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MULTILEVEL LOGISTIC REGRESSION ANALYSIS OF FACTORS ASSOCIATED WITH ACUTE RESPIRATORY INFECTION (ARI) AMONG UNDER-FIVE CHILDREN IN ETHIOPIA

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ABSTRACT

Acute respiratory tract infection (ARI) is considered as one of the major public health problems and it's recognized as the leading cause of mortality and morbidity in many developing countries. The greatest problem for developing countries is mortality from ARI in children less than five years of age. This study is an attempt to identify socio-economic, demographic, health, environmental and nutritional related predictors of ARI among under-five children in Ethiopia. In this study the data source is Ethiopian Demographic and Health survey (EDHS, 2011) conducted by Central Statistics Agency (CSA). From the sampled children, the two weeks prevalence of ARI among under-five children was about 12.3% in Ethiopia. The result of the analysis showed that fuel used for cooking, current age of the child, received vitamin A recently, underweight, wasting, region, had Diarrhea recently, number of under five children, mother currently working and household wealth index are significant risk factors of under five children in Ethiopia. The multilevel analysis showed that the variance of the random component related to the intercept term was found to be statistically significant implying difference in prevalence of ARI among the regions. It also found that fuel used for cooking, current age of the child, received vitamin A recently, underweight, wasting, region, had Diharria recently, number of under five children, mother currently working and household wealth index were significant determinant of variations of prevalence of ARI among regions. However, the significant predictors did not show underlying variation from region to region.

KEYWORDS: Acute respiratory infection, under-five children, multilevel logistic regression.

1. INTRODUCTION

Respiratory infections are infections in any area of the respiratory tract, including the nose, middle ear, throat (pharynx), voice box (larynx), windpipe (trachea), air passages (bronchi or bronchioles), and lungs**.** Acute Respiratory Infections (ARIs) are a group of diseases that includes pneumonia, influenza, and respiratory syncytial virus (RSV), and result in 4.25 million deaths worldwide every year. Pneumonia is the most serious outcome of ARI in young children which makes the body prevent from getting oxygen and can result in death**.** ARIs are also the leading cause of illness in children and their leading killer.[1]

The early symptoms of acute respiratory infection usually appear in the nose and upper lungs. Other symptoms include cough, runny nose and sore throat. If the disease advances, there may be high fever and chills and other serious symptoms are difficulty breathing, dizziness, low blood oxygen level and loss of consciousness. Also, acute respiratory infections are infectious, which means they can be spread from one person to another. So, ARIs may be spread through viruses and bacteria that are commonly found in a child's nose or throat, can infect the lungs if they are inhaled. They may also spread via air-borne droplets from a cough or sneeze. In addition, pneumonia may spread through blood, especially during and shortly after birth.[2]

Ethiopian children suffer four to eight episodes of ARI on average every year, with the highest occurrence in urban areas in overcrowded living conditions. In rural Ethiopia, 20% of the deaths of children aged under-five years and more than 30% of the infant deaths under one year are due to ARIs. A better knowledge of ARIs will enable us to detect children with an ARI more quickly and give appropriate treatment, or refer them if the disease is severe.[3]

Even though the problem of child morbidity due to ARI has been sufficiently documented, the reasons behind it are still poorly understood. There is also inconsistency across studies regarding the determinants factor behind occurrence of ARI in under-five children. Therefore, this study attempts to investigate the major socio-economic, demographic, health, environmental and nutritional related determinate of ARI in Ethiopia.

ARI cannot be tackled without understanding its causes that is why the study is crucial to assess the prevalence of ARI and identify underling factors of ARI among under-five children in Ethiopia. In line with the above reality, the study attempted to come up with possible solution and recommendation after having clear understanding upon the situation by giving due emphasis to answer the following research questions.

1. Are socio-economic, demographic, environmental and nutritional related proximate characteristics related to experiencing ARI?
2. Do regions differ in incidence of ARI among under-five children?
3. Do factors influencing incidence of ARI among under-five children differ through regions?

