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Gender differences of suicide in Japan, 1947-2010

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1. Introduction

About 800,000 people commit suicide worldwide every year (WHO, 2013a). In most countries, suicide rate in males is higher than that in females (Pampel, 1998; Hawton, 2000). Although mental disorders based on biological and genetic gender differences are one of the most prominent causes of suicide (Qin et al., 2000; Altemus, 2006; WHO, 2013a), socio-economic factors linked to changes in gender roles could also explain the gender different changes in suicide with increasing male suicide and decreasing female suicide (Hawton, 2000; Zhang et al., 2005; Dombrowski et al., 2008; Karch, 2011). The impacts of economic indices, such as income, bankrupt, economic inequality (Neumayer, 2003; West, 2003; Shah et al., 2009), and social indicators, including divorce, birthrate, family size, female labor force participation, on suicide have been broadly studied (Burr et al., 1997; Chuang et al., 1997; Neumayer, 2003). Unemployment rate as a composite variable for both economic and social factors is also widely investigated (Hamermesh et al., 1974; Chuang et al., 1997; Burr et al., 1997; Neumayer, 2003; West, 2003).

The mechanism of influencing on suicide of socio-economic factors can be explained as follows. The individual deprived of the economic and social role advantages may feel more stress, leading to bad health conditions, ending up with suicide directly or indirectly, for example, via smoking and/or alcohol abuse (Stack, 2000, a, b). Moreover, individuals are integrated into social groups, complying with specific norms, customs and conventions. The completed suicide of any family member is the worst tragedy for the whole family. Consequently, marriage, baby-birth and baby-raising, divorce, and even labor force participation which can strengthen or weaken family ties and social connections may have positive or negative effects on suicide (Chuang et al., 1997;

Neumayer, 2003; Chuang et al., 2003; Chen et al., 2009).

Meanwhile, the effects of socio-economic factors on suicide are gender-dependent (Yamamura, 2010). The studies on gender differences of suicide could generate information which can guide clinical practice and bring prevention strategies effective for both genders (Qin et al., 2000; Hawton, 2000) and demonstrate the broad implications of public health indeed.

The rank of Japanese suicide mortality rate in 2009 was the ninth worldwide (Lithuania as the highest one) among 105 WHO regions and the second one following South Korea in Asian areas (WHO, 2013b). Furthermore, suicide accounted for the seventh leading causes of death in Japan in 2010 (Japanese Ministry of Health, Labor, and Welfare, 2011). The absolute suicide number increased from 16,311 in 1950 to 31,655 in 2010. The annual number of suicides in Japan has been over the 30,000 level for 15 years since 1998 (Japanese Ministry of Health, Labor, and Welfare, 2013). In 2011, the absolute suicide number was 30,651 which were even 7 times higher than traffic accidents deaths (Japanese Ministry of Health, Labor, and Welfare, 2013). Besides, the annual number of attempted suicide (73,570 in 2010) was even 2 times higher than that committed which implied significant and severe burden on health, economics and family.

In our previous study, we found that Japanese suicide gender mortality ratio (male: female) increased during the period of 1947-2010 (Liu et al., 2012). Japanese male suicide mortality rate has gradually increased during the twentieth century while Japanese female suicide rate has experienced the long-term stability with small fluctuations (Yamamura et al., 2006). This indicates that socio-economic factors have different extent

impacts on suicide for males and females in Japan. Previous studies of socio-economic factors on Japanese suicide focused mainly on bankrupt, ageing, divorce, and unemployment (Lester et al., 1992a; West, 2003).

In this study, we were interested in the impacts of marriage-related factors on suicide. We assumed that there were different gender impacts of marriage-related factors on suicide in Japan due to the different gender role in Japanese society. We also assumed that divorce rate, marriage rate and unemployment rate, first marriage age, unmarried rate have different impacts on Japanese suicide by gender. In addition, previous study revealed that fertility was associated with a lower suicide rate for young adults aged 15-44 years old (Lester et al., 1992b). However, as far as we know, no research has talked about the effects of total fertility rate (TFR) on Japanese gender-specific suicide.

