Determinants of factors associated with anemia among children under five years in Lesotho

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Abstract

Context: Anaemia is a global public health problem which occurs mostly in developing countries. The objective of this study is to assess the prevalence and risk factors associated with anaemia among children under five years of age in Lesotho.

Data and method: The logistic regression model was used to analyse the Lesotho Demographic and Health Survey data for 2009 and 2014.

Findings: The results from the 2009 data set revealed that the nutritional (stunting) status of child, child's age and mother's anaemia status were the risk factors associated to childhood anaemia, whereas the findings from the 2014 data set showed that the nutritional status of child, whether the child had a fever in the last two weeks prior to the survey, child's age and mother's body mass index were risk factors associated with anaemia among children under five years.

Conclusion: There is a need to improve the child health at an early age and nutritional status.

Keywords: Anaemia, Children, Logistic regression; LDHS.

Introduction

Anaemia remains a public health problem in many countries. It is most prevalent among children under five years and pregnant women, especially in developing countries (Gorospe et al. 2014). According to the World Health Organisation (WHO 2015), anaemia is defined as low blood hemoglobin concentration. The hemoglobin concentration level, when it is below 7g/dl, can lead to death if there is no treatment provided on time (Ngesa and Mwambi 2014). Anaemia in early childhood can negatively affect mental development, performance in school, and physical and behavioural growth (McCann and Ames 2007; Kotecha 2011). Half of the micronutrients that contribute to the global burden of anaemia is iron deficiency (Benoist et al. 2008). However, there are small numbers of other micronutrients such as folate, vitamins A and B12 that also contribute. Parasitic infections, such as malaria, filariasis and chronic diarrhea, can also result in anaemia (Benoist et al. 2008). The estimates suggested that 47.4% of children globally under five years of age are anaemic (McLean et al. 2009). In Lesotho, the 2009 and 2014 nationally representative survey showed that 47% and 51% of the children under five years are anaemic; while in men 12% and 14% are anaemic; and in women 26% and 27% are anaemic (Population and ICF 2011; MOHSW and ICF 2010; MOHSW and ICF 2016). This shows that anaemia has been increasing in Lesotho, especially in children, and more focus is needed on improvement in children's health as their health is the future of the country (Isiugo-Abanihe and Oke, 2011). More research about anaemia under five years has been done in different countries (Kuziga et al. 2017; Kisiangani et al. 2015). It has been shown that the prevalence of anaemia might not be necessarily the same in each country, as there is variability in accessing health care and food with enough micronutrients across different countries. Currently, there is not much research on anaemia in Lesotho; only few studies such as (Makonnen et al. 2003; Oguntibeju 2003; Yasutake et al. 2013; Mugomeri et al. 2016) among others have been carried out. However, of all of these studies none was done on children under five years nationwide.

In addition, most of the studies done on anemia (Adegoke et al. 2012; Dey and Raheem 2016; Gorospe et al. 2014) used logistic regression and this model is very powerful when for instance the assumption of independence of observation is not violated. But when the data comes from a complex survey design, the measurements from the same cluster may be correlated and thus violate the assumption of independence. Therefore, the present study addressed this problem via survey logistic regression that accounts for the complexity of

sampling design, and clustering and possible correlation between observations from the same cluster. According to our understanding there was no study in the literature using the survey logistic regression to identify the risk factors associated with childhood anaemia in Lesotho nationwide.

Material and methods

Study area

Lesotho is a hilly landlocked country which is completely surrounded by South Africa and is situated between 28° and 30° south, and between 27° and 30° east (Moteetee 2005). The country covers an area of around 30,355 square kilometers with an estimated population of 2.203821 million. It has ten politico-administrative districts where the Maseru district is the capital city. Lesotho is an established government with the King as the Head of State and the Prime Minster as Head of Government and a double law framework comprising of customary law and common law. The country faces a severe HIV and AIDS problem, widespread poverty, high unemployment, food insecurity and other diseases which affect maternal health and nutritional status adversely (MOHSW and ICF 2016).

