Title: Fertility knowledge and the timing of first childbearing: A cross-sectional study in Japan

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Abstract

Although fertility educational initiatives have increased in developed countries to prevent infertility and to broaden fertility choices, the relationship between knowledge and behaviour is still poorly understood. In order to investigate the association between fertility knowledge and timing of childbearing, we investigated male and female participants between 35 and 44 years of age who had children ($n = 640$) from an online survey conducted in Japan in 2013. The age at which participants actually gave birth to or fathered their first child was compared between those who were aware for at least a decade of age-related decline in female fertility (hereinafter, those with past fertility knowledge) and those without. Age at first birth was significantly younger and more narrowly distributed among women with past fertility knowledge than among those without: Mean [SD]: 28.2[3.4] vs. 29.8[4.6]. A multivariate linear regression analysis showed that women with past fertility knowledge gave birth to their first child 2.34 [95% confidence interval: 1.09─3.59] years younger compared to those without such knowledge. No significant relation existed among men. Being informed in young adulthood about the facts of fertility might be related to starting a family at an earlier age although further longitudinal evaluation will be necessary.

Introduction

A large body of literature indicates findings that fertility knowledge is poor in many populations (Lampic et al., 2006; Bretherick et al., 2010; Peterson et al., 2012; Daniluk & Koert, 2013; Hammarberg et al., 2013; Lundsberg et al., 2014). In addition to beliefs in myths or an insufficient recognition of risk factors in their lifestyles (Bunting & Boivin, 2008), many people overestimate the duration of the reproductive lifespan and the likelihood of conceiving at older ages. Given that a lack of accurate information could account in part for the global trend to delay childbearing (Organisation for Economic Co-operation and Development, 2010; Mills et al., 2011), educational initiatives have been undertaken in some countries to prevent unintended infertility and to broaden fertility choices (De Cock, 2011; Daniluk & Koert, 2013; Hammarberg et al., 2013).

In Japan, where the present study was conducted, the total fertility rate has been low (1.41 in 2012) and the parental age at first birth has now reached more than 30 years of age (30.4 and 32.5 years for women and men, respectively in 2013) (Ministry of Health, Labour, and Welfare, 2014). Recent surveys showed that Japanese fertility knowledge was very low (Sugiura-Ogasawara et al., 2010; Bunting et al., 2012; Maeda et al., 2015) and that many people first learned about age-related decline in fertility quite recently from mass media or the Internet (Maeda et al., 2015). In that context, there is a growing recognition of the need for formal fertility education (Cabinet Office, 2015).

Nonetheless, the relationship between knowledge, intention, and the timing of childbearing is still poorly understood (Friese et al., 2006; Lampic et al., 2006; Bretherick et al., 2010; Daniluk & Koert, 2012; Fulford et al., 2013). Previous cross-sectional studies did not show an association between fertility awareness and intention to postpone childbirth (Lampic et al., 2006; Bretherick et al., 2010). Multifactorial decision-making

process related to career, education, relationships, partner's desire, financial security, health, and so on (Bretherick et al., 2010; Cooke et al., 2010; Roberts et al., 2011; Cooke et al., 2012) was cited as an explanation for not detecting the contribution of fertility knowledge to childbearing. Although recent works have confirmed the short-term effects of information intervention on intentions to delay childbearing (Wojcieszek & Thompson, 2013; Williamson et al., 2014), to date, there have been no studies regarding long-term consequences.

In order to investigate the relationship between fertility knowledge and the timing of first childbirth, we performed an online panel survey in October 2013 in Japan, and previously reported those factors related to fertility knowledge in the general population aged between 18 and 59 years old (Maeda et al., 2015). In the present analyses, we hypothesized that having fertility knowledge would help people to successfully have children at an earlier age.

Materials and Methods

Participants

An online survey was conducted by a market research company (Macromil, Tokyo, Japan), from September 30 to October 9, 2013, using social research panels (SRPs). We performed quota-sampling equally by gender and age-group block. Recruitment emails were sent to 31,566 people aged between 18 and 59 years old and those interested completed the survey ($n = 4,328$). Medical professionals and advertising professionals were excluded from the recruitment. Full details of the study are published elsewhere (Maeda et al., 2015).

