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Research

Maternal socio-demographic characteristics as correlates to nutritional status of under-five children: Multivariate regression model approach

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Abstract

All ages require nutritious food to grow, but children, especially those under the age of five, have a greater need for it -- for growth and development of essential organs and tissues. It is evident that under-five malnutrition is prevalent in sub-Sahara Africa and Nigeria in particular. Determining the correlates of nutritional status will play a vital role in combating malnutrition. Common indicators that are used to estimate nutritional status have discrepancies in their correlations with determinants of nutritional status, hence there is a need to adopt a model that could employ multiple indicators simultaneously. This study adopted a descriptive design among 227 <5 children whose mother was attending immunization at Onueke, Ebonyi State. Maternal socio-demographic characteristics as well as their anthropometrics were obtained z scores of the weight-for-age, BMI-for-age and height-for-age and MUAC served as indicators of nutritional status. Stunting, thinness, underweight and risk of malnutrition (based on low MUAC) were respectively 43.6%, 45.6%, 45.3% and 49.3%. Based on a multivariate regression model, the only maternal characteristic, correlating with low height for age was being in a polygamous marriage. Low weight for age was associated with younger mothers (age 15-24), those who were farmers, and those with less than high incomes. Low BMI for age was associated with not having a secondary school education and being a farmer or trader. Risk of low MUAC was not associated with any of these maternal characteristics. When all measures of nutritional status were combined, low nutritional status was linked to all measured maternal characteristics except marital status (single, married, divorced). Thus, to bridge discrepancies that may exist when different nutritional status indicators are used, it is recommended that a multivariate regression model which uses multiple indicators simultaneously be adopted to determined significant maternal characteristics that correlated with nutritional status.

INTRODUCTION

All ages require nutritious food to grow, but children, especially those under the age of five years have a greater need for it; for growth and development of essential organs and tissues (McMillan et al. 2018). Nutritional status is a significant health evaluation indication (Musa et al. 2014).

The Inter-Agency Group for Child Mortality Estimation (IGME) estimates that undernutrition was a contributing fac tor in almost 45% of young child mortality in 2011(IGME, 2012). In addition to having a significant negative impact on childhood mortality, under nutrition also results in significant physical and functional deficits in survivors, including a reduced capacity for learning, decrease in the economic output, and possibly an increased risk of developing certain chronic diseases as they age (Akombi et al. 2017).

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A malnourished child is more likely to experience neuro-cognitive delays, poor academic performance, and early school dropout, which increases the likelihood that they will later experience lower work productivity and earning potentials and make less of a contribution to the Gross Domestic Product (GDP) of the country (Kalu & Etim, 2018). The prevalence of stunting, underweight, and wasting amo ng children under the age of fivein Nigeria is 37%, 29%, and18%, respectively (NDHS, 2013).

Inconsistent availability of enough food and unhealthy eating habits were identified as some of the factors that contribute to persistent child malnutrition in low-income countries (Ezeh et al. 2021). Hence, the National Nutritional Health Survey (NNHS), National Bureau of Statistics (NBS) and National Population Commission (NPC) along with the Federal Ministry of Health has warned that malnutrition in Nigeria has remained at alert levels since 2014 (NPC, 2018).

However, research on the factors associated with these high levels of under-five malnutrition has been scarce, especially in Ebonyi State. Thus, this research was carried out to ascertain the prevalence of under-five malnutrition and maternal socio-demographic characteristics as correlates of under-five malnutrition in Onueke, Ebonyi State using the multivariate regression analysis approach.

METHODS

STUDY AREA

The study was conducted in Onueke Town in Ezza-South Local Government Area of Ebonyi State, South-East Nigeria. Though the town is part of state capital territory, it mainly hosts indigenous rural dwellers who are mostly farmers, traders and artisans. The study adopted a cross-sectional survey design.

POPULATION OF STUDY

The study sample comprised mothers with children under-five years who visited the immunization clinic of The Mother and Child Care Initiative Centre, Onueke. This centre serves as the major immunization and primary health care centre for the entire Onueke town, providing those services twice a week. At the arrival of mothers, those who gave consent and met inclusion criteria were included until 10 persons were examined on each day over a period of three months. Those whose children had a history of chronic illnesses or who had been at least three months on steroids were excluded.