Data source

The study used the 2009 and 2014 Lesotho Demography and Health Survey (LDHS). The survey used a sampling frame from the 2006 population and housing census supplied by Lesotho Bureau of Statistics. The data was collected based on multistage sampling technique with stratification. In the first stage 400 enumeration areas were selected (282 rural and 118 urban). In the second stage, systematic sampling was used among the selected households, where 25 households were selected in each selected enumeration area or cluster. More details on sampling techniques on the 2009 and 2014 data collection can be found in MOHSW and ICF (2010); and MOHSW and ICF (2016). The 2009 and 2014 LDHS provided the children's data set and this was used in the current study. A weighted total of 1295 children were obtained from 2009 LDHS and 1138 from 2014 LDHS.

We have used 2009 and 2014 LDHS in order to assess whether the determinants of anemia in Lesotho remained the same or differed in these two periods. In addition, we wanted to know which of the explanatory variables was significant in both periods, so that more attention can be given to policy making and underwriting.

Data analysis

Dependent variable

The outcome variable of interest in this study was anaemia status among children under five years. The anaemia status among children is classified mainly based on hemoglobin concentration level in blood measured in grams per deciliter (g/dl). A child is considered as anaemic if his/her hemoglobin concentration level adjusted for altitude is less than 11.0 g/dl otherwise it is not considered anaemic (WHO 2015).

Independent variables

The independent variables used in this study were also used in various similar studies on childhood anaemia in other areas (Benoist et al. 2008; McLean et al. 2009; Kotecha 2011; Habyarimana et al. 2016; Habyarimana et al. 2017) among others. Consequently, this forms the theoretical framework that will underpin the current research. These independent variables are grouped as socio-economic and demographic factors which include: sex of child (female, male); whether the child had fever, or not; cough or diarrhea in the two weeks prior to the survey or not; the birth order of the child; the child's birth weight; the child's age in months; whether the child had received drugs for intestinal worms or vitamin A supplementation in the six months prior to the survey or not; child nutritional status (underweight or not, stunted or not and wasted or not); mother's anaemia status; mother's education level (no education, primary, secondary and more); mother's age at birth; mother's body mass index; place of residence; and wealth index of the household.

Statistical analysis

The data used in this study was collected based on multi-stage sampling, stratified and cluster sampling with unequal probability of selection. Heering (2010) advised the necessity of accounting for the complexity of sampling design in order to avoid underestimation of the variance and also avoid wrong inferences.

Therefore, the current study used the survey logistic regression that accounted for complexity of sampling design and heterogeneity between observations from the same cluster inherent in DHS data.

Model formulation

Let y_{ikn} denote the anaemia status of child i from k^{th} stratum and n^{th} cluster. The outcome variable is defined as a dichotomous variable such that $y_{ikn} = 1$ if the child *i* is anaemic and $y_{ikn} = 0$ if the child *i* is not anaemics. In the present study, we have assumed

that outcome variable y_{ikn} is Bernoulli distributed as $y_{ikn}|\boldsymbol{\mu_{ikn}} \sim Bernoulli\ (\boldsymbol{\mu_{ikn}})$, with $\boldsymbol{\mu_{ikn}}$ known as the mean and is defined as $E(y_{ikn}) = \boldsymbol{\mu_{ikn}}$. It is linked to the independent variables as :

$$g(\boldsymbol{\mu_{ikn}}) = \boldsymbol{X'_{ikn}\beta}$$

where g (.) is the logit link function, $\boldsymbol{\beta}$ is a m-dimensional vector of categorical explanatory variables.

Data analysis

The present study used bivariate techniques to identify the association between potential explanatory variables and childhood anaemia. In the bivariate analysis, cross-tabulation technique was used for both 2009 and 2014 LDHS data. The p-values and Pearson's chi-square test were used to check whether the independent variables are significantly associated with anaemia or not. This was done using SPSS version 24.0. Any variables from bivariate results with p-value less than 0.2 were included in the analysis of multivariate survey logistic regression. This was done in order to account for any possible multicollinearity and confounding between the covariate (Schneider et al. 2008; Gari et al. 2017). Thereafter, any variable that was significant at 5% level of significance was reported in multivariate analysis in both 2009 and 2014 data sets. The analysis was done using Proc Survey logistic from SAS software version 9.4 and the model fit statistics was assessed based on Akaike information criteria (AIC) and -2 Log-Likelihood (-2LogL).

