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Research/Technical Note

Statistical Analysis of Regional Heterogeneity of Marital Dissolution Among Women in Ethiopia, EDHS 2016: Application of Multilevel Logistic Regression Model

Abdisa Teshome[1, *], Jaleta Abdisa[2]

[1]Department of Statistics, College of Natural Science, Bonga University, Bonga, Ethiopia
[2]Department of Statistics, College of Natural Science, Jimma University, Jimma, Ethiopia

Abstract

Divorce is a major life stressor for the individuals involved, with potentially strong negative consequences for the mental and physical health of all members of the family. The aim of this study was to investigate the existence of regional heterogeneity marital dissolution among women in Ethiopia. The study used data from the 2016 Ethiopia Demographic and Health Survey which was a stratified two stage cluster sampling procedure was used. The researcher has been used (n=11405) of all married women from the selected population of study nested within nine regional states and two administrative cities in Ethiopia at time of interview. The Multilevel model were used to explore the major risk factors and regional variations of marital dissolution in Ethiopia using R statistical software. The descriptive result revealed that among eligible married women the proportion of marital dissolution was 9.91%. Among the three multilevel logistic models the random slope model found to be the best description of the data set and to evaluate the within and between regional heterogeneity of marital dissolution. Using this model variables that significantly affect the marital dissolution in Ethiopia were residence, education level of women, work status of women, duration of marriage, number of children, education level of husband and number of unions. The effects of the determinant variables are the same for each region, but the number of children and education level of husband were the two variables which varies within and between in each region. The other important result from this paper is that missing data analysis using appropriate imputation technique was performed to make better inferences.

Keywords

Marital Dissolution, Multilevel Logistic Regression Model, Determinant

1. Introduction

Any reflections on divorce, originates from the concept of marriage. Marriage is a basic foundation for the formation of the family institution. Through marriage, a men and women are able to fulfill their responsibilities as a husband and wife together to build the family as well as for the creation of a new generation [1]. However, not all couples are able to undergo their marriage until the end, and even worse, they will face serious domestic unrest thus causing them to dissolve the marriage. Marital dissolution or Divorce, is a legislatively created, judicially administered process that legally termi-

*Corresponding author: tegteshome03@gmail.com (Abdisa Teshome)

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nates a marriage no longer considered viable by one or both of the spouses and that permits both to remarry.

Divorce has pervasive weakening effects on the family. Divorce is often extremely painful and more emotionally devastating than losing a job, about equal to experiencing a major illness, and somewhat less devastating than a spouse's death [2].

Thus, it is one of the major troubles that affect the family system. Besides, divorce involves the loss of social and economic capital as a result of the loss of household income, residential mobility and contact with the non-custodial parents [3]. Over a period of time the rates of divorce have increased significantly not only in the developed but in the developing nations as well [4]. However, the rate of divorce varies across culture and over time. As the many study shows there are various factors associated with marital dissolution and these are wide-ranging among the different cultures and geographical locations. According to Ambert [5] study the number of marriages goes down in reverse with the flourishing of most western economies; which resulting in the flourishing of the welfare state that has coincided with a decline of the role of the family. This is also revealed by Fagan and Churchill on the impacts of Cultural Revolution which has great role for divorce in the society [6]. As a result, divorce rate is keeping increases, particularly in industrialized western countries at its all-time high. Individuals who pass through the process of marital dissolution face-challenging situations psychologically that disrupt their overall well-being. The immediate sufferers of the marital dissolution who share the potential consequences are children and other relatives of the couples. Extensive evidence shows that children with divorced parents have worse performance compared to their peers whose parents stay married [7].

Marriage does not only serve to satisfy the fundamental biological need of sexual gratification through a socially acceptable way but also helps the individual to achieve a higher level of personality maturation. However, the increasing acceptance of divorce has dramatically altered the marriage situation. Thus, according to Hawkins and Fackrell in the United States 40-60 percent of all marriages end in divorce [8]. In India, even though the rate of divorce is rapidly increasing presently in 5% -7% [8].

Marital dissolution broken down into divorce and widowhood for 33 countries in sub-Saharan Africa. All estimates shown are for the interval 15-19 years after the first union began. On average 33 percent of unions have ended by this point, with 25 percent ending through divorce and 8 percent through spousal death [9]. Also, in a study on three district areas of Malawi combined 45 percent of the all marriages end in divorce within 20 years and besides the life table probabilities of divorce in Malawi range from 40 to 60 percent, where as 32 percent in Cote d'Ivoire, 33 percent in Ghana and 14 percent in Nigeria [10].

According to B.A.S and A. S. Erulkar [11] Ethiopia has one of the highest rates of early marriage in Sub Saharan African in which early marriage frequently leads to early divorce. Also, according to serkalem study [12], in Ethiopia women initiate divorce when they experience infidelity, extravagance, authority over their activities, physical abuse, age gap etc in their marriage. In Ethiopia approximately 45% of all first marriages end in divorce within 30 years [13]. These national level data also represent urban areas and the probabilities of marriages ending in divorce in Ethiopia catches up with that of the USA. Accordingly, by considering the social, economic and cultural change, taking place in the society and in line with the constitution and international instruments the Federal Democratic Republic of Ethiopian (FDRE) had updated and revised the old (1960) family law in 2000. The revised Family code (RFC) at national level serves for all citizens equally and has given equal weight about the cause and effects of divorce (RFC, 2000).

