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# Survival Analysis and Predictors of Time to First Birth After Marriage in Jordan

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**Abstract** The Waiting time-to-first birth is an important indicator of the reproductive behavior of married women. However, data on waiting time to first birth involve censoring and follow a skewed distribution, and thus need survival analysis techniques to analyze such data. The aim of this study was to model the time to first birth after marriage using survival analysis techniques and identifies the significant prognostic factors of time to first birth after marriage. The data for the study was extracted from the 2018 Jordan Population and Family Health Survey. The study considered 4,828 married women who were married within 10 years of the survey date. Descriptive statistics and non-parametric (Kaplan-Meier estimator, log-rank test) and semiparametric (Cox's model) survival analysis techniques were used for data analysis. The overall median time to first was estimated to be 15 months, indicating that about half of the married women become pregnant within the first six months of marriage. The risk of having first birth was found to be 52%, 61%, and 74% at 15, 18, and 24 months of marriage, respectively. Cox's proportional hazard model identified age at marriage, education, wealth index, contraceptive use status, and employment status as significant predictors of waiting time to the first birth. The moderate fertility level (about 3 births per woman) in Jordan can further be reduced by adopting a policy for delayed first birth after marriage. Policies for ensuring girls' universal education to at least a secondary level would help reduce fertility by increasing age at marriage and changing reproductive behavior.

**Keywords** Time to first birth, First birth interval, Predictor, Marriage, Survival analysis, Jordan

## 1. Introduction

Having first birth is a significant event in the life of a woman. It not only determines her level of fertility, but also her health, career development, and social well-being [1,2]. While early childbearing increase the risk of maternal and child morbidity and mortality, delayed childbearing, on the other hand, reduces fertility and population growth and improves the standard of living of mothers through education and career development [2-5].

The length of first birth interval or the waiting time to first birth interval often used as an indicator to understand the reproductive pattern and behavior of a population [6,7]. Different studies have identified different risk factors contributing to the length of the first birth interval. Mother's education and age at marriage are the most widely cited determinants of first birth interval. Age at the marriage of mothers is considered to be an important variable in the fertility process which is negatively associated with the length of the first birth interval [8,9]. Education has always been an important socio-economic determinant of reproductive life [10]. The other common determinants of marriage to first birth intervals are wealth status, place of residence, and employment status [1,11,12].

There is an inverse relationship between fertility and birth interval. The duration of marriage to first birth interval provides the most consistent and reliable measure of conception rate or fecundability, defined as the probability of conceiving in a month among fecundable women (excluding pregnant, sterile and amenorhheic women) [13]. In fact, the fecundability is inversely related to the duration of the conception wait [13,14]. At this crucial juncture, it is important to analyze the marriage to first birth interval data. However, one of the important features of this type of event history data collected through retrospective surveys or follow-up studies is that they involve censored or incomplete observations. Individuals that did not experience the event of interest during the study period are considered censored data. For example, consider the event of marriage to first birth interval for a random sample of married women considered in a retrospective survey. In this case, there are many women who still do not have any first birth either they just married or for various other reasons, and thus their duration of marriage to first birth is censored due to the survey date. For those who have the event, i.e. first birth (i.e., complete data), the

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duration of marriage to first birth is usually positively skewed. Estimating the average duration of marriage to first birth by considering only the complete data will underestimate the true duration. Tuma and Hannan [15] have proved that excluding censored data from the analysis can cause biased results. Thus, the presence of censoring complicates the research design and the statistical analysis that cannot be handled properly by standard statistical methods, such as ordinary regression models and/or logistic models. However, survival methods can be used to analyze time-to-event data that involves censoring. Over the period, various survival analysis techniques have been developed for analyzing survival data with censored observations. The aim of this study is to analyze the duration of marriage to the first birth interval and its prognostic factors in Jordan, using survival analysis techniques.

# 2. Materials and Methods

### 2.1. Sampling Design and Study Population

This study utilized secondary data from the 2018 Jordan Population and Family Health Survey (JPFHS) conducted as part of the global Demographic and Health Surveys (DHSs) program. ICF Macro International provided technical assistance through the DHS Program, which is funded by the United States Agency for International Development (USAID) and offers financial support and technical assistance for population and health surveys in countries worldwide. The details of the survey and the data may be seen in the final report of the 2018 JPFHS [16]. The survey included a nationally representative sample of 14,689 ever-married women of reproductive age. The sample was selected following a stratified cluster sampling design to provide national and subnational level estimates of major demographic and health indicators. The survey collected detailed information about marriage, birth history, and other socio-economic, demographic, and maternal and child health indicators.