The fourth Millennium Development Goal (MDG) target of reducing under-five mortality rate by two thirds by 2015 has renewed interest in accurate assessment of the numbers of children affected and underlying causes. Additionally information is needed to deal with acute respiratory infection, one of the main killers of under-five children in the developing world. Therefore this study will show the burden of ARI in under-five children in Ethiopia. Therefore, this study investigate the major determinate and their strength of association with occurrence of ARI under-five children in Ethiopia, which help to formulate the health promotional policies in future that will ultimately help to reduce the under – five mortality and morbidity due to ARI.

2. MATERIAL AND METHODS

The data for this study was obtained from Ethiopian Demographic Health Survey.[4] EDHS is a part of worldwide Demographic Health Survey Project which is funded by the United State Agency for International Development (USAID). The 2011 EDHS is the third major survey that was carried out under the aegis of Ministry of Health (MOH) and was implemented by Central Statistics Agency (CSA).

In 2011 (EDHS) a representative sample of approximately 17,817 households from 624 clusters was selected through the 11 regions and 2 administrative cities. The sample was selected in two stages. In first stage, 624 clusters (187 urban and 437 rural) were selected from the list of Enumeration Area (EA). The sample for this study will be consists of 11,654 under-five children, from which only 9,416 of them will be measured for complete anthropometric measurements height and weight. Thus, the analysis for this study on the occurrence of acute respiratory infection will be presented based on the 9,416 under-five children with complete anthropometric measurements;

In this study, the dependent variable will be ARI, coded as 1 if the child suffered from ARI in the two weeks prior to the survey date and 0 if otherwise. A child will be consider as having experience of ARI if the mother reported that the child had a cough in the last two weeks preceding the survey date along with short and rapid breathing. The symptoms are compatible with ARIs.

Therefore the i^{th} child is represented by a random variable Y_i, with two possible values coded as 1 and 0. Hence, the response variable for the i^{th} child is measured as a dichotomous variable

$$Y_i = \begin{cases} 1, & if\ the\ i^{th} \text{ child suffered from ARI} \\ 0, & Otherwise \end{cases}$$

Independent variables

Three major categories of factors were assessed as independent variables;

Socio- demographic and economic Characteristics; mother's education, wealth index, employment status and age of the mother; sex, age, birth order of the child and number of under-five children.

Health, environmental and nutritional related characteristics; had diarrhea recently, wasting (acute malnutrition), stunting (chronic malnutrition), underweight, duration of breast feeding, fuel used for cooking, place of residence and geographical region are important health and environmental characteristics that had been included in this study.

Binary Logistic Regression

Regression methods are essential to any data analysis which attempts to describe the relationship between a response variable and any number of predictor variables. Thus logistic regression is used in a wide range of applications leading to binary dependent data analysis.[5] The estimated coefficients tell us the increased or decreased chance of a child having ARI given a set of level of the determinant factors while controlling for the effects of other variables in the model.

The logistic regression model for explaining data is given by,

$$P_i = P(y_i = 1|x_i) = \frac{e^{X_i\beta}}{1+e^{X_i\beta}} = \frac{\exp(\beta_0+\beta_1x_{11}+\beta_2x_{12}+\cdots+\beta_px_{1p})}{1+\exp(\beta_0+\beta_1x_{11}+\beta_2x_{12}+\cdots+\beta_px_{1p})}, i = 1, 2, \ldots, n$$

Where, $P(y_i = 1|x_i)$ is the probability of i^{th} child having ARIs given child's characteristics x_i, and $\beta \epsilon R^p, \beta = (\beta_0, \beta_1, \ldots, \beta_p)^T$ is a vector of unknown logistic regression coefficients with dimension of $(p+1)x1$.

Multilevel Logistic Regression model

Multilevel analysis is a methodology for the analysis of data manifesting complex variability, with a focus on nested source of variability. The best approach to the analysis of multilevel data is an approach that represents within-group as well as between group relation within a single level analysis, where 'group' refers to the units at the higher levels of the nesting hierarchy. Probability models are used to represent the within-group and between-group variability. In other word, we conceive of variation within groups and variation between groups as random variability.

