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Modeling the Factors Affecting the First Birth in the Family's' Fertility in Hamedan Province

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Authors' contributions

This work was carried out in collaboration among all authors. Author AS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SD and MMA managed the analyses of the study. Authors HM and MK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: The role of fertility as the most important determinant of demographic fluctuations has given more importance to its studies compared with other demographic phenomena. In this context, different indexes are used to measure fertility patterns where the index of the first birth after marriage has received much attention.
Materials and Methods: This was a cross-sectional (descriptive-analytic) study in which the fertility data of women are converted into a fictitious cohort and investigated. In this study, married woman in the age group of 15 to 49 years in 500 families in Hamedan were selected. In this study, a

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researcher-made questionnaire was used that included information related to the number of live births (fertility) and factors related to it (i.e. date of marriage, age, the first pregnancy, number of unwanted pregnancies, average interval between children, and the use of contraceptives). Univariate and multivariate survival analysis was carried out for the interval between marriage and the first birth. In the univariate section, using Kaplan-Meir method and log-rank test, survival functions of the interval between the first births after marriage in different predictive variables were compared.

Result: Mean age of mothers at the first birth was 22.04±4.357 years and mean number of live births was 2.18±0.904. The first marriage age of women, parental education, women's employment, the use of contraceptives, and the number of live births were at a significance level of 5%.

Conclusion: It can be concluded that parental education, women's employment, and use of contraceptives play important roles in population growth.

Keywords: First birth interval; drugs; parametric models; cox regression; contraceptives.

1. INTRODUCTION

Population growth fluctuations constitute one of the important factors for socio-economic planning of each country. Fertility rate and behaviors related to it are the main components of population growth and are important issues in health and social sciences [1]. Fertility is affected by lots of factors including drugs such as prostaglandin F2α [2,3]. Also, the non-steroidal anti-inflammatory drugs may affect fertility in male rats [4]. Other effect of fertility drugs is ovarian cancer affecting fertility in women [5].

In other words, the role of fertility as the most important determinant of population growth has given importance to the studies related to it compared with other demographic phenomena and investigation of different socio-economic and cultural factors affecting it has dedicated a large share of the studies in this area to itself as well as even the period of high school events and menstrual causalities [6,7]. With improved health condition in communities, although the mortality rate is reduced significantly, the birth rate continues with the same process as before and even slower. With declining population growth in recent decades, we will witness young population decline in the future [8]. According to the report by Population Reference Bureau (PRB), Iran is among the top twenty countries with largest populations. However, over the past three decades, Total Fertility Rate (TFR) in Iran has decreased significantly [9]. Iran has the lowest fertility rate in the Middle East and studies on the level and fertility rate in Iran indicate that TFR of every 7 births for each woman in 1980 decreased to 1.9 births in 2006 and 1.8 in 2011. This process is observed in both urban and rural areas [10-12].

Since demographic situation of the country is changing, attention to new processes of fertility behaviors such as increased delay in birth is necessary, because its health and social consequences are very important in welfare, social, and health planning. Therefore, prioritization of factors related to population growth can be effective in demographic planning. Indeed, demographic policymaking is not possible without considering factors affecting fertility [13]. Fertility of women and fertility level of the country are directly and indirectly are under the influence of different factors such as accessibility of reliable pregnancy control methods, religious beliefs, traditions, cultural norms, abortion, marriage age, mortality rate of infants, professional and career opportunities, economic factors, urbanization, marriage age rising, delay in the birth of the first child, and increased interval between births and these factors can be classified into cultural, social, economic, and health factors [14-16].

Fertility method in each society is under the influence of intervals between the birth of children and factors affecting future pregnancies. These processes, together, determine fertility level and model in the population [17]. Mortalities of infants, children and mothers, health services for women and children, economic growth and age structure of the population are influenced by the number of born children. Therefore, the number of born children has important consequences for public health, economic conditions, and population structure [18,19].

To measure fertility patterns, different indexes are used. Among indexes used in this context, the first birth interval index is used more than other indexes such as the next birth interval [15], because the first event is rarely involved in

remembering problem and almost all people remember their first fertility. Second, delay in menstrual cycle that occurs after fertility, does not exist in this period, but other fertility intervals are highly influenced by the effect of irregular variations of this period [20]. As a result, across the world as well as Iran, fertility variations study on the interval between marriage and the first birth is very important.