Our response variable is the waiting time to first birth (survival time) after marriage which includes both censored and uncensored observations. To minimize the memory recall bias associated with reporting first birth, we have considered only women who were married within 10 years of the survey date. For any individual woman, if there was an event or first birth before the survey date, the observation was considered uncensored, and the survival time for uncensored observation was calculated by subtracting the date of the marriage from the date of first birth. On the other hand, if a woman had no birth before the survey date, the observation was considered as censored, and the survival time for the censored case was calculated by subtracting the date of marriage from the date of the survey. Thus our survival time was attached with a censoring index, which was coded as 1 if the event occurred and 0 otherwise. We defined the starting point of the study as the date of the survey and looked backward for ten years. The survival time T was defined as the time from the date of marriage to the date of the first birth, and the censoring time C was defined as the time from the date of marriage to the date of the survey. In this study, we have considered only the right censoring cases, excluding the reported pregnant women and the women with a first birth interval of fewer than nine months. Under the above-mentioned inclusion and exclusion criteria, a total of 4,828 women were left for our survival analysis. The explanatory variables considered in this study were: age at marriage, contraceptive use, education, ethnicity, place of residence, region, work status, and wealth index.

### 2.2. Survival Analysis

Survival analysis is a collection of statistical procedures for data analysis for which the outcome variable of interest is time until an event occurs. It is most important when survival time involved censored observations and thus cannot be analyzed using standard statistical methods which consider only uncensored data [17]. Survival data, or time-to-event data, measure the time elapsed from a given origin to the occurrence of an event of interest. In summarizing survival data there are three functions of central interest namely the survivor function, the hazard function, and the probability function. They are briefly discussed as follows.

Let T be a continuous random variable associated with the survival times of an event, t be the specified value of the random variable T, and f(t) be the underlying probability density function of the survival time T. Three quantitative terms are important in survival analysis. These are the survival function S(t), hazard function h(t), and the probability density function f(t). In the context of the present study, the survival function S(t) gives the probability that a woman "survives" longer than some specified time t without a birth, while the hazard function h(t) gives the instantaneous potential per unit time to have the first childbirth after time t, given that the individual had not had the first childbirth up to time t. The interrelationship among these functions can be shown mathematically as follows.

The distribution function F(t) represents the probability that the length of waiting time to first birth for a women is less than (or equal to) a specified time t, and is given by

$$F(t) = P(T < t) = \int_o^t f(u)du \text{ , where; } t \geq 0 \qquad (1)$$

Then the survivor function S(t), is given by

$$S(t) = 1 - P(T \leq t) = 1 - F(t) \qquad (2)$$

which, in this context, represents the probability that a woman will still have no birth at time t.

From equations (1) and (2) the relationship between f (t) and S(t) can be derived as

$$f(t) = \frac{d}{dt}F(t) = \frac{d}{dt}\left(1 - S(t)\right) = -\frac{d}{dt}S(t) \geq 0 \qquad (3)$$

The hazard function, $h(t) \geq 0$ is given as

$$h(t)=\lim_{\Delta t\to 0}\frac{P(t<T<t+\Delta t|T>t)}{\Delta t}=\frac{f(t)}{1-F(t)}=\frac{f(t)}{S(t)} \quad (4)$$

The cumulative hazard function is defined as $(t)=\int_0^t h(x)dx$. Lee and Wang [18] showed that $H(t)=-\log S(t)$. Then S(t) = exp(-H(t)) and f(t) = h(t)S(t).

There are three types of models for analyzing the survival time. These are: the nonparametric models, the semi-parametric model, and the parametric models. However, in this study we have used non-parametric and semi-parametric methods.

The Kaplan-Meier (K-M), Nelson-Aalen (N-A) and Life Tables (LT) are the three non-parametric methods for estimating the survival and hazard functions. Among these three methods, K-M method, developed by Kaplan and Meier [19], is the most commonly used non-parametric method in survival analysis. For a descriptive summary of the time to first birth after marriage, we used K-M estimator.

In K-M method, we assume that we have a sample of n independent observations denoted by ($t_i$, $c_i$), i=1, 2, ….,n of the underlying survival time variable *T* and the censoring indicator variable C. Among the n observation, let there are m≤n recorded time of first birth. Let $t_{(1)}\le t_{(2)}\le\cdots\le t_{(m)}$ are the rank-ordered survival time of first birth. Let $n_i$ be the number of women exposed to have a first birth at $t_{(i)}$ and $d_i$ be the observed number of women with first birth at $t_{(i)}$, then the K-M estimator of the survivorship function at time *t* is obtained from the equation

$$\hat{S}(t)=\prod_{t_{(i)}\le t}\left(\frac{n_i-d_i}{n_i}\right) \quad (5)$$

with $\hat{S}(t)=1$ if $t<t_{(1)}$.

