

# Awareness, knowledge, and use of folic acid among non-pregnant Korean women of childbearing age

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**BACKGROUND/OBJECTIVES:** Folic acid supplementation before pregnancy is known to reduce the risk of neural tube defects. The purposes of this study were to investigate the awareness, knowledge, and use of folic acid supplements along with their associated factors among non-pregnant Korean women of childbearing age.

**SUBJECTS/METHODS:** From August 2012 to March 2013, 704 women aged 19-45 years completed a self-administered questionnaire regarding their awareness, knowledge, and use of folic acid as well as questions to identify risk of inadequate folate intake.

**RESULTS:** Approximately 67% of women reported that they had heard of folic acid, and 23.7% had knowledge of both the role of folic acid in preventing birth defects and appropriate time for taking folic acid supplements to prevent birth defects. However, only 9.4% of women took folic acid supplements at the time of the survey. Women aged 19-24 years, unmarried women, and women who had never been pregnant were less likely to be aware and knowledgeable of folic acid or take folic acid supplements. In addition, women at high risk of inadequate folate intake were less likely to take folic acid supplements. In a multivariate analysis, women aged 19-24 years, women with a high school diploma or lower education level, and unmarried women were less likely to be aware and have knowledge of folic acid. The percentage of women taking folic acid supplements was significantly higher among knowledgeable women than among unknowledgeable women.

**CONCLUSIONS:** These results support our hypothesis that women with knowledge of folic acid are more likely to take folic acid supplements. Therefore, educational programs or campaigns to improve knowledge regarding the importance of folic acid and to promote consumption of folic acid supplements as well as folate-rich foods are needed to target young, less educated, and unmarried women.

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## INTRODUCTION

Neural tube defects (NTDs) such as spina bifida and anencephaly are common birth defects that contribute to infant mortality and disability [1]. They occur when the neural tube does not close completely within 28 days of conception. It is well established that adequate folate status of pregnant women is critical to prevent the occurrence of NTDs, and folic acid supplementation before pregnancy significantly reduces the risk of NTDs [2].

Since 1992, the United States Public Health Service has recommended that all women of childbearing age should consume daily supplements containing 400 µg of folic acid [3]. Currently, folic acid supplementation is officially recommended for women of childbearing age in many countries [4], and national campaigns have been implemented to increase the

awareness and consumption of folic acid [5]. In addition, more than 50 countries have adopted mandatory folic acid fortification policies to prevent NTDs by improving the nutritional status of folate in women [6,7].

Recent studies have shown that folic acid fortification reduces the prevalence of NTDs by an average of 46% [8], and the prevalence of spina bifida was reported to be significantly lower in countries with mandatory folic acid fortification policies than in those without such policies [9]. The prevalence of NTDs in countries with folic acid fortification policies is generally less than 10 per 10,000 births [10]. In Korea, an accurate estimate of the prevalence of NTDs remains unknown. However, when 10,868 Korean infants born in five local obstetric clinics from 2009 to 2010 were observed, the prevalence of NTDs was found to be 20.2 per 10,000 live and stillbirths [11].

Studies have shown that the folate nutritional status of Korean

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women of childbearing age is inadequate [12,13]. Approximately 50% of Korean women of childbearing age do not meet the estimated average requirement for dietary folate, and 20% have serum folate concentrations of < 7 ng/mL [12,13], which is the recommended concentration for effective prevention of NTDs [14]. In addition, according to the Korea National Health and Nutrition Examination Survey in 2007-2009, only 8.3% of women aged  $\geq 20$  years took folic acid or multivitamin supplements containing folic acid [15]. Therefore, adequate strategies to improve the nutritional status of Korean women and thus reduce the incidence of NTDs are needed.

Currently, no national folic acid campaigns have been conducted in Korea, and no policies for mandatory folic acid fortification have been implemented. The only existing program aimed at improving the folate nutritional status of Korean women provides folic acid supplements to pregnant women visiting public health centers [16]. However, this program is not effective in preventing NTDs since failure of neural tube closure occurs within 28 days of conception during which time most women do not realize they are pregnant. Therefore, it is important for women of childbearing age to be aware of the importance of folic acid and take folic acid supplements before pregnancy.