Results

The current study used the survey weights provided by the Lesotho Demographic and Health Survey data set in order to ascertain a national level representation. The prevalence of anaemia among children under five years in Lesotho was 47% and 51% in 2009 and 2014 respectively. In bivariate analysis in 2009, the results from cross-tabulation analysis are summarized in Table 1. The Pearson Chi-squared test was used to assess the association between the explanatory variables and childhood anaemia. It was found that the child's age, the incidence of cough in the last two weeks prior to the survey, stunting, children who received vitamin A and the mother anaemia status were significantly associated with childhood anaemia. The child's age group was significantly associated with childhood anemia (p-value < 0.001). The prevalence of anaemia was 62.8%, 45.4% and 38.6% among children aged between 0-19; 20-39 and 40-59 months, respectively. It was also found that the incidence of cough was significantly associated with childhood anaemia (p-value=0.018). The prevalence of anaemia was 53.7% among children who had a cough and 46.6% among children who did not coughing. It was observed that the mother's anaemia level was significantly associated with childhood anaemia (p-value=0.008). The prevalence of anaemia was 46.8% among children from anaemic mothers and 55.4% among children from none anaemic mothers. It was also observed that the stunting children were significantly associated with childhood anaemia (p-value=0.047). The prevalence of anaemia was 46.6% among stunted children and 51.9% among non-stunted children. The prevalence of anaemia among children who received vitamin A was 46.5% and 54.9% among children who did not receive vitamin A.

Table 1: Childhood anaemia by categorical variables 2009

Variable	Category	Anaemic	Not anaemic	p-value
Sex of the child	male	316 (48.8%)	331 (51.2%)	
	female	316 (48.8%)	332 (51.2%)	0.978
Birth order	1st	248 (51.5%)	234(48.5%)	
	2-3	253 (47.6%)	278(52.4%)	
	4-5	92 (46.9%)	104(53.1%)	
	6	39 (45.3%)	47 (54.7%)	0.508
Child's birth weight	< (2500g)	42 (48.8%)	44 (52.2%)	
	≥ (2500g)	403 (49.4%)	412 (50.6%)	0.914
Child's age in months	0-19	263 (62.8%)	156 (37.2%)	
	20-39	207 (45.4%)	249 (54.6%)	
	40-59	162 (38.6%)	258 (61.4%)	0.000
Had fever in the last two weeks	yes	113 (46.5%)	130 (53.5%)	
	no	517(49.2%)	533 (50.8%)	0.442
Had coughing in the last two weeks	yes	209 (53.7%)	180 (46.3%)	
	no	421 (46.6%)	483 (53.4%)	0.018

Had diarrhea in the last two weeks	yes	91 (55.2%)	74 (44.8%)	
	no	539 (47.9%)	587 (52.1%)	0.080
Had received drugs for intestinal worms	yes	61 (47.7%)	67 (52.3%)	
	no	561 (49.4%)	575 (50.6%)	0.711
Received vitamin A	yes	185 (46.5%)	213 (53.5%)	
	no	335 (54.9%)	275 (45.1%)	0.009
Stunted	yes	386 (46.6%)	443 (53.4%)	
	no	216 (51.9%)	200 (48.1%)	0.047
Wasting	yes	22(53.7%)	19 (46.3%)	
	no	579 (48.1%)	624 (51.9%)	0.486
Underweight	yes	107 (47.6%)	118 (52.4%)	
	no	494 (48.5%)	525(51.5%)	0.802
Mother's BMI	<18.5	25 (45.5%)	30 (54.5%)	
	≥18.5	600 (48.9%)	628 (51.1%)	0.621
Mother's education level	no education	14 (43.8%)	18 (56.2%)	
	primary	356 (48.4%)	379 (51.6%)	
	secondary & higher	261 (49.4%)	267 (50.6%)	0.800
Mother's anaemia level	anaemic	461 (46.8%)	525 (53.2%)	
	not anaemic	168 (55.4%)	135 (44.6%)	0.008
Mother's age at birth	<25 years	261 (51.5%)	246 (48.5%)	
	≥25 years	371(47.1%)	417 (52.9%)	0.122
Wealth index	poor	302 (50.7%)	294(49.3%)	
	middle	124 (47.3%)	138 (52.7%)	
	rich	206 (47.2%)	230 (52.8%)	0.477
Place of residence	urban	509 (47.9%)	553 (52.1%)	
	rural	123 (52.8%)	110 (47.2%)	0.179

