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Prevalence and Risk Factors Associated with Anemia among Women of Childbearing Age in Rwanda

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Abstract

Anemia among women of child bearing age is a global public health problem. In developing countries such as Rwanda, women and their children may be particularly susceptible to anemia. The main objectives of this study were to assess the prevalence of anemia among women of reproductive age in Rwanda and to identify the risk factors associated therewith. The current study considered socio-economic, demographic and environmental factors and the 2014/2015 Rwanda Demographic and Health Survey data was used for this purpose. Due to the complexity of the sampling design, the present study used survey logistic model that takes account of sampling weight, stratification and clustering. The SAS statistical software was used for the analysis of the results. The anemia status was assessed among 6 680 women aged between 15 and 49 years old and the prevalence of anemia among women of this child bearing age group, was found to be 19.2%. The study also revealed that body mass index, contraceptive use, use of mosquito bed nets, marital status, wealth quintile of the household, size of the household, literacy, tobacco use, type of cooking fuel, type of toilet facilities, type of source of drinkable water, and province of residence, were all factors associated with anemia among women of reproductive age in Rwanda. Hence the current study highlights several health, geographical and socio-economic issues that can assist health care professionals and other relevant authorities in fostering an environment that reduces the risk of anemia for women and children. *(Afr J Reprod Health 2020; 24[2]: 141-151).*

Keywords: Anemia, women, survey logistic, Rwanda, RDHS 2014/15

Résumé

L'anémie chez les femmes en âge de procréer est un problème de santé publique mondial. Dans les pays en développement comme le Rwanda, les femmes et leurs enfants peuvent être particulièrement sensibles à l'anémie. Les principaux objectifs de cette étude étaient d'évaluer la prévalence de l'anémie chez les femmes en âge de procréer au Rwanda et d'identifier les facteurs de risque qui y sont associés. La présente étude a pris en compte les facteurs socio-économiques, démographiques et environnementaux et les données de l'enquête démographique et sanitaire du Rwanda 2014/2015 ont été utilisées à cette fin. En raison de la complexité du plan d'échantillonnage, la présente étude a utilisé un modèle logistique d'enquête qui tient compte du poids d'échantillonnage, de la stratification et du regroupement. Le logiciel statistique SAS a été utilisé pour l'analyse des résultats. Le statut anémique a été évalué chez 6 680 femmes âgées de 15 à 49 ans et la prévalence de l'anémie chez les femmes de ce groupe d'âge en âge de procréer s'est avérée être de 19,2%. L'étude a également révélé que l'indice de masse corporelle, l'utilisation de contraceptifs, l'utilisation de moustiquaires, l'état matrimonial, le quintile de richesse du ménage, la taille du ménage, l'alphabétisation, l'usage du tabac, le type de combustible de cuisson, le type de toilettes, le type de source d'eau potable et la province de résidence, étaient tous des facteurs associés à l'anémie chez les femmes en âge de procréer au Rwanda. Par conséquent, la présente étude met en évidence plusieurs problèmes de santé, géographiques et socio-économiques qui peuvent aider les professionnels de la santé et d'autres autorités compétentes à favoriser un environnement qui réduit le risque d'anémie pour les femmes et les enfants. *(Afr J Reprod Health 2020; 24[2]: 141-151).*