Factors influencing folic acid supplementation during pregnancy among Korean women include planned pregnancy, experience of previous spontaneous abortions, and knowledge of the importance of folic acid [17,18]. However, there has been no published information on the factors associated with folic acid supplement use among non-pregnant Korean women of childbearing age. The purposes of this study were to investigate the awareness, knowledge, and use of folic acid supplements along with their associated factors among non-pregnant Korean women of childbearing age in order to explore our hypothesis that women with knowledge of folic acid are more likely to take folic acid supplements.

## SUBJECTS AND METHODS

### *Study design and participants*

A questionnaire survey was conducted from August 2012 to March 2013. Students and employees from two universities in the Gyeonggi and Chungbuk areas as well as childcare teachers and prospective childcare teachers who were enrolled in training institutions were recruited for the survey. A questionnaire was distributed to 799 women aged 19-45 years, and data from 704 women were analyzed after excluding incomplete responses. This study was approved by the Institutional Review Board of Chungbuk National University Hospital (CBNU-IRB-2012-BQ01).

### *Questionnaire*

A self-administered questionnaire was developed based on previous studies [19-21]. It included questions regarding demographic characteristics and folic acid as well as an eating habit checklist. The questionnaire was revised based on a pilot study of 15 women of childbearing age.

Information on demographic characteristics such as age, education, employment status, marital status, and pregnancy experience was obtained. Regarding the questions about folic

acid, the women were asked whether they had heard of folic acid as well as whether they took folic acid supplements. Regarding the assessment of knowledge of folic acid, the women were asked to answer multiple choice questions about nutritional classification of folic acid, the role of folic acid, and appropriate time to take folic acid supplements. The women were also asked about the source from where they obtained information on folic acid.

An eating habit checklist consisting of eight questions, which was originally developed to screen college students at risk of inadequate nutrient intake, was used to assess the risk of inadequate folate intake [21]. In the previous study, a score was given to each answer, and a cut-off point of total scores for diagnosing students as 'low risk', 'moderate risk', and 'high risk' was determined based on stepwise regression analysis, and determination of sensitivity and specificity [21]. Folate intake of college students diagnosed as the high risk group was found to be significantly lower than that of the moderate risk or low risk group [21]. The questions of the checklist surveyed how many days in the last week a woman ate three meals per day, whether she had enough time for breakfast, and how frequently she ate rice and kimchi the previous day as well as milk, meat, beans, and green vegetables over the last 3 days. Possible responses for eating frequency were 'more than three times', 'once or twice', and 'never'.

### *Definition of awareness, knowledge, and use of folic acid*

Folic acid awareness was defined as having heard of folic acid. Knowledge of folic acid was defined as knowing that folic acid prevents birth defects and that it should be taken before pregnancy for the prevention of birth defects. Folic acid use was defined as taking folic acid supplements or multivitamins containing folic acid at the time of the survey.

### *Statistical analysis*

All data were analyzed using SAS software (Version 9.4, SAS Institute Inc., Cary, NC, USA) and presented as frequency and percentage. Chi-square test was performed to test for differences in the proportions of categorical variables among two or three groups. Multivariate logistic regression analyses were performed to determine the variables associated with awareness and knowledge of folic acid. Age, education, employment status, and marital status, which were reported to be factors associated with awareness and knowledge in previous studies [19,22,23], were added to the model as independent factors. The results of the logistic analyses are presented as odds ratios (OR) and their 95% confidence intervals (CIs). A *P*-value of < 0.05 was considered statistically significant.

