

Literature Review: Nutrition

A Systematic Review of Interventions to Increase Awareness, Knowledge, and Folic Acid Consumption Before and During Pregnancy

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Abstract

1 Objective. We conducted a systematic review of studies designed to increase awareness of, knowledge about, and consumption of folic acid before and during pregnancy.

2 Data sources. Studies were identified from Cochrane Library, Medline, and the references of primary studies and reviews.

Study inclusion and exclusion criteria. Studies included randomized controlled trials, quasi-experimental interrupted time series studies, follow-up studies, case-control studies, and before-and-after studies, all of which were conducted between 1992 and 2005 on women ages 15 to 49 years and/or health professionals, evaluating awareness and/or knowledge and/or consumption of folic acid both before and after intervention. Studies were excluded if data were not presented both before and after intervention or were other outcomes than those mentioned here.

Data extraction. Data were extracted in relation to characteristics of studies, participants, interventions, and outcomes.

Data synthesis. Because of heterogeneity, we performed a narrative synthesis describing the direction and the size of effects.

Results. On average, women's awareness increased from 60% to 72%, knowledge from 21% to 45%, and consumption from 14% to 23%.

Conclusions. Interventions had a positive affect on folic acid intakes before and during pregnancy, although the average usage reached less than 25%. (*Am J Health Promot* 2007;22[1]:000-000.)

So what? Further research is needed to design more effective interventions to increase periconceptional use of folic acid.

Key Words: Folic Acid, Supplementation, Awareness, Knowledge, Usage, Intervention, Prevention Research. Format: literature review; Research purpose: intervention testing; Study design: content analysis; Outcome measure: cognitive, behavioral; Setting: state/national; Health focus: nutrition; Strategy: behavioral change; Target population age: youth and adults; Target population circumstances: geographic location

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OBJECTIVE

Folic acid supplementation before and during pregnancy prevents neural tube defects,¹⁻³ and since 1992 the U.S. Public Health Service has recommended that all women of childbearing age consume 400 µg folic acid each day.^{2,4,5}

Educational campaigns using different channels of communication have been used to promote folic acid intake before and during pregnancy, but their impact appears to be variable.^{4,6} While many women of reproductive age worldwide may be aware of the potential benefits of folic acid during pregnancy,⁷ their compliance with recommendations remains low.⁸⁻¹¹

In the United States, the Centers for Disease Control and Prevention and the March of Dimes have organized campaigns to inform both the public and health professionals about the necessity of daily consumption of folic acid supplements by all women of childbearing age.⁴ While health professionals may play an important role counseling the women on folic acid supplements,¹² they often fail to do so.^{7,13}

We reviewed the literature on interventions designed to improve the awareness, knowledge, and consumption of folic acid before and during pregnancy in order to assess which were most effective and to recommend future directions for researchers, health promotion practitioners, and clinicians.

METHODS

Data Sources

We searched electronic databases (Cochrane Library and Medline), re-

lying on the following standardized keywords: folic-acid* AND supplement* AND ["health-knowledge-attitudes-practice" OR "patient-education*" OR "preconception-care*" OR "pregnancy" OR "persuasive-communication*" OR "information-dissemination"] AND ["neural-tube-defects"/ prevention-and-control" OR "spinal-dysraphism" OR "spina bifida"] AND ["randomized controlled trial" OR "clinical-trials" OR "cohort-studies" OR "case-control-studies"].

We looked for primary studies, reviews, and conference proceedings. We also contacted an expert from Emory University in Atlanta, Georgia (G. Oakley) to get additional information about public health strategies promoting folic acid consumption. To clarify missing data identified in six studies, we contacted the authors of these studies.¹⁴⁻¹⁹

Study Inclusion and Exclusion Criteria

Criteria for inclusion a study were: (1) women of reproductive age (15-49 years) and/or health professionals; (2) presence of any type of intervention: printed and audio-visual media, electronic media (Internet), counseling, free distribution of folic acid supplements/multivitamins with folic acid, food labels (folate logo and messages from nutritionists on food packs), magnetized reminder, advertisements, training/presentations, or personal communication; (3) data about rates of women's awareness, knowledge, or consumption of folic acid and/or health professionals' knowledge about and counseling on folic acid before and after intervention; and (4) publication from the year 1992 up to 2005.

3 The assessment of methodologic quality was performed by one author according to the standard criteria developed by the Effective Practice and Organisation of Care Group,²⁰ the manuals developed by the Centre for Reviews and Dissemination from the University of York,²¹ the Cochrane Handbook for Systematic Reviews of Interventions 4.2.3,²² and other relevant tools.^{23,24} We applied specific standard criteria developed by the Effective Practice and Organisation of Care Group for each study design.

