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Investigating the knowledge surrounding folate and folic acid in a cohort of vegetarians

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Abstract

Background

The aim is to identify any gaps in the knowledge of folate and folic acid in vegetarians, which is of interest given the increasing adoption of vegetarian type diets.

Methods

In this convenience sample, 106 people answered an online questionnaire regarding folate intake and awareness among vegetarians. This was created using *Google Forms* and was shared via *Facebook*, including on various national and college vegetarian group pages. There were 44 questions. Twenty-four participants were excluded, because they reported eating fish, chicken or other meat. Final data analysis included 82 subjects. The majority of these vegetarians were females over the age of 30.

Results

Fifty-five percent (21 of 38) of those aged <30, and 23% (10 of 44) of those >30, did not know the recommended stage for folic acid supplementation. Thirty-four percent (23 of 67) of females did not know any good food sources of folate compared to 67% (10 of 15) of males.

Conclusions

There was an overall lack of knowledge regarding the recommended stage for folic acid intake and the required quantity of folic acid to be taken among vegetarians. This research suggests that more public health campaigns are needed in order to increase the knowledge and intake of folic acid.

Keywords: folate, folic acid, vegetarians

1. Introduction

Folate has many roles which are important for human health. Biologically, folate is required for one-carbon metabolism. This involves the transfer of one-carbon units in essential pathways incorporating deoxyribonucleic acid and ribonucleic acid synthesis, amino acid metabolism and a number of methylation reactions (Bailey *et al.*, 2015). There is evidence that intake of folate higher than normal dietary levels reduces the risk of Neural Tube Defects (NTDs), and, where cereal products are not fortified with folic acid by law, pregnant women are recommended to take supplements (Bender, 2009). Folic acid supplements, when taken in early pregnancy, have been shown to reduce NTDs (Webster-Gandy *et al.*, 2006). Folate

plays an important role in pregnancy and foetal development, as it is essential for cell division and tissue growth (FSAI, 2016). The second most common severe disabling human congenital defects are NTDs (Alfarra, 2011). They can arise at an early stage of pregnancy, between 21 and 28 days after conception (FSAI, 2016). The neural tube is an embryonic structure that develops into the brain and spinal column (Safefood, 2017a). An NTD occurs due to incomplete closure of the neural tube, leaving the developing brain or spinal cord exposed to the amniotic fluid (CDC 2003). There are many different malformations involved, and the terms used to describe them are based on clinical descriptions and the presumed embryological defect involved. The two most common NTDs are spina bifida (accounting for approximately 51% of NTDs) and anencephaly (40%) (FSAI, 2016). Other NTDs include encephalocoele (8%), iniencephaly (1%) and hydrocephalus (FSAI, 2016). Recent research has found that 24.9% of women in the Republic of Ireland (Safefood, 2017a) and almost half of women in Northern Ireland (Safefood 2017b) were not taking folic acid supplements prior to pregnancy even though it is known that it reduce the occurrence of an NTD (Czeizel & Dudas, 1992). One of the reasons that women do not take folic acid is that many pregnancies are unplanned globally (Singh, Sedgh and Hussain, 2010) and in Ireland (FSAI, 2016). Of those who do take folic acid, many commence supplementation too late, usually after the neural tube has closed between 21 to 28 days after conception (FSAI, 2016). A significant association has been shown between mothers of children with NTDs and a variation in the gene coding for an enzyme involved in folate metabolism (Whitehead *et al.*, 1995; van der Put *et al.*, 1995). The enzyme involved is 5,10- methylenetetrahydrofolate reductase (FSAI, 2016). The genetic variation codes for a thermolabile variant of the enzyme, which only has about 50% of the enzymatic activity. A study, based in Dublin, found low red blood folate (red cell folate) levels in people with this genetic variation (Molloy *et al.*, 1997). To improve folic acid intakes among women of childbearing age, a FSAI expert committee proposed one of two options to be implemented. The first option proposed is mandatory fortification, together with voluntary fortification and advice on supplementation. The second option proposed is voluntary fortification, together with advice on supplementation (FSAI, 2016). The National Adult Nutrition Survey (NANS) found women of reproductive age had median daily intakes of total folate of 260µg/day (Irish Universities Nutrition Alliance, IUNA, 2011), lower than the recommended daily allowance of 400µg/day for women of childbearing age. In the United Kingdom (UK), the mean daily intake of folate from food sources was above the appropriate reference nutrient intake of 200µg. However, 2% of women had an intake of folate below the lower reference nutrient intake of 100µg/day (National Diet and Nutrition Survey, 2014/2015 – 2015/2016). This is worrying, as adequate folate intake can reduce the risk of NTDs (Bender, 2009). Furthermore, the NANS found that women of childbearing age had the lowest Red Blood Cell (RBC) folate status, at 799nmol/L, which is lower than the optimal RBC (>907nmol/L) folate status for NTD protection (FSAI, 2016). Similarly, the National Diet and Nutrition Survey (NDNS) found that more than 90% of women of childbearing age had an RBC folate concentration below the recommended threshold, indicating an elevated risk of NTDs (NDNS, 2014/2015 – 2015/2016).