## RESULTS

### *Characteristics of the study participants*

Table 1 shows the characteristics of the participants. In total, 35.9% of women were 19-24 years old, and 35.5% were 25-34 years old. More than two-thirds of the women (68.5%) were college graduates or had a higher education level. More women were employed (53.9%), unmarried (65.5%), and had no experience of pregnancy (67.9%). Similar proportions of women

**Table 1.** Characteristics of the study participants

	N (%)
Total	704 (100.0)
Age (yrs)	
19-24	253 (35.9)
25-34	250 (35.5)
35-45	201 (28.6)
Education	
≤High school graduates	119 (16.9)
College students	103 (14.6)
≥College graduates	482 (68.5)
Employment status	
Unemployed	325 (46.1)
Employed	379 (53.9)
Marital status	
Unmarried	461 (65.5)
Married	243 (34.5)
Pregnancy experience	
No	478 (67.9)
Yes	226 (32.1)
Risk of inadequate folate intake	
High	224 (31.8)
Moderate	217 (30.8)
Low	263 (37.4)

**Table 2.** Awareness, knowledge, and use of folic acid

	N (%)
Total	704 (100.0)
Heard of folic acid	472 (67.0)
Knew that folic acid is a vitamin	155 (22.0)
Knew the roles of folic acid <sup>1)</sup>	
Prevents birth defects	251 (35.7)
Prevents anemia	223 (31.7)
Helps the growth of children	194 (27.6)
Knew that folic acid should be taken before pregnancy	238 (33.8)
Source of information about folic acid <sup>2)</sup>	
Media	107 (22.7)
Family/friends	98 (20.8)
Physicians/nurses	74 (15.7)
Internet	44 (9.3)
Books/magazine	42 (8.9)
Health functional food salesman	40 (8.5)
School	39 (8.3)
Other(e.g. pharmacists/dietitian)	28 (5.8)
Use of folic acid supplements	66 (9.4)

<sup>1)</sup> Multiple responses (A percentage was calculated out of a total of participants, N = 704)

<sup>2)</sup> A percentage was calculated out of women who had ever heard of folic acid, N = 472)

were at high risk (31.8%) and moderate risk (30.8%) of inadequate folate intake.

**Table 3.** Awareness, knowledge, and use of folic acid by selected characteristics

	Total	Awareness <sup>1)</sup>		Knowledge <sup>2)</sup>		Use <sup>3)</sup>	
		N (%)	N (%)	N (%)	N (%)		
Total	704	472 (67.0) <sup>4)</sup>	167 (23.7)	66 (9.4)			
Age (yrs)							
19-24	253	116 (45.8) <sup>4)***</sup>	21 (8.3) <sup>***</sup>	7 (2.8) <sup>***</sup>			
25-34	250	176 (70.4)	73 (29.2)	21 (8.4)			
35-45	201	180 (89.6)	73 (36.3)	38 (18.9)			
Education							
≤High school graduates	119	85 (71.4)	34 (28.6)	15 (12.6)			
College students	103	67 (65.0)	24 (23.3)	11 (10.7)			
≥College graduates	482	320 (66.4)	109 (22.6)	40 (8.3)			
Employment status							
Unemployed	325	190 (58.5) <sup>***</sup>	55 (16.9) <sup>*</sup>	23 (7.1)			
Employed	379	282 (74.4)	112 (29.6)	43 (11.4)			
Marital status							
Unmarried	461	252 (54.7) <sup>***</sup>	63 (13.7) <sup>***</sup>	19 (4.1) <sup>***</sup>			
Married	243	220 (90.5)	104 (42.8)	47 (19.3)			
Pregnancy experience							
No	478	265 (55.4) <sup>***</sup>	73 (15.3) <sup>***</sup>	23 (4.8) <sup>***</sup>			
Yes	226	207 (91.6)	94 (41.6)	43 (19.0)			
Risk of inadequate folate intake							
High	224	133 (59.4) <sup>*</sup>	46 (20.5)	13 (5.8) <sup>*</sup>			
Moderate	217	151 (69.6)	58 (26.7)	19 (8.8)			
Low	263	188 (71.5)	63 (24.0)	34 (12.9)			

<sup>1)</sup> Having heard of folic acid

<sup>2)</sup> Knowing both the role of folic acid in preventing birth defects and appropriate time to take folic acid

<sup>3)</sup> Taking folic acid supplements or multivitamins containing folic acid at the time of the survey