SAMPLE SIZE DETERMINATION AND SAMPLING TECHNIQUES

The sample size was determined using the method by Lau and Kuziemsky (2016) which is given by:

$$n = \frac{Z^2_{1-\alpha/2} P(1-P)}{d^2} \quad (1)$$

where, $Z_{1-\alpha/2}$ = standard normal variate for a given level of significance, P = Expected proportion in population based on previous studies or pilot studies, d = The absolute error or precision – chosen by researcher. Using d = 0.05 and P = 17.8% (proportion of malnourished children -- Umeokonkwo et al., 2020),

$$n = \frac{1.96^2 \times 0.178(1-0.178)}{0.05^2} = \frac{0.562}{0.05^2} \approx 225 \quad (2)$$

The minimum participants for the study are 225.

Measurements used the methods included in the guidelines of the International Society for the Advancement of Kinanthropometry (ISAK, 2001) except for height measurements of infants who could not stand and the fact that each measurement was only taken a single time. Research assistants were trained on this protocol. The mother's socio-demographic characteristics were first recorded followed by the child's background information as well as the anthropometrics (height, weight and middle upper arm circumference). The participants stood bare-foot on a plain floor close to the wall with their head erect and eyes looking forward then their height are measured using flexible steel tape (SECA model Sec-206). The measurement was in the nearest 0.1cm. For the infants who could not stand, their heights were measured as they lay on a clean level table provided for the study in accordance with WHO standard. The digital weighing scale (Seca digital floor scale, Sec880) with calibration of 0.1 kg was used for the measurement of the weight. The body mass index (BMI)was derived as a ratio of weight (kg) to height (m) squared. The socio-economic classification (SES) of the children was determined using the scheme devised for Nigeria by Ibadin & Akpade (2021).

The data were analyzed using descriptive statistics, chi-square test statistic, a binary logistic model and a multivariate regression model. The chi-square test statistic was utilized to ascertain the relationship between categorical variables before it could serve as independent variable for logistic regression model. When the expected frequency assumption for chi-square was violated, then the Fishers exact test was used.

MODEL SPECIFICATION

The multivariate regression model (Rencher, 2012) is given by

$$\mathbf{y} = \mathbf{XB} + \boldsymbol{\varepsilon} \quad (3)$$

where, **y** are vector of dependent variables (here Height-for-age, Weight-for-age, BMI-for-age and MUAC), are matrix of independent variables (maternal socio-demographic characteristics), **B** matrix of multivariate regression model coefficients, $\boldsymbol{\varepsilon}$ is vector of error component.

RESULTS AND DISCUSSION

Table 1 displays the frequency and percentage distribution of the maternal socio-demographic characteristics of the 277 study participants. There were no drop outs.

Table 1. Socio-demographic characteristics of the maternal participants

Variable	Frequency (n=227)	Percent
Maternal Age (Years)		
15-24	88	38.8
25-34	105	46.3
35-44	34	15.0

Table 1. *continued*

Marital Status		
Single	5	2.2
Married	220	96.9
Separated/Divorced	2	0.9
Family Type		
Monogamy	214	94.3
Polygamy	13	5.7
Children Ever Born		
⩽3	138	60.8
>3	89	39.2
Level of Education		
Tertiary	15	6.6
Secondary	140	61.7
Primary	72	31.7
Occupation		
Civil Servant	43	18.9
Farming	16	7.0
Trading	138	60.8
Laborer	30	13.2
Socio-economic Status (SES)		
Upper SES	4	1.8
Middle SES	119	52.4
Lower SES	104	45.8

The prevalence of the malnutrition (under nutrition and over nutrition) is presented in Table 2. In each of the indices, the under-nutrition is at least 41%.