Therefore, the purposes of this study were to further identify gender differences in age-adjusted suicide mortality rate between males and females and to ascertain the impacts of marriage-related factors on the suicide mortality rate by gender, separately, in Japan.

2. Methods

2.1. Data sources

We collected gender-specific data from Japanese official websites including age-adjusted suicide mortality rate, annual suicide number, first marriage age, marriage rate, divorce rate, unmarried rate, TFR and unemployment rate (Table 1).

2.2. Statistical analysis

Firstly, we explored the gender-specific long-term trend of age-adjusted suicide mortality rate in Japan covering a period of 1947-2010. Secondly, we carried out nonparametric rank test to examine gender differences of suicide, following with the curve estimation for both genders. Thirdly, we described the trends of marriage-related factors. Fourthly, we made Spearman ranking correlation analysis between marriage-related factors and gender-specific suicide mortality rate. Finally we used quantile regression to reveal the impacts of marriage related factors on suicide mortality rate by gender. Stata version 12.0 was used for all the statistics analysis.

3. Results

3.1. Long-term trend of suicide mortality rate and annual suicide number by gender

Figure 1 shows that the age-adjusted suicide mortality rate in male had been always higher than that in female in each year covering the period of 1947-2010. The male suicide mortality rate peaked around 1955 (38.5 per 100,000 populations) and dropped quickly afterwards until the 1970s; it increased in the 1980s with the second peak in 1983 (30.4 per 100,000 populations); it dropped during the early 1990s (19.9 per 100,000 populations in 1991); after 1997 (23.2 per 100,000 populations), it increased quickly to 32.1 per 100,000 populations in 1998 and then kept stable at that level. For female, an overall decreasing trend was seen with a peak during the 1950s (23.5 per 100,000 populations in 1958). It dropped gradually afterwards with small variations in 1970s and 80s, and was stabilized after 1998 (11.8 per 100,000 populations).

In terms of annual suicide number, the similar trend was displayed in Figure 1. There were also three peaks (with the number of 23,641 in 1958, 25,667 in 1986 and 31,755 in

1998) during the study period 1947-2010 for both genders. The female suicide number changed between 5,000 and 10,000. However, the male suicide number covered a larger range of 7,000-23,000.

No parametric rank test was adopted to test the equality of matched pairs for each year, and result ($p < 0.01$) confirms that male's suicide mortality rate was significantly higher than that female's. There was a significant gender-difference in suicide mortality rate in Japan.

3.2. Curve estimation by gender

Over the study period of 1947-2010, a non-linear trend of suicide was detected, with a "U" shape for male and "J" shape for female. Curve estimation function was adopted and results showed that cubic spline was the most fitted curve, with adjusted $R^2=0.49$ for male and adjusted $R^2=0.88$ for female (Figure 2).

3.3. Long-term trends of marriage-related factors

Figure 3 displays the long-term trends of marriage-related factors including the average age of first marriage, marriage rate and divorce rate, unmarried rate, TFR, and unemployment rate. The average age of first marriage in both male and female increased continuously from 25.9 years to 30.5 years in male and from 23.0 years to 28.8 years in female during the period of 1950-2010. The rate of increase in the average age of first marriage was higher in female than in male.

Marriage rate (per 1,000 population) decreased from 12.0 to 8.0 in 1955 and then increased slowly up to 10.4 in 1972. After that, it kept dropping downwards to 5.7 in 1987 and then stabilized around 6.0 till 2010. However, divorce rate (per 1,000 population) kept increasing slowly from 1.02 in 1947 to 1.99 in 2010. Furthermore,

unmarried rate also increased obviously from 1.5% in 1950 to 19.1% in 2010 and from 1.3% in 1950 to 10.0% in 2010 for male and female, respectively (Figure 3).

TFR declined from 4.54 in 1947 to 1.39 in 2010. But unemployment rate kept increasing from 1.2% to 5.5% (the peak value in 2002) for males and from 1.1% to 5.1% (the peak value in 2002) for females, respectively, with the similar trends during the period of 1968-2002. Then it showed a “V” curve trend covering the period of 2003-2010 with a minimum value (3.9 for males and 3.7 for females) in 2007 (Figure 3).