Some studies have found that serum and plasma folate are higher in vegetarians compared to non-vegetarians (Armstrong *et al.* 1974; Bar-Sella, Rakover and Ratner 1990; Gilsing *et al.* 2010; Huang *et al.* 2003). However, one study has indicated that folate concentrations were the same in vegetarians and non-vegetarians (Herrmann *et al.* 2001). Bedford and Barr found that, among women, vegetarians had significantly higher median supplement intakes of folic acid (Bedford and Barr 2005). However, the literature on folic acid awareness in vegetarians is lacking. It may be hypothesised that individuals following a vegetarian diet

may have increased awareness of folic acid and its benefits due to a possible increased health consciousness. A Dutch study of health attitudes in vegetarians, when compared to non-vegetarians, found that vegetarians had higher education levels, higher social economic status, smaller households, and lived in more urbanised residential areas than meat consumers. It was also reported that vegetarians had more positive attitudes regarding importance of product information, specialty shops, health and ecological products than meat consumers (Hoek *et al.*, 2004). To address the gap, the purpose of the present study is to investigate the knowledge of folate and folic acid in a cohort of vegetarians.

2. Materials and Methods

Study design

The convenience sample was designed to investigate the knowledge of folate and folic acid in both a cohort male and female vegetarians. The instrument used was an online questionnaire with full information given to the anonymised volunteer participants and as such was not considered by the TU Dublin School of Biological Sciences project committee to require ethical approval (see Appendix I). The questionnaire consisted of 44 questions and was created using *Google Forms* and was shared via *Facebook*, including on various national and college vegetarian group pages. The questionnaire was also posted on vegetarian society pages, on *Twitter* and sent to various vegan societies. The questionnaire was released on 7th March and closed on 20th March 2018;

Exclusion criteria

In total, 106 people answered the questionnaire. However, twenty-four participants were excluded because they reported eating fish, chicken or other meat. Final data analysis included 82 subjects (67 female, 15 male).

Instruments

The main instrument used in this study was a questionnaire (Appendix I); created with the guidance of Dr. Kate Younger (Technological University Dublin). The questionnaire was based a previously published survey on the intake/awareness of folic acid in undergraduate students, which had similar aims to our study (Geraghty, 2017). The questionnaire was updated to include questions on the intake of fish, meat and chicken to determine whether the respondents were vegetarian or not. The questionnaire consisted of dichotomous, multiple-choice, open-ended questions and some multiple-response questions. The questionnaire was divided into 4 sections (see Table 2.1).

Table 2.1: Sections in questionnaire

Section	Questions
1 - Demographics	Gender, age, whether they were students, the college they attended, the course studied and whether they had children. Other health-related questions were asked.
2 – Knowledge and awareness	Whether they had heard of it, who should take it, the benefits of taking it, where they sourced their information from, what neural tube defects are and the recommended stage and recommended intake in relation to folic acid.
3 – Dietary intake	Sources of folate, the consumption of selected food sources which contain folate and whether they checked labels. Other questions were asked for the purpose of determining whether the respondents were vegetarians.
4 – Nutritional supplements	What nutritional supplements they took, the reasons for taking them and their knowledge of whether the nutritional supplement they took contained folic acid or not.

Statistical analysis

Data were imported from *Microsoft Excel* into *Statistical Package for the Social Sciences (SPSS)*. All analyses were conducted using *SPSS v.24.0* (SPSS Inc., Chicago, IL) on a Samsung NP5355U3C notebook. The data were categorised in *SPSS*. Descriptive statistics were performed to describe the characteristics of the study participants. As all of the data were categorical, cross-tabulations were conducted to determine the differences between the frequencies of answers using chi-square tests to compare the variables for each question. This determined statistical significance. Multiple-response answers were categorised into individual columns. For larger tables, the adjusted residual value and chi-squared analysis determined which cells contributed to the significant *P* value. A new categorical variable was created to determine whether the nutritional supplement participants took contained folic acid. There was one pregnant woman in the present study, she was indicated as having a child. A two-sided *P*-value of <0.05 was considered to be significant.

Limitations

The sample size is small and, therefore, caution is required when interpreting findings. The question regarding whether the respondents had knowledge of their nutritional supplement containing folic acid could have been misinterpreted. Selection bias could have occurred, as those who completed the survey may have had more of an interest in health than those who did not. Another limitation is that the study relied on self-reporting which may be inaccurate.

3. Results

Demographic characteristics

Of the 106 people who answered the questionnaire, 82 were vegetarians. The remaining 24 were omnivores, whose results were excluded from the study. Of the vegetarians who answered the questionnaire, the majority ($n = 67$) were females over the age of 30 (see Table 3.1). Most of the sample consumed alcohol, with over a third consuming alcohol one to two times per week. More than half of the respondents had rarely/never smoked, with less than 10% ($n = 8$) currently smoking.

