Age at First Marriage of Nepalese Women: A Statistical Analysis (Status, Differential, Determinants, and Distributional Pattern)

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Abstract

Marriage is a legal union between two individuals. Marital status is an essential demographic variable affecting the fertility rate. Marriage is necessary for the fertility life of women in countries where fertility outside the marriage is not accepted socially. This paper presents Nepalese women's status, differential, and determination of age at first marriage (AFM). Some probability distributions were used to analyze the distributional pattern of AFM. The Skew Log-Logistic distribution is found to fit the AFM data of Nepalese women better. The cumulative probabilities of fitted results were used to construct the marriage life table. The average waiting time for marriage for Nepalese women is estimated at 17.768 years. The probability of marrying or not marrying at a particular age is also calculated. Each of these findings provides information about the trends and patterns of marital behavior within a specific population. Besides demography, the analysis of AFM could have significant implications for various other fields, such as sociology, economics, and public health. These findings show the necessity of education campaigns opposing child marriage and early marriage. These findings can create marital policies and initiatives for the specific subpopulations with the lowest mean AFM.

Keywords

Life-table; Log-logistic; marriage; Nepal

Introduction

Fertility, mortality, and migration are the three critical aspects of population change in any region. Marital status is an essential demographic variable affecting the fertility rate. Marriage is necessary to have a child in countries where unmarried fertility is socially unacceptable. The age at first marriage (AFM) is a crucial demographic variable, showing women's legal and biological age at first marriage. A higher Mean AFM is associated with reduced fertility because of a shortened reproductive span. According to Becker (1960), marriage is compared with the nation's trade with one another by considering the comparative advantage. Later, Becker (1973) further explained that the benefits of marriage depend on how the traits of each partner are combined. The benefits of marriage are influenced explicitly by each spouse's income, human capital, and comparable pay rates.

Because of a marriage, two people become lifelong partners. They are socially and legally bound to one another. In marriage, two people commit to living together as spouses and supporting each other financially, emotionally, and physically. The legal and social aspects of marriage vary widely across different cultures and countries. Nepal's mean age at first marriage (MAFM) is 17.703 (Ministry of Health and Population [Nepal] et al., 2023). Recently, Nepal's lawful minimum age for marriage for all sexes has increased to 20 years, with or without parental consent. Society does not accept childbirth outside the marriage in Nepal. However, marriages before the age of 20 are expected in the rural parts of Nepal. In the future, this legal provision will help to increase the MAFM for Nepalese women. In this context, the primary objectives of this research are:

i. To describe the nature and status of AFM of Nepalese women.
ii. To test the differential in the MAFM among different sub-populations.
iii. To explain the significant factors of AFM.
iv. To fit the suitable probability distribution to find the distributional pattern of AFM of Nepalese women.
v. To formulate the First Marriage life table of Nepalese women.

A large portion of marital research focuses on identifying issues connected with the timing of the marriage. Education and other socioeconomic variables are significant determinants of age in women's marriage. Marini (1978) examined education as the determinant of AFM and differentiates it for different sexes. Education and racial differences are considered the significant determinants of age at marriage for American people (Bloom & Bennett, 1990). Imron et al. (2020) examined the link between several characteristics and the AFM of women in East Java. They found that information about teenage sexual well-being, timing of first sexual intercourse, age and education level of a spouse, media exposure, and wealth quantile index are associated significantly with marriageable age. Nur et al. (2020) identified the causes of West Marawola's women's timing of first marriage. Female education positively correlates with delayed AFM (Lai et al., 2023; Zahangir & Nahar, 2021). Besides education, other influential variables of AFM are wealth index, religion, region of stay, and husband's education (Zahangir & Nahar, 2021). Boateng et al. (2023) highlighted the significance of marriage to fertility in Ghana. Singh et al. (2023) highlighted the necessity of raising the legal age of marriage for females from 18 years old. In this research, the age at menarche, educational level of females, income level of the family, and husband's education are statistically associated with the AFM of Nepalese women.

Distributional pattern of timing at first marriage

Marriage is one of the significant demographic variables in population studies. The mathematical modeling of demographic variables has received considerable attention from researchers worldwide, but Asian countries have lagged in this area (Gaire & Aryal, 2015). Three different models are found to analyze the distributional pattern of women according to their AFM. First is the 'latent state model,' which is the sum of two types of random variables:' not in search of mate' and 'search of a mate.' The second one is an 'unobserved heterogeneity model.' The third one is the diffusion model. Hernes (1972) proposed a mathematical nonhomogeneous diffusion model to analyze the timing of the first marriage. This model considered the social pressure of cohorts and married percentage of cohorts as the two forces to enter into marriage.

Diekmann (1989) used the third model type to study the AFM data in Germany and the United States. They applied Exponential, Sickle, Hernes, and Log-logistic models. Frequently used models to study the age pattern of females at first marriage are lognormal distribution (Aryal, 2008; Nydell, 1924; Prasojo & Prasetyoputra, 2019); a mixture of normal and exponential distribution (Bloom & Bennett, 1990; Coale & McNeil, 1972), a mixture of two exponential distributions (Liang, 2000). Further, Log-logistic distribution (Diekmann, 1989; Keeley, 1979); Type-I extreme value distribution (Nath et al., 1992); generalized log gamma model (Kaneko, 2003); and Coale-McNeil mixture model (Kostaki & Peristera, 2015) are also used to modeled AFM. Shrestha and Shrestha (2008) used the two nonparametric smoother techniques and applied them to Nepalese AFM data. The Log-logistic distribution is a frequently used model to capture the right skewed nature data. Since its density function is unimodal with heavy right tails, its hazard function increases fast along with the unimodality and decreases slowly, creating a right skew curve. To capture the right skewed nature of AFM data of Nepalese women, we considered Log-Logistic (LLog) and different versions of this distribution.

Methods, models, and data

This article used quantitative data on the timing of women's first marriage to analyze the distributional pattern. The ontological position of this research was objectivism. We tried to establish the probabilistic association between the age of women at first marriage as the independent variable and the probability of first marriage at that age as the dependent variable. So, the epistemological position of this research was positivism.

The ontological assumptions

This study focused on the objective reality of AFM among women in Nepal, considering it a realistic ontological perspective. The research explored the nature, status, differential, determinants, and distributional patterns of AFM in Nepalese women. The marriage behaviors and the distributional pattern of AFM can be observed using scientific methods. This research proposed new mathematical models and applied these models to real data sets. It was a theory testing approach.

The marriage behaviors of women were independent of our knowledge about them. A survey of women can obtain the data of AFM. The marriage behavior was the effect of their previous demographic, socioeconomic, and cultural background. These were the social realities of women and the leading cause of present marriage behavior. Their background may have a different effect on the current situation. The central claim of this research was that marriage behavior and its distributional pattern were observable phenomena supported by the assumption of positivism. The research subject remains unaffected by the researcher's actions, ensuring an independent investigative process (Remenyi et al., 1998; Saunders et al., 2003).

The epistemological assumptions

Epistemology is the theory of knowledge. It explains how we come to attain knowledge. The epistemological stand of our study was positivism. Positivism was defined and coined in the mid-19th century by Auguste Comte (1798–1857). Moon and Blackman (2014) described epistemology as how we create knowledge. The central theme of positivism is that we can apply the law of science to study the social world. Such methods' main aim and focus are to identify the causal relationship (Creswell, 2009), which was one of the aims of the present study. Epistemology is the discovery of 'scientific generalizations or laws' that exist (Ernest, 1994). This research aims to find the nature, status, differential, determinants, and causal association between age at marriage and the probability of marriage at that age of women. By this, we claim to attain objectivity.