There are seven standard criteria to assess the methodologic quality of randomized controlled trials, seven standard criteria to assess the methodologic quality of controlled before-and-after studies, and seven standard criteria to assess the methodologic quality of interrupted time series studies. Each criterion is scored as "done," "not clear," or "not done."²² We handled the scores according to data in each retrieved study. In addition, the quality was assessed by taking into consideration whether the following factors were addressed: sampling method; specification of eligibility criteria to include participants in study and exclusion criteria; description of nonparticipants; adjustment of potential confounders (age, ethnicity, income level, education level); loss to follow-up; and the validity of the instrument (standardized questionnaire/interview).

We assessed the quality of a study by its design and the description of the intervention (based on social marketing theory). We examined the rate of women aware of, knowledgeable about the effects of, or using folic acid before and after an intervention, and the rate of health professionals knowledgeable about and counseling on folic acid supplements.

Studies were excluded if data were not presented for both before and after intervention and if the outcomes were presented only as blood measures of folic acid or as prevalence rates of neural tube defects.

Data Extraction

Data were extracted in relation to characteristics of studies, participants, interventions, and outcomes.

Data Synthesis

The average levels of awareness, knowledge, and folic acid consumption were calculated before and after intervention and are expressed as the percentage of women aware of, knowing about, and taking folic acid. In order to quantify the inconsistency among results we used the statistical test I.^{2,25} Because of heterogeneity, we performed a narrative synthesis describing the direction and the size of effects.²²

RESULTS

The search retrieved 337 articles. One author assessed the records retrieved by electronic databases, looking at the title of every article to see if it was related to the topic and at its abstract to check for the inclusion criteria. If the title or abstract left room for doubt, the full text of the article was obtained, and after reading it we decided whether to include or exclude it.²²

We retained 31 studies published between 1992 and 2005. The justification for not reviewing studies prior to 1992 was that periconceptional folate guidelines were introduced starting with the year 1992.

The following study designs were used among the included studies: randomized controlled trial (2), quasi-experimental interrupted time series study (1), follow-up (3), case-control (1), before-and-after study with a control group (2), and before-and-after without a control group (22). We included all these study designs, particularly because few randomized trials addressed the topic of our review.

A majority of studies were judged as prone to selection bias when the sample appeared to not represent a general population (due to recruitment methods and places), or when the response rate to survey was lower than 80%. In 11 studies, participants were women attending a clinic or recruited by convenience sampling. Almost half of the studies recruited pregnant women and/or mothers. The most frequent method of survey was self-administered questionnaire or telephone interview. The women's response rate reported in 20 studies was, on average, 75%, ranging from 27% to 99%, but generally we did not find data about nonresponders to see if they were different from responders. In the other 11 studies no information was given about the response rate. In more than one third of the studies no information was provided about the validity of the instrument (how its content was developed and whether it was pilot tested). This does not include reliability testing data, since information about the reliability of the instrument used was even more scarce.

The outcomes of the studies were defined as follows: awareness, as ever hearing or reading about folic acid^{3,14,15,17,26-34}; knowledge, as having any information about the role of folic acid in prevention of neural tube defects or other congenital malformations^{3,17,26,29-31,33-39}; and consumption, as periconceptional daily intake of folic acid (before and after conception).^{3,17,18,26,27,29,30,35,40,41} The outcome measurements consisted of women's self-reported intakes.

5 Table 1 describes the awareness, knowledge, and use of folic acid before and after intervention in 20 studies with before-and-after design,²² including follow-up, case-control, before-and-after with control group, and before-and-after without control group. For each preintervention and postintervention comparison, the results presented are the average proportion of women aware of, knowledgeable about, and consuming folic acid before and after intervention, as well as the percentage increase from baseline (absolute change from baseline).²⁰ The direction of effects was consistent across the studies. All outcomes increased after intervention, and most of the increases were statistically significant, but the size of effect varied. Overall, the awareness increased from 60% (range: 28%–98%) to 72% (range: 42%–100%). The knowledge rose from 22% (range: 5%–77%) to 49% (range: 13%–93%). The consumption increased from 14% (range: 4%–73%) to 23% (range: 9%–85%). Even though more women became aware and knowledgeable of folic acid, there were wide discrepancies between awareness/knowledge and actual consumption.