In this study we considered two-level hierarchical analysis where children's are nested within regions. The modeling for such hierarchical data can be expressed by statistical models called random coefficient models. Multilevel analysis is an approach to analyzing such hierarchical data. The main statistical model of multilevel analysis is the hierarchical generalized linear model, for example multilevel logistic regression is an extension of the generalized linear model that includes random coefficients.

To keep the discussion on multilevel logistic regression models simple and taking in to account the data to be analyzed in this study we concentrate on the case of two-levels. Since multilevel model allow not only independent variable at any level of hierarchical structure but also at least one random effect above one level group [6]. In this study the basic data structure of the two-level logistic regression is a collection of N groups (regions) and within –group j (j=1, 2 , …,N) a random sample of n_j level-one unit (under-five children). The binary outcome variable coded "0" or "1", absence or presence of ARI, associated with two-level units i nested within level two unit j. Assume p_{ij} will be the probability that the response variable equals 1, $p_{ij} = P(y_{ij} = 1/x_{ij}, U_j)$represent the probability of having ARI for children i in the region j and also 1-p_{ij} is the probability of i[th] children not having ARI in then j[th] region. Like the ordinary logistic regression, p_{ij} is modeled using the link function, logit.

The two-level logistic regression model can be given as:

$$logit(p_{ij}) = log\left[\frac{P_{ij}}{1-P_{ij}}\right] = \beta_0 + \beta_1 X_{ij} + U_{oj}$$

Where U_{oj} is the random effect at level 2 without U_{oj} equation can be considered as a standard logistic regression model. Therefore, conditional on U_{oj}, the Y_{ij}'s can be assumed to be independently distributed as Bernoulli random variables. Here U_{oj} a random quantity and follows a normal distribution with umean zero and variance σ_u^2.[6]

By rearranging equation (3.12), we can split into two models; one for level 1 and other for level2.

$$logit(p_{ij}) = log\left[\frac{P_{ij}}{1-P_{ij}}\right] = \beta_{oj} + \beta_1 X_{ij} \text{ [Model: level 1]}$$

$$\beta_{oj} = \beta_o + U_{oj} \text{ [Model: level 2]}$$

Estimation of Between and Within- Groups Variance

The true variance between the group dependent probabilities, i.e. the population values of $Var(P_j)$, is given by:

$$\hat{\tau}^2 = S^2_{between} - \frac{S^2_{within}}{\tilde{n}}$$

Where $\tilde{n}$ is defined as: $\tilde{n} = \frac{1}{N-1}\left\{M - \frac{\sum_{j=1}^{N} n_j^2}{M}\right\}$

The within group variance in case of a dichotomous outcome variable is a function of group averages which is given by:

$$S^2_{within} = \frac{1}{M-N}\sum_{j=1}^{N} n_j p_j (1-p_j)$$

Empty Logistic Regression Model

This is expressed, for a general link function $f(p_j)$ is

$$f(p_j) = \beta_o + U_{oj}$$

Where β_o is the population average of the transformed probabilities and U_{oj} it is the random deviation from this average for group j. If $f(p)$ is the logit function, then $f(p_j)$ is just the log-odds for group j. Thus, for the logit link function, the log-odds have a normal distribution in the population of groups, which is expressed by:

$$logit(p_j) = \beta_o + U_{oj}$$

Random Intercept Model

The random intercept model expresses the log-odds, i.e. the logit of P_{ij}, as a sum of a linear function of the explanatory variables. That is,

$$logit(P_{ij}) = log\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_{oj} + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \cdots + \beta_k x_{kij}$$

$$= \beta_{oj} + \sum_{h=1}^{k} \beta_h x_{hij}$$

Where the intercept term $\beta_{oj}$is assumed to vary randomly and is given by the sum of an average intercept $\beta_o$and group-dependent deviations U_{oj}, that is

$$\beta_{oj} = \beta_o + U_{oj}$$

As a result we have:

$$logit(P_{ij}) = \beta_o + \sum_{h=1}^{k} \beta_h x_{hij} + U_{oj}$$

Solving for P_{ij} we have:

$$P_{ij} = \frac{e^{\beta_o + \sum_{h=1}^{k} \beta_h X_{hij} + U_{oj}}}{1 + e^{\beta_o + \sum_{h=1}^{k} \beta_h X_{hij} + U_{oj}}}$$