<sup>4)</sup> A percentage was calculated out of the women in the subgroup

\*  $P < 0.05$ , \*\*\*  $P < 0.001$  by chi-square test

### Awareness, knowledge, and use of folic acid

The awareness, knowledge, and use of folic acid among the participants are shown in Table 2. Approximately 67% of women had heard of folic acid, and 22.0% knew that folic acid is a vitamin. The proportions of women who knew the roles of folic acid in preventing birth defects, preventing anemia, and promoting growth of children were 35.7%, 31.7%, and 27.6%, respectively. One-third of women (33.8%) knew that folic acid should be taken before pregnancy for the prevention of birth defects. Overall, 23.7% of women had knowledge about the role of folic acid in preventing birth defects as well as appropriate time of its consumption. The main sources of information on folic acid were media (22.7%), family and friends (20.8%), and physicians and nurses (15.7%). The proportion of women who were taking folic acid supplements at the time of the survey was 9.4%.

### Awareness, knowledge, and use of folic acid by selected characteristics

Table 3 shows the distribution of women who had heard of folic acid (awareness), who knew both the NTD-preventive role of folic acid and appropriate time to take folic acid (knowledge), and who took folic acid supplements at the time of survey (use) based on selected demographic characteristics. Among women

**Table 4.** Multivariate logistic regression results for awareness and knowledge of folic acid

	Adjusted OR (95% CI) <sup>1)</sup>	
	Awareness <sup>2)</sup> (n = 472)	Knowledge <sup>3)</sup> (n = 167)
Age (yrs)		
19-24	1.00	1.00
25-34	<b>2.64</b> (1.64-4.26)	<b>3.28</b> (1.71-6.30)
35-45	<b>3.35</b> (1.32-8.45)	1.26 (0.52-3.07)
Education		
≤High school graduates	1.00	1.00
College students	<b>5.57</b> (2.59-11.99)	<b>3.01</b> (1.45-6.24)
≥College graduates	<b>3.33</b> (1.77-6.27)	1.44 (0.84-2.47)
Employment status		
Unemployed	1.00	1.00
Employed	1.04 (0.67-1.63)	1.18 (0.73-1.92)
Marital status		
Unmarried	1.00	1.00
Married	<b>7.04</b> (3.06-16.4)	<b>6.89</b> (3.61-13.14)

OR, odds ratio; CI, confidence interval.

<sup>1)</sup> Age, education, employment status, and marital status were included in the model.

<sup>2)</sup> Having heard of folic acid

<sup>3)</sup> Knowing both the role of folic acid in preventing birth defects and appropriate time to take folic acid

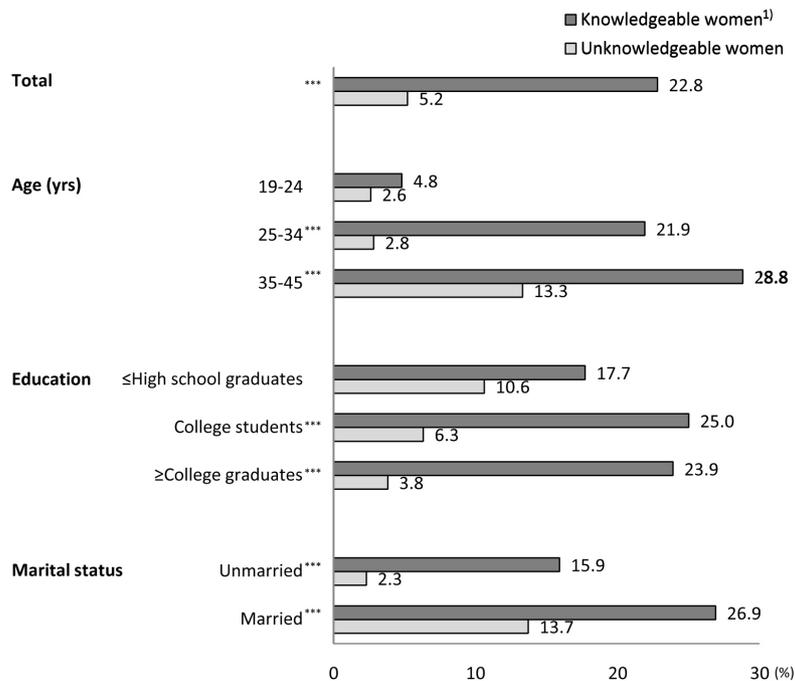
aged 35-45 years, 89.6% had heard of folic acid, 36.3% had knowledge of folic acid, and 18.9% took folic acid supplements. However, among women aged 19-24 years, only 45.8% had heard of folic acid, 8.3% had knowledge of folic acid, and 2.8% took folic acid supplements. There were no significant differences in awareness, knowledge, or use of folic acid among the groups