After obtaining summary statistics of survival time, a comparison of the survivorship experience of subgroups defined by the categories of a covariate were made. To test the statistical significant difference in survival time across the subgroups, log-rank (LR) test was used. The incidence rate (IR) of marriage to first birth, which is the probability that a woman would have a first birth after marriage at time $t_{k+1}$ given that she has not had a child by time $t_k$, was also determined. It is the probability of first birth occurring after a particular interval (time after marriage) given that the woman has had no birth before then.

To obtain the net-impact of the explanatory variables on time to first birth after marriage, we then applied semi-parametric model known as the Cox Proportional Hazard model [20]. In proportional hazard model, the effect of a unit increase in covariate is multiplicative with respect to hazard rate. The general form of the proportional hazard model is given as

$$h_i(t)=h_0(t)\exp\left(\beta_1x_{1i}+\beta_2x_{2i}+\cdots+\beta_px_{pi}\right) \quad (6)$$

where $h_0$(t) is the baseline hazard function; $X_{ji}$ is a vector of covariates and $\beta_j$ is a vector of parameters for fixed effects. To give a linear model for a logarithm of the hazard ratio, the model in Equation (6) can be written as

$$\log\left\{\frac{h_i(t)}{h_0(t)}\right\}=\beta_1x_{1i}+\beta_2x_{2i}+\cdots+\beta_px_{pi} \quad (7)$$

The sign of the coefficient indicates how a covariate affects the hazard rate. The hazard ratio (HR), expressed as the exponentials of the coefficients, implies more exposure to an event of interest if >1, HR < 1 means low exposure while HR = 1 has no effect on the exposure. Shorter and longer birth intervals are achieved when hazard ratios are above and below 1, respectively. The hazard ratio greater than 1 indicates the increased hazard of first birth (leading to shorter birth interval), while the hazard ratio less than 1 indicates the decreased hazard of first birth (leading to longer birth interval). The statistical significance of the coefficients was determined at a p-value < 0.05.

# 3. Result

Out of the 4,248 women considered in this study, 4148(85.9%) had given birth before the survey date and the rest 680(14.1%) had not given birth before the survey date, these later groups of women were considered as censored cases in survival analysis. For those who had a birth, the median waiting time to first birth after marriage was 13.2 months, and the skewness of waiting time to first birth after marriage was found to be 3.48. This indicates that the data on waiting time to first birth is highly skewed to the right. Nearly one-third (32%) of the women were married before age 20, 43% were married between age 20-24 years, while 26% were married at ages 25 and above (Table 1). The mean age at marriage was found to be 22.4 years. An overwhelming majority (93%) of the women had a secondary or above level of education. More than half (57%) of the women were contraceptive users at the time of the survey. About 82% of the women were native Jordanian, and 80% of the women were living in urban areas. About 15% of the respondents were engaged in employment. More than half (59%) of the women belonged to the poorest or poorer categories of wealth quintiles. The data in Table 1 indicate that the censored cases (i.e. women who did not have birth within 10 years before the survey date) and non-censored cases (i.e. women who had a birth before the survey date) differ according to their socio-demographic characteristics. Censoring cases occurred at a substantially higher rate among the women with higher age at marriage, having primary or less education, non-users of contraceptive, employed, and with richest wealth index.

Figure 1 presents the K-M survival function (S(t)), distribution function (F(t)) and hazard function (h(t)) of time to first birth after marriage. As stated earlier, S(t) represents the probability of not having the first birth after marriage until a specified time t, F(t) represents the probability that the length of waiting time to first birth for a woman is less than (or equal to) a specified time t, and h(t) represents the hazard

of first birth at a specified time t. It is evident that the survival function decreases sharply at the beginning until the 20th month of marriage and the rate of decrease becomes slower after that. This implies that most of the women gave first birth soon after marriage. The results indicate that about 38% (F(t) = 0.384) of women gave birth within 12 months of marriage, indicating that these women got pregnant within the first three months of marriage. Also, by the end of the second year of marriage, 74% (F(t) = 0.734) of the women had given first birth. Thereafter, their probability generally keeps declining about 10 years in marriage, and approximately 7% of married women gave birth for the first time after 8 years of marriage. The hazard rate showed a unimodal positively skewed distribution of the instantaneous probability of occurring first birth after marriage. Until 20 months after marriage, the hazard rate increased and then rapidly decreased over time.