Marsh and Furlong (2002) postulated that positivists usually apply quantitative methods as research tools, as this helps to attain the objective. The results should be generalizable and replicable. Since our ontological position was objectivist and the epistemological approach was positivist, we chose the quantitative method as a research tool and the deductive method to test the hypothesis based on the existing theory of the marriage behavior of women. So, the result of our survey was generalizable and replicable to the survey population. We believed there was a single reality, and valid and reliable statistical tools could measure this reality.

Data

To analyze the AFM of women, we considered the secondary data set for Nepalese women from the national representative Nepal Demography and Health Survey 2022 (Ministry of Health and Population [Nepal] et al., 2023). It is a national-level household sample survey. In this survey, out of 14,243 households selected, 13,833 lived with at least one person. There was a successful interview in 13,786 households, with a response rate of 99.7%. A total of 15,238 women aged 15–49 were identified as eligible for individual interviews. And 14,845 women responded to the interview. It comprised 10,631 data on the AFM of Nepalese females. This survey used a stratified sampling technique, selecting samples in two stages.

Test statistics used for data analysis

Descriptive statistics and box and whisker plots were used to present the nature and status of AFM of Nepalese women. One-way analysis of variance (ANOVA), a statistical tool used to compare the mean of several groups, was applied to test the significance difference between MAFM for Nepalese sub-populations. Similarly, the t-test statistics were used for the pair-wise comparisons of MAFM for different groups, such as ecological regions, provinces, ethnic groups, and educational level attainment. The data for these groups and the total data were presented using box and whisker plots. The Karl Pearson correlation coefficient and chi-square test of independence were used to find the factors associated with the AFM.

Probability distribution models

This section presents the mathematical expressions of the proposed models to fit the distributional pattern of AFM of Nepalese women. The Log-Logistic (LLog) and its generalized version of distributions were used to fit the distributional pattern of Nepalese women's chosen AFM data. The LLog is a probability distribution model to analyze the right-tailed positive data. The density function of the LLog is unimodal with heavy right tails. Similarly, the hazard function increases along with the unimodality and decreases slowly, creating a right skew curve. Also, the data of AFM shows outliers and a skewed nature. To capture such data, we choose LLog distribution and its generalized versions.

Log Logistic distribution

If X denotes the AFM of the females. This variable X follows the LLog distribution with probability density function (PDF) and the cumulative distribution function (CDF) with three parameters α, β, and γ were given as

$$f_1(x) = \frac{\frac{\alpha}{\beta}\left(\frac{x-\gamma}{\beta}\right)^{\alpha-1}}{\left(1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}\right)^{2}}\text{ , for } x > 0 \quad (1)$$

$$F_1(x) = \frac{\left(\frac{x-\gamma}{\beta}\right)^{\alpha}}{\left(1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}\right)}\text{, for } x > 0 \quad (2)$$

Where $\alpha > 0$ was the shape parameter, and $\beta > 0$ was the scale parameter. Different authors studied the basic properties of LLog distribution (Ashkar & Mahdi, 2006; Kleiber & Kotz, 2003; Lawless, 2003). Tadikamalla (1980) derived the k^{th} order moments for $k < \alpha$. The moment had been derived and expressed as:

$$E\left(X^k\right) = \frac{k\,\pi\,\beta^k}{\alpha \sin\frac{k\pi}{\alpha}} \quad (3)$$

This model was also used by Diekmann (1989) and Keeley (1979) to analyze the AFM.

Kumaraswamy Log-Logistic distribution

The PDF and the CDF of the four-parameter Kumaraswamy LLog (KuLLog) distribution introduced by De Santana et al. (2012) are expressed as in the following equations:

$$f_2(x) = \frac{\alpha\theta\lambda}{\beta}\left(\frac{x}{\beta}\right)^{\alpha\theta-1}\left(1+\left(\frac{x}{\beta}\right)^{\alpha}\right)^{-(\theta+1)}\left[1-\left\{\frac{\left(\frac{x}{\beta}\right)^{\alpha}}{1+\left(\frac{x}{\beta}\right)^{\alpha}}\right\}^{\theta}\right]^{\lambda-1} \quad (4)$$

$$F_2(x) = 1-\left[1-\left\{\frac{\left(\frac{x}{\beta}\right)^{\alpha}}{1+\left(\frac{x}{\beta}\right)^{\alpha}}\right\}^{\theta}\right]^{\lambda} \quad (5)$$

Transmuted LLog distribution

The four-parameter Transmuted Log-Logistic (TrLLog) distribution proposed by Aryal (2013) having PDF and the CDF as:

$$f_3(x) = \frac{\alpha}{\beta}\left(\frac{x-\gamma}{\beta}\right)^{\alpha-1}\left\{\frac{(1+\lambda)+(1-\lambda)\left(\frac{x-\gamma}{\beta}\right)^{\alpha}}{\left(1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}\right)^{3}}\right\} \tag{6}$$

$$F_4(x) = (1+\lambda)\left\{\frac{\left(\frac{x-\gamma}{\beta}\right)^{\alpha}}{1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}}\right\} - \lambda\left\{\frac{\left(\frac{x-\gamma}{\beta}\right)^{\alpha}}{1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}}\right\}^{2} \tag{7}$$

Rayleigh generated Log-Logistic distribution

The PDF and CDF of the four-parameter Rayleigh Generated Log-Logistic (RGLLog) distribution studied by Gaire and Gurung (2022) are expressed in the following equations.

$$f_4(x) = \frac{2\alpha\theta}{\beta\{1-exp(-\theta)\}}\frac{\left(\frac{x-\gamma}{\beta}\right)^{2\alpha-1} exp\left(-\theta\frac{\left(\frac{x-\gamma}{\beta}\right)^{2\alpha}}{\left(1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}\right)^{2}}\right)}{\left(1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}\right)^{3}} \tag{8}$$

$$F_4(x) = \frac{1}{\{1-exp(-\theta)\}}\left[1 - exp\left(-\theta\frac{\left(\frac{x-\gamma}{\beta}\right)^{2\alpha}}{\left(1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}\right)^{2}}\right)\right] \tag{9}$$

Gaire et al. (2023) recently applied the RGLLog distribution to model menopausal data.

Skew Log-Logistic distribution

The PDF and CDF of the three-parameter Skew Log-Logistic (SLLog) distribution introduced by Gaire et al. (2019) are expressed as:

$$f_5(x) = \frac{2\alpha}{\beta}\frac{\left(\frac{x-\gamma}{\beta}\right)^{2\alpha-1}}{\left(1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}\right)^{3}}\text{ , for } x > \gamma \tag{10}$$

$$F_5(x) = \frac{\left(\frac{x-\gamma}{\beta}\right)^{2\alpha}}{\left(1+\left(\frac{x-\gamma}{\beta}\right)^{\alpha}\right)^{2}}\text{, for } x > \gamma \tag{11}$$

Model validation tools

The AFM data were fitted by using the above-listed probability distributions. To test the validity and suitability of the proposed models, Akaike's information criteria (AIC) and Bayesian information criteria (BIC) at the maximum value of the negative log-likelihood (NLL) of the fitted probability distribution model were used. Also, the sum of the square of error (SSQ), chi-square test statistics, and coefficient of determination (R^2) have been used. These were statistical tools used to test the validity of model fitting. The optimization technique was used to minimize the SSQ in MS EXCEL. The chi-square test statistics were calculated as follows:

$$\chi^2 = \sum_{i=0}^{n} \left(\frac{(O_i - E_i)^2}{E_i} \right) \tag{12}$$

Where O_i was the observed number of women married at different ages. The E_i was the fitted number of women with AFM at different ages obtained from the fitting distribution for Nepalese women.