depending on educational status. Significantly higher proportions of employed women were aware of folic acid and had knowledge of folic acid compared with unemployed women. In addition, 90.5% of married women had heard of folic acid, 42.8% had knowledge of folic acid, and 19.3% took folic acid supplements, whereas only 54.7% of unmarried women had heard of folic acid, 13.7% had knowledge of folic acid, and 4.1% took folic acid supplements. Similar trends were observed according to pregnancy experience. Among women at low risk of inadequate folate intake, 71.5% had heard about folic acid and 12.9% took folic acid supplements, whereas among women at high risk, 59.4% had heard of folic acid and only 5.8% took folic acid supplements.

*Factors associated with awareness, knowledge, and use of folic acid*

Table 4 shows the results of the multivariate logistic regression analyses for awareness and knowledge of folic acid. Age, education, employment status, and marital status were included in the model. Prior pregnancy experience was not included in the model since all of the married women, except 17, had pregnancy experience. Women aged 25-34 years, college students, and married women were more likely to be aware and have knowledge of folic acid than younger women, women with lower educational status, and unmarried women, respectively.

The rate of folic acid supplement use was compared between women with knowledge of folic acid and women without knowledge (Fig. 1). Overall, knowledgeable women were more likely to take folic acid supplements than unknowledgeable women (22.8% vs. 5.2%). As age, education, and marital status



**Fig. 1.** Percentage of women taking folic acid supplements at the time of the survey. <sup>1)</sup> Women who knew both the role of folic acid in preventing birth defects and appropriate time to take folic acid, \*\*\*  $P < 0.001$  by chi-square test

were the factors associated with knowledge, rate of supplement use was also compared between knowledgeable and unknowledgeable women in each sub-group. The supplementation rate was significantly higher among knowledgeable women in each sub-group, except 19-24 years and  $\leq$ high school graduates, than among unknowledgeable women, respectively.

## DISCUSSION

Our results show that only 9.4% of the women participating in this study took folic acid supplements despite the recommendation of the Korean Nutrition Society since 2010 that women of childbearing age should consume folic acid supplements [24]. Among women aged 19-24 years, only 2.8% took folic acid supplements. Significantly lower rates of folic acid use were observed in women aged 19-24 years (2.8%), unmarried women (4.1%), those with no prior pregnancy experience (4.8%), those at high risk of inadequate folate intake (5.8%), and unknowledgeable women (5.2%).

Multivariate analysis that investigated the factors associated with awareness and knowledge showed that women aged 25-34 years, college students, and married women were more likely to have heard of folic acid and have sufficient knowledge of folic acid compared with younger women, less educated women, and unmarried women, respectively. The highest odds of awareness and knowledge of folic acid were related to marital status. It is likely that many Korean women became aware of folic acid after marriage or pregnancy. In a previous study, the majority (97.9%) of pregnant Korean women were reported to have heard of folic acid, 72% had knowledge of folic acid, and 24.6% had experience taking folic acid supplements starting at least 1 month before conception [18]. These proportions were much higher than those of the non-pregnant women in this study. Since it was reported that approximately 50-60% of pregnancies are unplanned in Korea [17,25], intervention to increase the awareness and knowledge of folic acid and use of folic acid supplements targeting young, less educated, and unmarried women is needed.