**Table 1.** Distribution of respondents who were married within 10 years of survey and their first birth status by demographic and socio-economic characteristics

| Characteristics | Total respondents n(%) | Status | |
|---|---|---|---|
| | | Censored: women who had no birth n (%) | Event: women who had births n (%) |
| **Total** | 4,828 (100) | 680 (14.1) | 4,148 (85.9) |
| **Age at marriage** | | | |
| <20 | 1,527 (31.6) | 170 (11.1) | 1,357 (88.9) |
| 20-24 | 2,055 (42.6) | 216 (10.5) | 1,839(89.5) |
| 25+ | 1,246 (25.8) | 294 (23.6) | 952(76.4) |
| **Mean age at marriage(SD)** | 22.4 (5.28) | 25.3 (7.53) | 21.9 (4.65) |
| **Current contraceptive use status** | | | |
| No | 2,743 (56.8) | 669 ( 24.4) | 2,074 (75.6) |
| Yes | 2,085 (43.2) | 11 (0.5) | 2,074 (99.5) |
| **Education** | | | |
| Primary or less | 364 (7.5) | 83 (22.8) | 281 (77.2) |
| Secondary | 2,380 (49.3) | 347 (14.6) | 2,033 (85.4) |
| Higher | 2,084 (43.2) | 250 (12) | 1,834 (88) |
| **Ethnicity** | | | |
| Jordanian | 3,969 (82.2) | 561 (14.1) | 3,408 (85.9) |
| Non-Jordanian | 859 (17.8) | 119 (13.9) | 740 (86.1) |
| **Place of residence** | | | |
| Urban | 3,875 (80.3) | 547 (14.1) | 3,328 (85.9) |
| Rural | 953 (19.7) | 133 (14) | 820 (86) |
| **Region** | | | |
| Central | 1,634(33.8) | 244(14.9) | 1,390(85.1) |
| North | 1,705(35.4) | 211(12.4) | 1,494(82.1) |
| South | 1,489(30.8) | 255(15.1) | 1,264(84.9) |
| **Work status** | | | |
| No | 4,123 (85.4) | 554 (13.4) | 3,569 (86.6) |
| Yes | 705 (14.6) | 126 (17.9) | 579 (82.1) |
| **Wealth index** | | | |
| Poorest | 1,492 (30.9) | 192 (12.9) | 1,300 (87.1) |
| Poorer | 1,358 (28.1) | 198 (14.6) | 1,160 (85.4) |
| Middle | 1,037 (21.5) | 141 (13.6) | 896 (86.4) |
| Richer | 635 (13.2) | 80 (12.6) | 555 (87.4) |
| Richest | 306 (6.3) | 69 (29.1) | 237 (77.5) |
| **Mean waiting time to first birth** | | | 13.2 |

