Original article

The Association Between Long Working Hours and Infertility

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A B S T R A C T

Background: This study aimed to investigate whether working long hours was related to infertility among female Korean workers, while taking age into consideration.
Methods: We used data from the 2018 National Survey on Fertility and Family Health and Welfare in Korea that is a cross-sectional, nationally representative, and population-based survey. Infertility was defined as women who were not pregnant after regular unprotected intercourse for a year. Working long hours was classified as $\geq$52 hours, and subgroups as per age were classified on the basis of being younger or older than 40 years of age. Differences in infertility risk between the long working hour group and none were estimated in crude and fully adjusted logistic regression models with age-group stratification.
Results: Of 5,909 Korean female workers, the crude and adjusted odds ratios (95% confidence intervals) of infertility for working long hours were 1.295 (0.948−1.737) and 1.303 (0.921−1.809), respectively. In the subgroup of patients below 40 years of age, the crude and adjusted odds ratios (95% confidence interval) were 1.957 (1.216−3.039) and 1.921 (1.144−3.120), whereas those aged 40 years or older had 0.994 (0.647−1.471) and 0.939 (0.560−1.501), respectively. The weighted prevalence of infertility increased as weekly working hours increased only for the younger than 40-year subgroup.
Conclusions: Infertility is associated with working long hours, especially in young-aged workers. Thus, the working schedule must be structured to better suit young female workers.
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1. Introduction

Infertility is a major chronic health problem in young adults [1]. In epidemiological studies, about 10−15% of all couples have difficulty in pregnancy [2]. Because of the low birth rates, infertility is a huge social issue in developed countries as well as a psychological burden for couples. Infertility is also a stressful experience for women with high levels of pressure. In addition, complications such as ovarian hyperstimulation syndrome, bleeding, and even infection may occur during the course of infertility treatments. As per a systematic analysis of national health surveys in 2010, approximately 10.5% of women around the world experienced secondary infertility and roughly 2% experienced primary infertility [3]. Given the higher proportion of secondary infertility, it is very important to identify the risk factors for secondary infertility.

Exposure to occupational hazards may induce wide-ranging reproductive effects such as fetal death, infertility, intrauterine growth retardation, preterm birth, and birth defects [4−6]. Long working hours have been reported to increase the risk of babies being born prematurely or having low birth weight and mothers experiencing pre-eclampsia [7]. However, studies regarding the impact of long working hours on infertility are scarce, and even the association with fertility is inconsistent: two studies showed a significant association between decreased fertility and working long hours [8,9], compared with the other two studies with no association results [10,11].

The inconsistency might have occurred because of insufficient consideration of the infertility age. Fertility rapidly decreases after advanced maternal age [12,13]. At 40, only 44% of women will have a conception ending in a live birth within one year, although 64% will

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have a conception ending in a live birth within four years [14]. Despite the necessity of considering the age, to the best of our knowledge, no study has evaluated the association between working long hours and infertility as per the age group. This study aimed to investigate working long hours and infertility among married female Korean workers, including age groups ≥40 and <40.

2. Materials and methods

2.1. Data collection and study participants

This study used data from the 2018 National Survey on Fertility and Family Health and Welfare (NSFFHW). The NSFFHW is a cross-sectional, nationally representative, population-based survey conducted by the Korea Institute for Health and Social Affairs [15]. A total of 11,200 ever-married women were involved in the 2018 NSFFHW, derived from nationwide cluster sampling based on the 2016 Korea National Population and Housing Census [16]. Pre-trained investigators conducted household-visit interviews with questionnaires on values and behaviors related to marriage, childbirth, and parenting. This survey was conducted only on women of childbearing age and included married women aged 15–49.

The present study investigated 5,909 Korean female workers aged 15 and older who had previously married. Those who faced difficulties in attempting pregnancy, due to bereavement, divorce, separation, or being single mothers, were excluded (Fig. 1).

2.2. Patient and public involvement

No patients were involved.