Mots-clés: Anémie, femmes, logistique d'enquête, Rwanda, RDHS 2014/15

Introduction

Anemia is a global public health problem among women of reproductive age, affecting both poor and rich countries. It is widely known that anemia has major negative consequences that impact on human health. It negatively affects the social and economic wellbeing of a country and all its communities. Anemia is an indicator of both poor nutrition and health[1]. Anemia among women of reproductive age has been associated with several morbidities such as stillbirth, preterm delivery, placenta abruption and low birth weight[2-5]. In addition, anemia is also associated with a higher risk of prenatal and maternal mortality[6]. Anemia is most prevalent among children below five years of age and in women in general. Globally the prevalence of anemia among women of reproductive age is estimated to be 29.4%[7]. This prevalence varies according to the geographical region. In the American region, the rate of prevalence of anemia is 16.8%, while in the European region it is 22.6%. The prevalence in the African region is 38.6% and, in the South–East Asian region, it is 41.9%[7]. In general, the prevalence of anemia among women of childbearing age in Rwanda has decreased over the last ten years. It was 26% in 2005 and decreased to 17% in 2010. However, recently the rate of anemia has increased slightly from 17% to 19%[8] making this a public health problem for Rwanda. According to WHO[9], iron deficiency is considered a public health concern if the prevalence of anemia exceeds 5% of the population. Women are generally known to be more vulnerable to iron deficiency causing anemia than men, worldwide. Anemia affects more than two billion people worldwide[9]. The type of anemia that is caused by iron deficiency affects people from every social class in society. It is, however, mostly related to a low educational level, poverty and a lack of access to food rich in iron[10]. But there are also some other causes of anemia among women of reproductive age, such as: literacy level, gender, income, age, body mass index (BMI), seasonality, and parasitological infections[11]. Some study[12] has found that there are certain diet components that are risk factors for anemia, such as folic acid, vitamin A, B12, C, as well as inadequate protein intake. Anemia due to folate and vitamin B12 deficiencies is also a public health burden. The prevalence rates of deficiencies in these diet components vary by country and world region[13].

The government of Rwanda developed various initiatives to eradicate anemia among women of reproductive age and children under five years of age. One example of such an initiative has been the promotion and introduction of biofortified crops among farmers since 2012, especially iron-biofortified beans. This strategy is relatively low cost and has positive impact on hemoglobin concentration in blood[14]. A recent study by Hass *et al*[15] on women at the University of Rwanda; Huye campus, their findings showed an increase of iron status among women who consumed iron-biofortified beans. There were campaigns launched against anemia and malnutrition, and twice-yearly, mother and child week events were held for vitamin A supplementation and deworming, food security strategies and improvement of child and maternal health and family in general.

There are a few studies in literature on the rates of anemia among women in Rwanda[16-17] but none of them were done nationwide. The main objective of the current study was to investigate the prevalence of anemia and to identify the risk factors associated with anemia among women of reproductive age in Rwanda. The study utilized the survey logistic regression model in the analysis, to account for sampling weight, stratification and clustering. Hence, a secondary objective was thus to exemplify the survey design modeling complex survey data. There is also no study in literature using survey logistic regression to identify the risk factors for anemia among women of childbearing age at a national level in Rwanda.

Methods

Source of data

The data used in the present study was sourced from the 2014/15 Rwanda Demographic and Health Survey and this data was previously described by Habyarimana *et al*[18]. The sampling used in this survey was a two-stage stratified

method. In the first stage, 113 enumeration areas (known as villages or clusters) were selected from urban areas and 379 from rural areas, with the probability proportional to the number of households residing in the village. In the second stage, systematic sampling was used for all households existing in the selected village where 26 households were selected from each village[8]. In total, 12 792 households were selected which had 13 487 women aged 15–49 years of age and 7 856 children under five years of age. More details on sampling techniques and data collection can be found in a study by NISR[8]. A hemoglobin measurement was done on all women of reproductive age (15–49 years old) and children under five years of age (6–59 months) for whom consent was obtained.

Outcome variable

The dependent variable of interest in the present study was anemia status. The anemia status is classified based on the level of hemoglobin concentration (Hb) in blood, measured in grams per deciliter (g/dL). It was classified as severe if Hb< 8.0, moderate when hemoglobin concentration was 8.0–10.9, mild if hemoglobin concentration is 11–11.9 and not anemic when (Hb $\geq$ 12.0) for non-pregnant women. In pregnant women, it is also classified as severe if Hb < 7.0, moderate when (7.0 $\leq$ Hb $\leq$ 9.9), mild if (10$\leq$ Hb $\leq$ 10.9) and not anemic when (Hb $\geq$ 11.0)[7]. In the current study, a woman of reproductive age (15–49 years old) was classified as anemic if her hemoglobin concentration in blood adjusted for both altitude and smoking, was less than 12g/dl and she was considered no anemic otherwise.