Table 1: Demographic characteristics of the study sample (NB some questions were not answered by all participants)

	(n)	%
Gender		
Female	67	82
Male	15	18
Age		
16-19	14	17
20-24	17	21
25-29	7	8
>30	44	54
Student		
Yes	21	27
No	57	73
Course		
STEM	7	37
Other	12	64
Smoker		
Yes	3	4
Socially (less than everyday)	8	10
No (ex-smoker)	23	28
No (never)	48	59
Alcohol		
Yes	71	87
No	11	13
Alcohol consumption frequency		
Rarely	33	46
1-2 times/week	27	38
3-5 times/week	11	15
Daily	1	1
Women with children		
Yes	14	21
No	52	78
Currently pregnant	1	6

Table 2 shows that nearly 40% (31 of 82) did not know the recommended stage for folic acid intake. Less than 12% ($n = 8$) of females indicated the correct stage, which is 12 weeks before and during the first trimester of pregnancy. A chi-squared test for independence indicated a significant association was found between age and recommended stage for folic acid with those under the age of 30 being significantly less likely to know. Chi-squared analysis revealed that a strong relationship ($P = 0.015$) exists between women with children and knowledge of the recommended stage of folic acid intake.

Over 80% (68 of 82) did not know the recommended intake, while only 6% ($n = 4$) of females and none of the males indicated the correct intake, which is 400 μ g/day supplemental intake. A chi-squared test for independence indicated no significant association ($P = 0.437$) between gender and knowledge of the recommended intake of folic acid.

Subjects within all age groups showed little knowledge of the recommended folic acid intake. Chi-squared analysis revealed that a relationship exists between women with children and the recommended intake of folic acid ($P = 0.025$).

*Recommended stage and intake of folic acid***Table 2:** Knowledge of the recommended stage and amount of folic acid that should be consumed among vegetarians. The emboldened numbers are those contributing to the significant *P* value.

	All (n)%	Gender Male (n)%	Female (n)%		Age <30 years (n)%	>30 years (n)%		Student Yes (n)%	No (n)%		Women with children With (n)%	Without (n)%	
	(82)	(15)18.3	(67)81.7	<i>P</i> value	(38)46.3	(44)53.7	<i>P</i> value	(21)26.9	(57)73.1	<i>P</i> value	(15)22.4	(52)77.6	<i>P</i> value
Recommended stage				0.098			0.015			0.366			0.005
No/don't know	(31)37.8	(9)60.0	(22)32.8		(21)55.3	(10)22.7		(11)52.4	(20)35.1		(1)6.7	(21)40.4	
Before	(21)25.6	(2)13.3	(19)28.4		(7)18.4	(14)31.8		(2)9.5	(17)29.8		(5)33.3	(14)26.9	
Throughout	(9)11.0	(3)20.0	(6)9.0		(5)13.2	(4)9.1		(2)9.5	(7)12.3		(0)0.0	(6)11.5	
1st trimester	(12)14.6	(0)0.0	(12)17.9		(2)5.3	(10)22.7		(3)14.3	(8)14.0		(7)46.7	(5)9.6	
12 weeks before & 1st trimester	(9)11.0	(1)6.7	(8)11.9		(3)7.9	(6)13.6		(3)14.3	(5)8.8		(2)13.3	(6)11.5	
Recommended intake				0.437			0.326			0.961			0.025
No/don't know	(68)82.9	(15)100.0	(53)79.1		(35)92.1	(33)75.0		(18)85.7	(48)84.2		(8)53.3	(45)86.5	
400mg/day	(3)3.7	(0)0.0	(3)4.5		(1)2.6	(2)4.5		(1)4.8	(2)3.5		(1)6.7	(2)3.8	
400µg/day	(4)4.9	(0)0.0	(4)6.0		(1)2.6	(3)6.8		(1)4.8	(2)3.5		(3)20.0	(1)1.9	
Daily/1 tablet	(1)1.2	(0)0.0	(1)1.5		(0)0.0	(1)2.3		(0)0.0	(1)1.8		(0)0.0	(1)1.9	
Other	(6)7.3	(0)0.0	(6)9.0		(1)2.6	(5)11.4		(1)4.8	(4)7.0		(3)20.0	(3)5.8	

Table 3 shows that over half the vegetarians survey (54 of 82) knew a good food source of folate. More males than females had “no knowledge” of any good food sources of folate. Approximately 60% (13 of 21) of students, compared to 35% (20 of 57) of non-students, were unaware of any good food sources. A significantly greater percentage of women without children than women with children had “no knowledge” of good food sources. Among who answered positively, most were aware that dark green vegetables/legumes were a good source. Foods with added folic acid include breads, breakfast cereals and beverages. Milks such as ‘Super’ milk contain added folic acid. Nearly 40% ($n = 31$) did not know any foods with added folic acid. There was a substantial difference as identified by chi-squared analysis between the age categories in terms of knowledge of foods with added folic acid, with those over age of 30 having greater knowledge than those under the age of 30 ($P = 0.001$). There was a significant difference between the age categories in their knowledge of foods with added folic acid; those over the age of 30 had greater knowledge than those under the age of 30 ($P = 0.001$). Almost 60% (26 of 44) of those in the >30 age category, compared to 30% (13 of 38) of those in the <30 age category, stated that cereal was fortified with folic acid. All Science, Technology, Engineering and Mathematics (STEM) students knew that “breakfast cereals” contained folic acid. Across the groups, only a very small percentage of respondents were aware that some milk is fortified with folic acid.

