

***Current Trends of High Allergen and  
Essential Fatty Acid Food intakes in  
Women of Childbearing age***

A major project submitted in partial fulfillment for the award of the degree Masters of Science (Nutrition, Dietetics and Exercise Rehabilitation), University of Wollongong.

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## **Current trends of high allergen and essential fatty acid food intakes in women of childbearing age**

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**Background:** The pathogenesis of allergy has been associated with early exposure to various food proteins and the essential fatty acid (EFA) content of the diet. Current recommendations suggest women should not eliminate foods from their diet during pregnancy and lactation to reduce the risk of nutritional compromise to both the mother and child (Prescott and Tang, 2005).

**Objectives:** This study aimed to (1) To compare the current dietary intakes of high allergen foods including nuts, fish, milk and eggs and EFA (omega-6 and omega-3) in women of childbearing age to those pregnant and/or lactating women; (2) To identify whether women of childbearing age are meeting the current Australian Dietary Guidelines intake for nuts, fish, milk and eggs and EFA (omega-6 and omega-3).

**Methods:** A total of 186 women aged 19-50 participated in this cross-sectional study by completing a Food Frequency Questionnaire (FFQ). Data on current intakes were collected and analysed, significant differences were determined using ANOVA and t-tests ( $p < 0.05$ ).

**Results:** Significant differences were found between nut intakes in women aged 35-50 years ( $n=67$ ) and lactating women ( $n=18$ ) and intakes of omega-6 and omega-3 fatty acids in lactating women compared to all other groups. The ratio of omega-6 to omega-3 was significantly different for all groups.

**Conclusion:** Women of childbearing age are not meeting the current dietary recommendations for nuts, fish, milk and eggs which may influence the similar trend found for EFA. More research is warranted to determine the exact effect of high allergen food intake and the EFA status during pregnancy and lactation on the prevalence of atopy in children.

### **References:**

Prescott S & Tang M 2005, The Australasian Society of Clinical Immunology and Allergy position statement: summary of allergy prevention in children. *Medical Journal of Australia* 182(9): 464-467

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## **Introduction:**

Atopy is a personal or familial tendency to produce IgE antibodies in response to low doses of antigens, usually proteins, and to develop typical symptoms such as asthma, rhinoconjunctivitis or eczema/dermatitis (van Gool et al, 2004). As a result, food-allergic individuals are at risk of developing life-threatening IgE-mediated systemic reactions upon ingestion of the particular allergen (Roehr et al, 2004) usually nuts, fish, milk or eggs.

The prevalence of allergies in children is rising with up to 40% of Australian children having allergic sensitisation with many developing allergic diseases such as food allergies (Prescott and Tang, 2004). This increase in prevalence has been associated with lifestyle and environmental changes in Western countries that might influence immune regulatory pathways in early life and the propensity for allergic disease (Calder, 2003; Calder, 2006; Dunstan et al, 2003; Laitinen et al, 2006; Prescott and Tang, 2005).

Diet remains a modifiable environmental risk factor that can potentially reduce this incidence through the avoidance of high allergen foods during pregnancy and lactation (Calder, 2003; Calder, 2006; Laitinen et al, 2006; Oddy et al, 2004). A concern for those consuming a typical Western diet, which is characterised by foods high in refined carbohydrates, saturated and trans fatty acids and vegetable oils is the high intake of omega-6 (n-6) polyunsaturated fats (PUFA) and the small content of omega-3 (n-3) in these foods (Gebauer et al, 2006). The intake of essential fatty acids (EFA) and high allergen foods have been suggested to play an important role in the pathogenesis of allergy (Halmerbauer et al, 2002; Lauritzen et al, 2006; Mahrshahi et al, 2003; Oddy et al, 2004; Peat et al, 2004; Roehr et al, 2004; van Odijk et al, 2003; Wijga et al, 2003; Zeiger, 2003).