Since delay in the first birth can reduce fertility rate of couples, understanding the effective factors in increasing the interval between marriage and the first birth is very important. Therefore, it is important to study the first birth in order to predict the future fertility. A long interval between marriage and the first fertility has negative consequences for mother and children. Increased maternal age at the first birth reduces fertility and increases the risk of baby death. Also, health options related to assisted reproductive technology [21-25].

According to the available studies, the first birth interval is determined through many social, cultural, and physiological factors. Factors affecting the age of the first child are various and from different levels. Factors affecting the age of the first child can be assessed at different levels of individual, family, social, economic, national, and international factors. The most important factors in this context are marriage age, women's education, women's employment after marriage, access to contraceptives, parental education, religious belief, social status, employment, peer pressure, women's freedom, and life acceptance [15,26-30].

According to the census in 2011, the fertility rate in Hamedan was 1.7% and developments have occurred in the population pyramid over the past two decades. Also, we observe inverted population age pyramid structure. In this regard, it is necessary to study fertility in this area and identify factors affecting its incidence.

Most of married women give birth to their first child several months after marriage, so that the data of these people are fully considered, but those women who do not have any child yet, are categorized as censored data. Therefore, the first birth interval is an example of survival data. Analysis of these data with conventional methods is not suitable since it is causal [31]. Survival analysis method is a special method to analyze these data to reduce causality.

In some studies, nonparametric and semi-parametric survival analysis methods such as Kaplan-Meir and log-rank test and Cox regression have been used. Nonparametric survival analysis methods (univariate), although describe information available in data, cannot investigate the simultaneous effect of predictive variables on the response variable. Also, Cox regression model is a semi-parametric method to model survival data that because of no need to determine the risk function completely and the advantage of simple interpretation of risk factors with minimum assumptions is highly applicable in practice [32]. However, Cox regression model requires Proportional Hazards (PH) assumptions that without them, the interpretation of results is difficult and leads to invalid analyses [33]. Another model that uses PH assumption is PH parametric model. This model, changes PH model assuming the basic risk function has one of the known statistical distributions. Although PH parametric model is suitable for most of clinical problems, PH model cannot be used as an alternative model to deal with non-proportional hazards. On the other hand, Accelerated Failover Time (AFT) model is one of the parametric survival models that can be used as an alternative for PH model, especially to overcome the problems that are resulted from PH assumption violation [34]. Therefore, if assumptions of a special probability distribution exist for data, inferences based on it will be more accurate. In particular, standard errors of estimates of quantities such as relative hazards and median survival time are less than when no distributional assumption is considered, in which Soltanian et al. and Nardi and Schemper had studies in this field [35-37].

AFT model investigates the effect of variables directly on survival time instead of hazards in PH model. Moreover, the interpretation of results in AFT model is easier than the results of PH model, because parameters show the effects of explanatory variables on survival time mean.

This study has concentrates on the beginning of family-building process that is transition to the first birthday using survival models. The purpose of the present study was to investigate factors affecting the first birth interval. Using its data, in addition to investigating first birth variable determinants, this study introduced a suitable statistical method to analyze this variable. It is expected that the findings of this study enhance the awareness of population policymakers about factors associated with fertility and birth interval and this influences fertility and health of mother and baby.

2. MATERIALS AND METHODS

The present study is a cross-sectional (descriptive-analytic) study in which the fertility data of women are converted into a fictitious cohort and investigated. Data collection tool in this study was a researcher-made questionnaire and to design the questionnaires to record demographic and maternal birth information, a review was conducted on similar studies including two sections of children and fertility information and demographic information of parents. The questionnaire included the number of live births (fertility) and related factors (i.e. date of marriage, age of first pregnancy, number of unwanted pregnancies, average interval between children, mother's age, mother's education, women's employment, husband's age, average income of the family, and the use of contraceptives) that selected according to the scientific texts. The statistical population of this study included married woman in the age group of 15 to 49 years who at least had one permanent marriage and were living in Hamedan province for 5 years. Since unwanted pregnancy can lead to the abortion incentives, it can disrupt the pregnancy outcome. Therefore, people who had unwanted pregnancy and also several pregnancies were eliminated from the study. In the present study, considering frequency increase ratio of the family to the first child of about 0.98 [31], type 1 error of 0.05, and maximum significant difference of 1.5%, and applying the cluster design effect of 1.5, a sample including 500 married women in the age group of 15 to 49 years using $n = \frac{z_{1-\frac{\alpha}{2}}^2 p(1-p)}{d^2}$ was determined.

