Original Article

Which mothers take folic acid and folate containing foods?

Colin Binns MBBS MPH PhD[1], Jane Scott MPH PhD [1,2], Nkeonyelu Nwafor MBBS MSc[2], Kathleen Graham BSc[1], Wendy Oddy PhD[1] and Andy Lee PhD[1]

[1]*School of Public Health, Curtin University of Technology, Perth, Western Australia*
[2]*Division of Developmental Medicine, University of Glasgow*

This study documented the prevalence (proportion) of mothers taking folic as supplements or as fortified foods and explored the factors that determined whether folic acid was taken. A cross sectional analysis of the baseline data of mothers who participated in the Perth Infant Feeding Study was performed. A total of 587 mothers who delivered at the two hospitals in the study completed baseline questionnaires. The factors associated with the decision to take folic acid supplements or fortified foods were investigated using multivariate logistic regression. Main outcome measures were the percentage of mothers taking folic acid or folic acid fortified foods. A total of 455 (78%) mothers stated that they took folic acid supplements before or during the first three months of their pregnancy. Of the 132 who did not take folate supplements only 35 (6% of all participating mothers) claimed to have taken folate fortified food or beverages. In the highest income group, 87% of mothers took folic acid supplements compared to 64% in the poorest group. The significant factors independently associated with not taking folic acid supplements or fortified food were "years of education" (OR '10 years or less' 0.45 (0.23-0.88)), "family income" (OR <$25000 0.40(0.20-0.80)), and for taking folic acid "the timing of the pregnancy." (OR 'actively trying' 2.01 (0.1.04-0.3.87)). There was a significant proportion of mothers who did not take folic acid periconceptually. The mothers who were not taking folic were less educated, from lower socio-economic groups and were not actively trying to fall pregnant at the time they became pregnant. The results suggest that in order to reach all Australian mothers, mandatory fortification of foods with folic acid should be required.

Key Words: folic acid, folate, pregnancy, Australia, socio-economic group

Introduction

Folic acid or folate is a vitamin, classified as a member of the B group of vitamins and was established as an essential nutrient for man and animals in 1946. The active form, pteryl monoglutamic acid, is referred to as folic acid, but many different forms are present in foods, where it is usually conjugated into a polyglutamate. A major problem with assessing dietary intakes of folate is the variation in bioavailability of many of the naturally occurring compounds. For this reason where there is a public health reason for taking additional folate it is usually given as folic acid, which has known bioavailability and activity. The function of folate is essential to one carbon transfers in the body and particularly in the synthesis of purines used in the formation of DNA and RNA and it also serves as a carbon carrier in the formation of haem. Folate deficiency is common on a world wide basis, particularly affecting indigent populations.[1, 2]

There has been increasing interest in the role of folic acid in the prevention of neural tube defects in recent years. Several major reviews summarised the evidence of the effectiveness of the use of folic acid as a public health intervention, either as a supplement or in the fortification of the food supply.[3-6]

Two Cochrane reviews have confirmed the efficacy of folate in pregnancy for the prevention of anaemia and neural tube defects (NTDs).[3,7] The Cochrane review on folate and NTDs concluded that "Periconceptional folate supplementation has a strong protective effect against neural tube defects." Other studies have shown a decline in acute lymphoblastic leukaemia and neuroblastoma in the children of mothers who have taken additional folic acid during their pregnancies.[8] In 1992 the United States Department of Health and Human Services recommended that all mothers take folic acid before becoming pregnant and in 1993 the National Health and Medical Research Council in Australia made a similar recommendation that all mothers take 0.5mg of folic acid daily prior to becoming pregnant.[9]

The recognition of the importance of folic acid supplementation during pregnancy saw a number of countries take action to fortify their food supply with folic acid. In Australia a need to develop an overall policy to reduce the incidence of NTDs became a priority. While NTDs are a public health problem that is not numerically large, they cause