3.4. Spearman ranking correlation and quantile regression results

Table 2 shows the Spearman ranking correlation results: for male, marriage rate had a negative association ($p < 0.01$) and divorce rate and unemployment rate had positive associations ($p < 0.01$) with suicide mortality rate; for female, first marriage age, divorce rate, unmarried rate and unemployment rate had negative associations ($p < 0.01$) and marriage rate and TFR had positive associations ($p < 0.01$) with suicide mortality rate.

The quantile regression analysis revealed that unemployment rate was positively associated with male's suicide mortality rate (Coefficient = 14.49; 95% CI: 14.93~20.05); TFR was positively associated (Coefficient = 1.63; 95% CI: 2.16~2.00) with female's suicide mortality rate and divorce rate was negatively associated (Coefficient = -2.38; 95% CI: -2.97~-1.78) with female's suicide mortality rate (Table 3).

4. Discussion

Over the study period, a non-linear trend was detected with a “U” shape for male and “J” shape for female and the rate in male had been always higher than that for female. The

unemployment rate could be used as a single predictor of suicide mortality rate for Japanese men, while TFR and divorce rate were both associated with Japanese women's suicide mortality rate.

Motohashi's study revealed that unemployment rate related closely to suicide mortality in both genders during 1953-72, while divorce rate and proportion in tertiary industry influenced on suicide during 1973-86 (Motohashi, 1991). The transition of industrial structure in Japan from an industrial to a service economic one could explain this kind of difference (Motohashi, 1991). However, during the late 1990s and early 2000s when the Asian financial crisis broke out, unemployment and personal bankrupt rate were positively associated with Japanese male suicide (Watanabe et al., 2006). In this study, we found that unemployment rate was only positively correlated with Japanese male suicide during the whole period of 1947-2010. Even though the unemployment insurance could mitigate the risk of unemployment (Watanabe et al., 2006), the social safety nets against unemployment are not well done enough yet for Japanese male employees (Chen et al., 2012). It indicates that Japanese males who experienced socio-economic crisis are at risk for suicide and deserve more attention for future interventions.

We also found that the unemployment rate was negatively associated with Japanese females' suicide. With the Japanese social context of "lifetime employment" for husbands and "professional housewives" for women, no more than half of employed women are regularly full-time workers today in contrast to nearly 70% in 1985 (North, 2010). Furthermore, Japanese women used to enter the part-time labor market immediately after school and customarily leave workplaces upon marriage or childbirth (North, 2010). Thus they suffer less labor pressure and even unemployment could protect

them against suicide. But male employees are usually subject to transfers, overtime at night, and work on weekends and holidays. These imply that Japanese men and women are sharing different economic burdens.

Previous study revealed that the relations between suicide mortality rate and socio-economic factors varied not only in gender (Andrés et al., 2010) but also in age, periods and localities (Aihara et al., 2002; Yamasaki et al., 2008). These prompted us to make further analyses on Japanese suicide by age and region (e.g., at the national level or the prefecture level).

One study showed that in Japan unemployment rate was more closely correlated with suicide mortality rate (especially for men) than social variables (e.g., divorce rate, birthrate) compared with other OECD countries (Chen et al., 2009). Unemployment rate could explain 19% of the variances in suicide mortality rate between Japan and other OECD countries during 1980-2000 (Chen et al., 2009). Conversely, another study displayed that Japanese men suffered particularly from divorce rate as the highest suicide cause and Japanese women were the most affected by the decreasing fertility during the period of 1957-2009 (Andrés et al., 2011).