Table 2 showed that the prevalence of anaemia among children was 51% in 2014. It was observed that the child age was significantly associated with childhood anaemia (p-value<.0001). The prevalence of anaemia was 62.7%, 55.0% and 43.6% among children aged from 0-19, 20-39 and 40-59 months respectively. It was also found that the incidence of fever was significantly associated with childhood anaemia (p-value=0.008). The prevalence of anaemia was 52.3% among children who had fever and 62.8% among children who did not have fever. It was observed that the incidence of diarrhea was significantly associated with childhood anaemia (p-value=0.024). The prevalence of anaemia was 62.7% among children who had diarrhea in the two weeks prior to the survey and 52.8% among children who did not have diarrhea in the two weeks prior to the survey. It was also observed that the stunting children were significantly associated with childhood anaemia (p-value=0.002). The prevalence of anaemia was 49.7% among stunted children and 64.5% among non-stunted children. The prevalence of anaemia was 62.0% among children who received drugs for intestinal worms and 51.5% among children who did not received the drugs for intestinal worms. Mother's age at birth was significantly associated with childhood anaemia (p-value= 0.011). The prevalence of anaemia was 58.9% among mothers who were less than 25 years old and 51.2% among those who were greater or equal to 25 years old. The mother's body mass index was significantly associated with childhood anaemia (p-value =0.001). The prevalence of anaemia was 51.7% among mothers whose body mass index was less than 18.5 and 64.9% among mothers whose body mass index was greater or equal to 18.5.

Table 2. Childhood anaemia by categorical variables 2014

Variable	Category	Anaemic	Not anaemic	p-value
Sex of the child	male	301 (56.2%)	235(43.8%)	
	female	315 (52.2%)	288 (47.8%)	0.185
Birth order	1st	230 (52.6%)	207 (47.4%)	
	2-3	260 (55.7%)	207(44.3%)	
	4-5	81 (51.3%)	77(48.7%)	
	6	46 (51.1%)	44 (48.9%)	0.673
Child's birth weight	< (2500g)	45 (58.4%)	32 (41.6%)	
	≥(2500g)	568 (53.7%)	489 (46.3%)	0.424
Child's age in months	0-19	227 (62.7%)	135 (37.3%)	
	20-39	224 (55.0%)	183 (45.0%)	0.000
	40-59	160 (43.6%)	207 (56.4%)	
Had fever in the last two	yes	493 (52.3%)	449 (47.7%)	
weeks	no	120(62.8%)	71 (37.2%)	0.008
Had coughing in the last two	yes	184 (54.4%)	154 (45.6%)	
weeks	no	429 (54.0%)	366 (46.0%)	0.883
Had diarrhea in the last two	yes	94 (62.7%)	56 (37.3%)	
weeks	no	520 (52.8%)	465 (47.2%)	0.024
Had received drugs for	yes	152 (62.0%)	93 (38.0%)	
intestinal worms	no	439 (51.5%)	413 (48.5%)	0.004
Received Vitamin A	yes	363 (54.3%)	306 (45.7%)	
	no	131 (53.7%)	113 (46.3%)	0.878
Stunted	yes	392 (49.7%)	397 (50.3%)	
	no	213 (64.5%)	117 (35.5%)	0.000
Wasting	yes	592 (54.3%)	499 (45.7%)	
	no	14 (48.3%)	15 (51.7%)	0.523