Independent variables

This study considered demographic, socio-economic and environmental factors and these factors were used in various other related studies concerning anemia among women[19-21]. Therefore this formed the theoretical framework of this study and the potential independent variables were: age of the respondent (categorized in years: 15–24, 25–34, 35–49), her BMI, household wealth quintiles (poor, middle, rich), size of the household (number of household members), contraceptive use, tobacco use, type of toilet facilities (no toilet, pit latrine with slab, pit latrine without slab or open, ventilated improved pit latrine (VIP), others), type of source of drinking water (piped into dwelling or yard, public tap, unprotected well, protected well, unprotected spring, protected spring, rivers, others), type of cooking fuel (charcoal, wood, straw/grass/shrub, others), place of residence (rural or urban), province of residence (Kigali, South, West, North, East), use of bed nets (yes, no), marital status (never married, married, formally married), pregnancy (yes, no), literacy (literate, not), use of drugs, malaria onset in pregnancy (yes, not), the respondent's education level (no education, primary, secondary and more), breastfeeding (yes, not).

Statistical analysis

The surveys done based on multi-stage sampling, stratified and cluster sampling with unequal probability of selection for elements to be included in the survey are known as complex survey design. When modeling the data collected from these surveys, the complexity of the sampling design must be taken into consideration[22,23]. Therefore, in order to account for the effect of stratification, clustering, sampling weights and to relax the assumption of independence of observation of the ordinary logistic regression model, the present study used a survey logistic regression model for the data analysis. Failure to account for clustering and sampling weights may lead to underestimation of the variability and consequently, wrong inference. In general, the theory of ordinary logistic regression and survey logistic regression is the same; they only differ in variance estimation. They are both members of the generalized linear models, and a maximum likelihood is used to estimate the parameters. The model formulation used in this study is discussed in detail as follows:

Let y_{ikm} denote the anemia status of woman i from stratum k and cluster m, with $i = 1, 2, 3, \dots, 6680$, $k = 1, 2, 3, \dots, 60$ and $m = 1, 2, 3, \dots, 492$. The outcome variable is defined as a dichotomous variable such that $y_{ikm} = 1$ if the women i is anemic and $y_{ikm} = 0$ otherwise. The current study assumes that the outcome variable

y_{ikm} is Bernoulli distributed as $y_{ikm}|\boldsymbol{\mu_{ikm}} \sim Bernoulli\ (\boldsymbol{\mu_{ikm}})$, where $\boldsymbol{\mu_{ikm}}$ is known as mean and it is given by $E(y_{ikm}) = \boldsymbol{\mu_{ikm}}$, and it is related to the covariates as follows: $g(\boldsymbol{\mu_{ikm}}) = \boldsymbol{X'_{ikm}\beta} + \boldsymbol{U'_{ikm}\gamma}$

where g(.) is the logit link function, $\boldsymbol{\beta}$ is a p-dimensional vector of regression of categorical independent variables and $\boldsymbol{\gamma}$ is a q-dimensional vector of regression coefficient for the continuous independent variables.

The analysis in the present study was done using SAS Proc Surveylogistic from SAS software version 9.4. The Taylor series method was used as variance estimator. The model fit statistics was done based on Akaike information criteria (AIC) and -2 Log-Likelihood (-2LogL) principles. The model test was done based on Likelihood ratio, score and the Wald test principles.