Eight studies were not included in Table 1 for the following reasons: the percentage of folic acid usage was not specified,⁴² the usage of folic acid was presented only as an odds ratio,⁴³ sufficient information was not presented (only the absolute number of women),⁴⁴ postintervention results compared to preintervention data were presented by the Student *t* test,⁴⁵ and only health professionals were addressed.^{19,36} In addition, two references were duplicates of a previously included study (de Bruin et al.⁴⁹).^{32,46}

The knowledge measured in one randomized controlled trial³⁹ increased overall from 14% before to 25% after intervention ($P < .001$).

One randomized controlled trial⁴¹ and one quasi-experimental interrupted time series study⁴⁰ are presented separately in Table 2, showing the proportion of women from intervention and control group who used folic acid daily and weekly. The folic acid use appeared to increase both in intervention and control groups.^{40,41}

While the direction of effect was the same in all reviewed studies (Table 1), the heterogeneity was apparent between studies ($I^2 > 96\%$, $P < .00001$). The causes for heterogeneity were multiple: differences in baseline (pre-intervention) level of the outcomes (Table 1) related to variations in population characteristics²² and differences in interventions.

Interventions were carried out mostly in the United States (California, Texas, Virginia, Arkansas, Florida, Utah, Michigan, Arizona), but also in Australia (Victoria, South Australia, Western Australia), Europe (the Netherlands, Denmark, Norway, the United Kingdom, Ireland, Germany), and Israel with women and/or health professionals between 1992 and 2002. The interventions were national or local campaigns that were launched between 1992 and 2002. The interventions with women used printed and audio-visual media (radio, TV, Internet) in 15 studies^{3,14-16,18,26,28,33-35,43,44,47-49} or printed media with other channels in 6 studies.^{27,29,31,39-41} The printed media were newspapers and magazines in 14 studies^{16,18,26,28,31,33-35,38,40,44,47-49}, posters in 10 studies^{16,26-28,31,35,39,40,47,49}, brochures in 7 studies^{26,28,29,34,40,48,49}; pamphlets in 6 studies^{16,26,27,35,41,47}; and leaflets in 4 studies.^{18,29,35,39} The interventions were placed mostly in medical centers,^{14-16,18,26,30,35,39,40,47} pharmacies,^{16,18,27,31,35,39,40,47,48} kindergartens and schools,^{16,35,37,47} and public places (i.e., libraries, shopping centers, bus stop, supermarkets, fitness centres, hairdressers).^{16,26,28,34,35,39,47} Other channels consisted of counseling in eight studies^{3,14,15,33,38,41,42,44}; free distribution of folic acid pills/multivitamins with folic acid in five studies^{18,29,30,40,41}; advertisements in five studies^{14-16,18,47}; magnetized reminders

in two studies^{26,40}; food labels (folate logo and messages from nutritionists on food packs) in three studies^{28,34,35}; slide presentations in two studies^{37,45}; and reminder phone calls in one study.⁴¹ The interventions with health professionals consisted of printed materials in seven studies^{14-16,27,31,35,47}; training in seven studies^{16,19,26,35,36,40,47}; professional publications in six studies^{16,35,36,47-49}; letters in six studies^{29,35,36,40,48,49}; personal communication in one study⁴⁸; incentives (coffee mugs, note pads) in one study⁴⁰; and reminder (patient history form) in one study⁴⁰ (Table 3).

7 Our review also found evidence related to health professionals' knowledge and behavior regarding folic acid recommendation. The health professionals' knowledge about folic acid (related to the advised dose of 0.4 mg/day before and during the first 3 months of pregnancy)^{2,4,5} increased from 13% to 58% before to 51% to 70% after intervention ($P < .0001$).^{35,36} Health professionals' knowledge about the recommended period for folic acid intake (one^{18,31,48,49} to two²⁷ months before up to three months after conception²⁷) augmented from 57% to 80% before to 79% to 85% after intervention ($P < .0001$).^{35,36} The percentage of health care providers recommending folic acid to women rose from 13% to 45% before to 19% to 62% after interventions, as described^{3,16,35,36,38} in Table 3 ($P < .0001$).³⁶ Most of the health practitioners who gave counseling were gynecologists (37% before and 74% after intervention),⁴⁸ pharmacists (38% before and 43% after intervention),⁴⁸ and nurses (3% before and 9% after intervention).³³

To understand the variable impact of interventions on women's and/or health professionals' behavior, we explored their effectiveness in relation to the following social marketing criteria: the duration of the campaign, the number of exposures the participants had to the message,⁵⁰ the content of the message, and the message's language and channel of communication.