Underweight	yes	499 (53.0%)	443 (47.0%)	
	no	107 (60.5%)	70 (39.5%)	0.067
Mother's BMI	<18.5	467 (51.7%)	437 (48.3%)	
	≥18.5	111 (64.9%)	60 (35.1%)	0.001
Mother's education level	no education	7 (53.8%)	6 (46.2%)	
	primary	508 (53.2%)	447 (46.8%)	
	secondary & higher	99 (58.6%)	70 (41.4%)	0.432
Mother's anaemia level	anaemic	173 (57.3%)	129 (42.7%)	
	not anaemic	439 (52.8%)	393 (47.2%)	0.177
Mother's age at birth	<25 years	247 (58.9%)	172 (41.1%)	
	≥25 years	368 (51.2%)	351(48.8%)	0.011
Wealth index	poor	147 (58.3%)	105 (41.7%)	
	middle	259 (52.2%)	210 (44.8%)	
	rich	209 (50.1%)	208 (49.9%)	0.095
Place of residence	urban	158 (50.2%)	157 (49.8%)	
	rural	457 (55.5%)	366 (44.5%)	0.104

Multivariate analysis

The results from survey logistic regression in both 2009 and 2014 showed that the model with intercept only has AIC (1.71175E9) and (1.45661E9) respectively, while the full model has AIC (1.64201E9) and (1.39001E9). Therefore, the full model was considered as the best fit model since it is the one with smallest AIC. Table 3 presents the parameter estimate, standard deviation (STD), P-value, odds ratio (OR) and confidence interval (CI). The results from the 2009 data set showed that stunting child, the mother's anaemia status and the child's age were significantly associated with anaemia at 5% level of significance. A child whose age was less than 19 months was 2.994 (OR: 2.994 (2.161; 4.147), p-value<.0001) times more likely to be anaemic as compared to those in age group 40-59 months while a child between 20-39 months of age was 1.366 (OR: 1.366 (1.016; 1.836), p-value=0.039) times more likely to be anaemic than those who were in the age group of 40-59 months.

The nutritional status of the child was significantly associated with childhood anaemia. A stunted child was 1.416 (OR: 1.416 (1.081; 1.854), p-value=0.012) times more likely to be anaemic than a non-stunted child. It is observed from the results that mother's anaemia status had a significant impact of childhood anaemia. A child born to a non-anaemic mother was 0.688(OR: 0.688 (0.514; 0.922), p-value=0.012) times less likely to be anaemic than a child born to an anaemic mother. The 2014 results revealed that the child's age group, his/her nutritional status (stunting), fever in the last two weeks prior to the survey and the mother's body mass index were significantly associated with anaemia among children under five years in Lesotho. A child whose age is less than 19 months was found to be 0.471 (OR: 0.471 (0.323; 0.687)), p-value=0.000) times less likely to be anaemic as compared to those in the age group of

40-50 months while a child between 20-39 months of age was 0.687 (OR: 0.687 (0.482; 0.977), p-value=0.037) times less likely to be anaemic than those who were in the age group of 40-59 months. A child who had fever in the last two weeks prior to the survey was 1.674 (OR: 1.674 (1.103; 2.540), p-value= 0.016) times more likely to be anaemic than a child who did not have fever in the last two weeks prior to the survey. It was noted that a stunted child was 1.787 (OR: 1.787 (1.219; 2.619)), p-value=0.003) times more likely to be anaemic than a child who was not stunted. It was also noted that mother's BMI was significantly associated with childhood anaemia. A child born to an underweight mother was 1.542 (OR: 1.542 (1.024; 2.321), p-value=0.038) times more likely to be anaemic compared to a child born to a normal weight or obese mother.

Table 3: Multivariate survey logistic regression analysis.

Variable	Estimate	STD	p-value	OR	95% CI
Year: 2009					
Intercept	-0.363	0.160	0.024	--	--
Stunting(ref=no)					
yes	0.348	0.137	0.012	1.146	1.081;1.854
Mother with anaemia (ref=no)					
yes	-0.373	0.148	0.012	0.688	0.514;0.922
Child age (ref=40-59)					
0-19	1.097	0.166	0.000	2.994	2.161;4.417
20-39	0.312	0.152	0.039	1.366	1.016;1.836
Year:2014					
Intercept	-0.474	0.609	0.437	--	--
Stunting (ref=no)					
yes	0.581	0.194	0.003	1.787	1.219;2.619
Fever (ref=no)					
Yes	0.515	0.212	0.016	1.674	1.103;2.540
BMI (ref=less than18.5) more or equal 18.5	0.433	0.208	0.038	1.542	1.024;2.321
Child age (ref=40-59)					
0-19	-0.752	0.191	0.000	0.471	0.323;0.687
20-39	-0.376	0.179	0.037	0.687	0.482;0.977