*Good food sources of folate and folic acid***Table 3:** Knowledge of good food sources of folate and foods with added folic acid among vegetarians

	All (n)%	Gender Male (n)%	Female (n)%		Age <30 years (n)%	>30 years (n)%		Student Yes (n)%	No (n)%		Women with children With (n)%	Without (n)%	
	(82)	(15)18.3	(67)81.7	<i>P</i> value	(38)46.3	(44)53.7	<i>P</i> value	(21)26.9	(57)73.1	<i>P</i> value	(15)22.4	(52)77.6	<i>P</i> value
Good food sources													
No/don't know	(33)40.2	(10)66.7	(23)34.3	0.044	(23)60.5	(1)22.7	0.001	(13)61.9	(20)35.1	0.062	(1)6.7	(22)42.3	0.024
Dark green vegetables/legumes	(42)51.2	(4)26.7	(38)56.7	0.069	(12)31.6	(30)68.2	0.002	(6)28.6	(32)56.1	0.057	(12)80.0	(26)50.0	0.077
Fortified food	(12)1.3	(1)6.7	(11)16.4	0.574	(6)15.8	(6)13.6	1.000	(4)19.0	(8)14.0	0.849	(3)20.0	(8)15.4	0.976
Foods with added folic acid													
No/don't know	(31)37.8	(8)53.3	(23)34.3	0.281	(22)57.9	(9)20.5	0.001	(12)57.1	(19)33.3	0.100	(2)13.3	(21)40.4	0.102
Bread/flour	(10)12.2	(2)13.3	(8)11.9	1.000	(2)5.3	(8)18.2	0.149	(0)0.0	(9)15.8	0.124	(3)20.0	(5)9.6	0.522
Breakfast cereal	(39)47.6	(4)26.7	(35)52.2	0.132	(13)34.2	(26)59.1	0.043	(6)28.6	(30)52.6	0.102	(9)60.0	(26)50.0	0.697
Milk	(5)6.1	(0)0.0	(5)7.5	0.621	(3)7.9	(2)4.5	0.866	(1)4.8	(3)5.3	1.000	(0)0.0	(5)9.6	0.490
Other	(11)13.4	(2)13.3	(9)13.4	1.000	(1)2.6	(10)22.7	0.019	(0)0.0	(9)15.8	0.124	(4)26.7	(5)9.6	0.202

The numbers in bold are those contributing to the significant *P* value.

Reported dietary intake of selected food sources that contain folate

Table 4 shows that the vast majority of respondents ate dark green leafy vegetables, with more than four fifths of those from all categories consuming these foods at least three times per week. Additionally, more than 40% of both males ($n = 6$) and females ($n = 31$) reported eating them “daily”.

Table 4: Self-reported dietary intake of selected food sources that contain folate among vegetarians. The numbers in bold are those contributing to the significant P value.

	Gender Male (n)%	Female (n)%		Age <30 years (n)%	>30 years (n)%		Student Yes (n)%	No (n)%		Women with children With (n)%	Without (n)%	
	(15)18.3	(67)81.7	P value	(38)46.3	(44)53.7	P value	(21)26.9	(57)73.1	P value	(15)22.4	(52)77.6	P value
Eat dark green vegetables/legumes			1.000			0.941			1.000			1.000
Yes	(15)100.0	(66)98.5		(37)97.4	(44)100.0		(21)100.0	(56)98.2		(15)100.0	(51)98.1	
Dark green vegetables/legumes consumption frequency			0.594			0.625			0.163			0.673
Rarely	(0)0.0	(1)1.5		(0)0.0	(1)2.3		(0)0.0	(1)1.8		(0)0.0	(1)2.0	
1-2 times/week	(1)6.7	(10)15.2		(4)10.8	(7)15.9		(1)4.8	(10)17.9		(2)13.3	(8)15.7	
3-5 times/week	(8)53.3	(24)36.4		(14)37.8	(18)40.9		(7)33.3	(25)44.6		(4)26.7	(20)39.2	
Daily	(6)40.0	(31)47.0		(19)51.4	(18)40.9		(13)61.9	(20)35.7		(9)60.0	(22)43.1	
Consume milk			0.286			0.850			0.377			0.644
Yes	(9)60.0	(30)44.8		(19)50.0	(20)45.5		(8)38.1	(30)52.6		(8)53.3	(22)42.3	
Milk consumption frequency			0.165			0.059			0.758			0.183
Rarely	(0)0.0	(9)29.0		(8)40.0	(1)5.0		(3)37.5	(6)19.4		(1)12.5	(8)34.8	
1-2 times/week	(1)11.1	(5)16.1		(3)15.0	(3)15.0		(1)12.5	(5)16.1		(0)0.0	(5)21.7	
3-4 times/week	(1)11.1	(5)16.1		(2)10.0	(4)20.0		(1)12.5	(5)16.1		(2)25.0	(3)13.0	
Daily	(7)77.8	(12)38.7		(7)35.0	(12)60.0		(3)37.5	(15)48.4		(5)62.5	(7)30.4	

Table 5 notes there was a significant difference using chi-squared analysis between the age groups in the consumption frequency of cheese ($P = 0.014$). One quarter of those (6 of 38) in the <30 age category, compared to none of those in the >30 age category, reported eating cheese “rarely”. Additionally, a larger number of students, four in 10, compared to non-students reported eating cheese “rarely”.