Table 4 shows a variable duration of campaigns to women and health professionals in the studies evaluated. We did not find any information related to

Table 1

The Average Rate of Women Aware of, Knowing About, or Using Daily Folic Acid, Before and After Intervention in 20 Studies

Before-and-After Design	Awareness			Knowledge†			Usage		
	% Before Intervention (Baseline)	% After Intervention	Percentage Increase from Baseline (P)*	% Before Intervention (Baseline)	% After Intervention	Percentage Increase from Baseline (P)*	% Before Intervention (Baseline)	% After Intervention	Percentage Increase from Baseline (P)*
Ahluwalia and Daniel ¹⁴	64	73	9*****						
Alozie Arole et al. ^{15‡}	60	71	11 (<0.001)						
Amitai et al. ²⁶	55	85	30 (<0.001)	18	77	59 (<0.001)	5	31	26 (<0.001)
Brandenburg et al. ^{27‡}	41	91	50 (<0.05)				5	25	20 (<0.05)
Bower et al. ^{47‡}				8	35	27**			
Bower 1997a‡							11	43	32 (<0.0001)
Broome 1999‡	31	62	31 (<0.05)	77	85	8 (<0.05)			
Byrne ²⁹	98	100	2**	73	73	0	9	19	10 (<0.05)
Chacko et al. ³⁰	52	86	34**				9	67	58**
Chan et al. ^{35‡}				32	58	26 (<0.0001)	10	36	26 (<0.001)
Daltveit et al. ³¹	50	60	10 (<0.01)	10	21	11 (<0.01)	10	47	37 (<0.01)
Egen and Hasford ⁴⁸	28	42	14 (0.02)				4	9	5 (0.077)
de Jong-van den Berg et al. ^{17§}	50	53	3**				36	43	7**
Johnson et al. ³⁷				29	93	64 (<0.05)			
Knudsen et al. ¹⁸							14	23	9 (<0.0001)
van der Pal-de Bruin et al. ⁴⁹	42	77	35**				5	21	16**
Petrini 1999	52	68	16**	5	13	8**	28	32	4**
Sillender and Pring ³³	61	76	15 (0.02)				73	85	12 (0.03)
Ward et al. ^{3‡}	77	95	18 (<0.001)	45	77	32 (<0.001)	10	23	13 (<0.001)
Williams et al. ^{34‡}	63	78	15 (<0.05)	21	36	15 (<0.05)			
Average	60	72	8	22	49	27	14	23	9

NOTE: Percentages are rounded. Blank cells indicate that the outcome was not measured in the study.

† Knowledge of association between folic acid and neural tube defects.

‡ In cases of trends we added the number of women whose outcome was measured more than one time before and/or after the intervention and divided it into the added number of all participant women before and/or after, respectively.

§ Data were presented for both cases and controls together, not separately for each group, both before and after intervention.

* P value determined by chi-square test for difference in proportions between results before and after campaign.

** P value not reported.

“media exposure” (how many times the messages have been seen or heard through different channels during the campaign).⁵⁰

The methods of delivering the tested interventions appear to differ in terms of content of the message, which were specified only in three studies,^{32,34,40} and its language, which also was mentioned only in three studies.^{14,26,40} All campaign strategies used more than one channel (Table 3). No study presented the results of each intervention channel separately. The effect of the intervention was reported for the specific campaign. Thus, we cannot present how the interventions differ by the type, or if multiple channels were

consistently more effective than a single one.

CONCLUSIONS

This systematic review of the published literature on the promotion of folic acid intake before and during pregnancy revealed marked heterogeneity of both design and results. The interventions led to small increases in awareness, knowledge, and consumption, so that *after* interventions, on average, still less than a quarter of women used folic acid. In relation to the U.S. Public Health Service guidelines recommending that *all* women of childbearing age consume folic acid

before pregnancy, it appears that the effectiveness of the interventions mentioned in this study was limited. Although health behavior is difficult to change, these results are disappointing, since folic acid appears to be safe, cheap, and cost effective.⁵¹ Poor dissemination of health knowledge is a well-recognized phenomenon,⁵² and this can be costly at the societal level.⁵³ Public health campaigns should aim for at least 60% to 70% of the target group, and preferably more than 80%, to act on the recommended health practice.⁵³ Our finding of a poor effect on behavior is not unusual.⁵²

A review of interventions aiming to motivate people to use stairs by placing

Table 2
Daily and Weekly Folic Acid Use in the Studies with Experimental and Quasi-experimental Design