In many countries, educational campaigns aimed at promoting the use of folic acid as well as increasing awareness and knowledge of folic acid have been carried out [5]. In the US, national and statewide folic acid campaigns have been implemented since the mid-1990s. The proportion of women who had heard of folic acid steadily increased from 52% in 1995 to 84% in 2005 while that of women who knew that folic acid prevents NTDs increased from 4% to 19%; use of folic acid supplements increased from 28% to 33% during the same period [26]. In Australia, a national folic acid campaign began in 1997. The proportion of women of childbearing age who knew of the role of folic acid in preventing NTDs increased from 25.5% in 1994 to 77.0% in 2007, that of women who knew the appropriate time for use increased from 11.5% in 1994 to 38.9% in 2007, and that of women who took folic acid supplements increased from 37.2% in 1998 to 63.7% in 2007 [27].

Chivu *et al.* [28] conducted a systematic review of 31 studies designed to increase the awareness, knowledge, and use of folic acid before and during pregnancy and concluded that folic acid awareness increased from 60% to 72%, knowledge from 21%

to 45%, and consumption from 14% to 23% due to interventional strategies. In 2009, a large cross-sectional survey of women aged 15-49 years in 18 European countries was conducted [29]. Overall, 70% of women had heard of folic acid, 17% knew that folic acid can reduce the risk of NTDs, and only 7% took folic acid supplements at the time of survey, although many European countries had implemented educational campaigns using different channels [5].

The gaps between awareness, knowledge, and use of folic acid could be explained by difficulties in behavioral changes. Many factors contribute to behavioral changes associated with use of folic acid supplements. Low use of folic acid supplements was reported to be associated with lack of pregnancy intention, high cost of folic acid tablets, forgetfulness, and lack of knowledge [30-32]. Incomplete outreach, lack of prior awareness and knowledge, unplanned pregnancy, and personal characteristics such as age and educational level were identified as barriers to the success of folic acid public health campaigns [33].

Prior findings that folic acid supplement users had much higher concentrations of plasma folate and red blood cell folate than non-users support the effectiveness of folic acid supplement use for improving folate nutritional status [19]. In a Japanese case control study, folic acid use was found to be associated with a reduced risk of spina bifida births, and knowledge about the preventive role of folic acid was associated with increased folic acid use [20].

In our study, we could not perform multivariate logistic analysis to determine whether knowledge is the most important factor affecting use of folic acid supplements since only 9.4% of women took folic acid supplements. Instead, supplementation rate was compared between knowledgeable women and unknowledgeable women. Overall, 22.8% of women with knowledge took folic acid supplements, whereas only 5.2% of women without knowledge did (Fig. 1). In addition, for each age, education, and marital category, knowledgeable women were more likely to take folic acid supplements than unknowledgeable women. These results support our hypothesis that women with knowledge of folic acid are more likely to take folic acid supplements. Therefore, education regarding folic acid is important, although educational campaigns seem to be generally ineffective in increasing the use of folic acid in other countries. As the most common source of information on folic acid is the media (22.7%), health professionals should try to provide reliable information about folic acid through the media.

The limitation of this study is that the educational level of the participants was relatively high. Therefore, the percentage of Korean women who knew of folic acid may be lower than that obtained in this study. In addition, some of the women who took multivitamins containing folic acid might not have intended to improve their folate nutritional status for an increased chance of getting pregnant. To the best of our knowledge, this is the first report regarding the awareness, knowledge, and use of folic acid among non-pregnant women in Korea. The results of this study may provide opportunities to promote interest in the development of folic acid campaigns. It would be necessary to organize campaigns to improve the knowledge regarding the importance of folic acid and to promote

consumption of folic acid supplements as well as folate-rich foods targeting young, less educated, and unmarried women.

## CONFLICT OF INTEREST

The authors declare no potential conflicts of interests.