According to Tilson and Larsen [13] in Ethiopia both early age at marriage and childlessness have a significant impact on the risk of divorce.

The most of the findings were specific to some area without considering the multi-ethnic and multi-cultural nature of the society, across regions of Ethiopia. This geographic scope limits the applicability of the result on large scale, particularly considering the complex multi-regional and multi-ethnic setting of Ethiopia. Thus, lack of appropriateness of the model applied for clustered data have generated interest in assessing determinant factors affecting marital dissolution by fitting a statistical model that can explain the data in most meaningful manner.

Therefore this study, has tried to fill the gaps in understanding the status of divorce in Ethiopia by taking into consideration demographic and socio-economic factors.

So aim of the study was to investigate the existence of regional heterogeneity in marital dissolution among women and the extent to which variation is relate to a set of explanatory variables in Ethiopia.

2. Data and Methods of Data Analysis

2.1. Sources of Data

The study was based on the national cross-sectional data from Ethiopia Demographic and Health Survey (2016, EDHS) conducted in 2016, which is the fourth comprehensive survey conducted as part of the worldwide Demographic and Health Surveys project. The EDHS collects nationally-representative data on women of child-bearing age (15-49 years) and their children.

The data for marital dissolution estimation would be extracted from the marital status insection of the Woman's Questionnaire from 15,683 women age 15-49 (CSA. 2016). So, the population of study was the married women in time of interviews. Thus, the analysis would be presented in this study on marital dissolution of women based on the 11405 ever married women.

The dependent (response) variable is marital status of women. The response variables was binary; it was coded 0 if -women were living together by the time of interview and 1 for divorced women.

The choice of explanatory variables was guided by different literatures as the determinant factors of marital dissolution and their categorization was taken EDHS data as reference. Broadly, the researcher grouped the explanatory variables into demographic and socio-economic factors such as mother's educational level, number of children ever born, father's level of education, place of residence, religion, age of women at first marriage, duration of marriage, occupation status of women and assessing the performance of population average and multilevel models using clustered data from the 2016 Ethiopia Demographic and Health Survey data set.

2.2. Methods of Statistical Analysis

Methods of Statistical analysis Extraction of variables, data exploration, cleaning, coding, and recoding, descriptive statistics were performed using IBM SPSS version 20, whereas the inferential part of our analysis were done using R version 3.6.

The statistical analysis employed in this study was based on marginal methods and multilevel logistic regression model which was the most popular model for binary data. These models are useful when the interest of the analyst lies in the individual response profiles rather than the marginal mean. The inclusion of random effects in the linear predictor reflects the idea that there is natural heterogeneity across subjects or clusters in some of their regression coefficients [14]. The most common multilevel model is a two-level hierarchic nested modelling with many level-1 units within a smaller number of level-2 units. For this study follows individuals as level-1 and regions as level-2. A multilevel structure can be cast, with great advantage, to incorporate a range of circumstances where one may anticipate clustering [15]. Models with subject-specific parameters are differentiated from population averaged models by the inclusion of parameters which are specific to the cluster. Thus, based on the nature of sampling design and nature of data, the authors apply the multilevel logistic regression model that takes into account the correlation of individual within the region. And using 5% level of significance we assess the individual effect variables on Marital divorced (MD).

2.3. Missing Data

Missing data represents a common problem for statisticians and researchers working with surveys and census. Missing data commonly occur in demographic and health survey and defined as no data values are stored for a variable or variables. A relatively few absent observations on some variables can dramatically shrink the sample size. As a result, the precision of confidence intervals was harmed, statistical power weakens and the parameter estimates may be biased. The amount of bias potentially introduced by missing data depends on the type of missing mechanism.

There are several methods to handle missingness of categorical data in surveys. Such as, complete case analysis, imputation of the mode, random imputation, the hot-deck method, imputation by polytomous regression, random forests [16]. In this paper from the method listed above, using hot-deck method performance we tried to handling the part of missing observation of two explanatory variables.

2.4. Multilevel Logistic Regression Model

For simplicity of presentation, two-level models were used for this study. First, consider a two-level model for binary outcomes with a single explanatory variable. The basic data structure of the two-level regression is a collection of N groups ('units at two levels') with in group *j*, (j = 1, 2, …, N) random sample of n_j level-one units (individual or number of divorced women's in region j). And the total sample size becomes $M = \sum_1^N n_j$. Suppose we have data consisting of women (level one) grouped into regions (level two). Let y_{ij} be the binary outcome variable, coded '1' or '0' associated with level-one unit i nested within level two unit j and X_{ij}, an explanatory variable at the women level. Also let π_{ij} be the probability that the response variable equals 1; $\pi_{ij} = pr(y_{ij} = 1)$. Like the ordinary logistic regression, π_{ij} is modeled using the link function, logit.

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

$$\text{logit}(\pi_{ij}) = \log\left[\frac{\pi_{ij}}{1-\pi_{ij}}\right] = \beta_0 + \beta_1 x_{ij} + u_{0j}$$

Where: $u_{0j} \sim_{IID} (0, \sigma_{u0}^2)$ is the random effect at level two.