Table 5: Self-reported dietary intake of selected food sources that contain folate among vegetarians

	Gender Male (n)%	Female (n)%		Age <30 years (n)%	>30 years (n)%		Student Yes (n)%	No (n)%		Women with children With (n)%	Without (n)%	
	(15)18.3	(67)81.7	P value	(38)46.3	(44)53.7	P value	(21)26.9	(57)73.1	P value	(15)22.4	(52)77.6	P value
Eat cheese			0.924			0.862			0.438			0.851
Yes	(9)60.0	(36)54.5		(22)57.9	(23)53.5		(10)47.6	(34)60.7		(9)60.0	(27)52.9	
Cheese consumption frequency			0.568			0.014			0.032			0.098
Rarely	(1)11.1	(5)13.5		(6)27.3	(0)0.0		(4)40.0	(2)5.7		(0)0.0	(5)17.9	
1-2 times/week	(1)11.1	(12)32.4		(6)27.3	(7)29.2		(3)30.0	(10)28.6		(3)33.3	(9)32.1	
3-4 times/week	(3)33.3	(10)27.0		(7)31.8	(6)25.0		(2)20.0	(11)31.4		(1)11.1	(9)32.1	
Daily	(4)44.4	(10)27.0		(3)13.6	(11)45.8		(1)10.0	(12)34.3		(5)55.6	(5)17.9	
Eat yoghurt			1.000			1.000			0.455			0.742
Yes	(7)46.7	(31)46.3		(18)47.4	(20)45.5		(8)38.1	(29)50.9		(8)53.3	(23)44.2	
Yoghurt consumption frequency			0.887			0.243			0.197			0.095
Rarely	(3)42.9	(12)38.7		(9)50.0	(6)30.0		(3)37.5	(12)41.4		(3)37.5	(9)39.1	
1-2 times/week	(2)28.6	(12)38.7		(7)38.9	(7)35.0		(5)62.5	(8)27.6		(2)25.0	(10)43.5	
3-4 times/week	(1)14.3	(5)16.1		(2)11.1	(4)20.0		(0)0.0	(6)20.7		(1)12.5	(4)17.4	
Daily	(1)14.3	(2)6.5		(0)0.0	(3)15.0		(0)0.0	(3)10.3		(2)25.0	(0)0.0	
Eat breakfast cereal			0.198			0.316			0.501			0.147
Yes	(13)86.7	(44)65.7		(29)76.3	(28)63.6		(16)76.2	(37)64.9		(7)46.7	(37)71.2	
Breakfast cereal consumption frequency			0.991			0.902			0.828			0.989
Rarely	(2)15.4	(8)18.2		(5)17.2	(5)17.9		(4)25.0	(6)16.2		(1)14.3	(7)18.9	
1-2 times/week	(4)30.8	(13)29.5		(9)31.0	(8)28.6		(4)25.0	(13)35.1		(2)28.6	(11)29.7	
3-4 times/week	(3)23.1	(11)25.0		(6)20.7	(8)28.6		(4)25.0	(10)27.0		(2)28.6	(9)24.3	
Daily	(4)30.8	(12)27.3		(9)31.0	(7)25.0		(4)25.0	(8)21.6		(2)28.6	(10)27.0	

Reported intake of nutritional supplements

Table 6 demonstrates that more than half of the males (8 of 15), compared to nearly three quarters of the females (49 of 67), took nutritional supplements. Chi-squared analysis revealed that no relationship exists between gender and nutritional supplement intake ($P = 0.232$). Across all of the groups, the main reason for taking nutritional supplements was selected as “other”. One of the reasons was because of their vegetarian/vegan diet with vitamin B₁₂ commonly mentioned. More women with children than women without children took nutritional supplements.

Overall, if nutritional supplements were taken, they were mainly taken three or more times per week. Approximately half of the females (26 of 67) and one third of the males (3 of 15) reported knowing the composition of the nutritional supplement they consumed. On investigation, it was self-reported that approximately half of the nutritional supplements ($n = 4$) actually contained folic acid.

Table 6: Self-reported nutritional supplement intake; reasons for taking the nutritional supplement; knowledge of whether the nutritional supplement contained folic acid; and whether the nutritional supplement they took actually contained folic acid among vegetarians. The numbers in bold are those contributing to the significant *P* value.