The observed associations between the nutritional and inflammatory factors in breast milk suggest that it may be possible to influence the immune milieu of the gut depending on the breast milk composition (Bjorksten et al, 2001; Laiho et al, 2003). It is these associations that have significant impact and play an important role for both pregnant and lactating women.

Biochemical measurements suggest an inverse relationship between EFA status particularly n-3 and atopic disease (Calder, 2003), however it is not clearly understood whether this is due to the quantity or relative amounts of these fatty acids (Laitinen, 2006). There are currently

two main hypotheses to explain the relationship between EFA and atopy where the first relates to the metabolism of the EFA and possible enzyme and metabolite deficiencies (van Gool et al, 2004). The second and most widely accepted is associated with the consumption of fat in developed countries and the consequent increase in the ratio of n-6 to n-3 (van Gool et al, 2004). Generally n-6 PUFA are considered pro-inflammatory and n-3 are anti-inflammatory however evidence is accumulating to suggest that n-6 may also be anti-inflammatory (Laiho et al, 2003), increasing the importance of the n-6 to n-3 ratio.

A study by Dunstan and colleagues (2003) found that fish oil supplementation in pregnancy achieved a significant increase in n-3 PUFA in neonatal cell membranes which was associated with a general trend for attenuated neonatal immune responses to allergens and reduced expression of allergic disease at one year of age. The significance of the Dunstan and colleague study is that it focuses on the modification of the immune system before the disease is established. Studies which are focused on prevention warrant more consideration as the majority of trials are conducted with inconsistent results once allergic immune responses have been established.

The Healthy Eating Guide (NHMRC, 2003) and public health campaigns are currently trying to promote the importance of a well-balanced diet so women are meeting the recommendations. Similarly, the marketplace is helping women achieve the EFA recommendations through current fortification of products including oils, bread, eggs, mayonnaise, margarines, salad dressings, pasta, milk, meat and poultry (Gebauer et al, 2006). It is expected that the number of foods with health claims and enrichment of n-3 will increase as more definitive research into the multiple benefits becomes available.

The aim of this cross-sectional study was to compare the diets of pregnant and/or lactating women to other women of childbearing age between 19-50 years for high allergen food intake and EFA content as assessed by a Food Frequency Questionnaire (FFQ). These intakes were then compared to current recommendations. The results from this paper will contribute to the implementation of preventative strategies employed by women of childbearing age to reduce the prevalence of allergies in children.

# Methods:

## Study design and population

This study was initiated by the RPAH Allergy Unit and was a continuation from previous research (Vanderley, 2005). The data collected from this cross-sectional study will continue to be used for future analysis and ongoing research. The study required each subject to complete a FFQ “Women’s Health, allergies, dietary preferences and supplement intake”. Each FFQ came with an information sheet and a reply paid envelope.

The questionnaire (Version: 1, Adult 06/04) was developed by the RPAH Allergy Unit in June 2004 to collect data regarding the different factors of women’s diet, environment and genetics which may lead to the increasing prevalence of children’s allergies primarily food allergies. The foods selected in the FFQ were from Woolworths and Coles online shopping lists and common alcoholic beverages. Each FFQ contains two primary sections with the first (personal information) being entered into a database developed by the RPAH Allergy Unit and the second (dietary intakes) into Microsoft Excel 2002 (Microsoft Corp, USA). Due to the early stages of research using the questionnaire, it is yet to be validated.

A total of 1513 questionnaires were distributed between 2004 and 2006 to women attending the RPAH Allergy clinic (1150), RPAH ante-natal clinic (80), University nutrition students (73), general public (80) and local Sydney child care centres (130). A population sample of women aged 19-50 years were included in this study, selected based on childbearing age and a completed FFQ. Women were excluded if they were outside these ages or if the FFQ was incomplete. No women recruited from the child care centres were included for this study due to the lack of recent data collection from these sources.