Without u_{0j}; Equation above would be a standard logistic regression model. Conditional on u_{0j}, the y_{ij} is assumed to be independent. The model below was often described as follows: one for level 1 and the other for level 2.

$$\text{logit}(\pi_{ij}) = \log\left[\frac{\pi_{ij}}{1-\pi_{ij}}\right] =$$

$\beta_{0j} + \beta_1 x_{ij} \ldots\ldots\ldots\ldots$ [Model: level 1] And

$$\beta_{0j} = \beta_0 + u_{0j} \ldots\ldots\ldots \text{[Model: level 2]}$$

The intercept β_{0j} consist of two terms: a fixed component β_0 and a group-specific component, random effect, u_{0j}. We assumes the u_{0j} follow a normal distribution with mean zero and variance σ_{u0}^2. In this model, the regression coefficient β_1 is common to all the groups.

2.4.1. Test of Heterogeneous Proportionality

For the proper application of multilevel analysis, the first logical step is to test heterogeneity of proportions between groups (in our case between Regions). Here we present two commonly used test statistics that were used to check for

heterogeneity [17]. To test whether there are indeed systematic differences between the groups, the well-known Chi-Square test for contingency table could be used. In this case, the Chi-Square test statistic is:-

$$x^2 = \sum_{j=1}^{N} n_j \left[\frac{\hat{\pi}_j - \hat{\pi}}{\hat{\pi}(1-\hat{\pi})}\right] \sim x^2_{(N-1)}$$

It can be tested a chi-square distribution with $N-1$ degrees of freedom. This chi-squared distribution is an approximation valid if the expected number of success (divorced)$(n_j\, \pi_j)$ and of failures others $n_j\,(1-\pi_j)$in each group all are at least one while 80 percent of them are at least five [18].

Estimating Between and Within Groups Variance

Consider a population having two-levels. The basic data structure of two-level logistic regression is a collection of N groups (units at level-two (regions)) and within region j (j=1, 2, …, N) a random sample of n_j level-one units. Then the true variance between the group dependent probabilities [17], i.e the population values of π_j was given by:

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

Where:$\tilde{n}$ is defined as:

$$\tilde{n} = \frac{1}{N-1}\left[M - \frac{\sum_{j=1}^{N} n_j^2}{M}\right],$$

For dichotomous outcome variables, the observed between-groups variance is closely related to the chi-squared test statistic equation. They are connected by the formula:

$S^2_{between} = \frac{\hat{\pi}(1-\hat{\pi})}{\tilde{n}(N-1)} X^2$, And the within-group variance in the dichotomous case is a function of the group averages via;- $S^2_{within} = \frac{1}{M-N}\sum_{j=1}^{N} n_j(1-\hat{\pi}_j)$

2.4.2. The Empty Logistic Regression Model

The empty two-level model for a dichotomous outcome variable refers to a population of groups (level-two units (regions)) and specifies the probability distribution for group-dependent probabilities π_j in $y_{ij} = \pi_j + \varepsilon_{ij}$ without taking further independent variables in to account. We focus on the model that specifies the transformed probabilities $f(\pi_j)$ to have a normal distribution. The link function $f(\pi_j)$ is:

$$f(\pi_j) = \beta_0 + u_{0j}$$

Where: β_0 is the population average of the transformed probabilities and u_{0j} the random deviation from this average for group j. If $f(\pi_j)$ is the logit function, then $f(\pi_j)$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 was expressed as:

$$\text{logit}(\pi_j) = \beta_0 + u_{0j}$$

$$\text{Where:}\pi_j = \text{logit}(\beta_0 + u_{0j}) = \frac{\exp(\beta_0 + u_{0j})}{1+\exp(\beta_0 + u_{0j})}$$

This model does not include a separate parameter for the level-one variance. This is because the level-one residual variance of the dichotomous outcome variable follows directly from the success probability, as indicated by tion, $var(\varepsilon_{ij}) = \pi_j$. The probability corresponding to the average value $\beta_0$denoted by π_0 is defined by $f(\pi_0) = \beta_0$. For the logit function the so-called logistic transformation of β_0, is defined by:

$$\pi_0 = \text{logit}(\beta_0) = \frac{\exp(\beta_0)}{1+\exp(\beta_0)}$$

3. Result

The results of the analysis are divided into the descriptive and inferential statistical analysis sections.

3.1. Descriptive Results

The study contains 11405 of married women from nine regional states and two administrative cities in Ethiopia were eligible for this study from EDHS in 2016. Among these eligible married women's, 1130 (9.91%) women of them have been divorced at the time of interview.

The marital dissolution rates among women vary across the region. The highest divorced rate was recorded in Tigray region by 2.02% and followed by the Amhara region (1.58%) were those region the divorce was highly rated in it. The SNNPR has the lowest percentage (0.29%), followed by Benishangul (0.48%) from married women living in Ethiopia that were eligible at the time of EDHS 2016 interviews. As shown in the table, also from the total married women in the residence group women in rural areas are more likely to be divorced than women in urban areas (5.29% and 4.62%) respectively at the time of interview. And marital dissolution rates for religion group, 5.77% married women following Orthodox and its higher as compared to others, 0.02% following Catholic, 0.89%, following Protestant, 3.19% following Muslim, and 0.04% following other religions of married women were divorced at the time of interview. And also, marital dissolution rates in Women's education level; 4.52%, 3.68%, 1.14% and 0.56% for married Women with; have no education, Primary education, secondary education and higher education respectively with the highest percentage at level of having no education.