	Gender Male (n)%	Female (n)%		Age <30 years (n)%	>30 years (n)%		Student Yes (n)%	No (n)%		Women with children With (n)%	Without (n)%	
	(15)18.3	(67)81.7	<i>P</i> value	(38)46.3	(44)53.7	<i>P</i> value	(21)26.9	(57)73.1	<i>P</i> value	(15)22.4	(52)77.6	<i>P</i> value
Take nutritional supplements			0.232			0.967			0.278			0.094
Yes	(8)53.3	(49)73.1		(27)71.1	(30)68.2		(17)81.0	(37)64.9		(14)93.3	(35)67.3	
Reason for taking nutritional supplement			0.824			0.241			0.210			0.028
General health	(1)12.5	(7)14.6		(3)10.7	(5)17.9		(1)5.6	(7)19.4		(3)23.1	(4)11.4	
Pregnant/trying	(0)0.0	(2)4.2		(0)0.0	(2)7.1		(0)0.0	(2)5.6		(2)15.4	(0)0.0	
Other	(7)87.5	(39)81.3		(25)89.3	(21)75.0		(17)94.4	(27)75.0		(8)61.5	(31)88.6	
Frequency of nutritional supplement intake			0.505			0.463			0.202			0.394
Rarely	(0)0.0	(2)4.0		(2)7.1	(0)0.0		(2)11.1	(0)0.0		(0)0.0	(2)5.6	
1-2 times/week	(1)12.5	(7)14.0		(3)10.7	(5)16.7		(2)11.1	(5)13.5		(3)21.4	(4)11.1	
3-5 times/week	(0)0.0	(9)18.0		(4)14.3	(5)16.7		(2)11.1	(7)18.9		(1)7.1	(8)22.2	
Daily	(7)87.5	(32)64.0		(19)67.9	(20)66.7		(12)66.7	(25)67.6		(10)71.4	(22)61.1	
Know nutritional supplement contains folic acid			0.742			0.151			0.623			0.138
Yes	(3)37.5	(26)51.0		(11)37.9	(18)60.0		(7)38.9	(19)50.0		(10)71.4	(16)43.2	
Take nutritional supplement containing folic acid			0.968			0.819			0.172			0.692
Yes	(4)50.0	(29)58.0		(15)53.6	(18)60.0		(13)72.2	(18)48.6		(7)50.0	(22)61.1	

4. Discussion

In this convenience sample, an online, self-completed questionnaire was utilised to investigate the knowledge of folate and folic acid in vegetarians. There was an overall lack of knowledge regarding the recommended stage for folic acid intake and the required quantity of folic acid to be taken among vegetarians.

Knowledge of the recommended stage and amount of folic acid that should be consumed among vegetarians

It was interesting to find that nearly 40% ($n = 31$) did not know the recommended stage for folic acid intake. Only 12% ($n = 8$) of female vegetarians knew the correct stage of folic acid intake (12 weeks before and during the first trimester of pregnancy). A study conducted by Cawley and co-workers (2016) found that a higher percentage of women, 24.7%, took folic acid for 12 weeks before conception. One possible reason for this is that the study conducted by Cawley and colleagues involved mostly pregnant women, whereas the present study only included one pregnant woman. Approximately 60% of the women in the Cawley study were aware of taking it at some stage before or during pregnancy.

In the present study, more of those vegetarians aged over 30 took folic acid before pregnancy compared to those under the age of 30. These findings are similar to those reported previously (Kalafatelis and Fryer, 2011). The findings are also consistent with an earlier report which has shown that women who comply with pre-conceptional guidelines are more likely to be older and better-educated (Cawley *et al.* 2016). Over 80% ($n = 68$) of vegetarians did not know the recommended intake. While none of the males indicated the correct intake and only 6% ($n = 4$) of the female vegetarians surveyed claimed that they knew the recommended amount of folic acid to take. This lack of knowledge is worrying as research conducted in the UK (Wald and Sneddon, 1991) and Hungary (Czeizel and Dudas, 1992) has shown that taking a folic acid supplement daily can help prevent NTDs.

Knowledge of the sources of folate

In this study over 50% ($n = 54$) of the vegetarian females knew green vegetables were source of folate, which is greater than that reported in a previous study conducted by Kalafatelia and Fryer (2011) which found that only 33% of women knew green vegetables were a source of folate. A possible reason is because the present study was conducted among vegetarians, who may have a knowledge of the nutritional composition of green vegetables. A third ($n = 31$) of those in our sample were unable to identify any foods that were good sources of folate; this is similar as the study conducted in New Zealand (Kalafatelis and Fryer, 2011). Similar to previous research, (Kalafatelis and Fryer, 2011) a greater number of respondents in the over-30 age group identified green vegetables as a good food source, compared to those in the under-30 age group. Overall, 80% ($n = 12$) of women with children in the present study knew that green vegetables contained folate. This is consistent with other studies which reported that those who were pregnant at the time of the survey or who had children before it were more likely to identify green vegetables as a source of folate (Kalafatelis and Fryer, 2011).

Knowledge of foods with added folic acid

The results suggest that approximately 30% of vegetarian females ($n = 23$) had “no knowledge” of foods with added folic acid. Of those who provided an example of a good source, most mentioned breakfast cereal. These results are consistent with other studies. For example, a study conducted by Kalafatelia and Fryer (2011) found that 39% of respondents did not know any foods that have folic acid added to them. Similarly, a report conducted by Food Standards Australia New Zealand found that the most commonly recognised examples of food containing

folic acid were breakfast cereals. In the same study, some knew that milk contained folic acid (Food Standards Australia New Zealand, 2010). This is consistent with the present study. This research found that more vegetarians in the >30 age category compared to those in the <30 age category knew that breakfast cereal contained folic acid, which is comparable to those found in the New Zealand survey (Kalafatelis and Fryer, 2011).

The present study also found that, compared to women with children, knowledge of food sources of folic acid was low among vegetarian women without children. Women with children identified a greater number of food sources, perhaps because they received this information during pregnancy. In addition, compared to women without children, women with children were more likely to identify breakfast cereal and bread as foods which contain folic acid. These results echo those found in the New Zealand survey (Kalafatelis and Fryer, 2011) and a thesis conducted with the participation of female nursing students (Rigney, 2009).