In this study, 500 households who at least had one married woman in the age group of 15 to 49 years were selected based on two-stage sampling method because we had no list of participants in advance then randomly selected 15 centers. For this purpose, in the first stage, 15 health centers (about 50% of total health centers) were randomly selected from 32 centers and in the second stage, from every health center, considering the ratio of people at the center, the number of housewives was determined. In the second stage of sampling, first, from every center, two to three clusters were selected randomly (according to the ratio of required people in each center) and then referring to the selected housewives' address, the next 11 housewives (as a block) were investigated.

In the present study, in order to obtain the interval between marriage and the first birth, due to the existence of the censored data, survival analysis methods were used. Univariate and multivariate survival analysis was carried out on the interval between marriage and the first birth. In the univariate section, using Kaplan-Meir method and log-rank test, survival functions of the interval between marriage and the first birth were investigated in different predictive variables and in the multivariate section, parametric and semi-parametric models were used to model this variable. To achieve the research goal, statistical analysis was carried out in several steps. In the first step, using Schoenfeld Residuals Test, PH assumption was investigated. Then, to determine the effects of different factors on the first birth interval, Cox proportional-hazards model was used. This model is usually based on the hazards model formula. In Cox model, exposure mode of coefficients shows the change in hazard ratio for variations in predictive variables. Hazard ratio more than 1 indicates shorter interval between marriage and birth. Moreover, two parametric survival models (log-logistic and generalized gamma) were assessed. In parametric models, the direct effect of explanatory variables on survival time is measured instead of hazards. The effect size for parametric models is time ratio 1 (TR) and to interpret the results in parametric models, time ratio is used for reporting. In this regard, TR larger than 1 indicates longer first birth interval and time ratio smaller than 1 indicates a shorter time period. Then, parametric models were assessed using A/C values and to compare optimal parametric model with Cox survival model, standard deviation of parameter estimation was used. After selecting the best model, important variables were investigated using step-by-step approach. All analyses were carried out using STATA and R with a significance level of 5%.

3. RESULT

According to the findings of this study, average mother's age at the first birth was 22.4±4.357 and average live births were 2.18±0.904. In this study, 388 women (77.6%) were housewives and 112 (22.4%) were employed. The first marriage age of 312 women (62.4%) was less than 20, 183 women were between 20 and 29, and 5 women were above 30 (Table 1).

Of 500 women, 456 women (91.2%) had experienced their first birth and for others,

censorship occurred (8.8%). Median and mean of interval between marriage and the first birth were 2 and 2.53 years, respectively. To estimate survival function for all variables, Kaplan-Meir method was used. Also, log-rank test was used to compare different groups with a significance level of 0.05. The results of log-rank test showed that at different levels of variables, women's first marriage age, parental education, use of contraceptives, and women's employment influenced the first birth interval. According to the results of Table 2, survival curves are not similar for different levels of variables; in other words, a significant difference exists between the groups. Our data were censored by 8.8% that is a good distinction, because in parametric models, more than 40-50% censorship is not allowed [35].

According to the hazard function which shows, up to 2 years after marriage, birth hazard increases and then decreases. According to the hazard function, it can be understood that the hazard level increases to a maximum point and then, decreases. Therefore, according to hazard function curve (Fig. 1), log- logistic distribution or generalized gamma of suitable parametric models is to fit the interval between marriage and the first birth.

Cox PH assumption was assessed for each variable in Cox PH model using goodness of fit test and Schoenfeld Residuals Test. According to the following table, PH assumption is confirmed (p = 0.88).