Also according to Table 1 marital dissolution rates in wealth Index; 3.15%, 1.10%, and 5.66% of married Women with wealth index; Poor, Middle, and Richer respectively and higher in richer people were divorced, Marital dissolution rates in a respondent's occupation status; 2.70%, 3.02%,

1.11% and 3.07% of married women have; Not working, Agricultural workers, Government employed and Salers workers were divorced respectively and the highest for salers workers. Marital dissolution rates in status of Age at first marriage; 8.12%, 1.74%, and 0.04% of married Women at age; Less than 20 years, 20-34 years and 35 & above were divorced respectively. Marital dissolution rate in having Children status; 2.26%, 5.63% and 2.02% of married women have; no Children, Less than three children, four and above were respectively divorced. Marital dissolution rates in number of unions of women with men; 7.08% and 2.83% of married women in once and more than once unions were divorced respectively. Marital dissolution rates of women in duration of marriage; less than four years and 5-9 years of married Women 7.31% and 2.60% were divorced respectively. Similarly, one can describe for the rest of factors in the same way.

Table 1. *Presents basic descriptive information that summarizes the associations between the risk factors and marital dissolution.*

Variables	Categories	Not Divorced Count (%)	Divorced Count (%)	Total
Place of Residence	Urban	2,656 (23.29)	527 (4.62)	3,183 (27.91)
	Rural	7,619 (66.80)	603 (5.29)	8,222 (72.09)
Region	Tigray	1,009 (8.85)	230 (2.02)	1,239 (10.86)
	Afar	902 (7.91)	60 (0.53)	962 (8.43)
	Amhara	1,167 (10.23)	180 (1.58)	1,347 (11.81)
	Oromia	1,377 (12.07)	85 (0.75)	1,462 (12.82)
	Somali	1,025 (8.99)	64 (0.56)	1,089 (9.55)
	Benishangul	831 (7.29)	55 (0.48)	886 (7.77)
	SNNPR	1,260 (11.05)	33 (0.29)	1,293 (1134)
	Gambela	766 (6.72)	63 (0.55)	829 (7.27)
	Harari	595 (5.22)	84 (0.74)	679 (5.95)
	Addis Adaba	712 (6.24)	155 (1.36)	867 (7.60)
	Dire Dawa	631 (5.53)	121 (1.06)	752 (6.59)
Religion	Orthodox	3,708 (32.51)	658 (5.77)	4,366 (38.28)
	Catholic	64 (0.56)	2 (0.02)	66 (0.58)
	Protestant	1,889 (16.56)	102 (0.89)	1,991 (17.46)
	Muslim	4,481 (39.29)	364 (3.19)	4,845 (42.48)
	Other	133 (1.17)	4 (0.04)	137 (1.20)
Edu.Level of women	No education	5,990 (52.52)	516 (4.52)	6,506 (57.05)
	Primary	2,789 (24.45)	420 (3.68)	3,209 (28.14)
	Secondary	927 (8.13)	130 (1.14)	1,057 (9.27)
	Higher	569 (4.99)	64 (0.56)	633 (5.55)
Wealth Index	Poor	4,600 (40.33)	359 (3.15)	4,959 (43.48)
	Middle	1,406 (12.33)	126 (1.10)	1,532 (13.43)
	Richer	4,269 (37.43)	645 (5.66)	4,914 (43.09)
Respondent's occupations	Not working	5,486 (48.10)	308 (2.70)	5,794 (50.80)
	Agricultural workers	2,317 (20.32)	345 (3.02)	2,662 (23.34)
	GEmployed	607 (5.32)	127 (1.11)	734 (6.44)
	Salers workers	1,865 (16.35)	350 (3.07)	2,215 (19.42)

Variables	Categories	Not Divorced Count (%)	Divorced Count (%)	Total
Age of first marriage	Less than 20 years	8,533 (74.82)	926 (8.12)	9,459 (82.94)
	20-34 years	1,717 (15.05)	199 (1.74)	1,916 (16.80)
	35 and above	25 (0.22)	5 (0.04)	30 (0.26)
Total number of Children	No Children	993 (8.71)	258 (2.26)	1,251 (10.97)
	Less than three child	4,363 (38.26)	642 (5.63)	5,005 (43.88)
	four and above	4,919 (43.13)	230 (2.02)	5,149 (45.15)
Number of unions	Once	8,617 (75.55)	807 (7.08)	9,424 (82.63)
	More than once	1,658 (14.54)	323 (2.83)	1,981 (17.37)
Duration of marriage	Less than four years	7,594 (66.58)	834 (7.31)	8,428 (73.90)
	5-9 years	2,681 (23.51)	296 (2.60)	2,977 (26.10)
Eduhs.imp of husband	No education	4716 (41.35)	518 (4.54)	5234 (45.89)
	Primary	3204 (28.09)	349 (3.06)	3553 (31.15)
	Secondary	1287 (11.28)	145 (1.27)	1432 (12.56)
	Higher	1068 (9.36)	118 (1.03)	1186 (10.40)
AlcD.imp	No	7678 (67.32)	780 (6.84)	8458 (74.16)
	Yes	2597 (22.77)	350 (3.07)	2947 (25.84)