Consumption of selected food sources that contain folate

As expected in the vegetarian sample, the consumption of dark green vegetables/legumes was high, with over 95% of the respondents reporting that they ate them and the majority consuming them 3-5 times per week or daily. Overall, approximately half of the respondents reported eating breakfast cereals, which is lower than that reported in National Adult Nutrition Survey (NANS) which is detailed food consumption data of the adult population in the Republic of Ireland. The survey found that 61% of adults who participated consumed “ready to eat” breakfast cereal (Irish Universities Nutrition Alliance (IUNA) 2011). Similar to NANS findings, 57% of subjects in the present study reported eating cheese which is a source of folate (IUNA, 2011). Forty-three percent of respondents reported eating yoghurt. This is consistent with NANS, which found that 42% of adults consumed yoghurt which contains some folate (IUNA, 2011).

Nutritional supplement intake

In the present study, more female vegetarians were found to consume nutritional supplements than males. Nearly three quarters of the females in this study ($n = 49$) took a nutritional supplement. This finding is contrary to that of Baykan and colleagues (2011), who indicated that the intake of any vitamin or mineral was reported by 20% of the entire sample of women. A possible explanation for this might be that the present study was conducted with vegetarians, whose diet could be deficient in vitamins and minerals. It was particularly interesting to find that more students took nutritional supplements compared to non-students. This could be due to the topic of study, with 37% of students in the present study doing a STEM course.

Reason for taking nutritional supplement

The main reasons for taking a nutritional supplements were for health, being pregnant or other reasons. Across the groups, 5-23% of subjects reported health reasons for using nutritional supplements. This is in contrast to a study conducted by Wardenaar and workers (2016), who found that a much greater percentage (61-89%) of the subjects reported taking nutritional supplements for health reasons. A possible reason is that the present study was conducted on vegetarians, who reported taking vitamin B₁₂ and other vitamins that may be lacking in a typical vegetarian diet. One interesting finding is that a similar number of both males and females took nutritional supplements for the same reasons. This was slightly surprising, as one might expect that more females would take nutritional supplements for general health, as found in a study conducted among a Dutch population (Wardenaar *et al.* 2016). More of those in the over-30 age group took nutritional supplements for general health than those in the under-30 age group. A plausible explanation for this is that the older age groups were more concerned about their health than younger groups.

Frequency of supplement intake

The frequency of supplement intake options were rarely; 1-2 times per week; 3-5 times per week or daily. The current study found that 18% of females ($n = 9$) consumed dietary supplements less than twice per week. This differs from a previous study by Balzo and colleagues (2014) which found that 49% of females consumed dietary supplements less than twice per week. A possible explanation is that their study was conducted with Italian teenagers, who may have had a lower intake of nutritional supplements. The present study found that 87% of males ($n = 7$) consumed dietary supplements between two and five times per week. This finding is contrary to the Balzo (2014) study which found that 43% consumed dietary supplements between two and five times per week. A possible reason could be that men are now more conscious of their general health.

Knowledge of nutritional supplements containing folic acid

The results indicate that, as expected, more females than males knew whether the nutritional supplement they took contained folic acid. Those over 30 years of age had a greater knowledge of whether the nutritional supplement contained folic acid than those under 30, suggesting that older age groups have a better knowledge. Likewise, most non-students and women with children knew that the nutritional supplement they took contained folic acid. This agrees with the other findings, as non-students and women with children tend to be older, than students and women without children, respectively (Kalafatelis and Fryer 2011). It should be noted that the question relating to the above in the survey was ambiguous, as it could have been interpreted in different ways.

In the present study most females knew the name and contents of the nutritional supplement they took with 53-60% of respondents consumed a nutritional supplement containing folic acid. This finding is in contrast to those reported in the Healthy Ireland survey which indicated that only 18% of women aged 25-34 took a folic acid supplement (Department of Health, 2016). Interestingly, in the present study a greater percentage of vegetarian students compared to non-students took a nutritional supplement containing folic acid. This could be because some of the students were doing a STEM course. The present study found that half of the women with children and over half of the women without children consumed a nutritional supplement containing folic acid. This outcome contrasts with a study conducted among female nursing students which found that most women without children had never taken folic acid supplements (Rigney, 2009). A possible explanation is that most of the women in the present study took a multivitamin containing folic acid, while multivitamin usage was low in the study involving nurses.

5. Conclusions

It can be concluded that, among this sample of vegetarians, there is a lack of knowledge regarding the recommended stage of folic acid supplementation and the required quantity of folic acid to be taken in order to prevent NTDs. Although the level of consumption of vegetables was high, vegetarians would still be advised to take 400µg/day of folic acid to help prevent NTDs in an occurring pregnancy. It was encouraging to find that vegetarians took a nutritional supplement containing folic acid. It could be possible that the vegetarians are consuming the recommended amount of 400µg/day. The findings of this study suggest that there is a lack of awareness of the importance of folate and folic acid in the diet among vegetarians. This needs to be addressed in order to reduce the number of NTD-affected pregnancies.