## Data and statistical analysis

The women of childbearing age in this study were divided into four groups; 19-34 years, 35-50 years, pregnant and lactating. Data restricted to high allergen food intakes of nuts, fish, milk and eggs was extracted from the completed FFQ of each woman and analysed to obtain a mean daily serve for each group. This data was then compared between groups to determine any significant differences between high allergen food intakes. The mean daily serve was also compared to the current recommended dietary intakes (RDI) from the Dietary Guidelines for Australian Adults (DGAA) (NHMRC, 2003) for each group.

Foods with high mean daily intakes were selected from the FFQ alongside those with known contents of EFA (**Table 1**) to obtain an indication of the n-6 and n-3 intakes of women of childbearing age and whether these differ for pregnant and/or lactating women. Omega-6 and omega-3 content of the foods is referenced elsewhere (Meyer et al, 2003; Meyer et al, 1999; Ollis, Meyer and Howe, 1999). Mean intakes for each group were then compared to current recommendations (NHMRC, 2006).

Group data were compared using One Way Analysis of Variance ANOVA (post-hoc: Bonferroni) and one sample t-tests were used when comparing to the recommendations. All statistical analysis was carried out using the statistical package for Social Sciences (SPSS Version 13.0 for Windows; Chicago, IL). A p value <0.05 indicated a significant difference between groups.

**Table 1:** Foods selected from the FFQ to be included for EFA dietary intake analysis.

<b>Individual food items extracted from FFQ for Essential Fatty Acid content</b>	
Salmon – steamed, grilled, oven baked	Cashews
Tuna – steamed, grilled, oven baked	Peanuts
Canned tuna in oil	Margarine – canola
Canned Salmon	Margarine – olive oil
Fish oil capsules	Butter
Sardines in oil	Vanilla ice-cream
Whiting or John Dory – steamed, grilled, oven baked	Block cheeses eg. Edam, cheddar, tasty, mozzarella
Walnuts	Olive oil
Boiled/poached egg	Canola oil
Potato crisps - plain	Plain Sweet Biscuits eg. Milk coffee
Mayonnaise - regular	French Dressing

### Ethics and Funding

Ethics approval was obtained from the Central Sydney Area Health Service (CSAHS) for four years commencing on the 27<sup>th</sup> July 2004. Amendments were made on 19<sup>th</sup> July 2006 for the continued participation of students into the Women’s Health Study. Funding for this study was provided by the RPAH Allergy Unit.

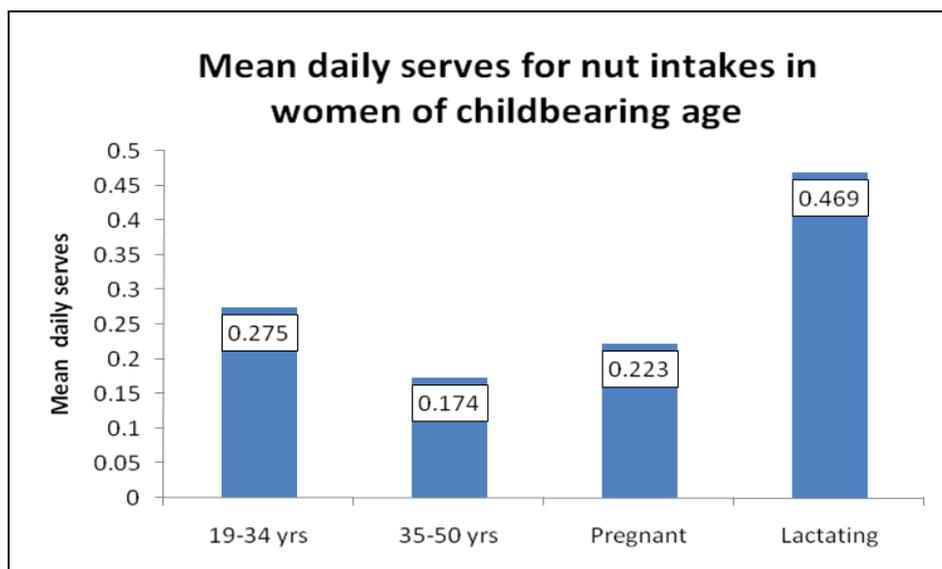
## Results:

The response rate for the return and completion of the FFQ improved from previous studies with 285 out of the total 1513 (18.8%) received and entered into the database from 2004 to 28<sup>th</sup> August 2006. For this study, data from 186 (12.3% of total distributed) subjects was used based on a completed FFQ and an age within the required bracket. This comprised of 131 from the RPAH Allergy Unit, 17 from the RPAH ante-natal clinic, 17 University nutrition students and 21 women from the general public. The women were divided into four groups; 19-34 years (n=72), 35-50 years (n=67), pregnant (n=29) and lactating (n= 18). The mean age for all groups was 33 years.

### *High allergen food intake*

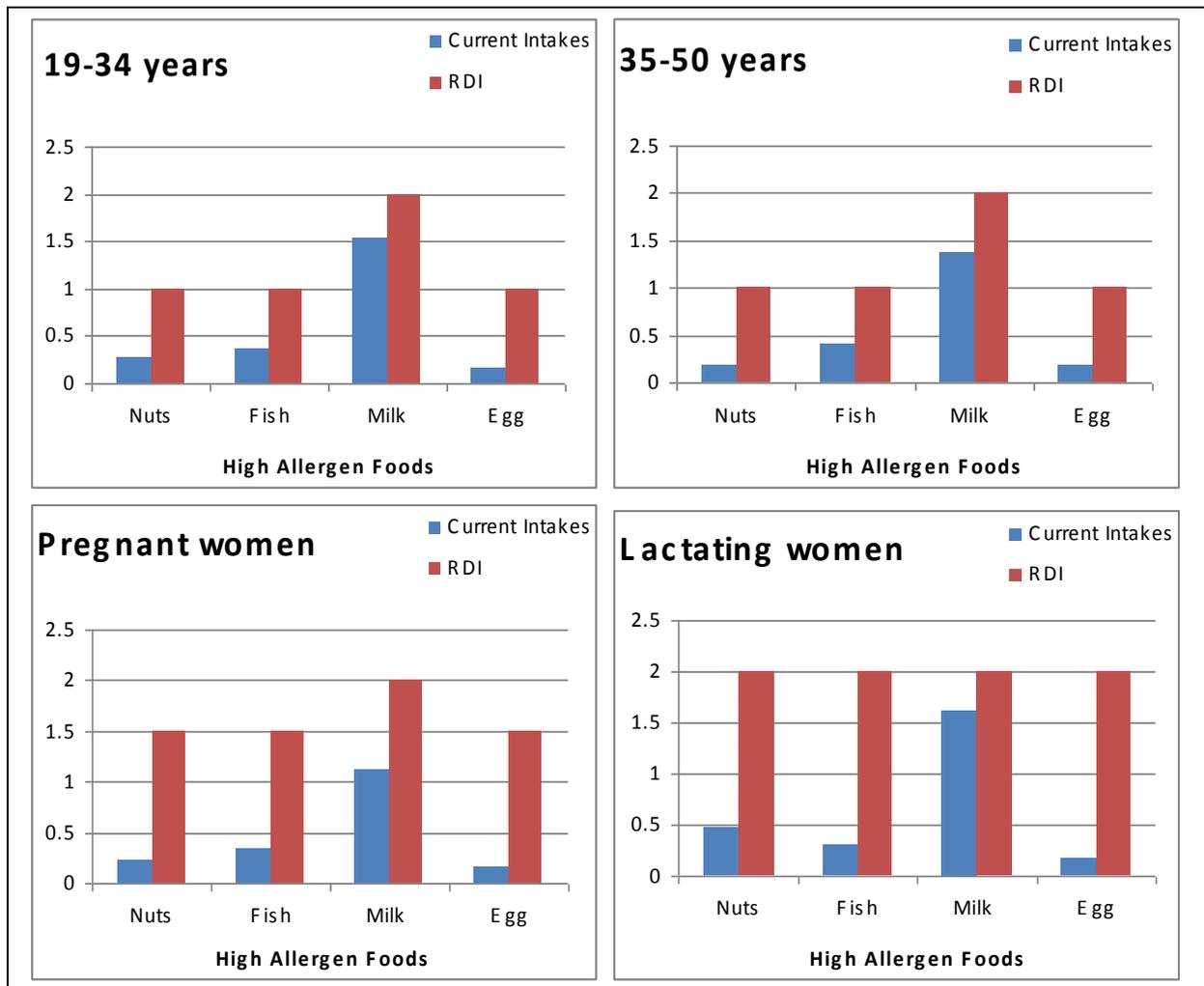
For all groups the maximum nut intake calculated by mean daily serves was 1.8. This was in contrast to fish (4.75) and milk (7.0). The lowest intake for the high allergen foods were eggs with a maximum of 1.47 daily serves. For all the foods, the minimum daily intake was zero.