Results

The preliminary data exploratory analysis was done based on cross-tabulation analysis and the results are summarised in Table 1. The results showed a significant statistical association between anemia among women of childbearing age and tobacco use, BMI, marital status, mosquito bed net use, wealth quintiles, pregnancy, respondent education, type of toilet facilities, type of source of drinking water, cooking fuel, place of residence, province of residence, contraceptive use, literacy and the taking of drugs of malaria during pregnancy. The global prevalence of anemia among women of reproductive age in Rwanda was 19.2%. The minimum number of members per family was 1 and the maximum number was 22, with the mean at 5.24 and the standard deviation error at 0.018. It was observed from the table that the prevalence of anemia was higher among smoking women than among non-smoking women in Rwanda (36.0% and 19.1% respectively, p-value=0.000). The prevalence of anemia was also higher among underweight women (26.2%) than among normal and obese women (18.2%). The results also showed that the prevalence of anemia was higher among formerly married women (24.0%) than women who married at the period of survey (19.1%). The prevalence of anemia also varied with the household wealth quintile in Rwanda. The results revealed that the prevalence of anemia was higher among women from poor families (22.5%) and lower among women from rich families (16.4%). It was also found that the prevalence of anemia among women of reproductive age in Rwanda varied according to bed net use (p-value=0.000). It was 18.1% among women who used bed nets and 21.5% among the women who did not use bed nets. The prevalence of anemia was higher among pregnant women (23.4%) and lower among non-pregnant women (18.9%, p-value=0.015). The results showed that the prevalence of anemia among women of reproductive age reduced with increasing level of education among the woman (p-value=0.044).

The results also showed that the prevalence of anemia varied with the type of source of water used (p-value=0.000). It was higher among women who used water from unprotected well 30.7 % and protected well 30.0 % and lower among women who used water piped into the dwelling or yard 17.7%.

It was observed from Table 1 that the prevalence of anemia was higher among women who took drugs for malaria in pregnancy (29.4% and 17.6% respectively, p-value=0.000). The prevalence of anemia also varied with literacy. It was observed from the table that the prevalence of anemia was 22.2% among illiterate women against 18.2% among literate women. The prevalence of anemia was higher among women who did not use contraceptive methods (21.1%) compared to women who used a contraceptive method (15.0%). The prevalence of anemia was higher among women who used cooking fuel other than charcoal, wood or straw/grass and/or shrubs (32.8%) and lower among women who used charcoal (17.0%).

The prevalence of anemia among women of reproductive age in Rwanda was higher among women from households without toilets (22.6%) and lower among women from households who had ventilated improved pit latrines (15.8%).

Model fit is presented in Table 2, where AIC and -2LogL were smaller for the full model compared to the model with intercept only, which means the full model was the better model fit. The global null hypothesis was tested in Table 3, where the likelihood ratio, score and Wald tests

Table 1: The prevalence of anemia with respect to various demographic, socio-economic and environmental factors by category among women of reproductive age in Rwanda

