < 0.001), prenatal US status (p = 0.002), gestational age at birth (p = 0.002), presence of an associated malformation (p = 0.002), diagnosis (p < 0.001), and admission mode (p < 0.001). These results are presented in table 1.

Variables that showed a significant difference between the two groups were considered for logistic regression analysis. Unadjusted OR showed significance for being a neonate, originating out of Dakar, prematurity, presence of an associated malformation, and some diagnoses, such as DA, CA and EA, for two admission modes: referral and self-referral. Finally, based on adjusted OR, two variables showed statistically significant differences: the presence of associated malformation increased the risk of mortality by 13 (p = 0.026), while the diagnosis of EA increased the risk of mortality by 46 (p < 0.001), as represented in table 2.

DISCUSSION

Our study retrospectively reviewed 226 cases of CMs of the GIT, of whom approximately a quarter died. This mortality rate is similar to those of other LMICs, as some authors reported mortality ranging from 19.23% to 50%.[6 13–16] This is far less than the approximately 5% mortality rate reported in Western studies.[6] In a recent review, originating from a low-income country was identified as an independent risk factor for mortality in CMs of the GIT, increasing the risk by approximately threefold compared with patients from HICs.[6] Several reasons have been pointed out to explain this difference. These include lack of prenatal diagnosis, unavailability of pediatric anesthesiologists, lack of surgical safety checklists, unavailability of ventilation, and high cost of parenteral nutrition (PN), which makes it unavailable for many patients in need.[6] Other possible factors are delayed referral to tertiary hospitals, inappropriate medical transfer of patients, and inadequate resuscitation during the transfer and on admission at the referral hospital.[7]

We found that EA was independently associated with increased mortality, increasing it by approximately 46 times. In previous studies in Senegal, the mortality of this condition was very high; for example, in previous decades, it was nearly 100%.[17] In the last decade, mortality decreased to 73%–80%,[9 11 17] which is still very high compared with HICs, where mortality reaches 7%.[6] Reasons for this high mortality in our environment were identified by some earlier studies, including lack of prenatal diagnosis, which leads to birth out of tertiary centers, which in turn leads to delayed diagnosis and management, since patients should be referred.[5 11 17 18] Delayed diagnosis exposes newborns to pulmonary compromising due to frequent episodes of choking, which leads to permanent respiratory distress, found in 40% of patients in a local study.[9] The lack of surgical neonatal intensive care units (NICUs), with the hospitalization of newborns in medical NICUs, also increases mortality in our settings.[17 19]

We highlighted that patients with associated malformations had a 13-fold likelihood of death. This may be linked to the severity of associated anomalies, which lead to more complex management, considering the lack of well-equipped NICUs in our context, as well as elsewhere in sub-Saharan Africa.[15 19 20]

Additionally, some factors frequently associated with mortality in several studies were not shown to be independent risk factors for mortality in our review. The first is being neonate. In fact, several authors have reported a higher mortality rate in neonates than in older patients.[14 19] However, another study did not find it to be an independent factor of mortality.[21] A recent Somalian study showed improved neonatal perioperative survival compared with other African settings. However, the highest mortality rate was found in patients with EA.[22] High mortality in neonates should therefore be linked to the diagnosis, delayed presentation, subsequent complications, and lack or underequipment of NICUs.[19 23–25] Second, we did not find the geographical origin of our patient to be an independent predictor of mortality, unlike other authors.[6] This can be explained by the fact that the distance from the tertiary hospital can interact with other factors, such as medical transportation during the referral, quality of resuscitation prior to referral and severity of the diagnosis.

We included 226 patients out of the 242 identified during the study period. First, missing data on prenatal US and gestational age at birth did not allow better analysis of the link between these elements and mortality. Second, data on the condition of referral (medical or not), place of birth (tertiary center or not), need for ventilation (yes vs no), need for PN (yes vs no), qualification of anesthesiologist (resident vs consultant), and qualification of the main surgeon (resident vs consultant) were not analyzed in our review.

In conclusion, our study found that mortality in patients with CMs of the GIT was very high, as in other sub-Saharan tertiary centers. Two factors were independently associated with mortality in Dakar in these conditions: presence of an associated malformation and a diagnosis of EA. Patients with these elements should benefit from specific care from diagnosis to postoperative care. Future multicenter studies on predictors of mortality in EA and polymalformation are encouraged to improve survival in these patients in our milieu.

Twitter Florent Tshibwid A Zeng @TshibwidA and Ndèye Aby Ndoye @Aby NDOYE

Acknowledgements The authors thank Dr Azad Patel for proofreading the manuscript. FTAZ is grateful to Else Kröner-Fresenius-Stiftung, Holger Pöhlmann Stiftung and the NGO Förderverein Uni Kinshasa (fUNIKIN) through the excellence scholarship program 'Bourse d'Excellence Bringmann aux Universités Congolaises, BEBUC', which funds his specialization in pediatric surgery.