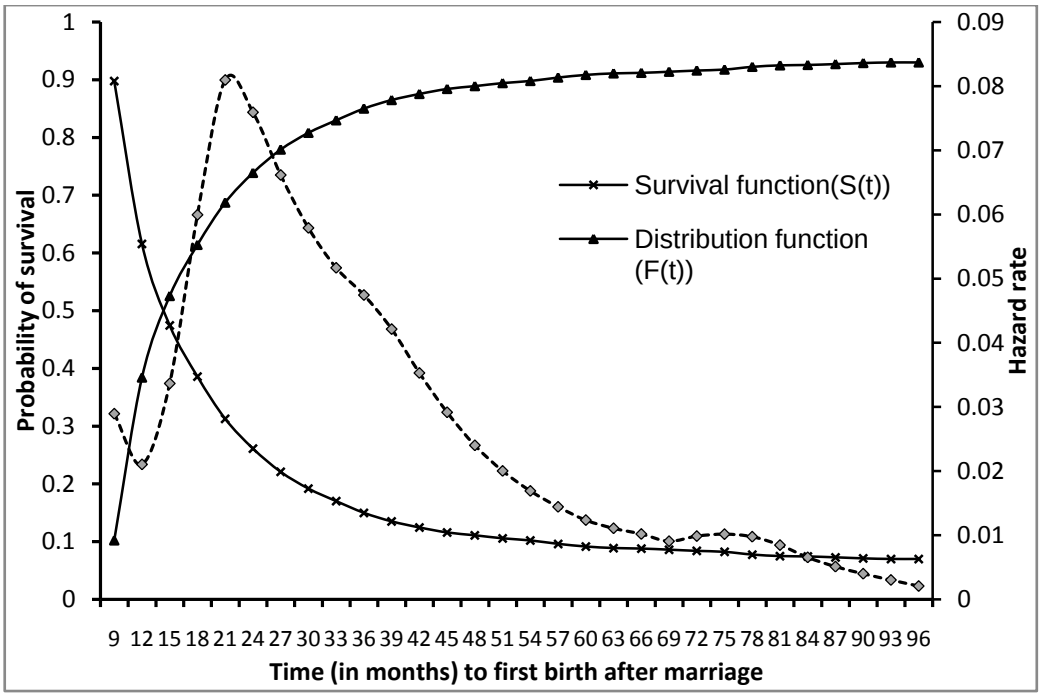
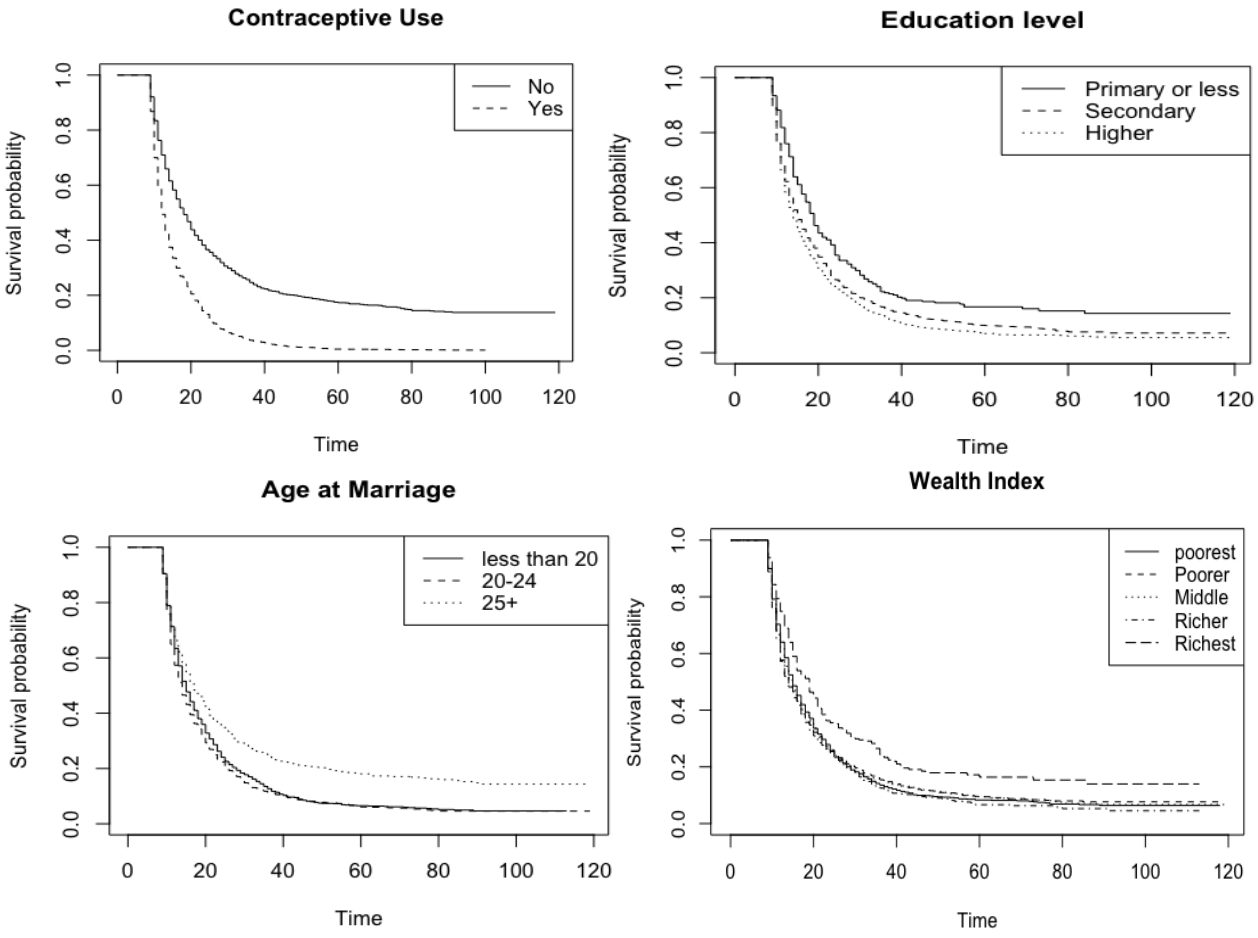