The mean daily serves for nuts for each group is shown in **Figure 1**. There was a significant difference ( $p=0.016$ ) found between lactating women and women aged 35-50 years. No other significant differences were observed between groups for the intake of high allergen foods.



**Figure 1:** Comparison between groups for mean daily serves of nuts

For all groups there were significant differences (**Table 2; Figure 2**) found between the intake of nuts, fish and eggs and the RDI. Pregnant women and those aged 19-34 and 35-50 years were consuming significantly lower intakes of milk than the RDI (**Figure 2**). Similarly lactating women fell short for the intake of milk however it was not statistically significant.



**Figure 2:** Mean daily serves of high allergen foods compared to the RDI for individual groups. Significant differences determined by a one sample t-test ( $p < 0.05$ ).

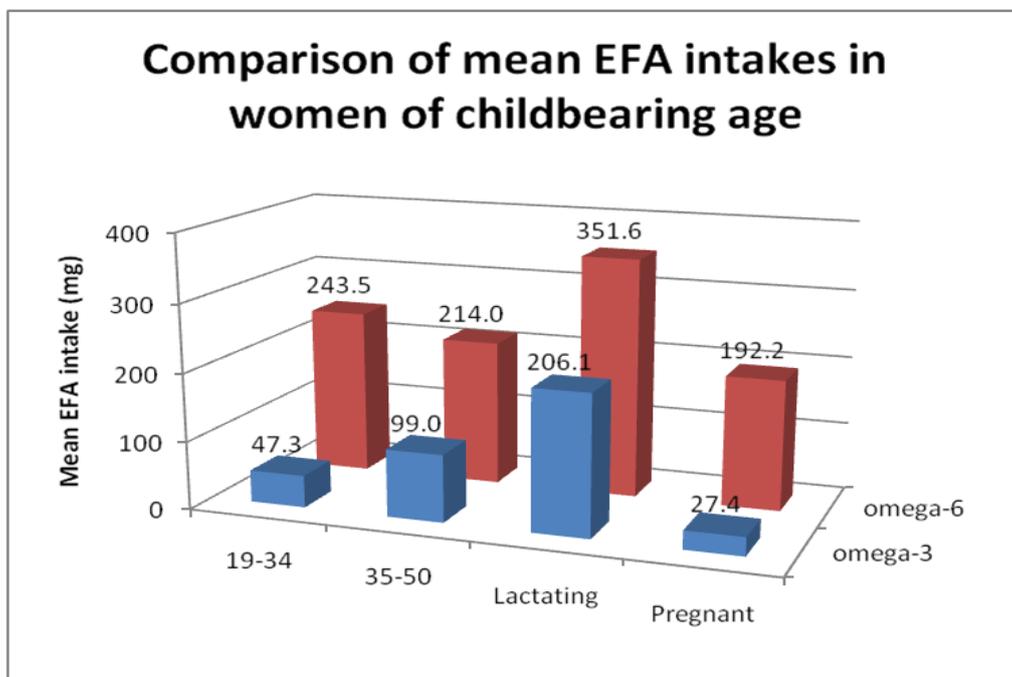
**Table 2:** Comparison between the mean intake (daily serves) for high allergen food and the current RDI in groups.