Of the participants aged between 35 and 44 years old ($n = 1,186$), we included those who had children ($n = 643$) for the present study. The participants stated the age at which they had given birth to or fathered their first child.

Past Fertility Knowledge

We used the Japanese version of the Cardiff Fertility Knowledge Scale (CFKS) (Bunting et al, 2012; Maeda et al., 2015) to assess fertility knowledge. Among 13 items measuring knowledge about facts, risks, and myths regarding male and female fertility, the first item asks whether the statement "A women is less fertile after the age of 36 years" is true or false. We asked participants who answered that item correctly when they first acquired that knowledge. The options were < 6 months before, 6 months - 1 year before, 1 - 3 years before, 3 - 5 years before, 5 - 10 years before, ≥ 10 years before the survey, and "Don't know." Those who were aware of age-related decline in fertility for at least 10 years were categorized as "those who had past fertility knowledge" to assure that all the participants with past knowledge had been aware of the fact in their early thirties.

The Japanese version of the CFKS (CFKS-J), developed using forward translation and back-translation, had a one-factor structure as the original CFKS and showed moderate reliability of the items in the present sample: Cronbach alpha = 0.72. The point bi-serial correlation coefficient of the first item "A women is less fertile after the age of 36 years" of the CFKS-J was moderate (0.52 and 0.53 for women and men, respectively).

Socio-demographic Variables

Gender, age in years, and annual household income of the participants were provided by the online market research company. Annual household income was categorized into four

groups: low, < 4 million Japanese Yen (JPY); moderate, 4 – 5 million JPY; high, ≥ 6 million JPY; and "unknown." At the time of the study 1 US Dollar = 96 Japanese Yen. Participants also indicated their educational background and marital status (married, yes/no). Educational background was categorized into three groups: junior high or high school education; junior college education; and university education. Participants who were married stated the age of their marital partner.

Data Analysis

We performed the present analyses by gender. We compared the socio-demographic variables between participants with and without past fertility knowledge (i.e., between participants who were aware of age-related decline in fertility for at least a decade and those who were not). The age at which participants actually had given birth to or fathered their first child was also compared based on their fertility knowledge. Statistical comparisons were carried out by Student's t tests, two-group variance-comparison tests, Welch's t tests, Fisher's exact tests, and chi-square tests, whenever appropriate. Multivariate linear regression analyses were used to assess the impact of past fertility knowledge on the age at first childbirth with adjustment for age, household incomes, educational backgrounds, and marital partners' age.

A two-sided P value of < 0.05 was used to define statistical significance. All the analyses were performed using STATA12-SE (StataCorp LP, College Station, TX, USA).

Ethical Considerations

Ethical review and approval was provided by the Institutional Ethics Committee of the National Center for Child Health and Development, Daito Bunka University, and the

University of Tokyo. Collection of online data complied with the "Code of Conduct of Marketing Research" and "Requirements for Compliance Program on Personal Information Protection (JIS Q 15001)" of the Japan Marketing Research Association.

Results

Of the 643 participants who had children, we investigated 344 women and 296 men, excluding two women and one man with missing values in the outcome.

Participant Characteristics

The percentage of the participants who had past fertility knowledge (i.e., those who had been aware of age-related decline in fertility for at least a decade) was 23.5% (81/344) in women and 19.3% (57/296) in men (Table I). Women and their partners were significantly older in those with past fertility knowledge than in those without. There were no other socio-demographic differences between those with and without past fertility knowledge.

The Relation of Fertility Knowledge to the Age at First Birth

Figure 1 shows that the age at first birth was significantly younger and more narrowly distributed in women with past fertility knowledge than those without: Mean (SD): 28.2 (3.4) vs. 29.8 (4.6) ($t = 3.46$, $P < 0.001$). The percentage of women who started a family at age 35 or later was 2.5% in those with past fertility knowledge and 16.3% in those without (Fisher's exact test, $P = 0.001$). The age at which male participants had fathered their first child did not differ between those with past fertility knowledge and those without: Mean (SD): 30.8 (4.1) vs. 30.9 (4.2) ($t = 0.07$, $P = 0.95$)

In multivariate linear regression analysis adjusting for age, educational background, household income, and marital partner's age, the mean age at first childbirth was 2.34 years younger in women who had past fertility knowledge ($P < 0.001$, Table II). It was significantly older in women who had higher educational background. In men, past fertility knowledge did not have a significant relationship to the age at first birth. The age at first childbirth was significantly younger in those who had higher household income.