Similarly, the formulas of AIC and BIC for the fitted models were given as

$$AIC = 2k - 2\,LL \tag{13}$$
$$BIC = k\,Ln(n) - 2\,LL \tag{14}$$

Here k was the number of parameters associated with the probability distribution. The constant n was the number of observations. The LL was the log-likelihood function at the maximum likelihood estimate of that distribution.

Construction of first marriage life table

The observed distributional pattern of the first marriage for Nepalese women was a right-skewed curve and deviates from the normality. So, the SLLog distribution was proposed and used to describe the distributional pattern of AFM among Nepalese women. The fitted results of the probability model used to fit the distributional pattern of AFM were used to construct the women's first marriage life table. We adopted all the procedures from the concept of mortality life-table. We assumed that age at first marriage was a universal event, and every woman must go through it. As in the mortality life table, we considered the females who got married at a certain age as death cases. By fitting the SLLog distribution, the proportion of females not marrying in a specified age or age group was a proportion of survival. The following procedure was used to construct the women's first marriage life table.

Suppose F_x was the fitted result of the proportion of women who married at age x year or less. The S_x was the proportion of those who survived or did not marry at age x, where $S_x = 1 - F_x$. Let us consider, l_0 was the hypothetical cohort of women of the first marriage life table, then, $l_x = l_0 S_x$. The probability of marrying between x to $x + t$ years of age was obtained by using the expression as

$$q_x = \frac{F_{x+t} - F_x}{1 - F_x} \tag{13}$$

Other symbols of life tables are: L_x was the person-year marrying by the cohort of women at age x. T_x was the total person-year married by the cohort of women after age x. The average number of years expected to marry at age x was denoted by (e_x)These terms were computed by using the following formulas

$$L_x = \frac{k(l_x + l_{x+k})}{2},\ T_x = \sum_x^n L_X + L_{X+1} + \cdots + L_{X+n} \tag{14}$$

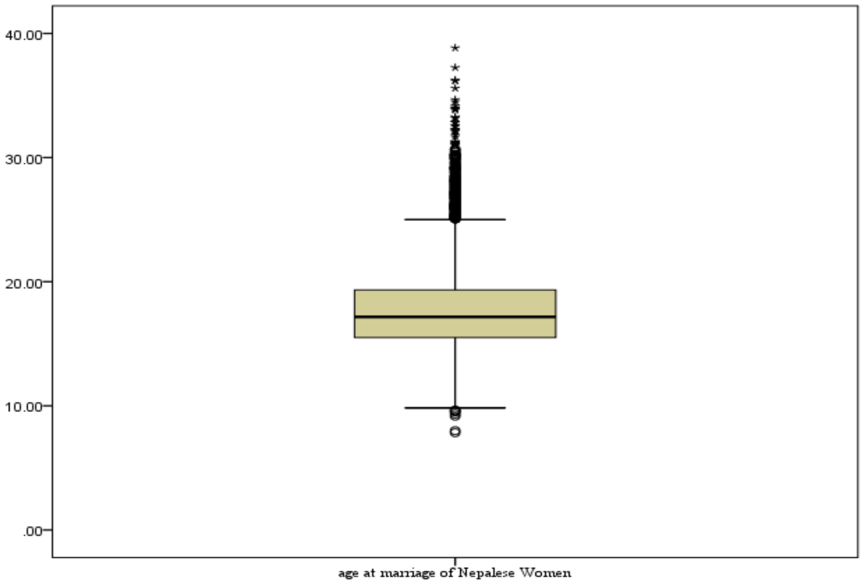
Where k was the number of years between years n to $n + k$

$$T_{x+1} = T_x - L_x \text{ and } e_x = \frac{T_x}{l_x} \tag{15}$$

Results and discussion

The AFM data comprised 10,631 married Nepalese women from the 14,845 respondents of the Nepal Demographic and Health Survey 2022 (Ministry of Health and Population [Nepal] et al., 2023). The MAFM for Nepali women was 17.7032 $\pm$ 3.28 years, with a skewness of 1.06 $\pm$ 0.024 and a kurtosis of 2.284 $\pm$ 0.048. The graphical presentation of the AFM data of Nepalese women is in Figure 1 using a box and whisker plot. The AFM data for Nepalese women show the right skew and outliers in the right.

Figure 1: Box and Whisker Plot of AFM for Nepalese Women



The MAFM was compared with the different sub-populations of Nepal, such as different provinces, ecological regions, ethnic groups, and educational attainment groups.

Comparison of MAFM among provinces of Nepal

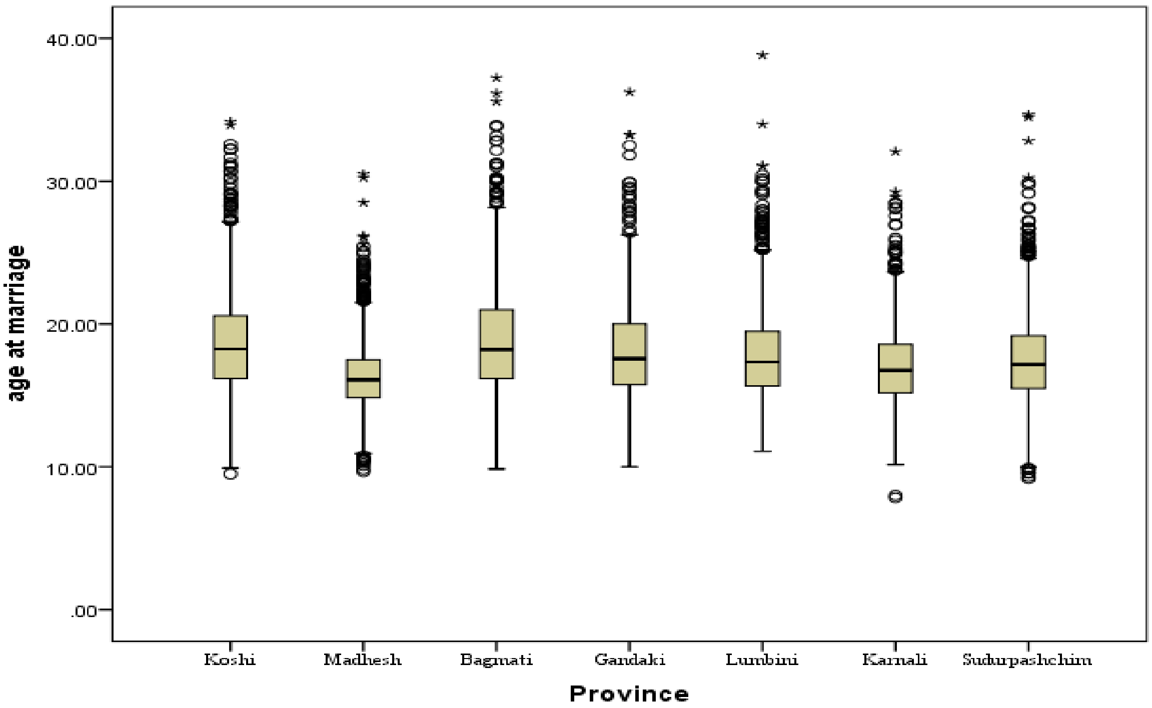
First, the MAFM was compared for different provinces in Nepal. These provinces are a political division of Nepal, and we present the results in Table 1. Bagmati province, the province with the capital city of Nepal, has the highest MAFM, 18.862 plus or minus 3.916 years, and Madhesh province shows a least 16.312 plus or minus 2.388 years.