	Nuts		Fish		Milk		Egg	
	Mean intake (daily serves)	RDI						
19-34 years	0.28*	1	0.36*	1	1.54*	2	0.17*	1
35-50 years	0.17*	1	0.41*	1	1.36*	2	0.17*	1
Pregnant	0.22*	1.5	0.34*	1.5	1.13*	2	0.16*	1.5
Lactating	0.47*	2	0.30*	2	1.62	2	0.17*	2

\* Significance one-sample t-test  $p < 0.05$

### Essential Fatty Acid intake

The maximum daily intake for n-6 in all four groups was 1395.1 mg, approximately one and a half times the maximum of n-3 (877.9 mg). Many of the subjects reported to consume low quantities of the selected foods which resulted in small mean intakes for both n-6 and n-3 in all groups. For each group mean intake of n-6 was considerably higher than n-3 especially for women aged 19-34 years and pregnant women (**Figure 3**).



**Figure 3:** Comparison between omega-6 and omega-3 mean intakes for women of childbearing age.

Lactating women were consuming a significantly ( $p<0.001$ ) higher amount of n-6 foods compared to women 19-34, 35-50 years and pregnant (**Figure 3**). For n-3 intakes the only comparison between groups that did not result in a significant difference was between women aged 19-34 years and pregnant women.

The ratio of n-6 to n-3 intakes (**Table 3**) when compared between all groups showed significant differences ( $p<0.001$ ).

**Table 3:** Comparison between omega-6:omega-3 ratio for all groups. Significant differences determined by ANOVA  $p<0.05$

	<b>Ratio (n-6:n-3)</b>	<b>ANOVA p value</b>
19-34 years	5.2:1	< 0.001
35-50 years	2.2:1	< 0.001
Pregnant	7:1	< 0.001
Lactating	1.7:1	< 0.001

Women of childbearing age are consuming significantly different amounts of n-6 and n-3 foods compared to the dietary recommendations for intake (**Table 4**). In general both n-6 and n-3 intakes are lower than the recommendations for each group. The trends found for the high allergen foods and the relatively small number of foods selected for analysis may greatly affect these results.

**Table 4:** Significant differences ( $p<0.05$ ) between the current intakes of omega-6 and omega-3 in women of childbearing age and the current dietary intake recommendation.

	<b>n-6 recommendation (g/day)</b>	<b>n-6 intakes to recommendation</b>	<b>n-3 recommendation (mg/day)</b>	<b>n-3 intakes to recommendation</b>
19-34 years	8	$p<0.001$	90	$p<0.001$
35-50 years	8	$p<0.001$	90	$p<0.001$
Pregnant	10	$p<0.001$	115	$p<0.001$
Lactating	12	$p<0.001$	145	$p<0.001$

## Discussion:

The aim of this study was to determine and compare the differences in high allergen and EFA food intakes in women of childbearing age by extracting data from a completed FFQ. This is important as the pathogenesis of allergy has arguably been associated with the intake of high allergen foods during pregnancy and lactation (Halmerbauer et al, 2002; Roehr et al, 2004; van Odiijk et al, 2003; Wijga et al, 2003; Zeiger, 2003). The results from this study demonstrated there were very few significant differences found for the intake of high allergen foods. However there were discrepancies present for the n-6 and n-3 intakes between groups and similarly, significant differences were observed between women's dietary intake and the current recommended intakes.