Our study was only partly consistent with these results. We found that in terms of Japanese men, unemployment rate was the main determinate of suicide. In terms of Japanese women, increasing divorce rate and decreasing TFR were the main protective factors for suicide. Depression can explain over 60% of the individual suicides in Japan (Nakao et al., 2006). Thus we assumed that the Japanese male's unemployment caused by economic recession increased divorce which resulted in lose of family and kinship ties. As a result, these males suffering from dual pressures of economy and psychology were

prone to be depressive and commit suicide. In contrast, Japanese females can generally receive compensation from their spouses during the divorce event. Besides this kind of laws favoring, women are more likely to be connected with community and neighborhoods and get more social supports due to their spare time (Yamamura et al., 2006). Therefore, the divorce did not stimulate females' suicide. On the contrary, it played a protective role for Japanese females. Does this mean that Japanese female in marriage is in low happiness or not satisfied with their daily marriage lives? This is worth of further explores in future. There is still another explanation for these studies differences. The effects of social determinate on suicide maybe changed over time during different research periods.

TFR was negatively associated with suicide for both males and females with the group of 15-44 years old in United States covering the period of 1933-1984. However, we found that TFR was only positively correlated with Japanese females' suicide during the period of 1947-2010. It can be inferred that Japanese women execute most of the specific issues in child-bearing and the childcare may have brought too much strain or pressure to them. When taking future purpose of Japanese TFR increasing into account, we should not omit to offer more supports to baby-birth and child-bearing.

In summary, effective suicide prevention in Japan should be not only comprehensive but also gender-dependent due to the different impacts of socio-economic determinates. For Japanese men, a renewed unemployment insurance system or effective income support programs are prerequisite. For Japanese women, supports and protection for child-bearing should be enhanced. Should we carry out marriage counseling or programs

towards Japanese couples in order to protect marriage for Japanese men and improve marital happiness for Japanese women? What kinds of programs would be effective, especially during economic crisis periods? These also deserve further studies.

We did not analyze the impact of mental disorders in our study which led to the maximum study limitation. Nevertheless, the findings of these gender differences in, and the associated factors with, suicide in Japan, warrant further studies including delineation of the implications of differential economic pressure between genders, as well as child-rearing pressure and marriage satisfaction.

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Conflict of interest

The authors have no conflicts of interests to state for the present manuscript.