3. Study variables

3.1. Infertility

Infertility is defined as 1 year of attempted conception without success [17]. Eighty-five percent of couples attempting pregnancy generally succeed in a year; therefore, in the clinical setting, infertility is evaluated when pregnancy does not occur after regular unprotected intercourse for a year [1,17]. In this study, those who answered positively to the following question were classified as infertile: "Have you ever been unsuccessful in getting pregnant after attempting to conceive for at least 1 year, even though you and your spouse did not use contraception?"

3.2. Working hours

Working hours were obtained by asking the following question: "How many hours do you actually work per week on average?". These data do not provide information on working hours at the time of infertility. We analyzed indirectly using the current working

hour under the assumption that there was no significant difference between the current working hours and the hours at the time of infertility. This study categorized working hours into two groups: less than or equal to 52 hours and more than 52 hours per week. This classification is based on the fact that 52 hours per week is the maximum allowable working hours as stipulated in the Labor Standard Act in Korea [15]. In addition, Korea Workers' Compensation and Welfare Services' states that if the hours worked weekly exceed 52 hours, the relationship between work and illness increases as work hours increase [18].

3.3. Age group

Because of delayed first pregnancy, social tendencies to have pregnancy after 40 years of age, job preparation, or postemployment performance, there is a trend of further delay of pregnancy in recent years [19]. These data do not provide information on the age at the time of infertility. We analyzed indirectly using the current age under the assumption that there was no significant difference between the current age and the age at the time of infertility. In this study, the age group was divided into two categories: below 40 years and above or equal to 40 years.

3.4. Other variables

Occupational classification was divided into 3 groups: white collar (managers, professionals, and clerical workers), pink collar (service and sales workers), and blue collar (crafts, machine operators and assemblers, and elementary occupations). Green collar (skilled agricultural, forestry, and fishery workers) and soldiers (n = 153) were excluded. Other categories including employment status (employer, self-employed, unpaid family worker, and paid worker), educational level (high school and college or higher), and average monthly household income (quartile) were also included in the analysis. The abortion question encompassed spontaneous miscarriage and induced abortion.

3.5. Statistical analysis

Data were analyzed using the SAS 9.4 software package (SAS Institute Inc., Cary, NC, USA). First, demographics of the study population and prevalence of infertility were described. Chi-square tests were used to test the significance of differences in the baseline characteristics (age group, educational level, occupational classification, occupational status, average monthly household income) in accordance with infertility. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated to assess the relationship between working long hours and infertility using crude and adjusted logistic regression models. We developed the logistic regression model with adding confounders to demonstrate the effect of each confounder, final model adjusted age, education,
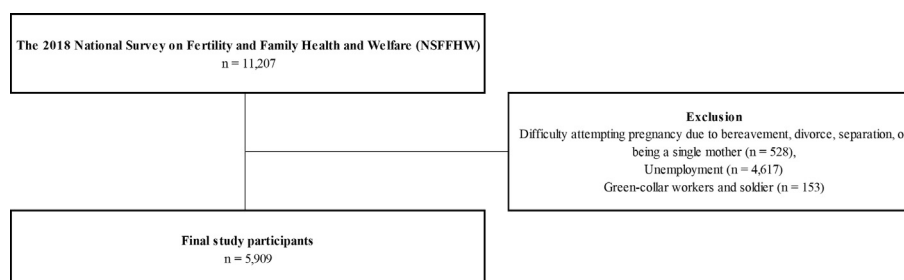

Fig. 1. The schematic diagram of study participants.

monthly household income level, occupational classification, and employment type. Furthermore, the same methods of subgroup analysis were performed by stratification into two age groups, experience of contraception, or abortion. To determine the infertility status in Korean women, the weighted prevalence of infertility was calculated for each age group (<40 and ≥ 40 years). Linear regression of weighted prevalence by each 1 working hour unit was performed to estimate gradient (β value) and *p*-value, with the exclusion of study participants who worked over 70 hours per week.