Table 2. Prevalence of malnutrition among sample under-five children

Variables	Frequency	Percent
Height-for-Age		
Normal	77	33.9
Stunted	99	43.6
Tall	42	18.5
Very Tall	9	4.0
BMI-for-Age		
Normal	70	30.8
Thinness	103	45.4
Overweight	38	16.7
Obese	16	7.0
Weight-for-Age		
Normal	71	31.3
Severe Underweight	48	21.1
Moderate Underweight	55	24.2
Overweight	53	23.3
MUAC		
Severe acute malnutrition	6	2.6
Moderate acute malnutrition	65	28.6
at the risk of malnutrition	41	18.1
Well nourished	115	50.7

BMI = body mass index, MUAC= middle upper arm circumference

Table 3 examines the relationship between nutritional status (using height-for-age as an indicator) and maternal socio-demographic characteristics. Only family type (χ^2=20.46, p<0.001) and number of children ever born (χ^2=9.183, p=0.002) were significant (p<0.05). Further analysis using a logistic regression model revealed that only family type was significantly and independently associated with height-for-age. Those participants from monogamous families were 84% (Adjusted OR=0.161, p=0.007) less likely to be malnourished compared to their counterparts from polygamous families.

When weight–for-age served as indicator of nutritional status, as represented in Table 4, maternal age (χ^2=10.61, p=0.004) and occupation ((χ^2=922.3, p<0.001) were significantly associated with nutritional status. It was observed that the youngest mothers were 4.19 times (Adjusted OR =4.19, p=0.036) more likely to have children with malnutrition. Farmers were 24.5 times (adjusted OR = 24.5, p=0.003) more likely to have children with malnutrition compared to the children of mothers engaged in other occupations. Finally, those mothers from upper SES families were 96% less likely to have children with malnutrition compare to those from middle and lower class.

When BMI-for-age is adopted as indicator of nutritional status, as shown in Table 5, only level of education and occupation were significantly (p<0.05) associated with nutritional status.

When MUAC was adopted as nutritional status indicator, as represented in Table 6, maternal age, marital status, residence, number of children ever born and social-economic class were each significantly associated with nutritional status. However, only maternal age, residence and number of children ever born could significantly and independently predict nutritional status.

Table 7 presents the result of the estimates from a multivariate regression model of the combined indicators of nutritional status on maternal socio-demographic characteristics. Columns 2, 3 and 4 of the table present the results when the nutritional status indicators (height–for-age, weight-for-height, BMI-for-age and MUAC) are categorized while columns 5, 6 and 7 are the results when the nutritional status indicators are continuous variables. Findings are similar either way. Maternal age, residence, family type, number of children ever born, level of education and SES were all significant correlates of nutritional status, whereas, marital status was not.

Thus it can be seen that the results varied greatly when any single measure of nutritional status was used. Our results suggest that it is expedient to adopt a modelling technique that could accommodate all indicators at once -- a multivariate regression model such as that presented in Table 7.

Table 3. Relationships between maternal socio-demographic characteristics and prevalence of malnutrition (Height-for–age)

Variable	Height–for-age		Chi-Square	p-value	Adjusted OR	p-value	CI for Adjusted OR	
	Normal	Malnutrition					Lower	Upper
Maternal Age								
15-24	14(30.4)	74(40.9)						
25-34	24(52.2)	81(44.8)	1.694	0.429				
35-44	8(17.4)	26(14.4)						
Marital Status								
Single	2(4.3)	3(1.7)						
Married	44(95.7)	176(97.2)	1.723	0.423				
Separated	0(0.0)	2(1.1)						
Residence								
Urban	11(23.9)	70(38.7)	3.482	0.062	0.566	0.219	0.228	1.404
Rural(ref.)	35(76.1)	111(61.3)			1	-	-	-
Family Type								
Monogamy	37(80.4)	177(97.8)	20.463*	<0.001	0.161	0.007	0.042	0.612
Polygamy(ref.)	9(19.6)	4(2.2)			1	-	-	-
Children Ever Born								
⩽3	19(41.3)	119(65.7)	9.183	0.002	0.538	0.112	0.250	1.156
>3(ref.)	27(58.7)	62(34.3)			1	-	-	-
Level of Education								
Tertiary	2(4.3)	13(7.2)			1.065	0.943	0.194	5.851
Secondary	23(50.0)	117(64.6)	4.899*	0.082	0.864	0.733	0.372	2.006
Primary(ref.)	21(45.7)	51(28.2)			1	-	-	-
Occupation								
Civil Servant	10(21.7)	33(18.2)						
Farming	2(4.3)	14(7.7)	1.640*	0.625				
Trading	30(65.2)	108(59.7)						
Laborer	4(8.7)	26(14.4)						
Socio-economic Status (SES)								
Upper SES	0(0.0)	4(2.2)						
Middle SES	28(60.9)	91(50.3)	1.750*	0.412				
Lower SES	18(39.1)	86(47.5)						

*Fishers Exact, CI= confidence interval, OR = odds ratio (estimated from logistic regression model), ref. = reference category, p<0.05 indicates significance.