## REFERENCES

- Wallingford JB, Niswander LA, Shaw GM, Finnell RH. The continuing challenge of understanding, preventing, and treating neural tube defects. *Science* 2013;339:1222-2002.
- Wolff T, Witkop CT, Miller T, Syed SB; U.S. Preventive Services Task Force. Folic acid supplementation for the prevention of neural tube defects: an update of the evidence for the U.S. Preventive Services Task Force. *Ann Intern Med* 2009;150:632-9.
- Recommendations for the use of folic acid to reduce the number of cases of spina bifida and other neural tube defects. *MMWR Recomm Rep* 1992;41:1-7.
- Gomes S, Lopes C, Pinto E. Folate and folic acid in the periconceptional period: recommendations from official health organizations in thirty-six countries worldwide and WHO. *Public Health Nutr* 2016;19:176-89.
- Al-Wassia H, Shah PS. Folic acid supplementation for the prevention of neural tube defects: promotion and use. *Nutr Diet Suppl* 2010;2:105-16.
- Centers for Disease Control and Prevention (CDC). CDC grand rounds: additional opportunities to prevent neural tube defects with folic acid fortification. *MMWR Morb Mortal Wkly Rep* 2010;59:980-4.
- Food Fortification Initiative (US). Defeating anemia [Internet]. Atlanta (GA): Food Fortification Initiative; 2016 [cited 2017 October 20]. Available from: [http://www.ffinetwork.org/about/stay\\_informed/releases/2015Review.html](http://www.ffinetwork.org/about/stay_informed/releases/2015Review.html).
- Blencowe H, Cousens S, Modell B, Lawn J. Folic acid to reduce neonatal mortality from neural tube disorders. *Int J Epidemiol* 2010;39:110-21.
- Atta CA, Fiest KM, Frolkis AD, Jette N, Pringsheim T, St Germaine-Smith C, Rajapakse T, Kaplan GG, Metcalfe A. Global birth prevalence of spina bifida by folic acid fortification status: a systematic review and meta-analysis. *Am J Public Health* 2016;106:e24-34.
- Food Fortification Initiative (US). Country profiles for grain fortification [Internet]. Atlanta (GA): Food Fortification Initiative; 2017 [cited 2017 October 20]. Available from: [http://www.ffinetwork.org/country\\_profiles/index.php](http://www.ffinetwork.org/country_profiles/index.php).
- Park JW, Jun JK, Koo JN, Seo DK, Moon JB, Suh YH, Kim SI, Oh KJ, Hong JS, Kim BJ, Park HJ, Park H, Kang HT, Bae S, Kim JH, Lee K, Hong YC, Cho SH. Prevalence of congenital anomalies in Korea: multi-center study. *Korean J Ultrasound Obstet Gynecol* 2011;13:148-56.
- Jang HB, Han YH, Piyathilake CJ, Kim H, Hyun T. Intake and blood concentrations of folate and their association with health-related behaviors in Korean college students. *Nutr Res Pract* 2013;7:216-23.
- Hwang EJ. Development of a screening tool for identifying risk of folate deficiency among women of child-bearing age [master's thesis]. Cheongju: Chungbuk National University; 2014.
- Daly LE, Kirke PN, Molloy A, Weir DG, Scott JM. Folate levels and neural tube defects. Implications for prevention. *JAMA* 1995;274:1698-702.
- Kang M, Kim DW, Baek YJ, Moon SH, Jung HJ, Song YJ, Paik HY. Dietary supplement use and its effect on nutrient intake in Korean adult population in the Korea National Health and Nutrition Examination Survey IV (2007-2009) data. *Eur J Clin Nutr* 2014;68:804-10.
- Ministry of Health and Welfare (KR). Our happy kids: policy guide for supporting pregnancy to child care [Internet]. Seoul: Ministry of Health and Welfare; 2011 [cited 2017 October 20]. Available from: [http://download.mohw.go.kr/front\\_new/modules/download.jsp?BOARD\\_ID=140&CONT\\_SEQ=250856&FILE\\_SEQ=124907](http://download.mohw.go.kr/front_new/modules/download.jsp?BOARD_ID=140&CONT_SEQ=250856&FILE_SEQ=124907).