**Figure 1.** Survival function, distribution function and hazard function of time to first birth after marriage



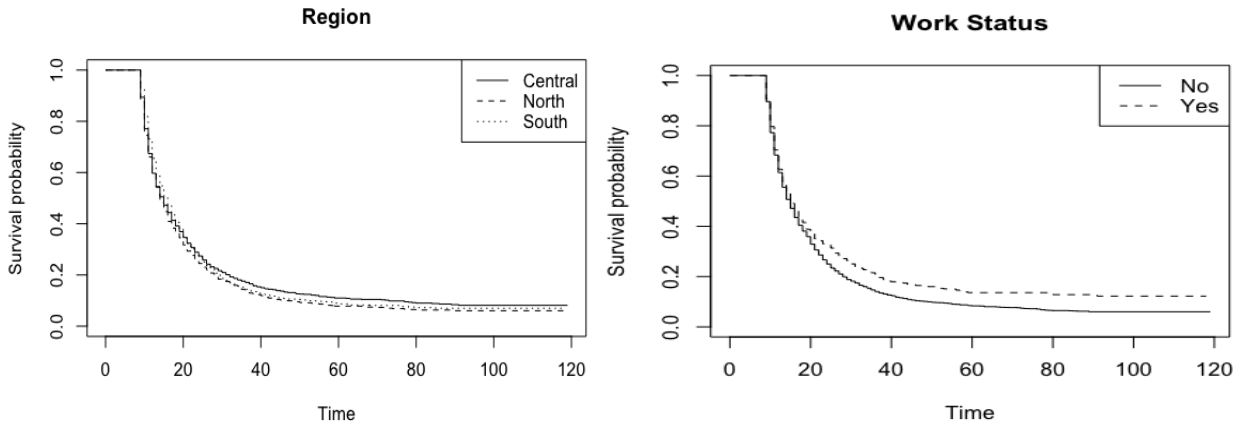



**Figure 2.** Survival function of time to first birth after marriage by characteristics of women

**Table 2.** Kaplan-Meier estimate of median survival time to first birth by covariates

| Factors | Median survival time to first birth | Incidence rate | Log-rank test P-value |
|---|---|---|---|
| **Total** | 15 | 0.057 | |
| **Age at marriage** | | | <0.001 |
| < 20 | 15 | 0.059 | |
| 20-24 | 14 | 0.064 | |
| 25+ | 17 | 0.045 | |
| **Contraceptive use** | | | <0.001 |
| No | 18 | 0.042 | |
| Yes | 12 | 0.082 | |
| **Education** | | | <0.001 |
| Primary or less | 19 | 0.040 | |
| Secondary | 15 | 0.056 | |
| Higher | 14 | 0.062 | |
| **Ethnicity** | | | 0.200 |
| Jordanian | 15 | 0.057 | |
| Non- Jordanian | 16 | 0.053 | |
| **Place of residence** | | | 0.700 |
| Urban | 15 | 0.057 | |
| Rural | 15 | 0.057 | |
| **Region** | | | 0.010 |
| Central | 15 | 0.065 | |
| North | 14 | 0.062 | |
| South | 16 | 0.053 | |
| **Work status** | | | 0.100 |
| No | 15 | 0.057 | |
| Yes | 16 | 0.054 | |
| **Wealth index** | | | <0.001 |
| Poorest | 15 | 0.058 | |
| Poorer | 14 | 0.061 | |
| Middle | 15 | 0.057 | |
| Richer | 14 | 0.062 | |
| Richest | 19 | 0.040 | |

Figure 2 presents a comparative analysis of the K-M survival functions obtained from two or more subgroups of women for some selected characteristics of women. The results indicate wide variations in the probability of not having first until a specified time after marriage across the subgroups of age, education, contraceptive use status, region of residence, work status, and wealth quintiles status. For instance, the probabilities of not having a first child until a specified duration was observed to be consistently lower among the women with a higher level of education than the women with primary or less education. Women married at ages 25 and above had a higher probability of survival without first birth after marriage than the women married below age 20 years. The log-rank test indicates significant differences in the survival functions of the sub-groups of populations for all the factors except work status, ethnicity, and urban/rural place of residence.

Table 2 presents the summary results of survival analysis of the time to first birth after marriage using Kaplan-Meier estimator across the demographic and socio-economic characteristics of women. The overall median survival time (MST) to first birth was observed to be 15 months (Table 2). The MST to first birth showed no consistent pattern of a relationship with the age at marriage. The MST to first birth was found to be 15, 14, and 17 months for the age group <20, 20-24, and 25 and above. The MST to first birth decreases with the level of education. The MST was found to be 19 months for the women with primary or less education as opposed to 14 months for the women with a higher level of education. The MST was found significantly lower among contraceptive users than non-users (12 months Vs 18 months). The MST was found to be higher among women from the South region (16 months) than other regions. Women with the richest wealth index were found to have the highest MST (19 months) than the richer or poorer group.