The model-based approach makes use of a probability distribution for the random variables of interest. Under this section we fit a statistical model included in this study and select it an appropriate one with estimate parameters. Before that we must remember about the missingness of our data. As we say under methodology the data have missing variables; so here, first we compare the model with missing and full data to see the effect of imputation. As we seen from Model comparison including missing value and after imputation the estimates from both models provide similar pictures of the relationships in the data (all estimates are in the same direction). Even though the imputed model is not equivalent to the model using the missing data, the most noticeable finding is that the number of significant variables were increased and the standard errors for the imputed model are lower than they are for the model with missing data, this may leads closer evident in the model to the actual data.

These differences indicate that hot deck imputation provided more reliable parameter estimates than the ignoring missed value, which were primarily due to the increased statistical power associated with the increased sample size, and their ability to preserve important data relationships and aspects of the data distribution [19]. Therefore, to fit the models in this study it should take the imputed data as a better option rather than ignoring of missing variables.

3.2. *Model Building:* Multilevel Logistic Regression Analysis

As we talked in methods, multilevel models were developed to analyze hierarchically structured data and we used the penalized quasi-likelihood (PQL) and adaptive gauss-Hermite quadrature (aghermite) method to estimate parameters.

3.2.1. Test of Proportions of Marital Dissolution Between Regions

The two-level structure is used with the region as the second-level unit and Women as level one unit. This is based on the idea that there may be differences in Women divorce between regions that are not captured by the explanatory variables and hence may be regarded as unexplained variability within the set of all regions. Before attempting to multilevel analysis, we should test the heterogeneity of marital dissolution among regional states of Ethiopia. As it can be shown in Table 2, the Pearson Chi-square (χ^2=379.225) which is highly greater than χ^2_{tab}=18.31 at 10 degree of freedom with P-value = 0.000 which, is less than 0.05 level of significance, implying strong evidence of heterogeneity for marital dissolution across regional states. Therefore, multilevel logistic regression is attempted.

Table 2. Tests of Heterogeneity.

Chi-Square Tests			
Statistics	**Value**	**Df**	**p-value**
Pearson Chi-Square	379.225[a]	10	0.000
N of Valid Cases	11405		
(*significant at 5% level)			

3.2.2. Empty Multilevel Logistic Regression Analysis

We began by fitting a null level-two model that is a model with only an intercept and regional effects. The probability of deviance based on Chi-square = 335.11 is greater than χ^2_{tab}=3.841 at one degree of freedom with p-value =0.000, which is highly significant in 5% level of significance. Therefore, level-two empty model is found to be significant; suggesting that evidence of regional effects on marital dissolution in Ethiopia in turn it suggests that multilevel analysis is better than single level analysis.

In empty multilevel model the overall log-odds of marital dissolution in the region is estimated as $\widehat{\beta_0}$ = -2.324. This means that the odds of divorced in an average region is exp (-2.324) = 0.0988 and the corresponding probability would be $\frac{0.0988}{1+0.0988} = 0.092$. The intercept for region j is -2.324+u_{0j}, where the variance of $u_{0j}$was estimated as $\delta^2_{u0} = 0.405$with (0.1695,.967) confidence interval, which is highly significant at 5% level of significance indicating the variations of marital dissolution among regional states of Ethiopia. The intra-regional correlation coefficient for empty multilevel model is estimated at 0.11 implying that 11% of the variance in marital dissolution could be attributed to differences across regions. The remaining 89% of the variation of in marital dissolution was explained with in region-lower level units.

Test of significance of random intercept is Ho: $\delta^2_{u0} = 0$ versus$\delta^2_{u0} \neq 0$, as shown in Table 3 the 95% confidence interval for the estimate of random intercept is not negative and different from zero. Also, the likelihood ratio statistic for testing the null hypothesis, that $\delta^2_{u0} = 0$, can be calculated by comparing the two-level model, with the corresponding single-level model without the level 2 random effects. The test statistic is 335(-2*(-167.5)) with 1 degree of freedom, so there is strong evidence that the between-region variance is non-zero.

This indicates that there is a significant Heterogeneity (variance difference) between Regional states of Ethiopia. And also, it tells as variance of random intercept is significantly different from zero.

Table 3. Result of Parameter Estimate of Intercept-Only Model with Random Effect.