3.6. Ethical approval

This study conducted analysis with secondary data and approval by the Institutional Review Board (IRB) of the Gachon University, Gil Medical Center (IRB No. GFIRB2019-295).

4. Results

A total of 5,909 women were included in the final analysis after excluding women in situations that made it difficult to attempt pregnancy (n = 528), who had unemployed status (n = 4,617), and who were either green collar workers or soldiers (n = 153) from the 11,207 baseline participants of the 2018 NSFFHW (Fig. 1). The characteristics of workers in accordance with infertility are shown in Table 1. Significant differences were confirmed at the educational level and occupational status ($p < 0.05$). There was no significant difference in infertility in accordance with occupational classification ($p = 0.4323$) or weekly working hours ($p = 0.0932$).

As shown in Table 2, the crude and full adjusted ORs (95% CI) of infertility for working long hours were 1.30 (0.95–1.74) and 1.18 (0.85–1.61), respectively. The crude and full adjusted ORs were calculated by two subgroups of age division, and the results of those younger than 40 were 1.96 (1.22–3.04) and 1.91 (1.17–3.01), whereas those 40 or older were 0.99 (0.65–1.47) and 0.87 (0.55–

1.31), respectively. The results from subgroup analysis in accordance with contraceptives showed that with contraceptive experience, the group had a significantly increased risk for infertility by long working hours (OR: 2.94, 95% CI: 1.12–8.76). In the subgroup for abortion experience, no abortion history group showed an elevated risk for infertility by long working hours (OR: 1.55, 95% CI: 1.05–2.24).

Fig. 2 shows the results of the weighted prevalence of infertility by a unit of 5 working hours per week for each age group (<40 and ≥ 40 years). It was visually found that the weighted prevalence of infertility increased with an increase in weekly work hours only for the subgroup aged younger than 40. Moreover, the estimated gradients, analyzed using the linear regression of weighted prevalence by a unit of 1 working hour, for <40 and ≥ 40 years of age were β = 0.19 ($p < 0.01$) and β = -0.08 ($p = 0.08$), respectively.

5. Discussion

This study shows the relationship between long working hours and age groups on infertility. Furthermore, this study identified an increased risk of infertility based on hours worked.

In previous studies, there were very few studies on the association between working long hours and infertility. An Italian study showed that time to pregnancy tended to increase as weekly hours worked increased, but it was not statistically significant, and the trend disappeared after adjustments [10]. A study conducted at the Thailand hospital with 1,496 pregnant women showed it took them an increased time to conceive over 9.5 months (OR:1.6; 95% CI; 1.0–2.7) and over 12 months (OR:1.6; 95% CI; 0.9–3.0) if the women worked over 71 hours a week. In a study of a cohort of pregnant women in Denmark, the adjusted fecundity OR increased to 1.08 (1.02-1.13) in women working under 35 hours compared with women working over 35 hours [11]. In the Nurses' Health Study 3 in the USA and Canada, weekly hours of nursing work over the past year increased to 1.20 (95% CI 1.07–1.35) [8].

Hormonal disturbance and decreased sexual intercourse are related to the infertility of female workers with long working hours. Long-term work can cause sleep disturbances and stress, which in turn can create hormonal disturbances [20]. Hypothalamic–pituitary–adrenal activation, which is related to sleep disorders, can also interfere with the reproductive system. Circadian dysrhythmia may result in infertility. Cyclic dysrhythmia is associated with changes in the secretion of reproductive hormones, and melatonin is linked to the reproductive system [20].

Stress also affects the reproductive system as it is linked with neuroendocrinological pathways [21]. Stress affects the hypothalamic–pituitary–adrenal axis, which causes changes in sexual behavior, as discussed previously, as well as changes in hormone levels such as luteinizing hormone and luteinizing hormone–releasing hormone [22]. Moreover, glucocorticoids, such as cortisol, inhibit the gonad axis [23]. Some reports showed higher cortisol levels in the cycle of infertile women compared to non-infertile women [24,25]. Oxytocin is also known to regulate sperm transport in the female genital tract [26]. Finally, the harmful effects of stress on the reproductive system can originate from an increasing impact on the levels of serum tumor necrosis factor and natural killer cell activity [27].