**Table 3.** Results from fitting the Cox PH model to data on marriage to first birth interval

| Covariate | Coefficient $(\hat{\beta})$ | SE $(\hat{\beta})$ | Hazard Ratio | 95% CI | *P*-value |
|---|---|---|---|---|---|
| **Age at marriage** | | | | | |
| <20 | Ref | | 1.00 | | |
| 20-24 | -0.0279 | 0.0426 | 0.97 | 0.86-1.10 | 0.647 |
| 25+ | -0.1467 | 0.0478 | 0.86 | 0.75-0.98 | 0.038 |
| **Education** | | | | | |
| Primary or less | Ref | | 1.00 | | |
| Secondary | 0.2460 | 0.0767 | 1.28 | 1.02-1.62 | 0.042 |
| Higher | 0.4058 | 0.0819 | 1.50 | 1.17-1.92 | 0.001 |
| **Wealth index** | | | | | |
| Poorest | Ref | | 1.00 | | |
| Poorer | -0.0592 | 0.0497 | 0.94 | 0.83-1.07 | 0.368 |
| Middle | -0.1782 | 0.0525 | 0.84 | 0.73-0.96 | 0.009 |
| Richer | -0.0918 | 0.0569 | 0.91 | 0.78-1.07 | 0.248 |
| Richest | -0.3835 | 0.0641 | 0.68 | 0.56-0.83 | <0.001 |
| **Region** | | | | | |
| Central | Ref | | 1.00 | | |
| North | 0.0582 | 0.0381 | 1.06 | 0.96-1.17 | 0.267 |
| South | -0.0909 | 0.0557 | 0.91 | 0.83- 0.98 | 0.034 |
| **Contraceptive-use** | | | | | |
| No | Ref | | 1.00 | | |
| Yes | 0.7132 | 0.0337 | 2.04 | 1.85-2.25 | <0.001 |
| **Residence place** | | | | | |
| Urban | Ref | | 1.00 | | |
| Rural | -0.0062 | 0.0559 | 0.98 | 0.89-1.11 | 0.914 |
| **Ethnicity** | | | | | |
| Jordanian | Ref | | 1.00 | | |
| Non-Jordanian | -0.0989 | 0.0515 | 0.91 | 0.78-1.05 | 0.181 |
| **Work-status** | | | | | |
| Unemployed | Ref | | 1.00 | | |
| Employed | -0.1874 | 0.0468 | 0.83 | 0.72-0.96 | 0.012 |

The overall incidence rate (IR) of first birth after marriage, which is defined as the probability of having the first birth after marriage at the time given that the woman has had no child before that time, is 0.057 (Table 2). The IR was higher (0.064) among women who were married at age 20-24 years than their younger (0.059) or older counterparts (0.047). The IR showed a negative association with the level of education, as the rates were 0.062, 0.056, and 0.040 among the women with higher, secondary, and primary or less education levels, respectively. The IR was higher among women living in the central region of Jordan (0.065), who were Jordanian, having a poorer or richer wealth index, and who are not working. The IR was found to be highest (0.082) among women who were contraceptive users.

To identify the significant predictors of the time to first birth after marriage, Cox proportional hazard model was fitted. The results indicate that, age at marriage, education, region of residence, wealth index, contraceptive use status, and work status as significant predictors of marriage-to-first birth interval. As mentioned earlier that the hazard ratio greater than 1 indicates the increased hazard of transition to first birth after marriage, leading to shorter first birth interval or faster transition to first birth after marriage. On the other hand, a hazard ratio less than 1 indicates the decreased hazard of transition to first birth after marriage, leading to longer first birth interval or delayed first birth. Age at marriage showed a negative association with the hazard of the time-to-first birth after marriage (Table 3). For example, women of age 25 and above had 14% lower hazard of having first birth after marriage than the women married at ages less than 20 years (HR=0.86, 95% CI: 0.75- 0.98), indicating delayed first birth among women with higher age at marriage.

Women's education showed a significant positive association with the hazard of first birth after marriage. Women with a higher level of education had 1.50 times higher hazard of giving first birth after marriage (leading to shorter duration of marriage to first birth interval) than women with primary or less level of education (HR=1.50, 95% CI: 1.17-1.92). Women with the richest wealth index had 32% lower hazard risk of giving first birth after marriage (leading to a longer duration of marriage to first birth) than the women with the poorest wealth index (HR=0.68, 95% CI: 0.56-0.83). Compared to women from the Central region, women from the South region had 9% lower hazard of giving first birth after marriage (HR=0.91, 95% CI: 0.83 -0.98), and thus had a longer interval between marriage to the first birth. Contraceptive users were found to have two times higher hazard of first birth than the non-users of contraceptive methods (HR=2.01, 95% CI: 1.85 – 2.25). Results also show that employed women had 17% lower hazard of having first birth, implying a longer duration of marriage to first birth among employed women than their unemployed counterparts (HR=0.83, 95% CI: 0.72-0.96).