Table 1: Mean and Standard Deviation of AFM for Nepali Women in Different Provinces

Province	*N*	Mean
Koshi	1,586	18.7506 $\pm$ 3.516
Madhesh	1,853	16.3126 $\pm$ 2.388
Bagmati	1,402	18.8619 $\pm$ 3.916
Gandaki	1,205	18.0320 $\pm$ 3.295
Lumbini	1,638	17.8577 $\pm$ 3.144
Karnali	1,439	16.9929 $\pm$ 2.778
Sudurpashchim	1,508	17.4804 $\pm$ 3.083
Total	10,631	17.7032 $\pm$ 3.282

Similarly, the MAFM for different ecological regions in Nepal is presented in Table 4. For different ethnic groups of Nepal, we present it in Table 7. We show the different educational levels attained by women in Table 10.

Figure 2: Box and Whisker Plot of AFM for Different Provinces of Nepal



The box-and-whisker plots of AFM data for Nepalese women are presented in Figures 2, 3, 4, and 5, depicting variations across different provinces, ecological regions, ethnic groups, and educational levels in Nepal.

The one-way ANOVA test, which was used to compare the mean of different sub-groups, was performed to test the hypothesis of whether the MAFM was significantly different in different provinces of Nepal. The MAFM was significantly different for provinces of Nepal with $p < .001$. The degree of freedom (*df*) was used to determine the critical and *p* values of the test statistics.

Table 2: The ANOVA for MAFM for Different Provinces of Nepal

	Sum of Squares	*df*	Mean Square	*F*	*p* value
Between province	8,175.328	6	1,362.555	136.161	< .001
Within Groups	106,313.390	10,624	10.007		
Total	114,488.718	10,630			

Further, the pair-wise comparisons of MAFM for each pair of the provinces of Nepal were performed using t-test statistics. This analysis shows that the MAFM for different provinces was significantly different except for Koshi and Bagmati. The results of the difference with their standard error (*SE*), *p* values, and 95% confidence limits of difference are shown in Table 3.

Table 3: Multiple Comparison of MAFM by t-Test

Provinces		Mean Difference (I–J)		
I	*J*	[95% CI]	*SE*	*p* value
Koshi	Madhesh	2.43793 [2.226, 2.650]*	0.10821	< .001
	Bagmati	-0.11129 [-0.339, 0.116]	0.11596	> .05
	Gandaki	0.71863 [0.482. 0.956]*	0.12089	< .001
	Lumbini	0.89288 [0.674, 1.111]*	0.11144	< .001
	Karnali	1.75770 [1.532, 1.984]*	0.11517	< .001
	Sudurpashchim	1.27020 [1.047, 1.493]*	0.11378	< .001
Madhesh	Bagmati	-2.54922 [-2.769, -2.30]*	0.11197	< .001
	Gandaki	-1.71930 [-1.949, -1.490]*	0.11707	< .001
	Lumbini	-1.54506 [-1.755, -1.335]*	0.10728	< .001
	Karnali	-0.68023 [-0.898, -0.462]*	0.11115	< .001
	Sudurpashchim	-1.16774 [-1.383, -0.953]*	0.10971	< .001
Bagmati	Gandaki	0.82991 [0.586, 1.074]*	0.12427	< .001
	Lumbini	1.00416 [0.779, 1.230]*	0.11509	< .001
	Karnali	1.86899 [1.636, 2.102]*	0.11871	< .001
	Sudurpashchim	1.38148 [1.151, 1.612]*	0.11736	< .001
Gandaki	Lumbini	0.17425 [-0.061, 0.410]	0.12006	> .05
	Karnali	1.03907 [0.797, 1.281]*	0.12353	< .001
	Sudurpashchim	0.55157 [0.312, 0.791]*	0.12223	< .001
Lumbini	Karnali	0.86483 [0.641, 1.089]*	0.11429	< .001
	Sudurpashchim	0.37732 [0.156, 0.599]*	0.11289	< .001
Karnali	Sudurpashchim	-0.48751 [-0.716, 0.259]*	0.11658	< .001

Comparison of MAFM among different ecological regions of Nepal

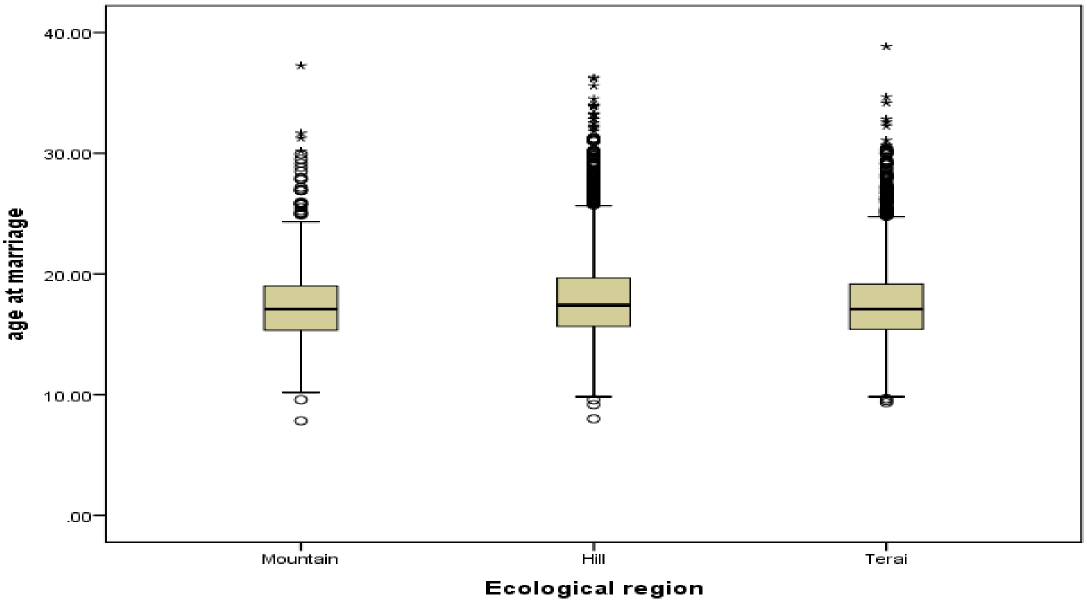
We performed a similar analysis for different ecological regions in Nepal. The Terai region is a plain region situated in the southern part of Nepal. The hilly area is the central hills and the Himalayas. The mountain region is northern Nepal, with the high Himalayas, including Mount Everest. The value of MAFM for different ecological areas in Nepal is presented in Table 4.