The lowest mean intakes recorded for milk and eggs from this study indicate pregnant women are generally consuming less of the high allergen foods than other women of childbearing ages (19-50 years). Due to the large number of subjects recruited from the RPAH Allergy Unit the above finding is not unexpected. Clinicians including those at the Allergy Unit, often recommend women in the third trimester of pregnancy and during lactation avoid high allergen foods (nuts, fish, egg and milk) especially for atopic or high-risk patients. Furthermore, it has been suggested that allergy prevention interventions through food avoidance have only been beneficial for infants from atopic families (Zeiger, 2003).

Surprisingly in the present study, women who were lactating had the highest mean intakes for nuts, milk and eggs and therefore no food allergen avoidance appear to be implemented by clinicians for this group. Randomised, double-blind controlled trials have not definitively shown that the avoidance of multiple potential food allergens such as nuts, milk, egg and fish during pregnancy and/or lactation can result in a reduced risk of allergic disease (Kramer and Kakuma, 2006; Prescott and Tang, 2004). Therefore, lactating women as a group in this study were abiding by the current recommendations which state pregnant or lactating women should not avoid foods to reduce the risk of nutritional compromise to the mother and foetus/child (Prescott and Tang, 2004). In contrast to this recommendation, the avoidance of peanuts and other nuts can be justified as they are not an essential food and will not lead to nutritional problems if restricted during pregnancy or lactation (Zeiger, 2003).

A number of studies have demonstrated the controversial relationship that exists between dietary factors and allergy prevalence. The PIAMA study (Wijga et al, 2003) investigated the role of diet in the development of asthma in pre-school children. The results indicated a significant inverse relationship between the consumption of milk fat and asthma. The authors concluded that various components of the products involved such as fatty acids, antioxidants or other micronutrients could have played a role. In a similar study known as SPACE, Halmerbauer and colleagues (2002) found by implementing preventative measures such as dust-mite protection covers on mattresses, the incidence of sensitisation to these allergens was lower. In contrast to the PIAMA study, the SPACE study found there were no differences identified between groups regarding food allergies despite one group adopting food allergen avoidance measures (milk, egg, fish, peanuts and tree nuts).

In the present study, women of childbearing age between 35-50 years consumed the lowest mean intake for nuts. The significant difference found between this group and lactating women in terms of nut intakes could represent the difference in energy requirements for both groups and the changed snacking pattern with age. This group also consumed the highest intake of fish which may represent the positive influence of education regarding the health benefits specifically the cardiovascular benefits (Akabas and Deckelbaum, 2006; Gebauer et al, 2006; Simopoulos, 2002). The impact of educational campaigns may also explain the high mean intake of milk for women aged 19-34 years. The benefits of milk and dairy products for the development of strong bones and therefore the prevention of osteoporosis are evident and outlined in the DGAA (NHMRC, 2003).

All groups did not meet the RDI for high allergen food intake. These discrepancies are likely to be associated with the study design where the recommendations were based on the food groups in the DGAA namely “nuts, fish, poultry and legumes” and “milk and dairy products”. It is therefore expected that when addressing these foods individually, the subjects will not meet the requirements. Moreover, nuts could be classified as a snack food and therefore don't constitute a large consumption in comparison to other staple foods.

The pregnant women in this study may be biased towards food avoidance measures and therefore the low n-3 intakes for this group could be indicative of the lower fish and nut intakes. The low intakes of n-6 in pregnant women and 35-50 years could be characteristic of the reduced snack consumption in these groups. In contrast to the pregnant women, the

lactating women in this study recorded mean intakes for n-6 and n-3 which were significantly higher than all other groups. Lactating women consumed the highest mean daily serves for milk and nuts which is likely to explain this difference between groups. A recent study (Lauritzen et al, 2006) investigated the EFA composition of breast milk from atopic mothers. It was found that compared with breast milk from non-atopic mothers, atopic breast milk had higher concentrations of n-6 and lower concentrations of n-3. From these results it can be assumed that to reduce the risk of allergy development in children from atopic families, higher intakes of n-3 are warranted during lactation.