- Kim MH, Han JY, Cho YJ, Ahn HK, Kim JO, Ryu HM, Kim MY, Yang JH, Nava-Ocampo AA. Factors associated with a positive intake of folic acid in the periconceptional period among Korean women. *Public Health Nutr* 2009;12:468-71.
- Kim J, Yon M, Kim CI, Lee Y, Moon GI, Hong J, Hyun T. Preconceptional use of folic acid and knowledge about folic acid among low-income pregnant women in Korea. *Nutr Res Pract* 2017;11:240-6.
- Ren A, Zhang L, Li Z, Hao L, Tian Y, Li Z. Awareness and use of folic acid, and blood folate concentrations among pregnant women in northern China--an area with a high prevalence of neural tube defects. *Reprod Toxicol* 2006;22:431-6.
- Kondo A, Kamihira O, Shimosuka Y, Okai I, Gotoh M, Ozawa H. Awareness of the role of folic acid, dietary folate intake and plasma folate concentration in Japan. *J Obstet Gynaecol Res* 2005;31:172-7.
- Lee HY, Hwang EJ, Hyun T. Development of an eating habit checklist for screening college students at risk of inadequate nutrient intake. *J Hum Ecol* 2015;19:67-79.
- Centers for Disease Control and Prevention (CDC). Knowledge about folic acid and use of multivitamins containing folic acid among reproductive-aged women--Georgia, 1995. *MMWR Morb Mortal Wkly Rep* 1996;45:793-5.
- Nawapun K, Phupong V. Awareness of the benefits of folic acid and prevalence of the use of folic acid supplements to prevent neural tube defects among Thai women. *Arch Gynecol Obstet* 2007;276:53-7.
- The Korean Nutrition Society. Dietary Reference Intakes for Koreans. 1st rev. ed. Seoul: The Korean Nutrition Society; 2010.
- Moon MJ, Chung JH, Choi JS, Ahn HK, Ryu HM, Lim HJ, Shin JS, Kim JO, Yang JH, Kim MY, Choi KH, Kim YJ, Han JY. The rate of planned pregnancy and associated factors related to planned pregnancy. *Korean J Obstet Gynecol* 2003;46:1741-5.
- Green-Raleigh K, Carter H, Mulinare J, Prue C, Petrini J. Trends in folic acid awareness and behavior in the United States: the Gallup Organization for the March of Dimes Foundation surveys, 1995-2005. *Matern Child Health J* 2006;10:S177-82.
- Chan AC, van Essen P, Scott H, Haan EA, Sage L, Scott J, Gill TK, Nguyen AM. Folate awareness and the prevalence of neural tube defects in South Australia, 1966-2007. *Med J Aust* 2008;189:566-9.
- Chivu CM, Tulchinsky TH, Soares-Weiser K, Braunstein R, Brezis M. A systematic review of interventions to increase awareness, knowledge, and folic acid consumption before and during pregnancy. *Am J Health Promot* 2008;22:237-45.
- Bitzer J, von Stenglin A, Bannemerschult R. Women's awareness and preconceptional use of folic acid: data from a large European survey. *Int J Womens Health* 2013;5:201-13.
- Chacko MR, Anding R, Kozinetz CA, Grover JL, Smith PB. Neural

- tube defects: knowledge and preconceptional prevention practices in minority young women. *Pediatrics* 2003;112:536-42.
31. Robbins JM, Cleves MA, Collins HB, Andrews N, Smith LN, Hobbs CA. Randomized trial of a physician-based intervention to increase the use of folic acid supplements among women. *Am J Obstet Gynecol* 2005;192:1126-32.
  32. French MR, Barr SI, Levy-Milne R. Folate intakes and awareness of folate to prevent neural tube defects: a survey of women living in Vancouver, Canada. *J Am Diet Assoc* 2003;103:181-5.
  33. Rofail D, Colligs A, Abetz L, Lindemann M, Maguire L. Factors contributing to the success of folic acid public health campaigns. *J Public Health (Oxf)* 2012;34:90-9.