Discussion

Our findings revealed that women who had known about age-related decline in fertility bore their first child 2.3 years earlier than those who had not known this fact. Importantly, only 2.5% of women with past fertility knowledge started a family at age 35 or later, compared with 16.3% of those without past fertility knowledge. To the best of our knowledge, this study is the first to indicate the relationship between fertility knowledge and the timing of childbearing.

Fertility educational initiatives have widened across developed countries over the past few years (De Cock, 2011; Daniluk & Koert, 2013; Hammarberg et al., 2013) and are increasingly widespread (Centers for Disease Control and Prevention, 2014; Cabinet Office, 2015). They are based on earlier studies that have revealed that fertility knowledge was generally low and that people did not know enough to make informed fertility choices (Lampic et al., 2006; Tough et al., 2007; Bretherick et al., 2010; Sugiura-Ogasawara et al., 2010; Peterson et al., 2012; Bunting et al., 2012; Daniluk & Koert, 2013; Hammarberg et al., 2013; Lundsberg et al., 2014; Maeda et al., 2015). Some women were reported to have faced unintended infertility due to a lack of knowledge (Friese et al., 2006; Cooke et al., 2010). However, to date, there has been no research

showing the association between fertility knowledge and childbearing and its timing.

Recent interventional studies reported the short-term effects of fertility education to increase participants' knowledge and to lower intentions to delay childbearing (Wojcieszek & Thompson, 2013; Williamson et al., 2014), but intentions do not always predict behaviour (Ajzen, 1991). Our study suggested the possibility that fertility knowledge indeed broadened people's fertility choices and organized their life-plans.

As for men, there was no apparent relationship between knowledge about fertility and childbearing. Although the point bi-serial correlation coefficient of the first item of the CFKS-J was moderate and was considered to reflect the total score, measuring men's past knowledge with the item specific to female fertility might have led to insignificant results. Further research on people's awareness of advanced paternal age and the adverse outcomes (Yang et al., 2007; Sartorius & Nieschlag, 2010) would be required to detect such potent relationships although the feeling of a "biological clock" is generally less influential to men's intention than women's (Langdridge et al., 2005; Lampc et al., 2006; Tough et al., 2007; Roberts et al., 2011).

The present study has some methodological limitations. First, this was a cross-sectional survey and the past knowledge about age-related decline in fertility was recalled. Instead of comparing outcomes between participants who had children and those who did not, our analyses focused exclusively on those who had children to minimize the recall bias. Second, we selected the participants aged between 35 and 44 years old because in the present analyses we defined past fertility knowledge, having been aware of age-related decline in fertility for at least 10 years, as an exposure. Participants up to 44 years old with past fertility knowledge would have known the fact by their early thirties and would have had enough time to make fertility decisions. Given

the increased parental age at first birth in Japan, we excluded participants in their twenties and early thirties, who were considered to be right in the process of starting a family. Third, we might have defined "the past fertility knowledge" too strictly. If women aged between 35 and 39 years who had been aware of the fact for at least five years were categorized as those with past fertility knowledge, the results were similar: the age at first birth was significantly younger and more narrowly distributed in women with past fertility knowledge than those without: Mean (SD): 28.5 (3.5) vs. 29.9 (4.8) ($P = 0.002$). Finally, selection bias due to the use of SRPs and volunteer bias toward those who were more interested in fertility are also possible. Online samples are associated with higher education (Haagen et al., 2003; Takahashi et al., 2011) and indeed the percentage of participants who had a university education was much higher than the average figures for the age group between 35 and 44 as calculated from the 2010 Population Census (14.6% in women and 29.3% in men, Statistics Japan, 2010). However, the proportion of those who had children (643 participants of 1,186 people aged between 35 and 44 years old) and the income distribution were comparable to the general population in Japan according to the public data (Statistics Japan, 2010; Ministry of Health, Labour and Welfare, 2015). Even though we cannot generalize the crude results to all populations, the adjusted data for the socio-demographic factors was not considered to be heavily influenced by the biases mentioned above.