Table 1. Demographic information and fertility of married women in the age group of 15 to 49 years in Hamedan province

Variable		Frequency (%)
Woman's first marriage age	Less than 20 years	312 (62.4)
	Between 20 and 29 years	183 (36.6)
	Above 30 years	5 (1)
Mother's age at the first birth	Under 20 years	275(55)
	Between 20 and 29 years	217(43.4)
	Above 30 years	8 (1.6)
Parental education	Elementary and secondary	235 (47)
	High school and diploma	142 (28.4)
	Associate degree and above it	123 (24.6)
Women's employment	Employed	112 (22.4)
	Housewife	388 (77.6)
Monthly income	Low (less than 9500000 rials)	217 (43.4)
	Average (9500000 to 20000000 rials)	196 (39.2)
	High (above 20000000 rials)	87 (17.4)
Number of live births	Less than 20000000 rials	348 (69.9)
	Above 20000000 rials	152 (30.4)
Use of contraceptives	No	92 (18.4)
	Yes	408 (81.6)
Man's first marriage age	Less than 25 years	313 (62.4)
	Between 25 and 29 years	108 (21.6)
	Above 30 years	79 (15.8)
Pregnancy status	Unwanted	109 (21.8)
	Wanted	391 (78.2)

Table 2. Factors affecting the first birth interval using Kaplan-Meir method and log-rank test

Variable	P value	X^2
First marriage age	0.0006	14.87
Women's employment	0.0079	7.07
Parental education	<0.001	23.15
Average income of parents	0.931	0.14
Use of contraceptives	0.0641	8.58
Man's first marriage age	0.67	0.78
Pregnancy status	0.64	0.21
Number of live births	0.053	3.73

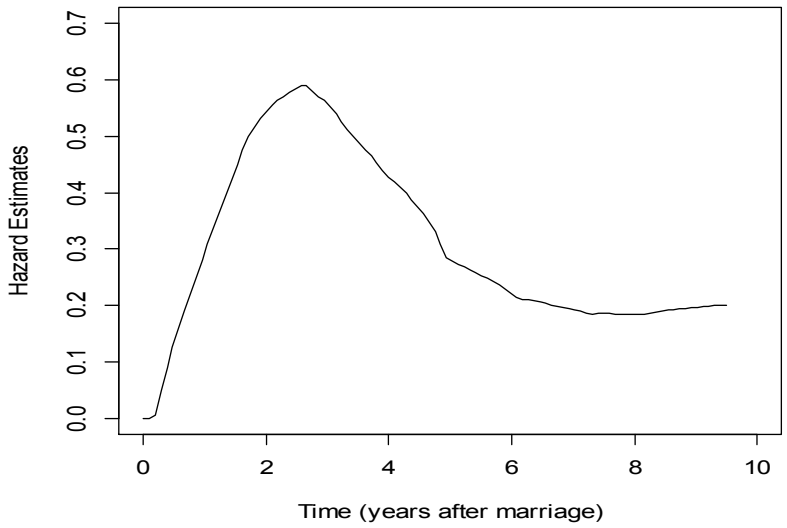

Fig. 1. Pregnancy hazard function in women with the first pregnancy

Table 3. The results of PH assumption test

Variable	Chi-square test	Significance value
Woman's first marriage age	0.56	0.75
Women's employment	0.12	0.72
Parental education	3.28	0.19
Monthly income of parents	2.68	0.26
The use of contraceptives	0.58	0.92
Number of live births	0.67	0.41
Man's first marriage age	2.42	0.29
Pregnancy status	0.29	0.59
General test	21.19	0.88

Of 500 women, 456 women (991.2%) have been experienced the first live birth, and 8.8% of them were censored (right censoring). The median survival time for these couples was 2 years after marriage and the average survival time for the first birth who experienced the event first was calculated to be 2.53 (Fig. 2).

According to the results of Table 4, women's first marriage age, parental education, women's employment, use of contraceptives, and number of live birth is significant at a significance level of 5%. The results show that parental education has a significant effect on first birth, so that parents with academic education have longer birth interval compared with those with elementary and secondary education and first birth interval TR in parents with academic education relative to parents with elementary and secondary education is 1.328. In other words, parents with academic education give birth to their first child later. Housewives give birth to their first child sooner compared with employed women (TR = 0.846, P = 0.005). Also, birth interval in women who use contraceptives is significantly longer than women who do not use contraceptives. Another variable affecting first birth interval is the number of live births where the first birth interval in women who have more than two children is significantly shorter than women who have less than two children.

According to the generalized gamma model, women's first marriage age, parental education, women's employment, use of contraceptives, and number of live births is significant at a significance level of 5% and the results of this model are similar to log-logistic model.

According to the Table, first birth rate for housewives is 25% more than employed mothers. First birth for parents with academic educations is 0.64 time larger than parents with elementary and secondary education.