Table 4: The MAFM for Different Ecological Regions in Nepal

Ecological region	*N*	Mean
Mountain	937	17.422 ± 3.1496
Hill	4,674	17.960 ± 3.4081
Terai	5,020	17.516 ± 3.1679
Nepal	10,631	17.703 ± 3.2818

Figure 3 presents the AFM data for the various ecological zones of Nepal using box and whisker plots.

Figure 3: Box and Whisker Plot of AFM for Nepalese Women in Different Ecological Regions



One-way ANOVA determines whether the averages for several ecological zones differ significantly. It shows that the MAFM significantly differs with $p < .001$ for different environmental regions in Nepal. It means at least one pair of groups shows a difference in MAFM.

Table 5: One-Way ANOVA for Different Ecological Regions of Nepal

	Sum of Squares	***df***	**Mean Square**	***F***	***p* value**
Between Ecological regions	556.796	2	278.398	25.970	< .001
Within Groups	113,931.922	10,628	10.720		
Total	114,488.718	10,630			

Table 6: Multiple Comparisons of MAFM for Different Ecological Regions Using a T-test

Ecological region		**Mean Difference**		
I	***J***	**(I–J) [95% CI]**	***SE***	***p value***
Mountain	Hill	-0.53731 [-0.767, -0.308]*	0.11719	< .001
	Terai	-0.09389 [-0.322, 0.135]	0.11652	> .05
Hill	Terai	0.44342 [0.313, 0.574]*	0.06655	< .001

Further, the multiple comparisons of MAFM for different ecological regions in Nepal were performed using t-test statistics. The Mountain and Terai pairs of parts showed no significant difference in MAFM. The other pairs of regions showed a substantial difference in MAFM. Table 6 displays the difference results and their *SE*, *p* values, and 95% confidence intervals.

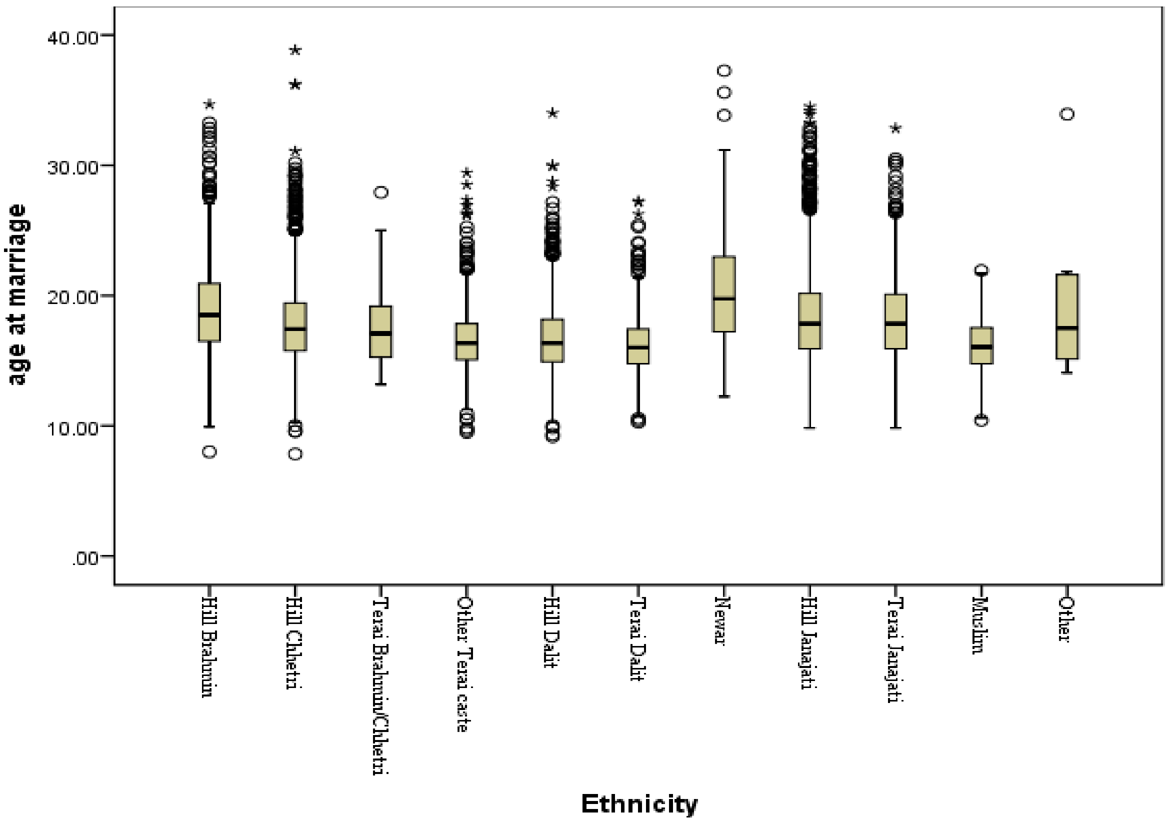
Comparison of MAFM among different ethnic groups of Nepal

Similarly, the MAFM for different ethnic groups of Nepal was computed along with their standard deviation and presented in Table 7. We observed that Newar, the prominent indigenous resident of the capital city of Nepal, has the highest MAFM of 20.316 plus or minus 4.257 years, while Terai Dalit shows a minimum MAFM of 16.252 plus or minus 2.447 years.

Table 7: MAFM for Different Ethnic Groups of Nepal

Ethnicity Group	*N*	Mean
Hill Brahmin	953	18.918 ± 3.6090
Hill Chhetri	2,477	17.8082 ± 3.0861
Terai Brahmin/Chhetri	93	17.448 ± 2.8735
Other Terai caste	1,296	16.530 ± 2.3862
Hill Dalit	1,248	16.7311 ± 2.8822
Terai Dalit	590	16.2518 ± 2.4474
Newar	256	20.3161 ± 4.2576
Hill Janajati	2,310	18.3392 ± 3.5332
Terai Janajati	1,037	18.2523 ± 3.3424
Muslim	364	16.2548 ± 2.1911
Other	7	19.8452 ± 6.9234
Total	**10,631**	**17.7032 ± 3.2818**

Figure 4: The Box-and-Whisker Plot of AFM for Different Ethnicities of Nepal



One-way ANOVA analysis revealed that, with $p < .001$, the mean for the various ethnic groups in Nepal differed significantly. It means at least one ethnic group had a different average than others.

Table 8: One-Way ANOVA for MAFM for Different Ethnicities of Nepal

	Sum of Squares	*df*	Mean Square	*F*	*p* value
Between Ethnicities	9,437.496	10	943.750	95.407	< .001
Within Groups	105,051.222	10,620	9.892		
Total	114,488.718	10,630			

The multiple comparisons of MAFM for different ethnicities of Nepal were performed using t-test statistics. The Newars and Muslim ethnic groups showed the highest difference in MAFM with $p < .001$. Most ethnic groups showed significant differences in MAFM except for some groups. The results of the difference with their *SE*, *p* values, and 95% confidence limits are shown in Table 9.