In conclusion, being informed in young adulthood about the facts of fertility, including age-related decline in fertility might be related to starting a family at an earlier age. Although the effects of recognition of other risk factors, such as advanced paternal age, are still inconclusive, these findings support educational efforts currently undertaken to facilitate informed decision-making. Further longitudinal evaluation will be necessary

to ensure the association between knowledge and behaviour and to prevent involuntary

childlessness.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the

content and writing of the paper.

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Tables

Table I Participants' characteristics and their associations between past fertility knowledge and related factors.

	Women			Men		
	Past fertility knowledge			Past fertility knowledge		
	Did not have (n = 263)	Had (n = 81)	P value	Did not have (n =239)	Had (n = 57)	P value
Age in years (mean, SD)	39.1 (2.6)	40.7 (2.3)	<0.001 [a]	39.6 (2.9)	40.1 (2.6)	0.26 [a]
Educational background (N, %)						
Junior high or high school education	71 (27.0)	27 (33.3)	0.23[b]	69 (28.9)	11 (19.3)	0.07 [b]
Junior college education	112 (42.6)	37 (45.7)		42 (17.6)	6 (10.5)	
University education	80 (30.4)	17 (21.0)		128 (53.6)	40 (70.2)	
Annual household income (N, %)						
< 4 million JPY	49 (18.6)	17 (21.0)	0.86 [b]	37 (15.5)	10 (17.5)	0.33 [c]
4 - 5 million JPY	91 (34.6)	24 (29.6)		91 (38.1)	15 (26.3)	
≥ 6 million JPY	70 (26.6)	22 (27.2)		91 (38.1)	28 (49.1)	
Unknown	53 (20.2)	18 (22.2)		20 (8.4)	4 (7.0)	
Ever married (N, % yes)	261 (99.2)	81 (100)	1.0 [c]	237 (99.2)	56 (98.2)	0.48 [c]
Partner's age in years (mean, SD)	n = 246	n = 70		n = 227	n = 53	
	40.9 (4.8)	42.4 (4.4)	0.02 [a]	38.4 (4.3)	38.5 (3.5)	0.96 [a]

JPY = Japanese Yen.

[a] Two-tailed t test.   [b] Chi-square test. [c] Fisher's exact test.

Table II Multivariate linear regression analysis for factors related to the age at first birth.

	Women (N = 253, Adjusted R^2 = 0.14)		Men (N = 257, Adjusted R^2 = 0.12)	
	Coeff.	95% CI	Coeff.	95% CI
Past fertility knowledge				
Did not know	Ref		Ref	
Know	-2.34	-3.59 to -1.09	-0.48	-1.69 to 0.74
Age in years				
Each additional year older	0.56	0.31 to 0.81	0.53	0.32 to 0.74
Partner's age in years				
Each additional year older	-0.24	-0.37 to -0.11	-0.30	-0.44 to -0.16
Educational background				
Junior high or high school education	Ref		Ref	
Junior college education	2.05	0.83 to 3.27	-0.54	-2.07 to 0.99
University education	2.92	1.51 to 4.33	1.13	-0.04 to 2.29
Annual household income				
< 4 million JPY	Ref		Ref	
4 - 5 million JPY	0.46	-0.88 to 1.79	-1.99	-3.38 to -0.61
≥ 6 million JPY	-0.001	-1.42 to 1.42	-1.41	-2.79 to -0.03

Coeff. = non-standardized coefficient. 95% CI = 95% confidence interval. Ref. = reference. JPY = Japanese Yen.

Figure legends

Figure 1. Parental age at first birth, by gender and by whether or not the participants had known about age-related decline in fertility for at least a decade.

(a) Women.   (b) Men.