# 4. Discussion

The aim of this study was to analyze the time-to-first birth after marriage, using the most recent Jordan Population and Family Health Survey (JPFHS) data of 2018. Since the time-to-first birth after marriage involved censoring events, which precludes the use of classical statistical models for analyzing such data, we applied survival analysis techniques. Both non-parametric (K-M method) and semi-parametric (Cox's model) methods have been used for analyzing time-to-first birth data and identify the prognostic factors of time to first birth occurrence. The median time to first birth after marriage was observed to be 15 months in Jordan. The risk of having first birth within 10 years of marriage before the survey date was found to be 52%, 61%, and 74% at 15, 18, and 24 months of marriage, respectively. The results indicate that about half of the married women become pregnant within the first six months of marriage. The median time to first birth after marriage in Jordan is relatively shorter than observed in most countries in South Asia and Africa. For example, in a recent study in Ethiopia, the median time to first birth was observed to be 30 months [21], while the median time of first birth interval was observed to be 20 months for Nigerian women [1], 25.2 months for Iranian women [9], and 25 months for Bangladeshi women [22]. The quick transition from marriage to first birth or shorter first birth interval in Jordan might be related to higher age at marriage and a lower rate of contraceptive use among the married women in the county compared to the women in Ethiopia or India. For example, among the married women considered in this study, 43.0% were using any family planning methods, while in Ethiopia, 74% of women were using any family planning methods. On the other hand, the median age at marriage in Jordan was 22 years, compared to 16 years in Ethiopia. Early marriage (i.e., below age 20) leads to a longer duration of marriage to the first birth interval due to the sub-fecundity of the adolescent girls.

Both non-parametric (log-rank test) and semi-parametric method (Cox model) identified age at first marriage, wealth index, education level, region, contraceptive use, and work status as significant prognostic factors of timing to first birth after marriage. Age at first marriage was found to be negatively associated with the hazard of first birth in Jordan, indicating delayed first birth among the women with higher age at marriage. This is conceivable, as the women with higher age at marriage might be more concerned about fertility control through spacing births. Our result is consistent with the findings of other studies [1,9,23].

A significant negative association was found between women's education and time-to-first birth. Women with secondary and above level education have a significantly shorter duration of first birth interval compared to women with primary or less education. This finding is consistent with the findings of the study conducted in Bangladesh and

India [24], Iran [9], and Ghana [25]. Women's educational attainment is a strong predictor of the reproductive behavior of women. Women with the secondary and above level of education spend a substantial amount of time in achieving education and thus likely to have entry into reproduction at a higher age, and thereby likely to have first birth quickly after marriage to compensate their late entry and achieve the desired level of fertility. Our findings, however, contradict the findings of the study of Fagbamigbe and Idemudia [1] in Nigeria; reporting women with no education or primary education had higher hazards of having first childbirth than those with higher education.

Another important finding of this study was that the employment status of the women had a significant association with time-to-first birth. The time-to-first birth interval following marriage for employed women was longer than for unemployed women. This is consistent with studies done in Bangladesh [26], Indonesia [12], and Ethiopia [21].

The results indicate that the contraceptive users had a higher hazard of first birth and thus shorter first birth interval than their non-users counterparts. Our findings contradict the findings of many studies documenting higher first birth interval for contraceptive users than the non-users of contraceptive, as contraceptive use help delaying birth [27-30]. It is worth mentioning here that we have considered current contraceptive use status, rather than at the time before first birth. As a result, it may happen that most of the current users in our study become contraceptive users after having their first birth in a quick succession after marriage.

The key strength of this study is that it is based on a nationally representative sample and population-based data, and thus the findings are generalizable to the national as well as sub-national levels. The study findings may have important policy implications for fertility planning in Jordan. The study has the potential to contribute to the literature. Nonetheless, the study is not free from limitations. The data used in the study is cross-sectional in nature which was obtained through retrospective interviews of a selected group of women who were married within 10 years of the survey date, and thus may have introduced recall biases and restricts the interpretation of causality. Further, using secondary data-limited us in the choosing of variables that were available.

## 5. Conclusions

The median time of transition from marriage to first birth was observed to be 15 months, which is shorter than most other developed and developing countries. The level of education showed a significant positive association with the hazard of first births and thus leading to a faster transition to the first birth. The wealth index showed a slower transition to first birth after marriage among women from middle and richest wealth index groups, leading to higher birth intervals. Women with employment were found to be less likely to have a faster transition to first birth, leading to a longer first birth interval. The early timing of first birth in Jordan might have contributed to the moderate total fertility rate of 2.7 births per woman. The fertility rate could further be reduced by adopting a policy to increase the gap between marriages to the first birth. Considering the prevailing complex socio-cultural norms in Jordan, direct intervention for delayed first birth may be difficult. However, policies for ensuring girls' universal education to at least a secondary level would help reduce fertility by increasing age at marriage and changing reproductive behavior.

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## Conflict of Interests

The authors declare that they have no conflict of interests.

## Ethics Approval

JPFHS data are public access data and were made available to us by MEASURE DHS upon request. Ethical clearance to conduct the JPFHS was approved by the Government of Jordan.

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