Table 4. Relationships between maternal socio-demographic characteristics and prevalence of malnutrition (weight-for-age)

Variable	Weight-for-Age		Chi-Square	p-value	Adjusted OR	p-value	CI for Adjusted OR	
	Normal	Malnutrition					Lower	Upper
Maternal Age								
15-24	21(65.6)	67(34.4)			4.194	0.036	1.081	16.274
25-34	8(25.0)	97(49.7)	10.612*	0.004	0.652	0.640	0.109	3.919
35-44	3(9.4)	31(15.9)			1			
Marital Status								
Single	2(6.3)	3(1.5)						
Married	30(93.8)	190(97.4)	3.007*	0.257				
Separated	0(0.0)	2(1.0)						
Residence								
Urban	9(28.1)	72(36.9)	0.927	0.427				
Rural(ref.)	23(71.9)	123(63.1)						
Family Type								
Monogamy	32(100)	182(93.3)	2.263	0.223				
Polygamy(ref.)	0(0.0)	13(6.7)						
Children Ever Born								

Table 4. *continued*

⩽3	20(62.5)	118(60.5)	0.046	0.849				
>3(ref.)	12(37.5)	77(39.5)						
Level of Education								
Tertiary	2(6.3)	13(6.7)						
Secondary	23(71.9)	117(60.0)	1.732	0.419				
Primary(ref.)	7(21.9)	65(33.3)						
Occupation								
Civil Servant	11(34.4)	32(16.4)			4.301	0.174	0.526	35.18
Farming	8(25.0)	8(4.1)	22.277*	<0.001	24.519	0.003	2.935	204.8
Trading	11(34.4)	127(65.1)			1.001	0.999	0.197	5.075
Laborer (ref.)	2(6.3)	28(14.4)			1			
Socio-economic Status (SES)								
Upper **SES**	0(0.0)	4(2.1)			4.3E-04	<0.001	1.1E-4	5.6E-2
Middle **SES**	23(71.9)	96(49.2)	5.294*	0.061	0.902	0.934	0.317	2.754
Lower **SES** (ref.)	9(28.1)	95(48.7)			1			

*Fishers Exact, CI= confidence interval, OR = odds ratio (estimated from logistic regression model), ref. = reference category, p<0.05 indicates significance.

Table 5. Relationships between maternal socio-demographic characteristics and prevalence of malnutrition (BMI-for-age Z score)

Variable	BMI-for-Age		Chi-Square	p-value	Adjusted OR	p-value	CI for Adjusted OR	
	Normal	Malnutrition					Lower	Upper
Maternal Age								
15-24	26(52.0)	62(35.0)			1.891	0.231	0.667	5.363
25-34	17(34.0)	88(49.7)	5.020	0.081	0.529	0.224	0.190	1.477
35-44	7(14.0)	27(15.3)			1			
Marital Status								
Single	0(0.0)	5(2.8)						
Married	50(100)	170(96.0)	1.113*	0.751				
Separated	0(0.0)	2(1.1)						
Residence								
Urban	14(28.0)	67(37.9)	1.649	0.199				
Rural (ref.)	36(72.0)	110(62.1)						
Family Type								
Monogamy	45(90.0)	169(95.5)	1.169*	0.167				
Polygamy (ref.)	5(10.0)	8(4.5)						
Children ever born								
⩽3	25(50.0)	113(63.8)	3.134	0.077	0.804	0.613	0.346	1.869
>3 (ref.)	25(50.0)	64(36.2)			1			
Level of Education								
Tertiary	4(8.0)	11(6.2)			1.605	0.688	0.159	16.21
Secondary	20(40.0)	120(67.8)	13.099*	0.001	0.211	<0.001	0.099	0.451
Primary (ref.)	26(52.0)	46(26.0)			1			
Occupation								
Civil Servant	7(14.0)	36(20.3)			3.665	0.070	0.899	14.94
Farming	6(12.0)	10(5.6)	8.306*	0.037	16.851	0.010	1.963	144.9
Trading	35(70.0)	103(58.2)			8.572	0.001	2.389	30.76
Laborer (ref.)	2(4.0)	28(15.8)			1			
Socio-economic Status (SES)								
Upper **SES**	0(0.0)	4(2.3)						
Middle **SES**	26(52.0)	93(52.5)	0.634*	0.796				
Lower **SES** (ref.)	24(48.0)	80(45.2)						

*Fishers Exact, CI= confidence interval, OR = odds ratio (estimated from logistic regression model), ref. = reference category, p<0.05 indicates significance.