Table 9: Multiple Comparisons of MAFM for Different Educational Attainment Groups

Ethnicity *I*	*J*	Mean Difference (I–J) [95% CI]	*SE*	*p* value
Hill Brahmin	Hill Chhetri	1.11018 [0.875, 1.345]*	0.11989	< .001
	Terai Brahmin/Chhetri	1.47039 [0.801, 2.140]*	0.34168	< .001
	Other Terai caste	2.38845 [2.125, 2.652]*	0.13421	< .001
	Hill Dalit	2.18731 [1.922, 2.453]*	0.13530	< .001
	Terai Dalit	2.66658 [2.344, 2.989]*	0.16476	< .001
	Newar	-1.39767 [-1.832, -0.964]*	0.22140	< .001
	Hill Janajati	0.57917 [0.342, 0.817]*	0.12109	< .001
	Terai Janajati	0.66609 [0.389, 0.943]*	0.14113	< .001
	Muslim	2.66361 [2.284, 3.044]*	0.19379	< .001
	Other	-0.92682 [-3.265, 1.412]	1.19310	> .05
Hill Chhetri	Terai Brahmin/Chhetri	0.36021 [-0.291, 1.011]	0.33220	> .05
	Other Terai caste	1.27827 [1.067, 1.489]*	0.10782	< .001
	Hill Dalit	1.07713 [0.863, 1.291]*	0.10918	< .001
	Terai Dalit	1.55640 [1.274, 1.839]*	0.14408	< .001
	Newar	-2.50784 [-2.913, -2.103]*	0.20648	< .001
	Hill Janajati	-0.53101 [-0.709, -0.353]*	0.09097	< .001
	Terai Janajati	-0.44409 [-0.672, -0.216]*	0.11633	< .001
	Muslim	1.55343 [1.207, 1.899]*	0.17655	< .001
	Other	-2.03700 [-4.371, 0.297]	1.19043	> .05
Terai Brahmin/Chhetri	Other Terai caste	0.91806 [0.256, 1.580]*	0.33763	< .01
	Hill Dalit	0.71693 [0.054, 1.380]**	0.33807	< .05
	Terai Dalit	1.19619 [0.508, 1.884]*	0.35090	< .001
	Newar	-2.86805 [-3.615, -2.122]*	0.38079	< .001
	Hill Janajati	-0.89122 [-1.543, -0.239]*	0.33263	< .001
	Terai Janajati	0.80430 [0.137, 1.472]**	0.34044	< .05
	Muslim	1.19322 [0.477, 1.910]*	0.36543	< .001
	Other	-2.39721 [-4.814, 0.019]	1.23267	> .05

Ethnicity *I*	*J*	Mean Difference (I–J) [95% CI]	*SE*	*p* value
Other Terai caste	Hill Dalit	-0.20114 [-0.446, 0.043]	0.12473	> .05
	Terai Dalit	0.27813 [-0.028, 0.584]	0.15620	> .05
	Newar	-3.78612 [-4.208, -3.365]*	0.21511	< .001
	Hill Janajati	-1.80929 [-2.023, -1.595]*	0.10915	< .001
	Terai Janajati	-1.72237 [-1.979, -1.466]*	0.13104	< .001
	Muslim	0.27516 [-0.091, 0.641]	0.18657	> .05
	Other	-3.31527 [-5.652, -0.979]*	1.19195	< .001
Hill Dalit	Terai Dalit	0.47927 [0.171, 0.787]*	0.15714	< .001
	Newar	-3.58498 [-4.008, -3.162]*	0.21579	< .001
	Hill Janajati	-1.60815 [-1.825, -1.392]*	0.11049	< .001
	Terai Janajati	-1.52123 [-1.780, -1.262]*	0.13216	< .001
	Muslim	0.47630 [0.109, 0.844]**	0.18735	< .05
	Other	-3.11413 [-5.451, -0.777]*	1.19208	< .001
Terai Dalit	Newar	-4.06424 [-4.526, -3.603]*	0.23538	< .001
	Hill Janajati	-2.08741 [-2.372, -1.803]*	0.14508	< .001
	Terai Janajati	-2.00049 [-2.318, -1.683]*	0.16219	< .001
	Muslim	-0.00297 [-0.414, 0.408]	0.20962	> .05
	Other	-3.59340 [-5.937, -1.249]*	1.19578	< .001
Newar	Hill Janajati	1.97683 [1.571, 2.383]*	0.20718	< .001
	Terai Janajati	2.06375 [1.634, 2.494]*	0.21950	< .001
	Muslim	4.06127 [3.558, 4.564]*	0.25654	< .001
	Other	0.47084 [-1.891, 2.833]	1.20489	> .05
Hill Janajati	Terai Janajati	0.08692 [-0.1435, 0.317]	0.11756	> .05
	Muslim	2.08444 [1.737, 2.432]*	0.17736	< .001
	Other	-1.50599 [-3.840, 0.828]	1.19055	> .05
Terai Janajati	Muslim	1.99752 [1.622, 2.373]*	0.19161	< .001
	Other	-1.59291 [-3.931, 0.745]	1.19275	> .05
Muslim	Other	-3.59043 [-5.943, -1.238]**	1.20012	< .05

*Note: *Mean was significant at $p < .01$, ** Mean was significant at $p < .05$*

Comparison of MAFM for different educational attainment groups of Nepal

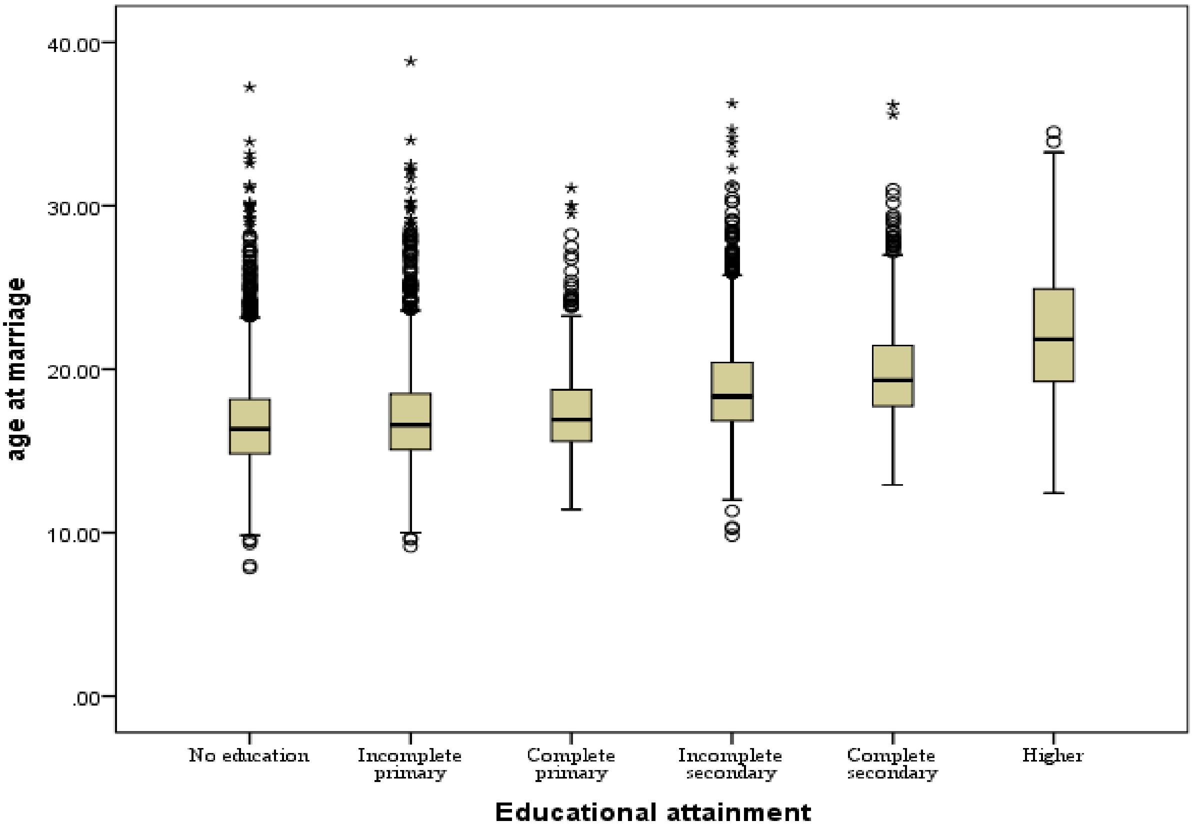
We performed a similar analysis for different educational attainment groups of women in Nepal. Table 10 presents the MAFM for each group.