Correspondence address: Prof. Colin Binns, School of Public Health, Curtin University of Technology, GPO Box U1987, Perth 6845, Western Australia
E-mail: c.binns@curtin.edu.au
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considerable stress to families, a diminution in quality of life to the individual and a large cost burden to the community. Early in 1994 a Working Party of the National Health and Medical Research Council was formed to consider the issues and to make recommendations.[10] This working party recommended that voluntary fortification of flour, bread, breakfast cereals and juices be allowed up to 50% of the folic acid RDI per serving size. As a result of this recommendation Australian and New Zealand Food Standards (now Food Standards Australia New Zealand, FSANZ) authorised a trial of voluntary fortification of the Australian food supply with folic acid.[11] Those companies who fortified their foods were permitted to use a health claim on their products. Following voluntary fortification and associated health promotion campaigns, awareness of the role of folate and its food sources was found to have increased in a telephone survey.[12] However the authors noted a lower level of awareness about folate in lower income and rural groups.

The program of voluntary fortification of food with folate resulted in an improved folate status in a study of 69 South Australian adolescents, but the authors concluded that "current levels of fortification may not be sufficient to provide maximal protection against neural tube defects at a population level."[13] Metz also documented an increase in blood folate levels, but of only 19% after voluntary fortification in Australia, compared to the 250% that occurred in the USA after mandatory fortification.[14]

A review by Bower and colleagues of data from the WA Birth Defects Registry found that following folate fortification the difference in the prevalence between indigenous and non-indigenous infants increased; the rate ratio increasing from 1.43 to almost 2.0.[15] This suggested that the indigenous population is not benefiting as much from voluntary fortification or is not taking folic acid supplements periconceptually.

Objectives

The objectives of this study were to document the prevalence (proportion) of new mothers taking folic acid as supplements or as fortified foods during their pregnancy and to study the factors that determined whether folic acid was taken.

Methods

The second Perth Infant Feeding Study (PIFS) II was undertaken between mid-September 2002 and mid-July 2003 using the same hospitals, survey tools and methodology as had been used in the first PIFS (PIFS I) ten years previously.[16-18] In the PIFS II additional questions were included about the use of folic acid supplements and foods and beverages containing added folic acid. These questions were identical to those used in the National Health Survey.[19] New mothers were visited by the research officer within the first three days following the birth of their infant and invited to participate in an infant feeding study. Attempts were made to contact all women delivering during the study period. Women were eligible for the study if they had delivered a live infant free of serious health problems requiring transfer to Perth's major maternity hospital for critical care. Mothers whose infants were admitted to the Special Care Units of the participating hospitals were eligible for recruitment. Participants completed the self-administered baseline questionnaire while in hospital or shortly after discharge from hospital. All participants were then followed up by telephone to ascertain how they were feeding their infants at home. The study instruments used in the two studies were essentially the same, with only minor improvements and additions being made to the instrument used in the PIFS II. As the baseline questionnaire was to be self-administered, a number of steps had been taken to ensure that it was easy to read, comprehend, and complete. The original questionnaire had been reviewed by literacy experts and pre-tested by a group of 20 new mothers prior to its use in the PIFS I.

Statistical analysis

Data were entered and analysed using the Statistical Package for the Social Sciences, Version 11.5 (SPSS for Windows, SPSS Inc., Chicago, IL, USA). Descriptive analysis of relevant variables was followed by univariate analysis, using the Chi square test, of variables that were possibly related to folic acid intake. Multivariate logistic regression analysis was used to investigate the factors in determining whether folic acid supplements or fortified food or beverages was taken.

Ethical considerations

The Human Ethics Committee of the Curtin University of Technology and the ethics committees of the two participating hospitals approved the study. Signed informed consent was obtained from participants. Confidentiality was assured and mothers were advised that their participation was voluntary and that they could withdraw at any time without prejudice.

Results

During the period of the study a total of 1068 women were eligible to participate and of these, 870 were contacted and 587 completed baseline questionnaires, representing 68% of women contacted. Demographic and delivery details are available on 233 of the women who were contacted but who declined to participate. There were no significant differences in the age (χ^2 = 4.574 df 4 P = 0.334) or level of education (χ^2 = 5.4834 df 2 P = 0.064) of participants in the PIFS II compared to non-participants, indicating they were representative of the population from which they were drawn with respect to these two characteristics. The basic demographic characteristics of the sample are shown in Table 1. The average age of the participants was 28.4 years; with 80% being in the 20-35 year age range. The youngest mother was 14 years and the oldest 45 years.