MaritalS	**Coef(β).**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
cons	-2.3241	.1951589	-11.91	<2e-16	-2.706561	-1.941552
Random-effects Parameters			Estimate Std. Err. [95% Conf. Interval]			
Reg: Identity						
var(_cons)= δ^2_{u0}			.405	.6362	.1694851	.9666301
ICC (rho) Reg			.1095533	.0433278	.0489933	.2271
Akaike's information criterion and Bayesian information criterion						
Model	Obsll (null)	ll (model)	df	AIC	BIC	
	11,405.	-3516.894	2	7037.8	7052.5	

LR test vs. logistic model: chibar2(01) = 335.11 Prob >= chibar2 = 0.00

3.2.3. Random Intercept and Fixed Effect Model Analysis

The next step in model fitting with this data is to add explanatory (predictor) variables in order to identify their relation to the response variable using multilevel logistic regression model. As the result below shows the random intercept model with fixed explanatory variables is a better fit as compared to the empty model, because of the criteria of random intercept model (6495.2 and 6490.7) is less as compared to that AIC and BIC of random intercept only model (7037.8 and 7052.5) respectively. Also, the deviance of the random intercept model, 7034 is reduced to 6369.2 when we include covariates for the same random intercept with fixed slope which implies that the random intercept with fixed slope model is better than the random intercept only model. The probability of Chi-square =672 is significant with p-value = 2e-16 implying that after controlling all indicators of marital

dissolution, the intercept varied across the region with variance of 0.17631, telling that there is significant variation of marital dissolution among Regional states of Ethiopia. And also, the variance is decreased from $\delta^2_{u0} = 0.405$ in Empty Multilevel model to $\delta^2_{u0} = 0.17631$ in to random intercept model indicating that marital dissolution determinants are accounted for decreasing a significant variation through regional states of Ethiopia.

Table 4. *Comparisons of the intercept-only model and random intercept fixed slope models.*

Model	Df	AIC	BIC	logLik deviance	Chisq	Chi	Df	Pr (>Chisq)
model0 (null two-level)	2	7037.8	7052.5	-3517	7034			
model1 (Saturated two-level model)	13	6495.2	6490.7	-3184.6	6369.2	672	11	< 2e-16 ***

*** Significant (P-value <0.05)

After the selection of model, we went to identify the significant variables using backward selection. Concerning that Age at marriage, religion, wealth index and imputed husband drink alcohol variables is not significant. By excluding those variables, we get only statistically significant variables with their categories as shown in table below.

Table 5. *Result of Parameter Estimate of random intercept and fixed slope multilevel logistic regression model.*

	MaritalS |	Coef.	OddsR	Std. Err.	z	P>|z|	[95% Conf. Interval of Coef]
Intercept|	-1.384	0.2532	0.241	-7.863	0.000	-1.734207	-1.07923
PlaceR | Urban(ref)							
Rural |	-0.641	0.534	.0912	-7.02	0.000	-.82472	-.46246
NumbChild | No Child(ref)							
Less than three children |	-0.7005	0.5013	.0886	-7.91	0.000	-.8631152	-.5192459
four and above |	-2.05184	0.1285	0.1215	-16.86	0.000	-2.387	-1.813682
Eduw | No education(ref)							
Primary |	-0.10481	1.11050	.084	0.1249	0.2117	-.059725	.3111
Secondary |	-0.31640	0.72880	.1316	-2.80	0.0052	-.570854	-.062328
Higher |	-0.942	0.38990	.1878	-5.23	0.000	-1.3086053	-0.576240
WSW | Not working (ref)							
Agricultural workers |	0.8407	2.31790	0.0910	9.13	0.000	.663787	1.017061
GEmployed |	1.2012	3.3243	0.1382	8.74	0.000	.9313	1.47325
Salers workers|	1.05347	2.86851	0.0896	11.55	0.000	.8687182	1.22784
Eduhs.imp| No education(ref)							
Primary |	-0.34610	0.7146	0.0824	-2.32	0.0205	-0.4983	-0.17382
Secondary |	-0.718351	0.4876	0.1205	-0.6599	0.000	-.9475141	-0.48904
Higher|	-0.58282	0.5583	0.1389	-3.16	0.000	-.839367	-0.32637
DurMar | less than four(ref)							
5-9 years|	0 .5159	1.67541	.09191	5.53	0.000	.335928	.716424
NumbU | Once(ref)							

	MaritalS |	Coef.	OddsR	Std. Err.	z	P>|z|	[95% Conf. Interval of Coef]
More than once|	0.52204	1.6702	.0816	6.31	0.000	.353342	.6725364
Random-effects Parameters |	Estimate	Std. Err.	[95% Conf. Interval]				
Reg: Identity |							
var(intercept) |	.17631	0.385	.0547847	.3801343			

LR test vs. logistic model: chibar2(01) = 67.40 Prob >= chibar2 = 0.0000
Note: ref. = Reference categories. * Significant (P-value <0.05)

3.2.4. The Random Coefficient Multilevel Logistic Regression Analysis

The variance components model that we have just specified and estimated above assumes that the only variation between regions is in their intercepts.

By allowing the random slope one by one, the result of Comparison of Different models with different Random coefficient shows that random coefficient estimates for intercepts and the slopes vary significantly at 5% level of significance, which implies that there is a considerable variation in the effects of variables. The comparison indicates that the estimates of this model show that variables; Duration of marriage, Respondent occupation and Educational level of women have very small or almost no regional variations and the number of Children, number of Union, Place of residence and the imputed education level of husband have highest regional variations compared to the others. Therefore, the multilevel model with a random intercept and slope is fitted for those showing highest variation between the regions. Because of the R software did not allow all variables as random slopes at the same time, we include two at once. Then the result shown that the better model was random slope Multilevel Logistic Regression Model with the name Model10 in the time of comparison we used and that contain NumbChild and Eduhs.imp variables, which has smallest AIC and largest log-likelihood.