Table 10: The MAFM for Different Educational Attainment Groups of Women

Educational attainment	*N*	Mean
No education	3,781	16.7564 ± 2.9592
Incomplete primary	2,981	17.0625 ± 2.9600
Complete primary	602	17.4273 ± 2.8414
Incomplete Secondary	2,098	18.8777 ± 3.0925
Complete secondary	871	19.8149 ± 3.0627
Higher	298	22.2411 ± 3.9524
Nepal	10,631	17.7032 ± 3.2818

The analysis found that the groups with no education have a minimum MAFM of 16.756 plus or minus 2.959 years. The higher educational group showed the highest MAAM of 22.241 *plus* or minus 3.952 years. The study showed that as women's education level increases, Nepalese women's age at first marriage increases.

Figure 5: Box and Whisker Plot of AFM for Different Educational Attainment of Nepalese Females



The one-way ANOVA analysis showed that the mean was significantly different for different educational attainment groups of Nepalese women with a $p < .01$. Table 11 presents the analysis results. It means the MAAM for at least one group significantly differed from the other groups.

Table 11: One-Way ANOVA for MAFM for Different Educational Levels

Sources	Sum of Squares	*df*	Mean Square	*F*	*p* value
Between Educational level	17,572.773	5	3,514.555	385.304	< .001
Within Groups	96,915.945	10,625	9.122		
Total	114,488.718	10,630			

Additionally, t-test statistics were used for multiple comparisons of MAFM for various educational attainment groups of Nepali women. The highest difference of MAFM of 5.484 plus or minus 0.182 years with $p < .01$ was found between groups of higher educated with no educated group. It was found that a higher significance difference in MAFM was seen for groups with higher differences in educational attainment. The results of the difference with their *SE*, *p* values, and 95% confidence limits are shown in Table 12.

Table 12: Multiple Comparisons of MAFM for Different Educational Levels

Educational attainment groups *I*	*J*	Mean Difference (I–J)	*SE*	*p* value
No education	Incomplete primary	-0.30610* [-0.4511, -0.1611]	0.07398	< .001
	Complete primary	-0.67089* [-0.9307, -0.4111]	0.13253	< .001
	Incomplete Secondary	-2.12123* [-2.2824, -1.9601]	0.08222	< .001
	Complete secondary	-3.05843* [-3.2809, -2.8359]	0.11351	< .001
	Higher	-5.48462* [-5.8408, -5.1284]	0.18172	< .001
Incomplete primary	Complete primary	-0.36479* [-0.6293, -0.1003]	0.13495	< .01
	Incomplete Secondary	-1.81513* [-1.9838, -1.6464]	0.08607	< .001
	Complete secondary	-2.75233* [-2.9804, -2.5243]	0.11633	< .001
	Higher	-5.17852* [-5.5382, -4.8188]	0.18349	< .001
Complete primary	Incomplete Secondary	-1.45034* [-1.7241, -1.1766]	0.13964	< .001
	Complete secondary	-2.38754* [-2.7013, -2.0738]	0.16008	< .001
	Higher	-4.81373* [-5.233, -4.3944]	0.21392	< .001
Incomplete Secondary	Complete secondary	-0.93721* [-1.1758, -0.6986]	0.12174	< .001
	Higher	-3.36339* [-3.7299, -2.9969]	0.18697	< .001
Complete secondary	Higher	-2.42618* [-2.8235, -2.0289]	0.20269	< .001

Associated factors of AFM of Nepalese women

The AFM for Nepalese women was found to be positively correlated with the income level of the family (r = 0.170, $p < .01$), the education level of girls (r = 0.347, $p < .01$) which was consistent with Lai et al. (2023) and Zahangir and Nahar (2021), and the husband's education (r = 0.169, $p < .01$) compatible with Zahangir and Nahar. The chi-square test of independence between AFM and different variables was used to test Five hypotheses. Pearson Chi-square showed that there exists a significant association between the AFM of Nepalese females and the income level of the family ($\chi^2 = 413.408$, $p < .01$), educational attainment of females ($\chi^2 = 1664.594$, $p < .01$), age at menarche ($\chi^2 = 452.895$, $p < .01$), husband education ($\chi^2 = 648.092, p < .01$), place of resident in ecological regions ($\chi^2 = 41.366, p < .01$).

Distribution fitting of AFM of Nepalese women

The distributional pattern of Nepal's AFM data was fitted using five skewed probability models (LLog and its generalizations). We present the fitted results and the different test statistics results in Table 13. The SLLog distribution fits the AFM data of Nepalese women significantly better than LLog and other versions of LLog distributions. The AIC, BIC, and chi-square values for the SLLog distribution were lower than those of other comparative distributions. The coefficient of determination and NLL values were found to be the maximum. The SLLog distribution was found to fit the AFM data of Nepalese females better from all the test statistics results and the graph of fitted results.

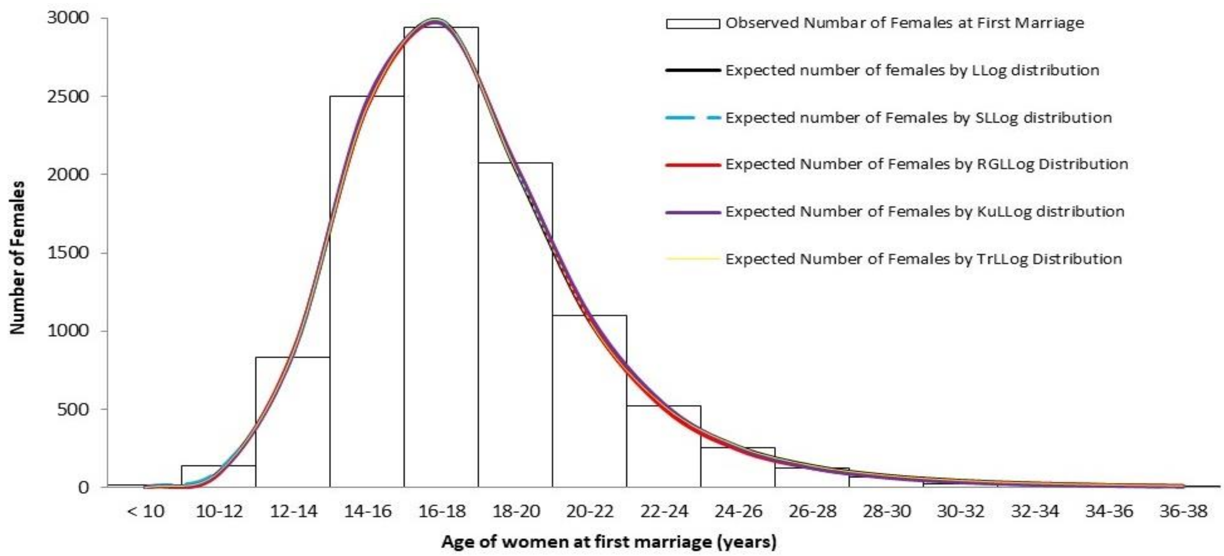
Table 13: Empirical and Fitted Value of the Number of Females by Different Distributions