Thus, a unit difference between the X_h values of two individuals in the same group is associated with a difference of β_h in their log-odds, or equivalently, a ratio of $\exp(\beta_h)$ in their odds.[6]

Random Coefficient Multilevel Logistic Regression Model

$$\text{logit}(P_{ij}) = \log\left(\frac{p_{ij}}{1-p_{ij}}\right) = \beta_o + \sum_{h=1}^{k} \beta_h x_{ij} + U_{oj} + \sum_{h=1}^{k} U_{hj} x_{ij}$$

The first part $\beta_o + \sum_{h=1}^{k} \beta_h x_{ij}$ is called the fixed part of the model, and the second part, $U_{oj} + \sum_{h=1}^{k} U_{hj} x_{ij}$ is called the random part of the model. The random variables or effects, $U_{0j}, U_{1j}, \ldots, U_{kj}$ are assumed to be independent between groups but may be correlated within groups. So the components of the vector $(U_{0j}, U_{1j}, \ldots, U_{kj})$ are independently distributed as a multivariate normal distribution with zero mean vector and variances and co-variances matrix Ω given by:

$$\Omega = \begin{pmatrix} \sigma_0^2 & . & \cdots & . \\ \sigma_{01} & \sigma_1^2 & \cdots & . \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{0k} & \sigma_{1k} & \cdots & \sigma_k^2 \end{pmatrix}$$

Data analysis

The analysis is carried out in three sections. In the first section, results of descriptive statistics are presented; in the second section, we identified and examined the determinants of acute respiratory infection among under-five children using ordinary logistic regression with the help of SPSS software. Finally, multilevel logistic regression model was employed to examine the factors and variations in prevalence of acute respiratory infection across region with the help of STATA software.

3. RESULTS AND DISCUSSION

A total of 9416 children between the ages of 0 to 59 months were included in the study from EDHS 2011 sample. The initial population consisted of 11654 infants of age less than 59 months. Out of this 9416 (80.8%) of under-five children with complete anthropometric measurements were selected and studied in the analysis and others were excluded due to incompleteness and inconsistency of data on the variables which are considered as important for the analysis. From the sampled children, the two weeks prevalence of ARI among under-five children was about 12.3% in Ethiopia.
Among the demographic and socio-economic factors maternal working status, number of under-five children, current age of the child, birth order of the child, maternal education and household wealth index were found to have a significant association with the two weeks incidence of ARI at the 5% significance level.

Similarly, among health, environmental and nutritional related factors region, place of residence, fuel used for cooking, received vitamin A recently , breast feeding, underweight, wasting, stunting and had Diarrhea recently were found to have a significant association with the two weeks incidence of ARI at the 5% significance level.

Results of Multiple Logistic Regression Analysis

Multiple logistic regressions were used to analyze the effect of each of the independent variables on child status of ARI, while controlling for the other independent variable. Accordingly Fuel used for cooking, Current age of the child, Received vitamin A recently, Underweight, Wasting, region, Had Diarrhea recently, Number of under five children, Mother currently working and household wealth index were found to be significant predictors for acute respiratory infection among under-five children (Table 4.1).

Fuel used for cooking was also significantly associated with two weeks incidence of ARI among under-five children. The likelihood of having ARI among under-five children who live in the household use safe fuel for cooking is 0.644 times lower than those under-five child live in the household use unsafe fuel for cooking. Indeed number of under-five children is significantly associated with incidence of ARI ($P<0.05$). Under-five child who lives in the household having more than two under-five children is 1.259 times more likely having ARI than who lives in the household have less than two under-five children.

Table 4.1: Maximum Likelihood Estimates for Ordinary Logistic Regression of predicting incidence of ARI among under-five children, Ethiopia (EDHS, 2011).