Table 6. Relationships between maternal socio-demographic characteristics and prevalence of malnutrition (MUAC)

Variable	MUAC		Chi-Square	p-value	Adjusted OR	p-value	CI for Adjusted OR	
	Normal	Malnutrition					Lower	Upper
Maternal Age								
15-24	26(29.5)	62(44.6)			3.751	0.025	1.181	11.906
25-34	55(62.5)	50(36.0)	16.084	<0.001	8.387	<0.001	2.678	26.266
35-44	7(8.0)	27(19.4)						
Marital Status								
Single	0(0.0)	5(3.6)				merged with separated		
Married	86(97.7)	134(96.4)	5.606*	0.031	0.978	0.978	0.195	4.901
Separated	2(2.3)	0(0.0)			1			
Residence								
Urban	45(51.1)	36(25.9)	14.954	<0.001	3.198	<0.001	1.667	6.137
Rural (ref.)	43(48.9)	103(74.1)			1			
Family Type								
Monogamy	84(95.5)	130(93.5)	0.372	0.771				
Polygamy (ref.)	4(4.5)	9(6.5)						
Children ever born								
⩽3	44(50.0)	94(67.6)	7.024	0.008	0.243	0.001	.106	.556
>3 (ref.)	44(50.0)	45(32.4)			1			
Level of Education								
Tertiary	10(11.4)	5(3.6)			2.503	0.196	0.622	10.068
Secondary	46(52.3)	94(67.6)	7.956	0.019	0.964	0.927	0.442	2.102
Primary (ref.)	32(36.4)	40(28.8)			1			
Occupation								
Civil Servant	13(14.8)	30(21.6)						
Farming	6(6.8)	10(7.2)	2.627	0.453				
Trading	59(67.0)	79(56.8)						
Laborer (ref.)	10(11.4)	20(14.4)						
Socio-economic Status (SES)								
Upper **SES**	4(4.5)	0(0.0)						
Middle **SES**	38(43.2)	81(58.3)	9.443*	0.005	0.672	0.217	0.357	1.264
Lower **SES** (ref.)	46(52.3)	58(41.7)			1			

*Fishers Exact, CI= confidence interval, OR = odds ratio (derived from logistic regression model), ref. = reference category, p<0.05 indicates significance.

Table 7. Multivariate Regression fit of nutritional status (all indicators combined) on maternal socio-demographics

Variables	Nutritional status (categorical)			Nutritional status (continuous)		
	Δ	F	p-value	Δ	F	p-value
Intercept	0.296	124.110	<0.001	0.275	137.842	<0.001
Age of the Mother	0.803	6.046	<0.001	0.850	4.433	<0.001
Residence	0.898	5.955	<0.001	0.942	3.213	0.014
Marital Status	0.940	1.640	0.112	0.981	0.499	0.857
Family Type	0.883	6.939	<0.001	0.906	5.432	<0.001
Number of Children Ever Born	0.918	4.644	0.001	0.957	2.326	0.048
Level of Education	0.869	3.802	<0.001	0.934	1.828	0.047
Occupation	0.771	4.771	<0.001	0.819	3.620	<0.001
Social Status	0.876	3.585	<0.001	0.914	2.417	0.015

Δ= Wilk's Lambda, p<0.05 indicates significance.

LIMITATION

The measurement of the participants' anthropometrics were carried out without footboard or headboard. Also, the measurement was done only once on each participant. These limitations may have introduced additional measurement error.