On the other hand, a possible proximal determinant of fertility is coital frequency. Working long hours can affect the relationship between a husband and a wife with less time for conversation and a sexual life. This could result in negative emotions and depression and even affect the plan to have babies [28].

However, despite negative consequences related to working long hours, this study shows no association between working long hours and infertility after an advanced maternal age. This may be

Table 1
Baseline characteristics of the workers in accordance with infertility

Characteristics	Noninfertility, n (%)	Infertility, n (%)	P-value
Total	5,215 (88.3)	694 (11.7)	
Age			
15–39	2,307 (44.3)	313 (45.1)	0.6672
40–49	2,908 (55.7)	381 (54.9)	
Education			
High school or below	1,716 (32.9)	192 (27.7)	0.0056
College or above	3,499 (67.1)	502 (72.3)	
Average monthly household income			
Low quartile	1,286 (24.6)	190 (27.4)	0.2407
Middle-low quartile	1,214 (23.4)	143 (20.6)	
Middle-high quartile	1,301 (24.9)	180 (25.9)	
High quartile	1,414 (27.1)	181 (26.1)	
Occupational classification			
White collar	3,106 (59.6)	428 (61.6)	0.4323
Pink collar	1,490 (28.6)	182 (26.2)	
Blue collar	619 (11.8)	84 (12.1)	
Employment type			
Employer	174 (3.4)	31 (4.4)	0.0108
Self-employer	461 (8.8)	77 (11.1)	
Unpaid family worker	309 (5.9)	54 (7.8)	
Paid worker	4,271 (81.9)	532 (76.7)	
Weekly working hour			
≤52	4,902 (94.0)	641 (92.4)	0.0932
>52	313 (6.0)	53 (7.6)	
Contraceptive experience			
Yes	199 (3.8)	288 (41.5)	<0.0001
No	5,016 (96.2)	406 (58.5)	
Abortion experience			
Yes	1,549 (29.7)	242 (34.9)	0.0054
No	3,666 (70.3)	452 (65.1)	

Table 2
Results from logistic regression analysis of infertility in accordance with long working hours and age group

Subgroup	Odds ratio (95% confidence interval), referred to the group of non-long working hours			
	Crude model	Model 1	Model 2	Model 3
Overall (n = 5,909)	1.30 (0.95–1.74)	1.27 (0.93–1.71)	1.28 (0.93–1.72)	1.18 (0.85–1.61)
Subgroup for age group				
<40 y (n = 2,620)	1.96 (1.22–3.04)	1.97 (1.22–3.06)	1.97 (1.22–3.07)	1.91 (1.17–3.01)
≥40 y (n = 3,289)	0.99 (0.65–1.47)	0.99 (0.64–1.46)	0.99 (0.64–1.47)	0.87 (0.55–1.31)
Subgroup for contraceptive experience				
Yes (n = 487)	3.19 (1.37–8.71)	3.15 (1.23–9.22)	3.27 (1.27–9.58)	2.94 (1.12–8.76)
No (n = 5,422)	1.09 (0.71–1.61)	1.07 (0.69–1.58)	1.07 (0.70–1.58)	0.97 (0.62–1.47)
Subgroup for abortion experience				
Yes (n = 1,791)	0.77 (0.43–1.30)	0.81 (0.45–1.36)	0.81 (0.45–1.37)	0.68 (0.37–1.19)
No (n = 4,118)	1.67 (1.15–2.37)	1.62 (1.11–2.29)	1.62 (1.11–2.30)	1.55 (1.05–2.24)

Model 1: adjusting for age.
Model 2: Model 1 + adjusting for education and average monthly household income.
Model 3: Model 2 + adjusting for occupational classification and employment type.

due to the strong effect of fertility on age alone. This could be seen as a result of the decrease in sexual activity due to aging; however, aging alone can still affect infertility despite adjusting for sexual activity [29].