Study		% Use Before Intervention	% Use After Intervention	Percentage Increase from Baseline (P)	
Daily	Robbins et al. ⁴¹	Intervention group	24	40	16*
		Control group	24	36	12 (0.549)
Weekly	Robbins et al. ⁴¹	Intervention group	38	64	26*
		Control group	43	51	8 (0.008)
	Lawrence et al. ⁴⁰	Mail/pharmacy intervention group	35	40	5 (0.03)
		Provider intervention group	39	43	4 (NS)
		Control group	37	41	4 (NS)

NOTE: Percentages are rounded. NS indicates no statistical significance.
* P value not reported.

signs by elevators and escalators (“point-of-decision prompts”) showed a median increase in stair climbing of 54% from a baseline level under 12%.⁵⁴ Educational interventions to promote the use of booster seats among children aged 4 to 8 years resulted in 38% of the intervention group using them, compared with 3% in the no-intervention group.⁵⁵

According to social marketing theory, mass media positively influences people’s awareness and knowledge, whereas behavior is more readily changed through such things as health professionals’ counselling and interpersonal communication.⁵⁶

The gaps between awareness, knowledge, and usage could be related to determinants of behavioral change. The adoption of a behavior by women is modified positively by awareness and by knowledge,⁵⁰ but it could be impeded by a variety of other coexisting factors,^{57,58} such as unplanned pregnancy,^{3,18,33,36,41,45,48} perceived barriers or threats (high cost, unwillingness or difficulty in taking tablets),^{16,27,30,41} forgetfulness,^{30,41} lack of time,⁴¹ women’s education level,³² age group,^{26,34}

and culture.⁵⁸ The positive short-term achievements of educational campaigns may not be sustained over time.^{40,47}

In the studies reviewed here, we found little use of the formal social marketing tools: test marketing (before intervention launching); audience segmentation (i.e., by age, education, ethnicity, marital, and socio-economic status); positioning of message (appropriate words and symbols); identification of a target population (women and/or health professionals); consumer research (for appropriate intervention tailoring); and the market entry strategy (channels of communication),⁵⁶ which may be critical to achieve the implementation. The qualitative formative research (such as marketing research methods, behavioral research, focus groups, clinical studies, public opinion polling and survey, and cognitive and psychodynamic psychology research),⁵⁸ to identify the baseline knowledge, folic acid consumption, and needs of women from different socio-economic strata, was done in only three studies^{28,34,40} before the intervention began.

These results showing slow adoption of periconceptional intake of folic acid contrast sharply with the successful uptake of new medications, such as statins (in use by more than 70% of patients after myocardial infarction), and they would be comparable to the low referral (10%–20%) of these same patients to cardiac rehabilitation. It appears as if patented technologies, with strong financial incentives to the industry, allow powerful marketing strategies involving both physicians and the public.

The findings of this review indicate that the health education approaches to date have had suboptimal effects both on the consumption of folic acid by women of reproductive age and on health professionals. This low level of compliance (under 25%, on average, for women) indicates a need to develop and test more effective health education interventions to promote folic acid supplement use by women of reproductive age. The failure to achieve folic acid supplement usage by more than one third of women of reproductive age led the Centers for Disease Control and Pre-

Table 4
Duration of Campaigns Launching Interventions to Women and to Health Professionals

Duration of Campaigns	Targeting Women of Childbearing Age	Targeting Health Professionals
Less than 1 h	Three ^{37,41,45}	One ¹⁹
2 wk	Five ^{16,25,29,31,46}	
1–6 mo	Ten ^{16,18,32,33,35,39,40,42,43,46}	Five ^{16,32,35,46,47}
1 y to <2 y	Eight ^{3,14,15,28,30,34,35,48}	Six ^{14,15,22,27,35,48}
2 y to <3 y	Three ^{14,15,26}	Four ^{7,14,15,36}

vention to promote fortification of flour as an alternative method, which has apparently been successful in reducing neural tube defects in the United States, as well as in Canada and elsewhere.⁵⁹

Similarly, our results may justify a decision to adopt folic acid fortification of flour as in Canada, the United States, and other countries, a method which appears to have reduced neural tube defect rates and raised average levels of folic acid, with concurrent reductions in homocysteine levels in some community surveys.⁶⁰

8 This review has some limitations related to the retrospective nature of the studies retrieved and their methodologic quality; the inherent weaknesses of the individual studies, including the use of self-report (recall bias) data; the nonrepresentativeness of samples; and the heterogeneity of study design and interventions.

SO WHAT? Implications for Health Promotion Practitioners and Researchers

Our literature review shows that interventions for preventing birth defects have positively affected the use of folic acid before and during pregnancy, although the reported use was still unacceptably low given the importance of folic acid.

The evidence suggests the need for further research on intervention design, especially addressing barriers to behavioral change and applying social marketing principles.

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