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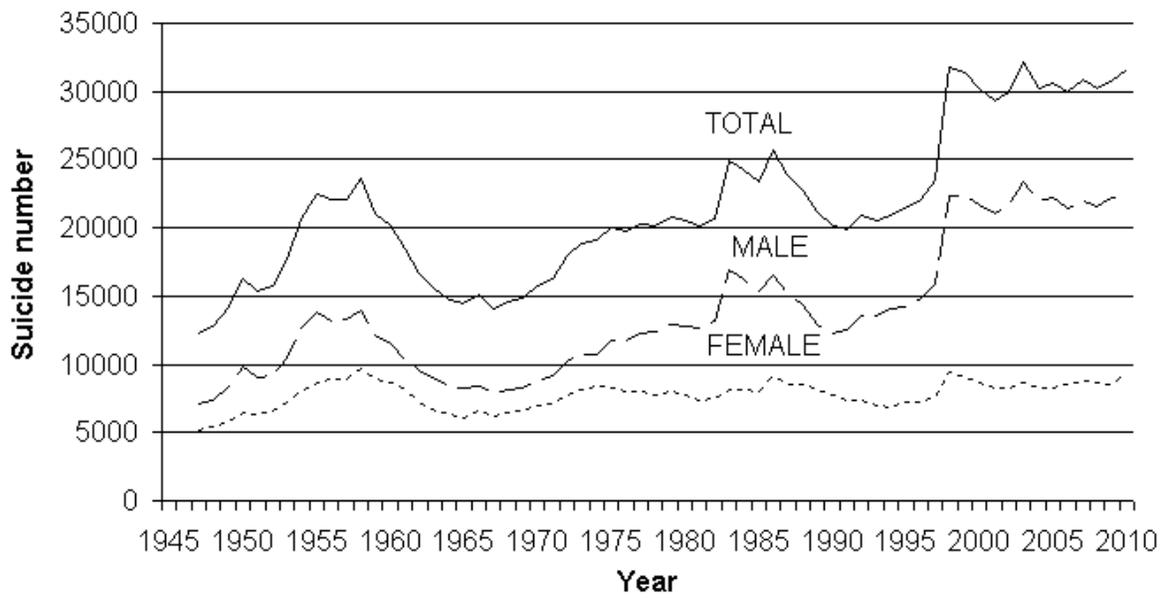
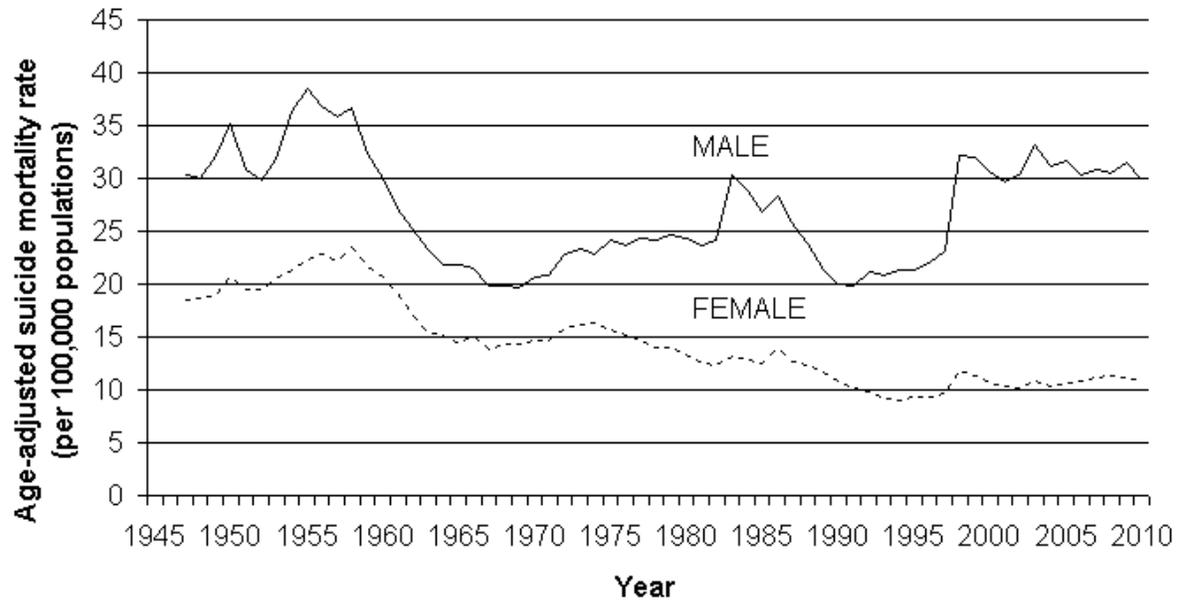


Figure 1. Age-adjusted suicide mortality rate and annual suicide number in Japan by gender, 1947-2010.