A total of 455 (78%) mothers stated that they took folic acid supplements. Of the 132 who did not take folate supplements only 35 (6% of all participating mothers) claimed to have taken folate fortified food or beverages. (see Table 2) This left 97 (16%) of the sample who did not take folate supplements or did not consciously consume foods or drinks that contained additional folate.

Table 1. Demographic characteristics of the sample (*N* = 587).

	Number	Percentage
Maternal age (years)		
<20	32	5.5
20–24	124	21.1
25–29	169	28.8
30–34	176	30%
35_	86	14.7
Maternal education		
Did not complete high school	211	35.9
Completed high school or equivalent[a]	307	52.3
Bachelor degree or higher	69	11.8
Mother's country of birth		
Australia/New Zealand	428	72.9
United Kingdom/Ireland	53	9.1
Other	106	18.1
Parity [b]		
Primiparous	219	36.8
Multiparous	367	63.2
Birthweight (g)		
<2500	13 .	2 2.
>2500	574	97.8
Method of delivery		
Vaginal	411	70.
Caesarean	176	29.

a Includes those with a trade or technical certificate/diploma.
b. Data missing for one case

Table 2. Use of folate supplements or folate fortified foods and drinks (*N* = 587).

	Yes *N* (%)	No *N* (%)	Don't Know or missing *N* (%)
Mother ate folate food products	294 (50.1)	197 (33.6)	96 (16.4)
Mother drank folate beverages	123 (21.0)	347 (59.1)	117 (19.9)
Mother took folate supplements	455 (77.5)	114 (19.4)	18 (3.1)

The demographic characteristics of the mothers and other factors likely to influence the intake of folic acid tablets, or foods or drinks with added folate, are shown in Table 3. There was overlap between the mothers who tool folic acid supplements and those who took foods with added folate. Sixty one per cent of the mothers who took folic acid supplements also took foods with food or drink with added folate. Associations between the factors and consumption of folate were assessed using the chi square statistic.

The factors listed in Table 3 were then examined using a backwards stepwise logistic regression model to control for potentially confounding factors. In the final model (Table 4) the significant factors were "years of education", "family income" and "the timing of the pregnancy." Mothers with a lower level of education and lower family income were less likely to take folic acid tablets or foods or beverages with added folate. Not surprisingly mothers who were not actively seeking to become pregnant were less likely to take folic acid during their pregnancy.

Table 3. Factors relating to the use of folate supplements or folate fortified foods or drink ('*N*' and column percent).

	Folate (any)	No Folate	Total
Age			
20 years or less	29 (5.9)	20 (20.6)	49 (8.4)
21-30 years	267 (54.6)	45 (46.4)	312 (53.2)
31 years or older	193 (39.5)	32 (33)	225 (38.4)
Antenatal class attendance			
This pregnancy	162 (33.2)	21 (21.9)	183 (31.4)
Previous pregnancy	167 (34.2)	30 (31.3)	197 (33.7)
No attendance	159 (32.6)	45 (46.9)**	204 (34.9)
Education			
10 years or less	126 (26.4)	40 (42.5)	166 (29.1)
11 or 12 years	195 (40.9)	37 (39.4)	232 (40.6)
>12 years	156 (32.7)	17 (18.2)**	173 (30.3)
Health insurance			
Yes	94 (19.2)	10 (10.3)	104 (17.7)
No	395 (80.7)	87 (89.7)*	482 (82.3)
Family income			
< $25000	95 (19.8)	38 (40.4)	133 (23.2)
$25001-40000	153 (31.9)	29 (30.9)	182 (31.7)
$40001-50000	91 (19)	12 (12.8)	103 (17.9)
>$50000	141 (29.4)	15 (16)**	156 (27.2)
Aboriginal descent			
Yes, Aboriginal	7 (1.5)	7 (7.3)	14 (2.4)
No	469 (98.5)	89 (92.7)**	558 (97.6)
Timing of pregnancy			
Actively trying to get pregnant	254 (53.1)	26 (29.5)	280 (49.5)
Mistimed pregnancy	144 (30.1)	37 (42)	181 (32)
Unplanned pregnancy	80 (16.7)	25 (28.4)**	105 (18.6)
Mother smoked before pregnancy			
Yes	179 (36.5)	49 (51)	228 (38.9)
No	311 (63.5)	47 (48.9)**	358 (61.1)
Mother drank alcohol before pregnant			
Yes	344 (70.5)	61 (63.5)	405 (69.3)
No	144 (29.5)	35 (36.5)	179 (30.6)
Employment status in past 6 months			
Employed	264 (54.4)	35 (36.8)	299 (51.6)
No	221 (45.7)	60 (63.2)**	281 (48.4)
Marital status			
Never married	29 (5.9)	10 (10.3)	39 (6.6)
Now married	288 (58.8)	43 (44.3)	331 (5.6)
Defacto	166 (33.9)	43 (44.3)	209 (35.6)
Divorced/separated	7 (1.4)	1 (1.1)	8 (1.4)