Table 4. The goodness of fit results for Cox semi-parametric models and parametric log-logistic models and generalized gamma

Variable		Cox		Log-logistic		Gamma	
		Hazard ratio (SE)	P	Time ratio (SE)	P	Time ratio (SE)	P
Women's first marriage age	Under 20 years						
	Between 20 and 29 years	0.750 (0.073)	0.004	1.10 (0.070)	0.001	1.200 (0.069)	0.001
	Above 30 years	0.768(0.187)	0.281	1.140 (0.160)	0.348	1.140 (0.159)	0.336
Parental education	Elementary and secondary						
	High school and diploma	0.880(0.100)	0.295	1.022 (0.059)	0.708	1.066 (0.062)	0.278
	Associate degree and above	0.640(0.077)	<0.001	1.328(0.085)	<0.001	1.290 (0.082)	<0.001
Women's employment	Employed						
	Housewife	1.260 (0.144)	0.042	0.846(0.051)	0.005	0.806(0.047)	<0.001
Family monthly income	Low						
	Average	0.970 (0.101)	0.790	0.989 (0.055)	0.859	0.990(0.054)	0.868
	High	0.990 (0.133)	0.992	0.991(0.071)	0.905	1.010 (0.071)	0.893
Use of contraceptives	No						
	Yes	0.927(0.927)	0.028	1.130 (0.085)	0.048	1.190 (0.097)	0.030
Number of live births	Less than 2						
	More than 2	1.170 (0.055)	0.001	0.890 (0.026)	<0.001	0.900 (0.026)	0.001
Men's first marriage age	Under 25 years						
	Between 25 and 30 years	0.970 (0.114)	0.861	1.080 (0.067)	0.201	1.107(0.069)	0.101
	More than 30 years	0.910 (0.121)	0.488	1.060 (0.076)	0.359	1.070 (0.074)	0.320
Pregnancy status	Wanted						
	Unwanted	1.040 (0.110)	0.723	0.950 (0.059)	0.480	0.960 (0.058)	0.612

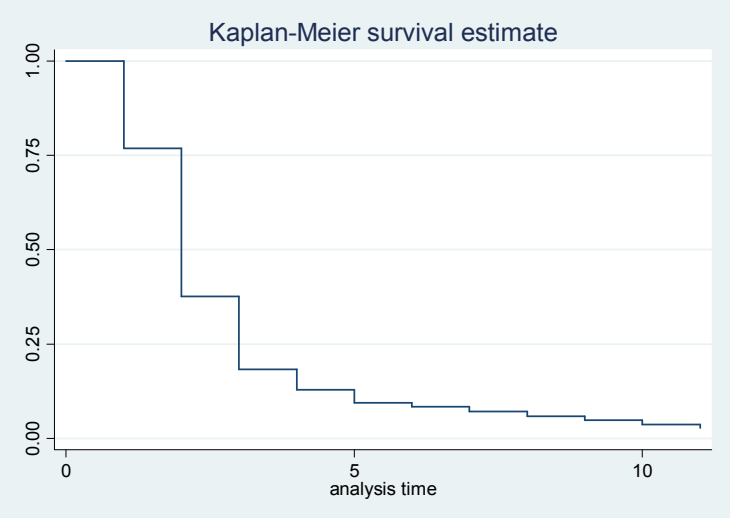

Fig. 2. Survival function using Kaplan-Meir method

Table 5. Comparison of parametric models according to AIC

Model	(log likelihood)	AIC
Log-logistic	-398.39	822.78
Generalized gamma	-390.95	809.91

Although different distributions were statistically significant at a 5% level, Akaike's Information Criterion (AIC) investigation showed that the generalized gamma survival model compared with log-logistic model, is a more suitable model to investigate first birth interval, because it has the smallest AIC value.

4. DISCUSSION

First birth interval is a very important factor in the family dimension. The results showed that of 500 women, 456 women (91.2%) experienced the first live birth after marriage and 8.8% are censored and median and mean of survival time were 2 and 2.53 years, respectively. In a study by Shayan et al. investigating data related to 654 people, 621 people (95%) have experienced the first live birth and median and mean of survival time were 2.1 and 2.6, respectively [15]. In a study by Logubayom who investigated survival analysis on birth interval after marriage, 74% of women experienced their first live birth within the first three years and survival time median for the first birth after marriage was 2 years [38]. Average birth interval between marriage and the first birth in a study in Birjand was 28.52±8.85 months [39]. In a study by Fallahzadeh et al. in Yazd, average interval between births estimated as 49.76±1.82 months [40]. A study by Bakht et al. in Hamedan province estimated birth interval after marriage as 24.5 months [41]. A study by Razeghi and Abbasi-Shavazi showed that a significant difference exists between different provinces in terms of having the first child within the first five years of marriage [30]. These studied were consistent with our results because of interval between marriage and the first birth, in which our study showed a mean of 2.53 years.