Discussion

The prevalence of anaemia among children under five years in Lesotho was 47% and 51% in 2009 and 2014 respectively. This shows an increase of 4% in the period of five years. The main objective of the current study was to assess the risk factors of anaemia among children under five years based on the 2009 and 2014 LDHS data sets. The findings from this study revealed that childhood anaemia in Lesotho decreases with increasing the age of the child in both the 2009 and 2014 analyses. These findings are consistent with many previous studies such as Kotecha (2011); Zhao et al. (2012); and Dey and Raheem (2016). This means that older children have a lower likelihood of being anaemic than younger children.

The findings from this study also highlighted the association of stunting with anaemia among children under five years in 2009 and 2014. This finding was found elsewhere (Kotecha 2011; Zhao et al. 2012; Leite et al. 2013; Khan et al. 2016). This is an indication of chronic malnutrition which might cause iron deficiency (Woldie et al. 2015).

The findings from the present study pointed out a significant association between mother's body mass index and childhood anaemia only in the 2014 data set. The results showed that children born to an underweight mother had a higher likelihood of being anaemic whilst normal, overweight and obese mothers are less likely to have children susceptible to anaemia. A similar result was found in studies by Habyarimana et al. (2017) and Fonseca et al. (2016). This may be due to the fact that underweight people are more likely to have other associated co-morbidity illnesses that may be associated with anaemia.

It was also found from the 2009 results that mother's anaemia status was significantly associated with childhood anaemia. The results showed that a

child born to anaemic mothers had a higher likelihood of being anaemic than a child born to a non-anaemic mother. This finding was also found in other similar studies (Ngnie-Teta et al. 2007; Yang et al. 2012; Pita et al. 2014).

In addition, the findings from the analysis of the 2014 data set demonstrated that the recent incidence of fever had a positive impact on childhood anaemia. The results showed that a child who had fever in the last two weeks prior to the survey had a higher likelihood of being anaemic than a child who did not have fever. This is in line with results found in studies by Santos et al. (2011); Konstantyner et al. (2012) and Gayawan et al. (2014), among others. This may be due to the fact that fever is commonly accompanied by a number of diseases and morbidity that are known to positively affect anaemia such as diarrhea, cough and malaria among others (Konstantyner et al. 2012). The findings from this study highlighted that the child's age and stunting were common risk factors of childhood anaemia in both studies (2009 and 2014). It was also found that fever and mother's body mass index were significant factors associated to childhood anaemia in 2014. In addition, mother's anaemia status was not statistically significant in 2014. A possible reason could be that in a period of 5 years the mothers have begun to practice a more healthy diet that reduces their risk of anaemia.

In the current bivariate study, a statistical association between childhood anaemia and place of residence, cough and diarrhea in the last two weeks prior to the survey, wasting and vitamin A supplementation was found but the study did not find any statistical significance in multivariate survey logistic regression in both data sets.

Conclusion

The current study identified the risk factors associated with anaemia among children under five years in Lesotho from 2009 to 2014. The findings from the study revealed that stunting and child's age were significant determinants of childhood anemia in both surveys (2009 and 2014) and this suggests that much attention on child health at an early age and the improvement of nutritional status especially stunting of children under five years must still be addressed with diligence. The findings from the current study also revealed that the determinants of childhood anemia in Lesotho increased from 2009 data set to 2014 and the prevalence of anemia also increased by 4%. This could possibly be due to a shortage of educating the public of proper diet and eating habits. Consequently, more workshops, roadshows, paraphernalia and even social media could be used to further educate the adult population with respect to diet and eating habits. The findings from this study also suggest an improvement of of the incidence of fever. The findings of this study may assist public health institutions in Lesotho and policy makers to formulate preventative measures and design intervention strategies that target children under five years.

Limitation

This study used cross-sectional data from LDHS and this data may not be able to address the causality but rather association; therefore, a longitudinal study is suggested to solve this problem.