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Fuel used for cooking	Unsafe (ref.) Safe	-.440	.174	6.352	1	.012*	.644	.458	.907
Maternal educational level				6.498	3	.090			

	No education(ref.) Primary	-.072	.077	.861	1	.354	.931	.800	1.083
	Secondary	-.434	.208	4.344	1	.037	.648	.431	.974
	Higher	-.413	.300	1.890	1	.169	.662	.367	1.192
Current age of the child in month				28.689	5	.000*			
	< 6 month (ref.) 6-11 month	-.396	.131	9.052	1	.003*	.673	.520	.871
	12-24 month	-.681	.130	27.280	1	.000*	.506	.392	.654
	25-34 month	-.567	.143	15.754	1	.000*	.567	.429	.751
	35-47 month	-.571	.156	13.502	1	.000*	.565	.416	.766
	48-59 month	-.491	.161	9.253	1	.002*	.612	.446	.840
Receiving vitamin A recently	No (ref.) Yes	-.384	.078	24.243	1	.000*	.681	.585	.794
Underweight	No (ref.) Yes	.345	.088	15.287	1	.000*	1.411	1.188	1.678
Stunting	No (ref.) Yes	.162	.085	3.628	1	.057	1.176	.995	1.388
Wasting	No (ref.) Yes	.479	.099	23.277	1	.000*	1.615	1.329	1.962
	No (ref.) Yes	.479	.099	23.277	1	.000*	1.615	1.329	1.962
Type of place of residence	Rural (ref.) Urban	-.035	.141	.063	1	.801	.965	.733	1.272
Region				137.528	10	.000*			
	Addis Ababa (ref.) Afar	.432	.343	1.586	1	.208	1.541	.786	3.021
	Amhara	1.201	.332	13.042	1	.000*	3.322	1.732	6.374
	Oromia	1.074	.328	10.730	1	.001*	2.928	1.540	5.569
	Somali	1.218	.333	13.356	1	.000*	3.379	1.759	6.493
	Benshangulgumize	1.261	.334	14.271	1	.000*	3.531	1.835	6.793
	SNNP	.752	.333	5.106	1	.024*	2.121	1.105	4.071
	Gambela	1.261	.337	14.026	1	.000*	3.530	1.824	6.831
	Harari	-.868	.447	3.764	1	.052	.420	.175	1.009
	Tigray	1.639	.327	25.061	1	.000*	5.149	2.710	9.780
	Dire Dawa	.824	.343	5.763	1	.016*	2.279	1.163	4.466
Had Diarrhea recently	No(ref) Yes	1.341	.075	316.626	1	.000*	3.822	3.297	4.430
Number of under-five children	<=2(ref) >2	.230	.090	6.568	1	.010*	1.259	1.506	1.501
Mother currently working	No(ref) Yes	-.193	.077	6.283	1	.012*	.824	.709	.959
Birth order of the child				2.627	3	.453			
	1st (ref) 2-3	.055	.101	.300	1	.584	1.057	.867	1.288
	4-5	.148	.106	1.961	1	.161	1.160	.943	1.426
	>6	.026	.106	.060	1	.807	1.026	.833	1.264
Wealth index				26.283	4	.000*			
	Poorest (ref) Poorer	-.075	.110	.470	1	.493	.927	.748	1.150

	Middle	-.295	.099	8.864	1	.003*	.744	.613	.904
	Richer	-.478	.112	18.324	1	.000*	.620	.498	.772
	Richest	.073	.152	.230	1	.632	1.075	.799	1.448
	Constant	-2.68	.445	36.152	1	.000*	.069		

*Significance at 5% level of significance, Ref. = reference category, $\widehat{OR}$ = Estimated odd ratio

From health and nutritional related factors of a child underweight, wasting and recently Diarrhea had significantly associated with ARI status of under-five children (P<0.001). Under-five children who were wasting were 61.5% more likely to experience ARI than who were not wasted. Under-five children who were underweight were 41.1% more likely to experience ARI than under-five children who were not underweighted. Indeed Under-five child who had Diarrhea recently were 3.822 times more likely have ARI than who had not Diarrhea recently.

Child status of receiving vitamin A recently is significantly associated with incidence of ARI. A child who had received vitamin A recently was 31.9% less likely to suffer in ARI compared to a child not receive vitamin A recently. The analysis also showed that under-five children whose mothers had work 29.1% less likely to experience ARI than under-five children whose mother had no work.