Variable	Categories	Anemic		P-value
		Yes (%)	No (%)	
Current pregnancy	Yes	115 (19.2)	376 (80.8)	.015
	No	1170 (18.9)	5019 (81.1)	
Age in years	15–24	500 (19.1)	2111 (80.9)	0.098
	25–34	393 (18.1)	1784 (81.9)	
	35–49	392 (20.7)	1500 (79.3)	
Currently breastfeeding	Yes	366 (19.3)	1527 (80.7)	.898
	No	919 (19.2)	3868 (80.8)	
Smoking	No	1250 (19.1)	5345 (80.9)	.000
	Yes	27 (36.0)	48 (64.0)	
BMI (kg/m^2)	Underweight (BMI<18.5)	1176 (18.8)	5088 (81.2)	.000
	Normal or obese (BMI ≥18.5)	107 (26.2)	301 (73.8)	
Marital status	Never married	485 (19.1)	2058 (80.9)	
	Currently married	625 (18.2)	2809 (81.8)	
	Formerly married	174 (24.8)	529 (75.2)	
Wealth index	Poor	589 (22.5)	2033 (77.5)	.000
	Middle	235 (18.8)	1013 (81.2)	
	Rich	460 (16.4)	2349 (83.6)	
Bed net use	Yes	815 (18.1)	3680 (91.9)	.000
	No	470 (21.5)	1715 (78.5)	
Respondent education	No education	179 (22.5)	618 (77.5)	0.044
	Primary	824 (19.1)	3491 (80.9)	
	Secondary and higher	281 (17.9)	1286 (82.1)	
Type of source of drinking Water	Piped into dwelling/ yard	130 (17.7)	606(82.3)	
	Public tap	317 (18.3)	1415 (81.7)	
	Unprotected well	46 (30.7)	104 (69.3)	
	Protected well	36 (30.0)	84 (70.0)	
	Unprotected spring	393 (19.3)	1645(80.7)	
	Protected spring	165 (19.8)	654 (80.2)	
	River/dam/lake/ponds/ stream/canal	149 (18.2)	669 (81.8)	
	Others	29 (18.4)	129 (81.6)	
Cooking fuel	Charcoal	196 (17.0)	959 (83.0)	.000
	Wood	809 (18.7)	3511 (81.3)	
	Straw/grass/shrub	235 (23.0)	787 (77.0%)	
	Others	22 (32.8)	45 (67.2)	
Place of residence	Urban	217 (16.4)	1108 (83.6)	0.003
	Rural	1068 (19.9)	4287 (80.1)	
Province of residence	Kigali	133 (14.8)	766 (85.2)	.000
	South	367 (22.9)	1238 (77.1)	
	West	258 (17.9)	1183 (82.1)	
	North	167 (15.3)	921 (84.7)	
	East	359 (21.8)	1287 (78.2)	
Contraceptive use	Yes	308 (15.0)	1745 (85.0)	.000
	No	976 (21.1)	3651 (78.9)	
Literate	Yes	882 (18.1)	3985 (81.9)	.000
	No	401 (22.2)	1403 (77.8)	
Drug for malaria in pregnancy	Yes	70 (29.4)	168 (70.6)	.000
	No	481 (17.6)	2251 (82.4)	
Type of toilets	No toilet	57 (22.6)	195 (77.4)	.000
	Pit latrine with slab	757 (18.2)	3404 (81.8)	
	Pit latrine without slab/open	324 (20.7)	1238 (79.3)	
	VIP latrine	59 (15.8)	315 (84.2)	
	Others	64 (30.8)	144 (69.2)	

Table 2: Model fit

Criterion	Intercept only	Intercept and covariates
AIC	6377.771	6268.112
SC	6384.556	6464.871
-2 Log L	6375.771	6210.112

Table 3: Testing global null hypothesis

Test	F Value	Num DF	Pr > F
Likelihood Ratio	5.17	25.3420	<.0001
Score	5.22	28	<.0001
Wald	5.59	28	<.0001

were all highly significant (p-value <.0001) and this means that all parameters are not zero.

The results from multivariate survey logistic regression are summarised in Table 4. The findings of this study revealed that the age of the respondent, her BMI, her literacy level, her tobacco use status, use of mosquito bed nets, use of contraceptive methods, province of residence, the wealth quintile of her household, type of cooking fuel, type of toilet facilities and type of drinking water source, were risk factors associated with anemia among women of reproductive age in Rwanda.

The body mass index was significantly associated with a higher risk of anemia in women of reproductive age in Rwanda (p-value=0.0146). The risk of anemia was 0.74 (OR: 0.739) times less among women of normal weight as compared to underweight women (BMI <18.5kg/m^2). The study revealed that marital status was significantly associated with increased risk of anemia among women of reproductive age. A woman formerly married was 1.337 (p-value=0.0043) times more likely to be anemic than a non-married woman. The findings also showed that a currently married woman was 1.21 (p-value=0.0237) times more likely to be anemic than a non-married woman.

It is observed from Table 4 that the likelihood of becoming anemic among women of reproductive age in Rwanda reduces with the increasing family wealth quintile. Wealth quintile of the household was a significant factor affecting the anemia status of women of reproductive age in Rwanda. It was observed that a woman from a poor household was 1.4 (OR= 1.405, p-value=0.0003) times more likely to be anemic than a woman from a rich family. The study did not find a significant statistical effect between middle wealth quintile and a rich family, but the coefficient was positive and this means that anemia is higher among women from the middle wealth quintile than women from rich families.