* $P<0.05$; ** $P<0.01$; comparisons within each demographic group.
Some totals do not add to 587 due to some missing data.

Discussion

It is now 11 years since mothers were first urged to take folic acid periconceptually in Australia during which time there have been a number of national and state health promotion programs to educate mothers about the benefits of folate. Yet after all of these programs only 78% of the mothers in the PIFS II took folic acid supplements, although when the results of this study are compared to those of other countries reported in an international review, this is the highest reported result.[20]

The results of this present study are higher than the rates reported for Western Australia (WA) in 1995 when the prevalence rate for taking folic acid in the first trimester was 51.9%.[21] Bower's study evaluated the

Table 4. Factors associated with taking folic acid or folate containing foods or drink after adjustment for potential confounders* (N = 550)**

Variable***	Odds ratio	95% confidence interval
Sociodemographic factors		
Education		
10 years or less	0.45	0.23-0.88
11-12 years	0.60	0.31-1.16
>12 years	1	
Income		
$10-25000	0.40	0.20-0.80
$25001-40000	0.77	0.37-1.57
$40001-50000	0.93	0.4-2.17
$>50000	1	
Biomedical factors		
Timing of Pregnancy		
Actively Trying	2.01	1.04-3.87
Mistimed	0.96	0.52-1.78
Unplanned	1.0	

*Non-significant variables were mother's age, marital status, drinking alcohol prior to pregnancy, smoking prior to pregnancy, abori-ginality, health insurance status, attendance at antenatal classes, had worked in the six months before her pregnancy. ** Sample size included in the logistic regression is less than the total sample of 587 due to missing data for some variables. *** All variables in the final model were variables for which, when excluded, the change in deviance compared with the corresponding chi-square test statistic on the relevant degrees of freedom was significant.

effectiveness of a health promotion campaign targeted at women of childbearing age, which resulted in a marked improvement in knowledge of the importance of folic acid i.e. increasing from 6.9% to 56.6% in the women with twelve or less years of education and from 13% to 76% in those with a tertiary education. The increased consumption of folic acid has resulted in a fall of 30% in the prevalence of NTDs in the past decade.[22] However this fall in the rate of NTDs did not extend to the indigenous community.[21] In this study the number of indigenous mothers was too small for any difference to be statistically significant. The fall in rates noted in Western Australia is not as great as the decline in Canada where folate fortification is mandatory where Ray et al reported that the post fortification rate ratio of NTDs was 0.52 (95% CI 0.40-0.67).[22]

The increase in the rates of taking folate in WA since the 1995 study by Bower and colleagues suggests a growing awareness of the importance of folate in pregnancy. During this period there have been continuing health promotion programs promoting the use of folic acid and folate containing foods, particularly vegetables, and folate fortified foods (cereals, breads and milk). Nevertheless Bower concluded that her study of indigenous mothers provided good evidence of the need for mandatory folate fortification in Australia.[21] This study provides additional evidence for the same conclusion, based on the low proportion reporting folate use in the lower socio-economic group. In the highest income and education groups, 87% and 84% of mothers respectively, took folic acid supplements, compared to 64% and 71% in the poorest and least educated groups. These latter groups are notoriously hard to reach in health promotion programs. If Australia is to increase folic acid usage in these difficult to reach groups, then folate fortification should become mandatory.