6. Future Work

Based on the findings in this study, the following recommendations can be made:

- a) Existing public health campaigns on the importance of folic acid supplementation for all women, using both traditional communication channels and web-based media could be investigated to assess their effectiveness.
- b) Reiterate the public health message that all women of childbearing age capable of becoming pregnant to take an additional 400µg folic acid/day as a food supplement.
- c) Awareness of the importance of folic acid in the diet of all teenage students could be included in the Social Personal and Health Education programme which is operated in all secondary schools.
- d) Staging a folic acid awareness week in Ireland similar to the World Folic Acid Awareness Week, as Irish women are at particular risk of NTD-affected pregnancies.
- e) Primary care healthcare professionals should inform women in their care about folic acid intake.

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Appendix I

Questionnaire

An initial message explained the purpose of the questionnaire:

This questionnaire is primarily designed to investigate folate intake and awareness among vegetarians. This questionnaire is for the purpose of a research project carried out by DIT Public Health Nutrition students. We would appreciate if you could take the time to complete this questionnaire, any information provided will be kept strictly confidential.

Section 1

1. What is your gender?
Female
Male
2. In which of the following age groups do you belong?
16-19
20-24
25-29
>30
3. Are you studying in college/university? (If no, please skip to Q5)
Yes
No
4. If so, where and what course?
Your answer
5. Are you a smoker?
Yes
Socially (less than everyday)
No (Ex-smoker)
No (Never)
6. Do you consume alcohol? (If no, please skip to Q8)
Yes
No
7. If so how often do you consume alcohol?
Rarely
1-2 times per week
3-5 times per week
Daily
8. Do you have any children?
Yes
No
I am currently pregnant

Section 2

9. Have you ever heard of folic acid? (If no, please skip to Q12)
Yes
No
10. If so, where have you heard of folic acid?
GP
Health Professional
Family or friends

The media

The internet

Other

11. How would you describe folic acid?

Your answer

12. Do you know of any benefits of taking folic acid? (Yes/No) If so, what are the benefits?

Your answer

13. Are you aware of any people who must ensure they have adequate folate/folic acid intake? (Yes/No) If so, who?

Your answer

14. Do you know what neural tube defects are? (Yes/No) If so, what are they?

Your answer

15. Are you aware of the relationship between folic acid and neural tube defects?

Yes

No

16. Do you know at what stage before or during pregnancy that it is recommended that women have adequate folate/folic acid intake? (Yes/No) If so, at what stage?

Your answer

17. Are you aware of the recommendations for folic acid intake? (Yes/No) If so, what are they?

Your answer

Section 3

18. Do you know of any foods that are good sources of folate? (Yes/No) If so please mention below.

Your answer

19. Do you eat any dark green leafy vegetables or legumes? (Broccoli, spinach, beans, chickpeas). (if no, please skip to Q21)

Yes

No

20. If so, how often would you consume these foods?

Rarely

1-2 times per week

3-5 times per week

Daily

21. Do you consume milk? (If no, please skip to Q23)

Yes

No

22. If so, how often would you consume it?

Rarely

1-2 times per week

3-4 times per week

Daily

23. Do you eat cheese? (If no, please skip to Q25)

Yes

No

24. If so, how often would you consume it?

Rarely

1-2 times per week

3-4 times per week

- Daily
25. Do you eat yoghurt? (If no, please skip to Q27)
- Yes
- No
26. If so, how often would you consume it?
- Rarely
- 1-2 times per week
- 3-4 times per week
- Daily
27. Do you eat egg? (If no, please skip to Q29)
- Yes
- No
28. If so, how often would you consume it?
- Rarely
- 1-2 times per week
- 3-4 times per week
- Daily
29. Do you eat fish? (If no, please skip to Q31)
- Yes
- No
30. If so, how often would you consume it?
- Rarely
- 1-2 times per week
- 3-4 times per week
- Daily
31. Do you eat chicken? (If no, please skip to Q33)
- Yes
- No
32. If so, how often would you consume it?
- Rarely
- 1-2 times per week
- 3-4 times per week
- Daily
33. Do you eat other meat? (Beef, pork, lamb). (If no, please skip to Q35)
- Yes
- No
34. If so, how often would you consume it?
- Rarely
- 1-2 times per week
- 3-4 times per week
- Daily
35. Do you eat any breakfast cereals? (If no, please skip to Q37)
- Yes
- No
36. If so, how often would you consume it?
- Rarely
- 1-2 times per week
- 3-4 times per week
- Daily

37. Folic acid is added to a number of different foods. Are you aware of food with added folic acid? (Yes/No) If so, please mention below.

Your answer

38. Do you check nutritional information on the labels of products before you purchase or consume them? (Yes/No) If so, please specify which products.

Your answer

Section 4

39. Do you currently take any supplements (e.g. Vitamins, Minerals, Omega 3) (If no, please skip to submit)

Yes

No

40. If so, which of the following do you take?

Centrum

Pharmaton

Wellwoman

Cleanmarine

Clonfolic

MorEPA

Other

41. If answered other for Q24, please specify.

Your answer

42. What is your reason for taking these supplements?

Your answer

43. How often would you take these supplements?

Rarely

1-2 times per week

3-5 times per week

Daily

44. Do you know if the supplement contains folic acid?

Yes

No