Tobacco use was significantly associated with risk factors of anemia (p-value= 0.0464). The study revealed that a woman who did not use tobacco was 0.617 times less likely to be anemic compared to a woman who did. Contraceptive use was significantly associated with the increased risk of anemia among women of reproductive age in Rwanda (p-value <.0001). It can be observed from Table 4 that a woman who did not use a contraceptive method was 1.6 (OR=1.586,) times more likely to be anemic compared to a woman who had used a contraceptive method. Literacy had a significant effect on the anemia status of women of reproductive age in Rwanda (p-value=0.0289). The risk of anemia was 1.18 times higher in illiterate women as compared to literate women (OR: 1.179 (CI: 1.017 1.366)).

The size of the household was also found to be a significant risk factor associated with anemia among women of reproductive age. The results revealed that for a unit increase in family size, the odds of anemia increased by 5% (OR: 1.045, p-value=0.0088). Province of residence had a significant effect on anemia status. It was observed from the results that a woman from Southern Province and Eastern Province was 1.526 and 1.483 respectively (p-value=0.0040 and p-value=0.0072) more likely to be anemic than a woman from Kigali City.

Type of toilet facilities was significantly associated with the risk of anemia among women of reproductive age in Rwanda. The results from the study revealed that having any type of toilet reduces the risk of anemia. The risk of anemia was 0.6 times lower among women from households with a pit latrine with slab, as compared to women from a household without a toilet (or toilet facilities) (OR: .591 (0.391 0.895)). The risk of anemia was 0.7 (OR=0.693, p-value=0.0290) times lower among women from a household with other types of toilets (not Pit latrine without slab/open, not Pit latrine with slab and not Ventilated improved pit latrine) compared to a woman from a household with no toilet facilities.

Table 4: Demographic, socio-economic and environmental factors associated with anemia among women of reproductive age in Rwanda from multivariate survey logistic regression

Parameter	Estimate	Standard Error	P-value	Odds ratio (OR) (95% CI)
Intercept	-1.8850	0.3968	<.0001	
Size of the household	0.0439	0.0167	0.0088	1.045 (1.011 1.080)
BMI(Kg/m^2) (<18.5=ref)				
≥18.5	-0.3020	0.1231	0.0146	0.739 (0.580 0.942)
Marital status (never married=ref)				
Currently married	0.1907	0.0840	0.0237	1.210 (1.026 1.427)
Formerly married	0.2906	0.1012	0.0043	1.337 (1.096 1.632)
Wealth index (rich=ref)				
Poor	0.3400	0.0939	0.0003	1.405 (1.168 1.690)
Middle	0.1696	0.1081	0.1174	1.185 (0.958 1.465)
Type of cooking fuel (wood=ref)				
Charcoal	0.1656	0.1327	0.2128	1.180 (0.909 1.532)
Straw/grass/shrub	0.0836	0.0990	0.3993	1.087 (0.895 1.321)
Others	0.6449	0.2464	0.0092	1.906 (1.174 3.093)
Literate (yes=ref)				
No	0.1644	0.0750	0.0289	1.179 (1.017 1.366)
Contraceptive use (yes=ref)				
No	0.4615	0.0845	<.0001	1.586 (1.344 1.873)
Provinces (Kigali=ref)				
South	0.4136	0.1469	0.0051	1.512 (1.133 2.018)
West	-0.00249	0.1542	0.9871	0.998 (0.737 1.351)
North	0.1211	0.1523	0.4268	1.129 (0.837 1.523)
East	0.3918	0.1457	0.0074	1.480 (1.111 1.970)
Toilet facilities (No toilet=ref)				
Pit latrine without slab/open	0.0502	0.2244	0.8232	1.051 (0.676 1.634)
Pit latrine with slab	-0.4863	0.2117	0.0221	0.615 (0.406 1.634)
Ventilated improved pit latrine	-0.2349	0.1544	0.1288	0.791 (0.584 1.071)
Other type	-0.2951	0.1742	0.909	0.744 (0.529 1.048)
Type of source of drinking water (Piped into dwelling/yard=ref)				
rivers/dam/lake/stream/canal	0.3517	0.1756	0.0459	1.421 (1.007 2.008)
Public tap	0.1650	0.1415	0.2441	1.179 (0.893 1.557)
Protected well	0.5214	0.2194	0.0179	1.684 (1.094 2.592)
Unprotected well	0.5743	0.2985	0.0550	1.776 (0.988 3.193)
Protected spring	0.1792	0.1385	0.1962	1.196 (0.911 1.570)
Unprotected spring	0.2107	0.1648	0.2018	1.235 (0.893 1.707)
Others	0.1291	0.2753	0.6392	1.138 (0.662 1.955)
Bed net use (yes=ref)				
No	0.1531	0.0749	0.0414	1.165 (1.006 1.350)
Tobacco use (yes=ref)				
No	-0.4834	0.2421	0.0464	0.617 (0.383 0.992)