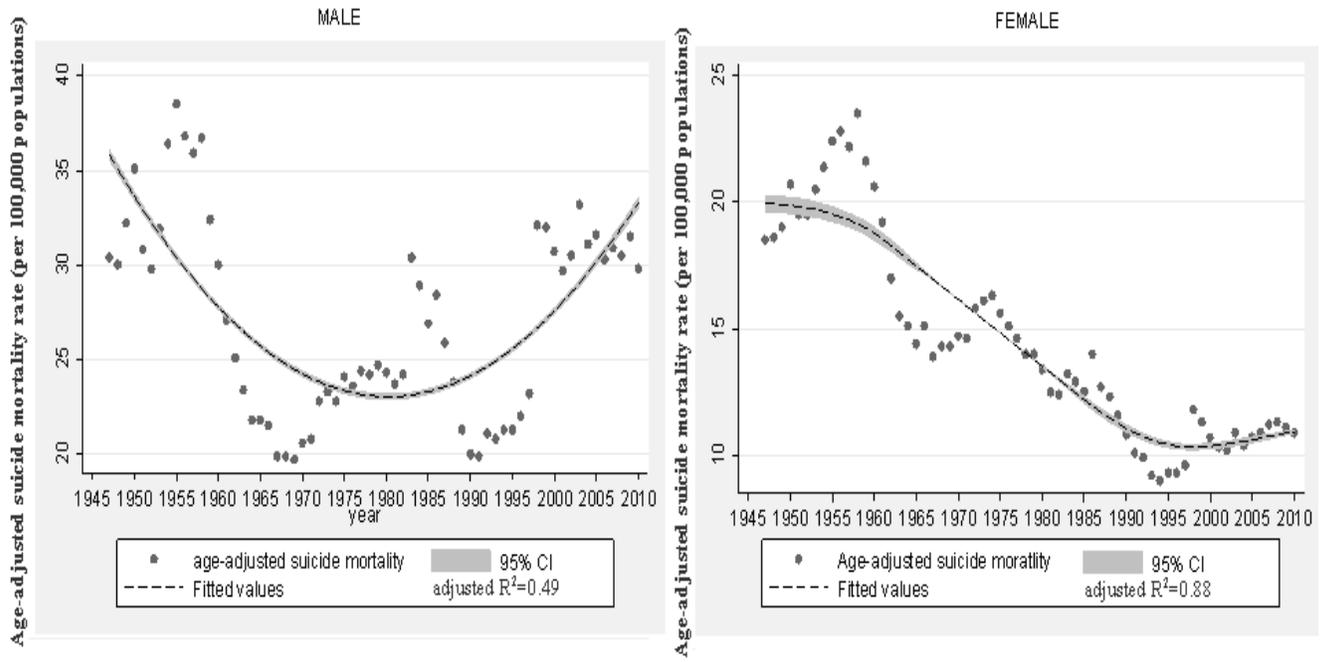


Figure 2. Fitted cubic spline curves (with 95% CI) and scattered yearly observed suicide mortality rate for male and female in Japan, 1947-2010.