Multilevel Empty Random Intercept Logistic Regression Analysis

The deviance- based Chi-square (χ^2 =147.83, P-value<0.001) in Table 4.9, shows empty with random effect is better than the empty model without random effect. Conversely, the variance of the random effect of the region random intercept (σ_0^2 =0.4259387, S.E=0.2062133), and the Wald test statistics is (the square of the Z-ratio), Z^2= $(0.4259387/0.2062133)^2$ which is compared with a Chi-squared distribution on 1 degree of freedom, give a P-value less than 0.05. Therefore, we conclude that there is significant variation in suffering ARI among under-five children (Table 4.2). The intercept (β_o)= -2.177952 interpreted as the average overall odds of ARI incidence. This can be further interpreted as the average probability of ARI incidence everywhere in Ethiopia is exp (-2.177952)/ [1+exp (-2.177952)] = 0.102.

The intra correlation coefficient (ICC) for this model is calculated accordingly. This result is ICC=0.115 implied that 11.5% of variation in the incidence of ARI can be explained by grouping under-five children in regions (higher level units). The remaining 88.5% of the variation of the incidence of ARI is explained within region-lower level units.

Table 4.2: Results of empty random intercept Logistic regression model analysis (EDHS, 2011).

Fixed part	**Coefficient**	**S.E**	**Z-value**	**P-value**
β_0 = intercept	-2.177952	0.202245	-10.77	0.000*
Random part	**Variance component**	**S.E**	**Z-value**	**P-value**
Level-two variance, σ_0^2=U_{0j}	0.4259387	0.2062133	2.0655	0.01945*
Rho (ρ)	0.1146247	0.049133	2.333	0.0098*
Deviance based on chi-square	147.83			0.000*
Deviance AIC	3432.676 6869.352			

Multilevel Random Intercept and Fixed Coefficient Logistic Regression Analysis

In this model we allowed the probability of the incidence of ARI to vary across regions, but we assumed that the effects of predictor variables are the same for each region. That is, the random intercept varies across regions, but under-five children and mother's level predictor variables are fixed across region in predicting incidence of ARI.

According to the result of the random intercept with fixed model, the fixed part showed that fuel used for cooking, current age of the child, received vitamin A recently, wasting, had Diarrhea recently, number of under-five children and wealth index of the household were found be significant determinants of variation in the incidence of ARI in all regions with respect to the corresponding reference category (Table 4.3). The estimated coefficient and odds ratio have similar interpretation like in ordinary logistic regression.[7] discussed above. However, the result of the random part has additional information which is discussed below.

Table 4.3: Results of Random Intercept and Fixed Coefficient Model analysis.

Fixed effects Covariate		**Estimated Coefficient**	**S.E**	**Z-value**	**P-value**
Fuel used for cooking	Unsafe (Ref.) Safe	-.4714339	.1740355	-2.71	0.007*
Current age of the child month	<6 (Ref.)				
	7-11	-.4032809	.1311454	-3.08	0.002*
	12-23	-.6655854	.1281172	-5.20	0.000*
	24-35	-.5953643	.1282677	-4.64	0.000*
	36-47	-.605118	.1267408	-4.77	0.000*
	48-59	-.5262457	.1276851	-4.12	0.000*
Received vitamin A recently	No(Ref.)				
	Yes	-.3829011	.0776052	-4.93	0.000*
Underweight	No(Ref.)				
	Yes	.4425381	.0751149	5.89	0.000*
Wasting	No(Ref.)				
	Yes	.4447926	.0971194	4.58	0.000*
Had Diarrhea recently	No(Ref.)				
	Yes	1.344338	.0750493	17.91	0.000*
Number of under five children	≤2 (Ref.)				
	>2	.2311557	.0882033	2.62	0.009*
Mother currently working	No(Ref.)				
	Yes	-.1860264	.0766341	-2.43	0.015*
Wealth index	Poorest (Ref.)				
	Poorer	-.0808637	.1092146	-0.74	0.459
	Middle	-.2907228	.0988233	-2.94	0.003*
	Richer	-.4694457	.1114486	-4.21	0.000*
	Richest	.0068957	.1219159	0.06	0.955
Constant		-1.965951	.2284311	-8.61	0.000
Random effect		**Variance component**	**S.E**	**Z-value**	**P-value**
Level-two variance: $\sigma_0^2 = var(U_{0j})$		.3734037	.1844842	2.024	.0215*
Rho (ρ)		.101928	0.0530	1.923	0.027*
Deviance based Chi-square 124.55 0.000*					
Model selection criteria					
Deviance 3161.5551 AIC 6366.021					