Type of source of drinking water was also found to be a significant factor associated with anemia among women of reproductive age in Rwanda. The results showed that the risk of anemia was 1.7 times more among women from a family where they used well water (OR: 1.685 (CI: (1.095 2.592), p-value=0.0177) compared to women who used water piped into the dwelling. The risk of anemia was 1.4 times more likely among women from the family who used the water from rivers/dam/lake/stream/canal (OR: 1.421, p-value=0.0459) compared to women from the family who used water piped from the dwelling.

A geographical factor, such as province of residence was also found to be a significant risk factor for anemia. The risk of anemia was 1.48 times more likely among women from Eastern province compared to women from Kigali (OR: 1.483 (1.113 1.974), p-value=0.0072). It was observed from Table 4 that a woman from

Southern Province was 1.53 times more likely to be anemic as compared to a woman from Kigali City (OR: 1.526 (1.145 – 2.034), p-value=0.0040). Type of cooking fuel was also found to be a significant risk factor for anemia among women of reproductive age. The results showed that women from a household where they used cooking fuel other than charcoal and straw/grass/shrub were 1.9 times more likely to be anemic compared to women from the households where they used wood (OR: 1.9606, p-value=0.0092). The study also found a significant association between mosquito bed net use and anemia status, among women of reproductive age (p-value=0.0414). The results showed that the risk of anemia was 1.165 times greater among women who did not use bed nets than women who did use bed nets.

Discussion

The prevalence of anemia among women of reproductive age is one of the major problems of public health that is especially common in developing countries. The knowledge of all the risk factors associated with anemia among women of childbearing age provides insight into the methods and policies that can be used to fight this public health problem effectively.

The current study was carried out based on the 2014/15 Rwanda Demographic and Health Survey (RDHS) data set. A survey logistic regression model was used to assess the risk factors associated with anemia among women of reproductive age. This model accounts for sampling weights, stratification and clustering and relaxes the assumption of independence of observations violated by ordinary logistic regression.

The following socio-economic, demographic and environmental factors had a significant statistical association with anemia in the multivariate survey logistic regression model; namely BMI, marital status, literacy, smoking status, contraceptive use, the size of the household, wealth quintile of the household, province of residence, bed net use, type of cooking fuel, type of toilet facilities, and type of drinking water source. The study tried various two-way interaction effects, but none was significant.

The results of this study, in general, agreed with other findings from related studies. It was observed from the analysis that BMI had a significant effect on anemia status. The results showed that an underweight woman was more likely to be anemic than a normal, overweight or obese woman. This finding is consistent with the results from other studies[20,21,24-27]. Even though higher BMI may not always imply better micronutrient intake, underweight ($BMI<18.5g/m^2$) people are more likely to have other associated co-morbidity illness and consequently found to be deficient in some essential micronutrients which may be then be associated with anemia.

The findings from this study also revealed that the marital status of the woman had a significant effect on the anemia status of the woman. The results from this study showed that the risk of having anemia was higher among women formerly married compared to non-married women. Similar results were found also among married women, where the risk of having anemia was higher among married women than among non-married women. But in a study carried out in Kano in northern Nigeria by Nwizu *et al*[28], it was found that married women were less likely to be anemic compared to single or divorced women.

It was observed from the results of this study that the risk of having anemia among women of reproductive age in Rwanda increased with increasing numbers of family members. Similar findings have been reported[29]. The direct reason may be low family income that is disproportional to the family size and may cause food insecurity and insufficient health care for the family.