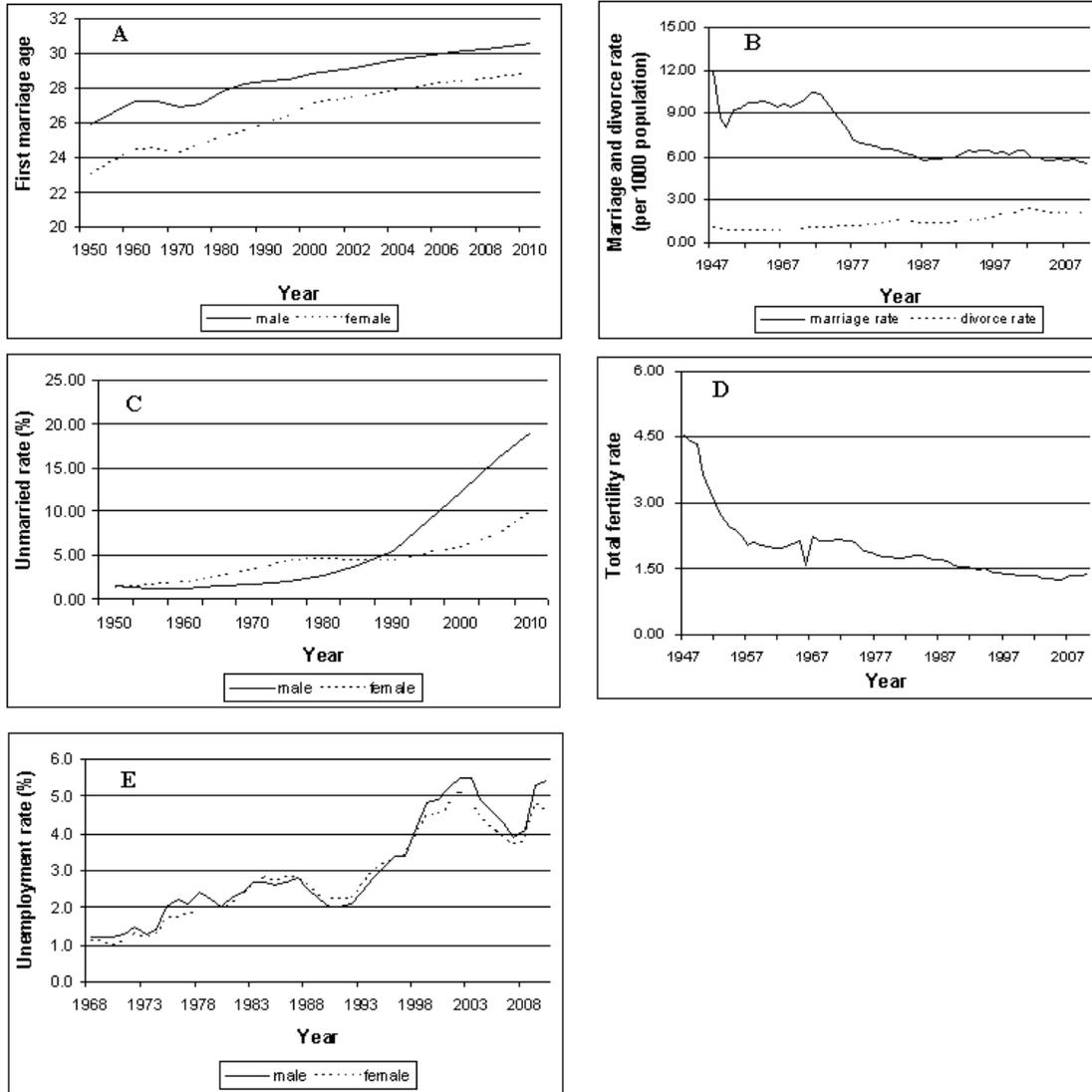


Figure 3. Trends of marriage-related factors in Japan (A: First marriage age by gender; B: Marriage rate and divorce rate; C: Unmarried rate by gender; D: Total fertility rate; E: Unemployment rate by gender).

Table 1

Study variables and data sources.

Variable	Unit	Period	Sources
Age-adjusted suicide mortality rate	per 100,000 populations	1947-2010	http://www8.cao.go.jp/jisatsutaisaku/whitepaper/w-2011/html/honpen/part1/s1_1_01.html .
Annual suicide number			
First marriage age	Years old	1950-2010	http://www.stat.go.jp/english/data/handbook/c02cont.htm
Marriage rate	per 1,000 populations	1947-2010	www.stat.go.jp/data/nenkan/zuhyou/y0222000.xls
Divorce rate	per 1,000 populations	1947-2010	www.stat.go.jp/data/nenkan/zuhyou/y0222000.xls
Unmarried rate	%	1950-2010	http://www.mhlw.go.jp/shingi/0110/s1012-4/s1012-4c.html www.mhlw.go.jp/wp/hakusyo/kousei/10/backdata/.../2020402.xls
TFR	Births per women	1947-2010	www.ipss.go.jp/syoushika/tohkei/newest04/s-siryoyou/8.xls
Unemployment rate	%	1968-2010	www.stat.go.jp/data/roudou/longtime/zuhyou/lt03-08.xls

Table 2

Spearman ranking correlation results by univariate analysis.

	Suicide mortality rate (Male)		Suicide mortality rate (Female)	
	Spearman's ρ	<i>p</i> value	Spearman's ρ	<i>p</i> value
First marriage age	0.25	0.27	-0.59	<0.01
Marriage rate	-0.39	<0.01	0.73	<0.01
Divorce rate	0.44	<0.01	-0.83	<0.01
Unmarried rate	-0.15	0.62	-0.85	<0.01
TFR	0.01	0.91	0.85	<0.01
Unemployment rate	0.79	<0.01	-0.71	<0.01

Table 3

Final model* of quantile regression on predictors of suicide by gender in Japan.

	Coefficient	Standardized Error	t value	p value	95% CI		Pseudo R ²
					lower	upper	
Male							
Unemployment rate (male)	2.78	0.38	7.25	<0.01	2.00	3.55	
Constant	14.49	1.27	13.81	<0.01	14.93	20.05	0.4985
Female							
TFR	1.63	0.18	8.88	<0.01	1.26	2.00	
Divorce rate	-2.38	0.30	-8.04	<0.01	-2.97	-1.78	
Constant	13.51	0.67	20.13	<0.01	12.16	14.86	0.4992

* Autocorrelation (AC) and Partial Autocorrelation (PAC) plots of the models' residuals demonstrate the residuals are randomly distributed without any patterns.