Table 6. *Model Comparisons between random intercept with fixed slope and random slope.*

	Df	AIC	BIC	logLik deviance	Chisq	Chi	Df	Pr (>Chisq)
(sign.sat. random Intercept mod.)	9	6392	6458	-3187.5	6374.6			
(rand. coef mod.)	14	6258.3	6360.6	-3115.7	6230.3	144.2	5	0.001 **

These results indicate a statistically significant difference in the relative fits of the two models. Furthermore, the AIC and BIC are both lower for Model random coefficient, suggesting that it provides better fit to the data than random intercept and fixed slope. Thus, we can conclude that the coefficients determinants are significantly vary across regions. The largest log-likelihood compared to random intercept model. Thus, allowing them to vary among the regions leads to a more optimal model than forcing them to be the same. Additionally, the random coefficient model is significantly describing the association of marital dissolution and the considered explanatory variables. Therefore, the random Coefficient model is enough to analyses. In a random slope model, the between-group variance is a function of the variable(s) with a random coefficient *x*ij. The result of Variance Covariance Matrix of random effects of variables Number Children and imputed husband education level (Eduhs.imp) in the Region were shown below.

Table 7. Result of Parameter Estimate of Random Coefficient Multilevel Model.

Variablesand level	Estimate(β)	Std. Error	exp(β)	Pr(>|z|)
(Intercept)	-1.44416	0.26543	0.236	0.001
PlaceRRural	-0.53880	0.09263	0.583	0.001
RespOccAgricultural workers	0.84655	0.09211	2.33	0.001
GEmployed	1.22646	0.14103	3.41	0.001
Salers workers	1.05540	0.09038	2.87	0.001
NumbChildLess than three child	-0.56479	0.17197	0.568	0.00102
Four and above	-1.92798	0.18125	0.145	0.001
EduwPrimary	0.04924	0.08520	1.05	0.56331
Secondary	-0.37886	0.13164	0.685	0.00400
Higher	-0.99900	0.18974	0.368	0.001
NumbU More than once	0.53032	0.08288	1.70	0.001
Eduhs.impPrimary	-0.44760	0.21430	0.639	0.03673
Secondary	-0.53450	0.33078	0.586	0.00613
Higher	-0.58548	0.32888	0.557	0.0504
DurMar5-9 years	0.50209	0.09408	1.65	0.001

Random-effects	Estimate	Std. Err.	[95% Conf. Interval]	
Reg: Unstructured				
var(NumbCh~d)	.2188019	.0735106	.113252	.4227232
var(Eduhs.imp)	.2437504	.0779585	.1299866	.4570797
var(_cons)	.6881272	.1786233	.4137071	1.144576
corr(NumbCh~d,Eduhs.imp)	-.1302919	.4977573	-.8093087	.6977737
corr(NumbCh~d,_cons)	-.4774833	.3277244	-.8744691	.3025517
corr(Eduhs.imp,_cons)	-.7121363	.2103481	-.9388767	-.0544711

LR test vs. logistic model: chi2(6) = 118.30 Prob > chi2 = 0.0000

$$\Omega = \begin{bmatrix} \delta_0^2 & \delta_{20} & \delta_{50} \\ \delta_{02} & \delta_2^2 & \delta_{52} \\ \delta_{05} & \delta_{25} & \delta_5^2 \end{bmatrix} = \begin{bmatrix} 0.68813 & -0.477483 & -0.712136 \\ -0.477483 & 0.218802 & -0.130292 \\ -0.712136 & -0.130292 & 0.24375 \end{bmatrix}$$

As shown in the above table the var($\mathbf{u_{0j}}$), var($\mathbf{u_{2j}}$) and var($\mathbf{u_{5j}}$) are the estimated variance of random intercept and slope of marital dissolution factors for Number of Children and imputed husband education level respectively.

Random slope captures residual variation across regions in levels and differentials in marital dissolution. As the table 7 shows the analysis revealed that within a region and holding other variables constant, the odds of marital dissolution of women who lives rural were (OR=0.583) times more likely than that of urban. The effect of Education Level is highly significant and negative implying that within a region, have negative relationship with log-odds of marital dissolution and women having secondary and Higher education are associated with decreased odds of marital dissolution. Women having primary education were not statistically significant. The result shows that within a region and holding other variables constant Odds of divorced women with secondary education is (OR=0.685) times less likely than that of women with no education and Odds of divorced women with higher education

is (OR=0.368) times less likely than that of women with no education.

Number of children they have also the factor significantly related to marital dissolution as the result indicates. The result shows that within a region and holding other variables constant Odds of divorced women with Less than three childrenare (OR=0.568) times higher and women with four and above childrenare (OR=0.145) times lower likely than that of women with no children.