According to the results of this study, parametric survival model to analyze these data is suitable due to several reasons: according to the hazard function, the use of parametric models is suitable. Parametric models may provide complementary data for physicians and authors to be alert about how risks change in the future [42]. Also, comparing standard error coefficients in parametric models and Cox regression, standard error coefficients of parametric models are smaller than Cox model. TR compared with PH is more suitable to determine the direct effects of variables in the first birth interval.

The results of goodness of fit of Cox model are almost close to the results of using parametric models. In this study, the important recognized factors by log-logistic model and generalized gamma and Cox regression model were similar

and since the accuracy of parametric models is higher, their use is of great priority. According to the results of hazard function, it can be understood that hazard increases up to a maximum point and then decreases; therefore, it is similar to hazard function, log-logistic, or generalized gamma. Log-logistic models and generalized gamma were fitted to the data and were compared with the use of AIC. Generalized gamma has the smallest AIC value and as a result, it is the best model. In a study by Choromzadeh et al. on factors affecting birth interval, normal log distribution for the first birth interval with the smallest AIC value was selected as the best distribution [8]. Hidayat et al. in a study in Indonesia tried to determine the best method to model the first birth and concluded that the first birth does not follow exponential distribution [31].

The results showed that parents with academic education give birth to their first child later than parents with elementary and secondary education. This is consistent with the findings of Hidayat et al., Rasekh et al. and Choromzadeh et al. [8,31,43]. Parents with higher education pay more attention to the welfare of their children and this is more important than the number of children.

Marriage age has a direct and strong effect on the interval between marriage and birth. Shayan et al. in a study in Shiraz, using parametric and semi-parametric models (Cox model), mentioned factors affecting the interval between marriage and the first birth that were marriage age and women's education [15]. Rasekh et al. using generalized Cox regression models and considering dependency between birth intervals, investigated birth interval. In this study, women's age is a factor affecting birth interval [44]. In the present study, increased marriage age increases the interval between marriage and the first birth. From theoretical view, marriage age has an inverse relationship with the interval between marriage and the first birth and people who marry soon, experience their first birth late [45]. The reason for conflicts between the results of the present study and other studies is that most people in this study have diploma and are housewives and for this reason, they do not have educational and occupational problems that cause delay in birth. In summary, the author would like to focus on other factors like socio-cultural factors, sickness, death of child, family problems all these have an impact on population growth.

In this study, family income did not have any impact on the first birth, but in a study by Logubayom (2013) and a study by Shayan et al. family income was one of the factors affecting the first birth [15,39]. Also, housewife mothers have shorter interval between marriage and firth birth compared with employed mothers. It seems that this interval will become longer unless birth is not in conflict with mother's employment. This is not consistent with the results of a study by Hidayat [31]. The fundamental assumption of many studies is based on the conflict between fertility and economic activity [46]. According to these assumptions, work barriers, birth, and costs, it is expected that women's employment leads to a longer delay in birth and decreased number of children. But in some studies, no significant effect was observed on the interval between marriage and the first birth and in other studies, employed women showed higher fertility [6,47].

5. CONCLUSION

The most important factor affecting population status was identified using the survival model for education and employment of women and use of contraceptives and with the encouragement of youths to marry at an early age and promotion of society awareness level (especially young people), it is possible to prevent the negative consequences of decline in population growth and increase fertility significantly to prevent lack of active forces and population ageing in the society.

CONSENT AND ETHICAL APPROVAL

Human rights were respected in accordance with the Helsinki Declaration 1975, as revised in 1983. The informed consent was taken from the patients as well as from women. The study was approved by ethics committee of Hamedan University of Medical Sciences (Ethical cod# IR.UMSHA.REC.1393.16). This study was conducted as the master thesis of Masoumeh Akhgar at Hamedan University of Medical Sciences.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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