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References

Adegoke, S., Ayansanwo, A., Oluwayemi, I. and Okeniyi, J., 2012. Determinants of mortality in Nigerian children with severe anaemia. *SAMJ: South African Medical Journal*, *102*(10), pp.807-810.

Benoist, B.D, McLean, E., Egll, I. and Cogswell, M (2008). "Worldwide prevalence of anaemia 1993-2005: WHO global database on anaemia." Worldwide prevalence of anaemia 1993-2005: WHO global database on anaemia.

Dey, S. and Raheem, E (2016). "Multilevel multinomial logistic regression model for identifying factors associated with anemia in children 6–59 months in northeastern states of India." Cogent Mathematics **3**(1): 1159798.

Fonseca, C., Marques, F., Robalo Nunes, A., Belo, A., Brilhante, D. and Cortez, J (2016). "Prevalence of anaemia and iron deficiency in Portugal: the EMPIRE study." Internal medicine journal **46**(4): 470-478.

Gari, T., Loha. E., Deressa, W., Solomon, T., Atsbeha, H., Assegid, M., Hailu, A. and Lindtjørn, B (2017). "Anaemia among children in a drought affected community in south-central Ethiopia." PloS one **12**(3): e0170898.

Gayawan, E., Arogundade, E.D. and Adebayo, S.B (2014). "Possible determinants and spatial patterns of anaemia among young children in Nigeria: a Bayesian semi-parametric modelling." International health **6**(1): 35-45.

Gorospe, J., Bismonte, S.A., Arcilla, R.G. and Gironella, G (2014). "Ordinal Logistic Regression Analyses on Anemia for Children Aged 6 Months to 5 Years Old in the Philippines."

Habyarimana, F., 2016. Key determinants of malnutrition of children under five years of age in

Rwanda: Simultaneous measurement of three anthropometric indices. *African Population Studies*, *30*(2).

Habyarimana, F., Zewotir, T. and Ramroop, S (2017). "Structured Additive Quantile Regression for Assessing the Determinants of Childhood Anemia in Rwanda." International journal of environmental research and public health **14**(6): 652.

Heering, S.G., West, B.T. and Berglund, P.A. Applied survey data analysis: Statistical in the social and behavioral sciences series. New York: Chapman & Hall/CRC 2010.

Isiugo-Abanihe, U.C. and Oke, O.A., 2011. Maternal and environmental factors influencing infant birth weight in Ibadan, Nigeria. *African Population Studies*, *25*(2).

Khan, J.R., Awan, N. and Misu, F (2016). "Determinants of anemia among 6–59 months aged children in Bangladesh: evidence from nationally representative data." BMC pediatrics **16**(1): 3.

Kisiangani, I., Mbakaya, C. and Makokha, A., 2015. Prevalence of anaemia and associated factors among preschool children (6-59 months) in Western Province, Kenya. *Public Health and Preventive Medicine*, *1*(1), pp.28-32.

Konstantyner, T., Roma Oliveira, T.C. and de Aguiar Carrazedo Taddei, J.A (2012). "Risk factors for anemia among Brazilian infants from the 2006 National Demographic Health Survey." **2012**.

Kotecha, P.V (2011). "Nutritional anemia in young children with focus on Asia and India." Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine **36**(1): 8.

Kuziga, F., Adoke, Y. and Wanyenze, R.K., 2017. Prevalence and factors associated with anaemia among children aged 6 to 59 months in Namutumba district, Uganda: a cross-sectional study.

Leite, M.S., Cardoso, A.M., Coimbra, C.E., Welch, J.R., Gugelmin, S.A., Lira, P.C.I., Horta, B.L., Santos, R.V. and Escobar, A.L (2013). "Prevalence of anemia and associated factors among indigenous children in Brazil: results from the First National Survey of Indigenous People's Health and Nutrition." Nutrition journal **12**(1): 69.

Makonnen, B., Venter, A. and Joubert, G (2003). "A randomised controlled study of the impact of dietary zinc supplementation in the management of children with protein–energy malnutrition in Lesotho. I: Mortality and Morbidity." Journal of tropical pediatrics **49**(6): 340-352.