However despite the differences found in individual n-6 and n-3 intakes in the present study, the literature suggests the ratio of n-6 to n-3 is the most important consideration with an optimal ratio between 5:1 and 10:1 (NHMRC, 2006). In this study both pregnant women (7:1) and those aged between 19-34 years (5.2:1) lay within this range. Both groups had similar consumption of high allergen foods which may represent the similar trend. Despite lying within the optimal range, the data highlighted that both these groups were consuming significantly lower quantities of omega-3 than the recommendations and therefore this ratio may not accurately reflect the exact dietary intakes. Similarly, women aged 35-50 years and lactating women were not meeting the recommendations for both EFA intakes. Whilst these groups demonstrated ratios that lay outside the optimal range, it is clear that these groups are consuming a relatively higher intake of n-3 and therefore may display more beneficial results in the long-term.

It could be suggested that the current optimal ratio is conservative for safety and ethical reasons due to the relatively early stages of research into the benefits of n-3. More specifically, the optimal ratio used for this study (NHMRC, 2006) is problematic as it is based on non-pregnant and non-lactating women and has only been estimated based on relative increases in body weight (pregnant) and inclusion of infant recommendations (lactation).

A study designed to investigate the association between childhood asthma and the ratio of n-6 to n-3 found that higher ratios were associated with significantly increased risk estimates for current asthma (Oddy et al, 2004). The CAPS study (Mihreshahi et al, 2003) found similar results where increasing the n-3 fatty acids in the diet in the first 18 months of life resulted in a potential beneficial effect on wheezing. A follow-up to this study (Peat et al, 2004) found

more definitive results where n-3 supplementation and n-6 restriction significantly reduced atopic cough.

The trends found for EFA intake may be a result of the types of foods that were selected for analysis. The snapshot of a woman's diet used for EFA analysis included foods that had the greatest mean intake and a few extras containing high amounts of n-3 due to time restrictions. These foods do not provide an accurate representation of the total EFA intakes and further research is needed to analyse the whole FFQ for n-6 and n-3 content. Further limitations of this study include the large population cohort from the RPAH allergy unit and therefore bias to this high-risk population. Similarly the use of nutrition students presents bias because this group is educated into the requirements of a healthy diet and therefore do not represent the average Australian woman. Due to the extent of the FFQ, it is assumed that only highly motivated subjects completed it and therefore this presents a level of bias.

The results from the present study demonstrate the need for further research into the impact of high allergen and EFA food intakes on the outcome of allergy in women of childbearing age and not exclusively for those from atopic families. Research focused on comparing the diets of atopic and non-atopic women and the prevalence of allergies in their children will further determine the impact of dietary intakes. Finally public health campaigns aimed at addressing an increase in n-3 intakes with the aim of achieving optimal n-6 to n-3 ratios will result in many long-term benefits.

## **Conclusion/recommendations:**

Diet is a modifiable risk factor that has been associated with the rising prevalence of allergies. The results suggest there are possibilities for an association between the intake of high allergen foods and the ratio of n-6 to n-3 on the prevalence of allergy particularly for atopic families. Subsequently, the results from this cross-sectional study also identified women of childbearing age are not meeting the RDI for high allergen and EFA foods. Clinicians are required to support the need for a balanced diet during pregnancy and lactation, with the avoidance of foods only when necessary. A public health campaign to promote the potential benefits of a diet rich in omega-3 containing foods with the target of an optimal ratio of n-6:n-3 could play an important role for allergy risk reduction in the future. Finally, a follow-up study is warranted to determine the association between the diets of the pregnant women in the present study and the prevalence of allergies in their children.

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**Appendix (a):**  
**Information Sheet for Participants**

**Appendix (b):  
Food Frequency Questionnaire**

**Appendix (c):**  
**Revised Food Frequency Questionnaire**  
**(To be distributed 2006/2007)**

**Appendix (d):**  
**Ethics application letter**