There are many factors that lead to decreased fertility with age. Women are born with ovum; the number of ovum and the quality of ovum decrease with age. The quality of the ovum decreases because of declines in the circulating anti-müllerian hormone and inhibin B concentrations with increases in the circulating levels of follicle-stimulating hormone [30]. The decrease in fertility by age is associated with increases in spontaneous abortion and aneuploidy. A previous study showed that the prevalence of aneuploidy is high in female adults for advanced maternal age [31]. The risk of other diseases that affect fertility may also increase with age. As they age, women experience increased risks for other diseases affecting fertility, such as leiomyomas, tubal disease, and endometriosis [32].

In Fig. 2, the young female worker group's fertility was proportional to the hours worked weekly. Contrarily, it showed a decrease at 66–70 h. This may be due to healthy worker survivor effects. Health-prone workers tend to quit or transfer away from jobs without occupational hazards.

Working women with contraceptives might be suffering from various obstetrics and gynecology problems; they were vulnerable for infertility by long working hours in current analysis. Long working hours could be a severe risk factor for infertility among obstetrics and gynecology problems.

This study has several strengths. To our knowledge, this is the first study to show the relationship between working long hours and age groups regarding infertility. Although previous studies were conducted by adjusting the age, this is the first study to show the difference by stratification in accordance with advanced maternal age.

However, this study also has limitations. Because this was a cross-sectional study, the cause-and-effect relationship between working long hours and infertility could not be confirmed. Further longitudinal studies are needed to establish causality. The current findings were obtained from analysis with unmatched survey times and infertility, in which relationships between working hours and infertility remain unclear. Future research based on the time of infertility is necessary to reveal any specific cause-and-effect relationship between working hours and infertility. The NSFFHW also
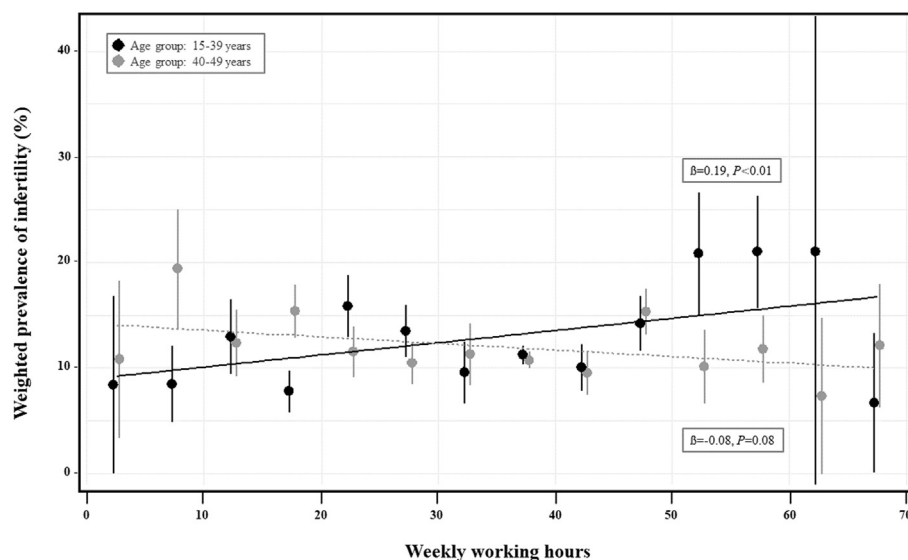

Fig. 2. Weighted prevalence of infertility by weekly working hours.

did not contain variables related to additional confounders, such as genetic factors.

In conclusion, we showed an association between female infertility and working long hours. Poor working conditions, including extended time at work, are more hazardous for female workers. Therefore, the work schedule must be structured to better suit female workers. In addition, attention is needed to the health of young female workers.

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Conflicts of interest

The authors have no conflict of interest to declare.

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