McCann, J.C. and Ames, B.N (2007). "An overview of evidence for a causal relation between iron deficiency during development and deficits in cognitive or behavioral function–." The American journal of clinical nutrition **85**(4): 931-945.

McLean, E., Cogswell, M., Egli, I., Wojdyla, D. and De Benoist, B (2009). "Worldwide prevalence of anaemia, WHO vitamin and mineral nutrition information system, 1993–2005." Public health nutrition **12**(4): 444-454.

Ministry of Health and Social Welfare (MOHSW) [Lesotho] and ICF Macro (2010). *Lesotho Demographic and Health Survey 2009*. Maseru, Lesotho: MOHSW and ICF Macro.

Ministry of Health [Lesotho] and ICF International (2016). *Lesotho Demographic and Health Survey 2014*. Maseru, Lesotho: Ministry of Health and ICF International.

Moteetee, M.M., 2005. Report on the quality and responsiveness of health services to meet the needs of women in crisis settings. *WHO, June*, pp.1-8.

Mugomeri, E., Musa, N.K. and Chatanga, P (2016). "Heamoglobin response to routine iron and folate supplementation during pregnancy in an HIV-endemic rural area roma, Lesotho." Medical Technology SA **30**(1): 10-14.

Ngesa, O. and Mwambi, H (2014). "Prevalence and risk factors of anaemia among children aged between 6 months and 14 years in Kenya." PLoS One **9**(11): e113756.

Ngnie-Teta, I., Receveur, O. and Kuate-Defo, B (2007). "Risk factors for moderate to severe anemia among children in Benin and Mali: insights from a multilevel analysis." Food and Nutrition Bulletin **28**(1): 76-89.

Oguntibeju, O.O (2003). "Parasitic infestation and anaemia: The prevalence in a rural hospital setting." J Indian Acad Clin Med **4**: 210-212.

WHO (2015). "The global prevalence of anaemia in 2011."

Pita, G.M., Jiménez, S., Basabe, B., García, R.G., Macías, C., Selva, L., Hernández, C., Cruz, M., Herrera, R. and O'Farrill, R (2014). "Anemia in children under five years old in Eastern Cuba, 2005-2011." Medicc Review **16**(1): 16-23.

Population, C. and ICF, M (2011). "Lesotho 2009: results from the Demographic and Health Survey." Studies in family planning **42**(4): 305.

Santos, R.F.D., Gonzalez, E.S.C., Albuquerque, E.C.D., Arruda, I.K.G.D., Diniz, A.D.S., Figueroa, J.N. and Pereira, A.P.C (2011). "Prevalence of anemia in under five-year-old children in a children's hospital in Recife, Brazil." Revista brasileira de hematologia e hemoterapia **33**(2): 100-104.

Schneider, J.M., Fujii, M.L., Lamp, C.L., Lönnerdal, B., Dewey, K.G. and Zidenberg-Cherr, S (2008).

"The use of multiple logistic regression to identify risk factors associated with anemia and iron deficiency in a convenience sample of 12–36-mo-old children from low-income families–." The American journal of clinical nutrition **87**(3): 614-620.

Woldie, H., Kebede, Y. and Tariku, A (2015). "Factors associated with anemia among children aged 6–23 months attending growth monitoring at Tsitsika Health Center, Wag-Himra Zone, Northeast Ethiopia." Journal of nutrition and metabolism **2015**.

Yang, W., Li, X., Li, Y., Zhang, S., Liu, L., Wang, X. and Li, W (2012). "Anemia, malnutrition and their correlations with socio-demographic characteristics and feeding practices among infants aged 0–18 months in rural areas of Shaanxi province in northwestern China: a cross-sectional study." BMC Public Health **12**(1): 1127.

Yasutake, S., He, H., Decker, M.R., Sonenstein, F.L. and Astone, N.M (2013). "Anemia among adolescent and young women in low-and-middle-income countries." International Journal of Child Health and Nutrition **2**(2): 105-112.

Zhao, A., Zhang, Y., Peng, Y., Li, J., Yang, T., Liu, Z., Lv, Y. and Wang P (2012). "Prevalence of anemia and its risk factors among children 6–36 months old in Burma." The American journal of tropical medicine and hygiene **87**(2): 306-311.