Age group	Observed	Fitted Number of Women				
		LLog	RGLLog	TrLLog	KuLLog	SLLog
Below 10	16	0.843	0.337	0.843	3.310	6.934
10–12	136	102.370	88.823	102.365	97.272	117.134

Age group	Observed	Fitted Number of Women				
		LLog	RGLLog	TrLLog	KuLLog	SLLog
12–14	836	867.140	879.433	867.134	862.966	860.335
14–16	2,503	2,441.493	2,443.721	2,441.491	2,483.024	2,461.701
16–18	2,945	2,986.072	2,966.537	2,986.069	2,967.673	2,979.028
18–20	2,076	2,034.129	2,065.195	2,034.128	2,061.095	2,043.521
20–22	1,102	1,060.294	1,068.574	1,060.296	1,101.723	1,080.548
22–24	523	521.613	502.458	521.616	535.273	529.107
24–26	257	263.624	240.729	263.627	256.071	259.659
26–28	122	140.171	123.219	140.173	124.817	131.352
28–30	65	78.571	68.119	78.572	62.796	69.024
30–32	26	46.223	40.483	46.225	32.728	37.685
32–34	16	28.376	25.615	28.377	17.662	21.325
34–36	4	18.078	17.081	18.078	9.852	12.469
36–38	4	11.894	11.898	11.895	5.665	7.509
α		4.694	2.577	4.694	5.354	7.993838
β		8.349	10.390	8.349	12.009	14.94593
γ		8.883	8.999	8.883	–	0.522858
θ		–	5.489	$1.59\text{x}10^{-4}$	2.958	–
γ		–	–	–	1.497	–
NLL		-80.836	-102.744	-89.760	-76.4	-74.2629
AIC		167.672	213.487	187.519	160.8	154.5258
BIC		169.796	216.043	192.395	163.7	156.443
SSQ		12,675.840	10,802.986	12,675.840	3,772.7	5,805.789
χ^2		64.114	75.278	64.123	33.2	22.34273
R^2		0.999	0.999	0.999	1.000	1.000

Figure 6 presents the graphical comparison between the observed and fitted number of women for AFM for Nepalese females. The figure shows that the SLLog distribution provided a good approximation for describing the distribution of AFM of Nepalese females. Based on the analysis and graphical presentation, we recommend the SLLog distribution to tell the age pattern of females at first marriage for Nepalese women.

Figure 6: Observed and Fitted Value of the Number of Women for AFM



Construction of first marriage life table for Nepalese women

Using the fitted cumulative probability of the SLLog distribution, we constructed the first marriage life table for Nepalese women. The life table technique yielded an MAFM of 17.768 years for the Nepal Demographic and Health Survey (NDHS) 2022 (Ministry of Health and Population [Nepal] et al., 2023) data. The finding was consistent with the observed value of MAFM for Nepalese women, which was 17.7032 years. Also, the estimated MAFM for the Ministry of Health [Nepal] et al. (2017) data was 17.522 years. There was a slight increase in the MAFM for Nepalese females. The cohort analysis of MAFM for Nepalese women was recommended to better understand the changing pattern of AFM.

Table 14: Marriage Life Table for Nepalese Women (NDHS 2022)

Age of Women	F_x	S_x	l_x	q_x	L_x	T_x	e_x
< 10	0.00065	1.00000	100,000	0.01103	999,673.9	1,776,841	17.768
10–2	0.01167	0.99935	99,934.77	0.08188	198,767.7	777,167.1	7.777
12–4	0.09260	0.98833	98,832.95	0.25519	189,573.2	578,399.4	5.852
14–6	0.32416	0.90740	90,740.25	0.41462	158,324.6	388,826.2	4.285
161–8	0.60438	0.67584	67,584.38	0.48587	107,146.7	230,501.5	3.411
18–20	0.79660	0.39562	39,562.29	0.49971	59,902.3	123,354.9	3.118
20–22	0.89824	0.20340	20,340.01	0.48910	30,515.89	63,452.57	3.120
22–24	0.94801	0.10176	10,175.88	0.46981	15,374.74	32,936.68	3.237
24–26	0.97244	0.05199	5,198.861	0.44825	7,955.251	17,561.94	3.378
26–28	0.98479	0.02756	2,756.39	0.42692	4,277.221	9,606.691	3.485
28–30	0.99128	0.01521	1,520.832	0.40672	2,392.391	5,329.47	3.504
30–32	0.99483	0.00872	871.5592	0.38794	1,388.636	2,937.079	3.370
32–34	0.99684	0.00517	517.077	0.37059	833.5607	1,548.443	2.995
34–36	0.99801	0.00316	316.4837	0.35459	515.6828	714.8819	2.259
36–38	0.99871	0.00199	199.1991	-	199.1991	199.1991	1.000

The average number of years expected to wait for marriage for a female at birth was 17.703 years. The column (q_x) of the marriage life table gives the probability of marriage in a particular year. We estimated that when a female was 10, there was an 8.19% chance of marriage within a year. Further, when the female was 20, there was a 48.91% chance of marriage within a year.

Conclusion

We examined the nature and status of AFM for Nepalese females. The differential of MAFM for Nepalese women was evaluated for different subgroups: provinces, ecological regions, ethnic groups, and educational attainment groups. Analysis showed a significant differential in MAFM for these sub-populations of Nepal. Further, the family's income level, female education, husband's education, place of residence in ecological regions, and age at menarche were significantly associated with the AFM of Nepalese women. The distributional pattern of AFM of Nepalese women was analyzed using different probability distributions. The SLLog distribution was found to fit the data better. Using the distribution fitting results, we constructed the marriage life table for Nepalese females.

We estimated the waiting time for marriage of Nepalese girls at birth to be 17.768 years. The analysis of AFM can have significant implications for various fields, such as sociology, economics, and public health. The MAFM and probability of marrying or not marrying at a particular age obtained from life table techniques gave insights into the trends and patterns of marriage behavior in a specific population. The status, differentials, and differences in the MAFM for different sub-populations of Nepal indicated that there was a need for awareness programs against early marriage and child marriage. Recently, Nepal endorsed the legal provision of 20 years of marriageable age for both males and females, with or without parental consensus. There was more to do by Nepal's federal, provincial, and local governments. These results help to develop policies and programs for sub-populations where the MAFM was minimal.

Further, this information and the results can be helpful for policymakers and program designers in developing interventions to promote different development programs. Ultimately, it helps to address social disparities. Additionally, the analysis of AFM and the results of the marriage life table can help forecast population trends related to fertility and marriage rates. These can have significant implications for social and economic development. The analysis of AFM provides essential insights into the dynamics of marriage behavior and its consequences for individuals and societies.

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