It was observed from the analysis that the risk of anemia among women lessened with the use of mosquito bed nets. Women who used bed nets were less vulnerable to anemia compared to women who did not use bed nets. The use of bed nets in this study was used as a proxy for malaria infection. It has been reported that the prevalence of malaria was higher among people who did not use bed nets than people who used them. In a study done in Sierra Leone by Wirth *et al*[30], it was

found that malaria and inflammation were each associated with anemia.

The results from this study showed that the risk of anemia was higher among women from poor households than among women who live in rich families. This finding is similar to others[8,20,31]. This might be due to the fact that poorer households may not be able to afford enough healthy food. The study, however, did not find a significance difference between women from middle wealth quintile households and women from rich households. The results also showed that tobacco use had a significant impact on a woman's anemia status. Similar observations were made by Singh[32]. The results from this study showed that literacy had a significant effect on anemia status, this observation was found elsewhere[33]. Anemia was higher among illiterate women than among literate women and this might be since a literate woman may access information more easily on aspects such as maternal healthcare services and on nutritional education that may then help her to protect herself against anemia[34]. Furthermore, a literate woman may generate an income for the household which in turn contributes to her well-being and that of her family in general. The education level is known to have an important effect on the socio-economic context of anemia prevalence, especially in developing countries but the present study did not find a statistically significant association between education levels and anemia.

The results from this study showed a significant association between contraceptive method use and anemia status. The risk of having anemia was found to be lower among women currently using contraception methods, then among those women who did not use contraceptive methods. This finding was reported in other related studies[20,35-37].

The findings of this study showed that the province of residence had a significant effect on the anemia status of a woman. Women from Eastern Province and from Southern Province were found to be more likely to be anemic than women from Kigali City. This finding is consistent with other findings[8]. This may be since the malaria prevalence rates listed in the RDHS 2014/15 were higher in these provinces when compared to Kigali City[8]. In addition, women from Kigali City may access information on maternal healthcare more easily and be better able to access medical infrastructure and services, than women from other regions of the country.

This study revealed a significant association between toilet facilities and anemia status among women of reproductive age in Rwanda. This finding agrees with other study[20]. Women from households without toilet facilities have an increased risk of infection by hookworms and parasites[19,38] and this supports our findings, which are that the lack of toilet facilities in households or communities directly increases the risk of anemia. The association of unhygienic toilet conditions with anemia can also be explained in general, by poor health or chronic blood loss through gastrointestinal parasite infection[20].

The present study did not find any statistically significant association between pregnant or breastfeeding women, amenorrhea, education level, number of children ever born, age of the respondent and place of residence and anemia among women of reproductive age in Rwanda in multivariate survey logistic regression.

Conclusion

The main objective of this study was to identify the risk factors associated with anemia and the prevalence of anemia among women of reproductive age in Rwanda. The analysis was done using a survey logistic regression model, to account for sampling weights, stratification and clustering. The study revealed that BMI, marital status, literacy, tobacco use, contraceptive use, the size of the household, wealth quintile of the household, province of residence, mosquito bed net use, type of cooking fuel, type of toilet facilities, and type of drinking water source, were determinants of anemia among women of reproductive age in Rwanda. The findings from the present study can aid policy makers and public health-related institutions when initiating strategies for reducing the prevalence of anemia among this specific population group in Rwanda.

Limitations

The current study used cross-sectional data from the Rwanda Democratic Health Survey (RDHS) for 2014/2015 and this data may not be able to address causality. Therefore, longitudinal studies that will solve this problem are suggested for future work. Also, we were interested to use data on dietary intake but the RDHS data set does not provide this information on individuals surveyed. Therefore, longitudinal studies that will solve these problems are suggested for future work.

Ethical Considerations

This study does not involve any experimental or interaction with human or animal subjects. The study uses secondary data from 2014/2015 RDHS. The 2014/15 RDHS was reviewed and approved by Rwanda National Ethics Committee, National Institute of Statistics of Rwanda and International Review Board of ICF International. We were granted permission by ICF international, Inc. to use these deidentified data.

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