In an earlier Western Australian study, Bower found that 62.6% of new mothers claimed to have a planned pregnancy but only 51.4% had informed their GPs about their intention to conceive.[23] However, our study showed that 49.5% of pregnancies were unplanned. This is in keeping with findings from the Department of Health (UK) and USA data, which states that about 50% of pregnancies are unplanned.[24] In a New Zealand study 55% of pregnancies were unplanned.[25] To be beneficial in preventing neural tube defects women are advised to take folic acid supplements periconceptually, that is, from one month before conception to three months after. While the reported use of folic acid during pregnancy was relatively high it is unlikely that all of these women would have been making efforts to increase their folic acid intake prior to pregnancy, given that many of them were not actively trying to fall pregnant. This adds further weight to the argument for mandatory folate fortification.

There are a number of limitations that need to be considered when interpreting the results of this study. The study population were mothers delivering at two Perth hospitals, which are generally representative of public patients. The results may not be applicable to private patients who are generally in the upper income brackets. The study was based on the results of a questionnaire and some of the mothers may not have been aware of the addition of folate to foods or beverages that they consumed. However it is unlikely that mothers consuming folate tablets each day for a period of months would not be aware of what they were taking.

Conclusion

This study updates previous studies of the use of folate in Australia. While the percentage of mothers taking folate appears to have increased, in this study there were a significant proportion of mothers who did not take folic acid periconceptually. The mothers who are not taking folic are less educated, are from lower socio-economic groups and are not actively trying to fall pregnant at the time they became pregnant. The results suggest that in order to reach all Australian mothers, mandatory fortification of foods with folic acid should be required.

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Appendix

The specific questions asked about folic acid were:

1. Just before you became pregnant or during the first three months of your pregnancy, did you eat any food products because they had folate added to them?
2. Just before you became pregnant or during the first three months of your pregnancy, did you drink any beverages because they had folate added to them?

3. Just before you became pregnant or during the first three months of your pregnancy, did you take any vitamin or mineral supplements because they had folate added to them?

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Original Article

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Colin Binns MBBS MPH PhD[1], Jane Scott MPH PhD[1,2], Nkeonyelu Nwafor MBBS MSc[2], Kathleen Graham BSc[1], Wendy Oddy PhD[1] and Andy Lee PhD[1]

[1]*School of Public Health, Curtin University of Technology, Perth, Western Australia*
[2]*Division of Developmental Medicine, University of Glasgow*

哪类母亲摄入叶酸增补剂和富含叶酸的食物

本研究证实了母亲摄入叶酸作为增补剂或强化食品现象的流行，并探究了决定母亲是否摄入叶酸的因素。对参与佩斯婴儿哺育研究的母亲的基础数据进行代表性研究。参与此项研究并在这两个医院生产的 587 名母亲完成了基础数据的问卷调查。采用多元逻辑回归对决定母亲是否摄入叶酸的因素进行检验。主要测定指标为摄入叶酸或富含叶酸食物的母亲占总体的比例。共有 455（78%）名母亲声称在怀孕前或怀孕的前三个月中曾摄入叶酸增补剂。在剩余的未摄入叶酸增补剂的 132 名母亲中，有 35 名（占总体 6%）母亲声称食用过富含叶酸的食物或饮料。在最高收入实验组中，有 87%的母亲摄入过叶酸增补剂，而在最低收入实验组中，仅有 64%的母亲摄入过叶酸增补剂。与未摄入叶酸增补剂或富含叶酸食物独立相关的显著因素为接受教育的时间（优势比（10 年或更少的时间）为 0.45，致信区间为 0.23-0.88）和家庭收入（优势比（少于 25000 美元）为 0.40，致信区间为 0.20-0.80）。而与摄入叶酸独立相关的显著因素为怀孕的时间（优势比（积极尝试）为 2.01，致信区间为 1.04-3.87）。有相当一部分母亲并未预先摄入叶酸。这些未摄入叶酸的母亲所受教育较少，来自于较低的社会经济阶层，而且在她们怀孕之前，并没有积极地去尝试怀孕。本研究说明：要使所有的澳大利亚母亲补充叶酸，富含叶酸食物的强制性推荐是必须的。

关键词：叶酸、怀孕、澳大利亚、社会经济阶层。