Contributors FTAZ: conceptualization, formal analysis, methodology, software, writing—original draft and editing. PAM: data curation, writing—original draft and writing—review. DG: formal analysis and software. NFS: conceptualization,

data curation, methodology and writing—original draft. IBW: data curation, formal analysis and validation. RN: data curation, formal analysis and editing. YD: data curation, formal analysis and software. MF: methodology, validation and writing—review. NAN: conceptualization, validation and writing—review. AS: methodology and writing—review. ON: conceptualization and writing—review. GN: conceptualization, formal analysis, methodology, supervision, validation, writing—review and guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval The ethics committee of our hospital approved our study and waived the consent to publication due to the retrospective aspect of our study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

ORCID iD

Florent Tshibwid A Zeng http://orcid.org/0000-0003-3712-3955

REFERENCES

1 Abdul-Mumin A, Anyomih TTK, Owusu SA, *et al*. Burden of neonatal surgical conditions in northern Ghana. *World J Surg* 2020;44:3–11.
2 Wu VK, Poenaru D, Poley MJ. Burden of surgical congenital anomalies in Kenya: a population-based study. *J Trop Pediatr* 2013;59:195–202.
3 Wright NJ, Anderson JE, Ozgediz D, *et al*. Addressing paediatric surgical care on world birth defects day. *Lancet* 2018;391:1019.
4 Kouame B, N'guetta-Brou I, Kouame GY, *et al*. Epidemiology of congenital abnormalities in West Africa: results of a descriptive study in teaching hospitals in Abidjan: Cote d'Ivoire. *Afr J Paediatr Surg* 2015;12:51–5.
5 Goldenberg RL, Nathan RO, Swanson D, *et al*. Routine antenatal ultrasound in low- and middle-income countries: first look - a cluster randomised trial. *BJOG: Int J Obstet Gy* 2018;125:1591–9.
6 Wright NJ, Leather AJM, Ade-Ajayi N, *et al*. Mortality from gastrointestinal congenital anomalies at 264 hospitals in 74 low-income, middle-income, and high-income countries: a multicentre, international, prospective cohort study. *Lancet* 2021;398:325–39.
7 Chirdan LB, Ngiloi PJ, Elhalaby EA. Neonatal surgery in Africa. *Semin Pediatr Surg* 2012;21:151–9.
8 Ndour O, Bouraima A, Fall AF. Management of intestinal atresia at the aristide le dantec hospital in dakar, senegal: a preliminary study. *Internet J Pediatr Neonatol* 2014;18:1–6. Available: https://www.researchgate.net/publication/303856947_Management_Of_Intestinal_Atresia_At_The_Aristide_Le_Dantec_Hospital_In_Dakar_Senegal_A_Preliminary_Study
9 Fall M, Mbaye PA, Horace HJ, *et al*. Oesophageal atresia: diagnosis and prognosis in Dakar, Senegal. *Afr J Paediatr Surg* 2015;12:187–90.
10 Ndour O, Fall AF, Alumeti D. Facteurs de mortalité néonatale dans le service de chirurgie Pédiatrique du CHU aristide le dantec de dakar. *Mali Médical* 2009;24:33–8. Available: https://www.researchgate.net/publication/285774014_Facteurs_de_mortalite_neonatale_dans_le_service_de_chirurgie_pediatrique_du_CHU_Aristide_Le_Dantec_de_Dakar
11 Traoré M, Ndoye M, Leye P. Esophageal atresia management issues in senegal: mortality is still high. *Anesth Pain Res* 2020;4:1–5.
12 Ilori IU, Ituen AM, Eyo CS. Factors associated with mortality in neonatal surgical emergencies in a developing tertiary hospital in Nigeria. *Open J Pediatr* 2013;03:231–5.
13 Cheung M, Kakembo N, Rizgar N, *et al*. Epidemiology and mortality of pediatric surgical conditions: insights from a tertiary center in Uganda. *Pediatr Surg Int* 2019;35:1279–89.
14 Livingston MH, DCruz J, Pemberton J, *et al*. Mortality of pediatric surgical conditions in low and middle income countries in Africa. *J Pediatr Surg* 2015;50:760–4.
15 Ekenze SO, Ajuzieogu OV, Nwomeh BC. Neonatal surgery in Africa: a systematic review and meta-analysis of challenges of management and outcome. *Lancet* 2015;385 Suppl 2:S35.
16 Bickler SW, Kyambi J, Rode H. Pediatric surgery in sub-Saharan Africa. *Pediatr Surg Int* 2001;17:442–7.
17 Ndoye NA, Sagna A, Traoré MM. Management and prognostic factors of esophageal atresian underequipped facilities: about 93 cases. *Indian J Med Res Pharm Sci* 2017;4:1–5. Available: https://www.academia.edu/32952506/MANAGEMENT_AND_PROGNOSTIC_FACTORS_OF_ESOPHAGEAL_ATRESIAIN_UNDER_EQUIPPED_FACILITIES_ABOUT_93_CASES
18 Hofmeyr GJ. Routine ultrasound examination in early pregnancy: is it worthwhile in low-income countries? *Ultrasound Obstet Gynecol* 2009;34:367–70.
19 Ameh EA, Seyi-Olajide JO, Sholadoye TT. Neonatal surgical care: a review of the burden, progress and challenges in sub-Saharan Africa. *Paediatr Int Child Health* 2015;35:243–51.
20 Toobaie A, Emil S, Ozgediz D, *et al*. Pediatric surgical capacity in Africa: current status and future needs. *J Pediatr Surg* 2017;52:843–8.
21 Drake TM, Fitzgerald JEF, Poenaru D, *et al*. Determinants of morbidity and mortality following emergency abdominal surgery in children in low-income and middle-income countries. *BMJ Glob Health* 2016;1:e000091.
22 Kart Y, Ugur C. Our neonatal surgery experiences in Somalia. *J Indian Assoc Pediatr Surg* 2022;27:153–6.
23 Lindley RM, Shawis RN, Roberts JP. Delays in the diagnosis of anorectal malformations are common and significantly increase serious early complications. *Acta Paediatr* 2006;95:364–8.
24 Ameh EA, Ameh N. Providing safe surgery for neonates in sub-Saharan Africa. *Trop Doct* 2003;33:145–7.
25 Ekenze SO, Ajuzieogu OV, Nwomeh BC. Challenges of management and outcome of neonatal surgery in Africa: a systematic review. *Pediatr Surg Int* 2016;32:291–9.