CONCLUSIONS

The present study examined maternal socio-demographic characteristics as correlates to nutritional status of under-five children in Onueke, Ebonyi State. While correlates varied widely when each different nutritional status indicator was used separately, we adopted a multivariate regression approach which combined the indicators which found that all maternal characteristics except for marital status were significant correlates -- maternal age, residence, family type, number of children ever born, level of education and SES.

AUTHOR CONTRIBUTIONS

CJN was involved in the conception, design, methodology, data analysis, and writing original draft. EOO, CBN and AEE were involved in providing critical suggestions for design of the study, data collection and result interpretation. The final manuscript has been approved by all the authors.

CONFLICT OF INTEREST

The authors declare that they have no other potential conflicts of interest.

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REFERENCES

Akombi J.B., Agho K. E., Hall J.J., Merom D., Astell-Burt T., and Renzaho A.M.N. 2017. Stunting and severe stunting among children under-5 years in Nigeria: A multilevel analysis. *BMC Paediatrics*, 17(1), 1-16. https://doi.org/10.1186/s12887-016-0770-z

Ibadin M.O. and Akpede G.O. 2021. A revised scoring scheme for the classification of socio-economic status in Nigeria. *Nigeria Journal of Paediatrics*. 48(1): 26-33. https://doi.org/10.4314/njp.v48i1.5

Ezeh O. K., Abir T., Zainol N. R., Al Mamun A., Milton A. H., Haque M., and Agho, K. E. 2021. Trends of stunting prevalence and its associated factors among Nigerian children aged 0–59 months residing in the northern Nigeria, 2008–2018. *Nutrients*, 13(12), 4312. https://doi.org/10.3390/nu13124312

ISAK. 2001. International Standards for Anthropometric Assessment. South Africa. https://id.oclc.org/worldcat/entity/E39QH7JmpdXDhdk3BWjDHMxDY6

Kalu R.E., and Etim K.D. 2018. Factors associated with malnutrition among under-five children in developing countries: A review. *Global Journal of Pure and Applied Sciences*, 24(1), 69-74. https://doi.org/10.4314/gjpas.v24i1.8

Lau F. and Kuziemsky C. 2016. Handbook of e-health evaluation: An evidence-based approach. University of Victoria, Victoria, British Columbia Canada. https://pubmed.ncbi.nlm.nih.gov/29431951/

McMillan A., Renaud J.B., Burgess K. M., Orimadegun A E., Akinyinka O O., Allen S J., Miller J D., Reid G. and Sumarah M W. 2018. Aflatoxin exposure in Nigerian children with severe acute malnutrition. *Food and Chemical Toxicology*, 111(1), 356-362. https://doi.org/10.1016/j.fct.2017.11.030

Musa T H, Musa H H, Ali E A., Musa N E. 2014. Prevalence of malnutrition among children under-five years old in Khartoum State, Sudan. *Polish Annals of Medicine*, 21(1), 1-7. https://doi.org/10.1016/j.poamed.2014.01.001

National Demographic and Health Survey, NDHS, 2013. National Population Commission, Federal Republic of Nigeria: Final Report on Nigeria Demographic and Health Survey, 2013.ICF International Rockville, Maryland, USA. https://dhsprogram.com/pubs/pdf/FR293/FR293.pdf

National Population Commission (NPC), 2018. National Bureau of Statistics National Population Commission, Federal Republic of Nigeria: Final Report on Nigeria Demographic and Health Survey 2018, Calverton, Maryland, USA: ORC Macro, 163-167. https://dhsprogram.com/pubs/pdf/FR359/FR359.pdf

Rencher A.C. 2012. Methods of multivariate Analysis (3rd Edition). John Wiley and Sons, New Jersey, USA. https://doi.org/10.1002/9781118391686

The Inter-agency Group for Child Mortality Estimation (IGME). 2012. Levels & Trends in Child Mortality. Report 2012Estimates Developed by the UN Inter-agency Group for Child Mortality Estimation. Retrieved at https://www.who.int/publications/m/item/levels-and-trends-in-child-mortality-report-2012

Umeokonkwo A.A., Ibekwe M.U., Umeokonkwo C.D., Okike C O., Ezeanosike O. B., and Ibe B C. 2020. Nutritional status of school age children in Abakaliki metropolis, Ebonyi State, Nigeria. *BMC Paediatrics*, 20(1), 1-9. https://doi.org/10.1186/s12887-020-1994-5