*significant at 5% level Ref. =reference category

The random part of random intercept and fixed slope model show that the intercept variance of the random effect is 0.3734037, whereas the variance of the intercept for the empty multilevel model is 0.4259387. The variance of random effect of the intercept and fixed slope model decreased compared to random effects of the intercept empty model. The reduction of the random effect of the intercept variance is due to the inclusion of fixed explanatory variables. That is, taking in to account the fixed independent variables can provide extra predictive value on incidence of ARI in each region.

The intra correlation coefficient (ICC) for this model (ICC=0.102) implied that 10.2% of variation in the incidence of ARI can be explained by grouping under-five children in regions (higher level units). The remaining 89.8% of the variation of the incidence of ARI is explained within region-lower level units.

DISCUSSION OF THE RESULT

The descriptive analysis of the study revealed that the prevalence of acute respiratory infection among under-five children in Ethiopia was 12.3%. This is consistent with the finding reported in the 2005 EDHS (13%).

Based on the result of this study under-five children who live in Amhara, Somali, Benshangulgumize, SNNP, Gambela, Tigray and Dire Dawa were more likely to suffer from acute respiratory infection than under-five children who live in Addis Ababa.

The study revealed that incidence of ARI was significantly associated with age of the child. Under-five children in the age group of 6-11 month were 32.7% less likely having ARI to those children in the age group of less than 6 month. Similarly children in the age group of 48-59 month were 38.8% less likely having ARI as compared to those children in the age group less than 6 month. This result is consistence with done in Bangladesh revealed that during the first three months of life, infants have the highest risk of acute respiratory infection. This evidence also showed that there was an inverse relation between age of child and prevalence of ARI. Infants (age <12 months) were suffering more from ARI than toddlers (age 12-23 months) and children (24-59 months).[8]

The analysis also showed that under-five children whose mothers had work are 29.1% less likely to experience ARI than under-five children whose mother had not work. This finding contradicts the finding in Fortaleza city, Ceara State, Brazil where the risk of acute respiratory infection, pneumonia increased with the proportion of the mother had spent working since her child was born.[9]

A child who had received vitamin A recently was 31.9% less likely to suffer in ARI compared to a child not received vitamin A recently. This present findings is in agreement with a study done in Bangladesh which showed child without taking vitamin A in last six months had 29% higher odds of suffering from ARI.[10]

Household wealth index also showed a statistical significant association with incidence of ARI. Being a higher wealth quintile, compared to lowest (poorest), reduce the probability of ARI occurrence by 7.3%-50.2%. This finding is in line with study done in Uganda Being a higher wealth quintile, compared to lowest (poorest), reduce the probability of ARI occurrence by 5%-18%.[11] This may due to families with high socio-economic status are supposed to drink more piped water, and use hygienic toilets.

CONCLUSION

This study revealed that socio-economic, demographic, health, environmental and nutritional related variables have important effect on incidence of ARI among under-five children in Ethiopia. The results of multiple logistic regression showed that Fuel used for cooking, Current age of the child, Received vitamin A recently, Underweight, Wasting, region, recently Diarrhea, Number of under five children, Mother currently working and household wealth index were most important determinants for incidence of ARI among under-five children in Ethiopia.

In multilevel logistic regression analysis the random parts of the intercept and the coefficients provided additional information. In empty with random intercept model and random intercept the overall variance of the constant term was found to be significant, which indicates the existence of differences in incidence of ARI among under-five children across region. The significant determinants for the variations of prevalence of ARI among regions were Fuel used for cooking, Current age of the child, Received vitamin A recently, Underweight, Wasting, region, recently Diarrhea, Number of under five children, Mother currently working and household wealth index.

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