

## 1 Association between healthy eating in pregnancy and allergic status 2 of the offspring in childhood

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4 Over the past few decades there has been a steady increase in the prevalence of non-  
5 communicable diseases (NCD), including allergic disease. Changing lifestyle and  
6 subsequent diet may explain this increase seen in the prevalence of atopic disease.  
7 Epidemiological evidence also suggests that diet may be key in the prevention of  
8 allergic disease <sup>1</sup>. There are three important characteristics in terms of the maternal  
9 diet that has been investigated for the prevention of allergic disease: 1) the role of  
10 particular nutrients such as vitamins (A, D and E), zinc, fatty acids, or 2) the role of  
11 particular foods such as fruits and vegetables, fish, or 3) the total dietary intake such  
12 as a 'Mediterranean diet' or a healthy diet. Research utilising the healthy eating index  
13 tool, specific to the pregnancy diet, found no association between overall healthy  
14 eating score and recurrent wheeze in infants at the age of three <sup>2</sup>. However, maternal  
15 intake of celery and citrus fruit specifically has been associated with an increased risk  
16 of sensitisation to food allergens in two year olds <sup>3</sup>. One case control study found no  
17 effect of consumption of fish, butter and margarine on development of atopic  
18 sensitisation in the offspring of allergic mothers; however a protective effect of fish  
19 intake (2-3 times a week or more) was identified in the non-allergic mothers' group  
20 with the risk of food sensitisation in the offspring reduced by greater than a third <sup>4</sup>.  
21 Thus, the question is whether the associations seen are due to the individual  
22 nutrients/foods or whether it is part of an overall nutritional composition of the  
23 weaning diet. In this study we aimed to investigate if maternal diet, and specifically  
24 seafood intake during pregnancy, is associated with the infant's allergic outcomes in  
25 a well allergy-characterised birth cohort at three and ten years of age.

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27 The FAIR study methodology has been described previously <sup>5</sup>. In short, pregnant  
28 women with an estimated delivery time between 1<sup>st</sup> September 2001 to 31<sup>st</sup> August  
29 2002 were approached at antenatal clinics on the Isle of Wight. The study comprised a  
30 whole population birth cohort (FAIR). Ethical approval for the study was obtained  
31 from the Isle of Wight, Portsmouth and South East Hampshire Local Research Ethics  
32 Committee (REF 09/01) and the NRES South Central - Southampton B Research  
33 Ethics Committee (REF 10/H0504/11). Following consent, a validated food frequency

34 questionnaire (FFQ) was completed at 36 weeks gestation. At three, six and nine  
35 months, as well as one, two, three and ten years, information regarding feeding  
36 practices and reported symptoms of allergic disease in the offspring was obtained  
37 using a standardised questionnaire. We adapted the Alternative Healthy Eating Index  
38 (AHEI-P)<sup>6</sup>, suited for pregnancy for our study. The AHEI-P is a 90 point scale with  
39 the following 9 components contributing 10 maximum points each: vegetables, fruit,  
40 ratio of white to red meat, fibre, trans fat, ratio of polyunsaturated to saturated fatty  
41 acids, folate, calcium and iron from foods. For the purpose of this study, an allergy-  
42 focused *healthy eating indicator* with a score of 70 was devised using the same  
43 scoring system as above for the following intake of nutrients which have been shown  
44 to influence allergy outcomes<sup>1,7</sup>: (wheat/fibre=10, fruit/vegetables=10, calcium=10,  
45 iron=10, white fish=10, oily fish=10, omega=10).

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47 The original birth cohort consisted of 969 pregnant women (91% of the target  
48 population). The age of the pregnant women ranged from 15 to 44 years old, with a  
49 mean age of 27 years and 10 months. Maternal history of allergy was reported in 558  
50 (57.6%) of the mothers. Frequency of intake of foods during pregnancy, as  
51 determined by the validated FFQ was available from 937 mothers. The majority of  
52 mothers consumed white fish during pregnancy (85.2%), 44.8% consumed oily fish  
53 and 38.4% consumed shellfish. Healthy Eating indicator scores were low with the  
54 majority of mothers scoring between 10-20 points (79.3%) out of a possible 70.  
55 *Healthy eating indicator* (Table 1) as a continuous score was not significantly  
56 associated at three years of age with atopy (p=.739, OR 1.005) or allergic disease  
57 (p=.907, OR 1.001). This was also the case at ten years of age; atopy (p=.232,  
58 OR=1.013), allergic disease (p=.620, OR=1.004). White fish consumption and  
59 shellfish consumption by itself (Table 1) was not significantly associated with any of  
60 the allergy outcomes at three and 10 years of age. However, moderate to frequent  
61 consumption of oily fish was significantly associated with atopy at three years  
62 (p=.028, OR=1.751, 95% CI: 1.063-2.887).

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64 In summary, maternal food intake and the consumption of white fish and shellfish  
65 were not found to be associated with sensitisation or allergic disease during  
66 childhood. However, maternal consumption of oily fish was shown to be a risk for  
67 atopy at three years of age, and allergic disease at ten years of age; this remained

68 significant after controlling for the presence of allergic history in the mother. In terms  
69 of healthy eating in pregnancy, Nurmatov <sup>1</sup> concluded that although epidemiological  
70 data is weak, there is support for vitamins A, D and E, zinc, fruits and vegetables, and  
71 a Mediterranean diet being preventative of asthma. However, similar to our results  
72 Lange <sup>2</sup> found no association with overall healthy eating during pregnancy and  
73 recurrent wheeze. With regards to the consumption of fish and shellfish it has been  
74 hypothesised that, as oily fish contains Eicosapentaenoic acid which inhibits the  
75 formation of prostaglandin E2, maternal consumption may be protective against  
76 allergic disease. Equally fatty fish consumption during pregnancy is hypothesised to  
77 reduce the child's allergy risk by modulating early life immune development <sup>8</sup>. In the  
78 present study, no associations of maternal white fish and shellfish consumption with  
79 risk of atopy, allergic disease in the offspring were found. Surprisingly, we found that  
80 moderate to frequent consumption of oily fish increased the risk of atopy at three  
81 years. These results conflict with previous studies, which mainly, however not solely,  
82 suggest maternal fish intake during pregnancy is protective against the development  
83 of asthma and atopy <sup>3,4,8-10</sup>. A possible explanation for this finding is that the  
84 beneficial effects of n-3 PUFAs could be counterbalanced with the harmful impact of  
85 pollution of seafood as the concentration of contaminants is higher in fatty fish and  
86 shellfish than in lean fish. Further research is needed to explore if the observed results  
87 could be replicated.

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