And also for a random slope part with in a region and holding other variables constant the Odds specific to Number of children is multiplied by $\exp[u_{2j}\text{NumbChild}_{ij}]$. Where j=1, 2,….., 11

That means mathematically: -

$$\frac{\pi_{ij}/u_{0j}}{1-\pi_{ij}/u_{0j}} = \exp(\beta_0 + \cdots + \beta_{02}\text{NumbChild}_{ij} + \cdots \ldots \ldots + u_{2j}\text{NumbChild}_{ij}).$$

So is a multiple of $\exp[u_{2j}\text{NumbChild}_{ij}]$.

The outcome of work status of women is highly statistically significant and positive indicating that within region women's, of having Agriculture work, Gov't employed and saler worker are associated with increased Odds of marital dissolution. The outcome shows that within region and holding other variables constant the Odds of divorced women, with Agriculture worker and saler worker were (OR=2.33) and (OR=2.87) times more respectively than that of women with in not working groups and Odds of divorce with women Gov't employed was (OR=3.41) times lower than that of women with in not working groups. Also, the outcome of education status of husband statistically significant suggesting that with in a region and holding other variables constant, the husbands having primary, secondary and higher education level are associated with the Odds of divorced women. The result reveals that within a region and holding other variables constant; the Odds of marital dissolution with husbands primary, secondary and higher education level were (OR=0.639, OR=0.586 and OR=0.557) times lower respectively than those husbands have no education.

And also for a random slope part with in a region and holding other variables constant the Odds specific to husband education level is multiplied by $\exp[u_{5j}\text{husbEduLevel}_{ij}]$. Where j=1, 2, …11

That means mathematically: -

$$\frac{\pi_{ij}/u_{0j}}{1-\pi_{ij}/u_{0j}} = \exp(\beta_0 + \cdots + \beta_{05}\text{husbEdu Level}_{ij} + \cdots \ldots \ldots + u_{5j}\text{husbEduLevel}_{ij}).$$

So is a multiple of $\exp[u_{5j}\text{husb EduLevel}_{ij}]$.

The number of women unions with men is also other statistically significant variable within region and holding other variables constant; the Odds of divorced women with more than once was (OR=1.67) times less likely than that of women with union once. The other determinant is marriage duration which statistically significant within region and holding other variables constant; the odds of divorced women with 5-9 years duration is (OR=1.65) times more likely than that of less than four years.

4. Discussion

The main aim of this study was to examine the regional heterogeneity and factors associated with divorced women in Ethiopia using multilevel logistic regression procedure on data set extracted from the nationally representative 2016 EDHS data.

Descriptive analysis, chi-square test and multilevel logistic regression analyses were used in this study. Multilevel logistic regression model allows to shows the regional variation and identify the factors associated with marital dissolution in Ethiopia. Before the analysis of data using multilevel approach, the researcher test variation of the levels of Marital Dissolution using chi-square test, and it was significantly showed that there is regional variation regarding Marital Dissolution in the regions. Results obtained based on the empty model the overall variance of the constant term suggest that marital dissolution were differed across regions. In addition to this, random intercept with fixed slope model is the best model to assess the regional variation and factors associated with marital dissolution in Ethiopia. The descriptive results of this study shows that the marital dissolution has significant association with geographical and practiced in all regions. Tigray, Amhara, Addis Ababa and Dire Dawa regions presented with the highest marital dissolution and the lowest level were observed in SNNP and Ben-Gumuz regions. The result of this study shows that there is a difference in women's divorce status among rural and urban residence. It indicates that marital dissolution is higher among women who reside in rural areas than for urban women, which is consistent with results obtained by [20, 21]. Women with secondary and higher education were less likely to be divorced compared to women with no education. This finding supports the research findings of [22] and consistent with the results of [20]. The result of this study revealed that number of living children in the household is an important variable which significantly affects marital dissolution due to divorce, which is consistent with [13] results. Women with no child experienced the lower rate of divorce as compared to women who have less than three children and women with four and above children have less likely rate of divorce as compared to women who have no children in the household, which is inconsistent to the[21] results.

The variables significantly affecting marital dissolution were region, place of residence, educational level of women, number of children, duration of marriage, number of unions, work status of women and educational level of husband. This result is consistent with; the previous study done using logistic regression [21] in Addis Ababa University by using

2005 EDHS data, except variables age at first marriage, religion and wealth index which are not significant in this study. And also, this finding supports the research findings of [20] who found that the educational background of women have a powerful effect on marital dissolution. This model also indicates that, the same variables listed above have found to be significant implying significant log odds effects on marital dissolution in Ethiopia.

5. Conclusion

Since test of heterogeneity is highly significant indicating significant variation between regions. Thus, the multilevel modelling is good to fit EDHS 2016 data. Random intercept with fixed model is the best model to assess regional variation and factors associated with marital dissolution. Based on best model (random intercept with fixed slope), the most important conclusion from this study is that variables with missing data can have adverse effects on analyses and hence imputation methods can be considered. From the fitted model in this study, place of residence, educational level of women, number of children, work status of women, duration of marriage, number of union and educational level of husband were determined factors related to marital dissolution of married women. The study reveals that between regions variation is more important than individual level variation and the variables; number of children and husband education level are the two variables that mostly shows variation between and within the region in marital dissolution.

Author's Contributions

AT conceived the idea. AT and JA contributed to the design and extraction of the data; and analysis. AT drafted the manuscript. All authors read and approved the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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