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## Influences on adherence to diet and physical activity recommendations in women and children; insights from six European studies

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### Abstract

**Background**—Across Europe poor health behaviours are associated with increased risks of non-communicable diseases. There is particular concern about young women, children and families, not least as health behaviours operating before and during pregnancy and in early postnatal life may have profound long-term consequences for children's health. Using findings drawn from seven European countries, we aimed to identify barriers to the implementation and take up of dietary and physical activity recommendations, and to consider how best to achieve changes in mothers' behaviours and, thereby, improve adoption of health recommendations. Six studies across the seven countries were used for this narrative synthesis of findings.

**Key messages**—A woman's education is a strong influence on her own and her children's health behaviours. Women's diets vary across ethnic groups and according to number of children, but psychological factors, such as self-efficacy and sense of control, which may be amenable to

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#### Conflicts of interest

KMG and LP have received reimbursement for speaking at conferences sponsored by companies selling nutritional products, and is part of an academic consortium that has received research funding from Abbott Nutrition, Nestec and Danone.

modification, are powerful too, particularly in women with lower educational attainment. Maternal influences on children's behaviours are strong. Differences exist in infant feeding across countries, and there are apparent urban/rural differences in children's diets and physical activity.

**Conclusions**—Interventions are needed before, as well as during, pregnancy, to improve the diets of families with young children. Interventions to address psychological barriers to eating well and being more active are indicated.

## Keywords

Children; diet; physical activity; pregnancy; women

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## Introduction

Nutrition during early development impacts on later health and there is an increasing focus on the health behaviours of women and children. In 2007, the Commission of European Communities set out a strategy for nutrition-, overweight- and obesity-related health issues in which it noted the deterioration in dietary quality and physical activity over previous decades and its relationship with increased risks of non-communicable diseases.[1] Health behaviours that lead to poorer growth, development and health are difficult to modify and while advice and recommendations abound, the uptake by individuals is still not optimal. For example, the UK National Diet and Nutrition Survey has shown that few groups adhere to the recommendations for fruit and vegetable consumption, and the proportion of individuals achieving recommended levels is still low.[2]

As part of the *EarlyNutrition* programme[3] we conducted a narrative synthesis of findings from six studies. We aimed to identify barriers to the implementation and uptake of dietary and physical activity recommendations in women and children. Specifically, we sought to identify the behavioural and lifestyle influences on adherence to current dietary and physical activity recommendations, and maternal influences on the child's diet and physical activity. We examined the similarities and differences between the main influences on diet, dietary behaviours and physical activity across six studies in seven European countries.

## Methods

One cohort study, three intervention studies and two cross-sectional studies were included in the narrative. The studies have been described elsewhere and the references provide full details. Brief summaries are as follows:

### Cohort study

The Southampton Women's Survey (SWS)[4] is a study of 12,583 Southampton women in the UK aged 20-34 years who were assessed when they were not pregnant; 3,158 of these women were followed through a subsequent pregnancy and the children followed through infancy and childhood. Information on diet was obtained before and during pregnancy and during infancy and childhood. Objective information on physical activity from Actiheart measurements (Cambridge Neurotechnology Ltd, Papworth, UK) was obtained on a subset of mothers and children when the children were 4 years of age.

## Intervention studies

UPBEAT[5, 6] is a multicentre randomised controlled trial comparing a behavioural intervention designed to improve glycaemic control with standard antenatal care, in obese pregnant women. Women with a body mass index (BMI)  $\geq 30\text{kg/m}^2$  and a singleton pregnancy between 15 weeks and <19 weeks' gestation are eligible, unless they have pre-defined, pre-existing diseases. The behavioural intervention is delivered by a health trainer over eight group sessions. Dietary data from the pilot study of 183 women have been used here.[6]

The Childhood Obesity Project (CHOP) [7] is a double-blind, randomised controlled trial of 636 children randomised to two groups fed two types (standard and follow-on) of cows milk-based formula with either a lower or higher protein content for the first year of life. Additionally, an observational group of 298 exclusively breastfed children was included. Children were recruited in five countries (Belgium, Germany, Italy, Poland, and Spain). Infants were enrolled during the first eight weeks of life. Information was available on diets of the infants at six months of age.

The Southampton Initiative for Health (SIH)[8] is a before and after controlled trial of an intervention introduced to Children's Centres in Southampton, UK. The intervention aimed to increase the self-efficacy and perceived control, and through this, the diet and physical activity levels of women attending Sure Start Children's Centres, by training Children's Centre staff in skills to support behaviour change. Diets and physical activity levels of 527 women in Southampton (intervention area) and 495 in Gosport and Havant (a demographically-similar control area) were assessed before the training intervention began and these data were used in this analysis.

## Cross-sectional studies

The Growth, Exercise and Nutrition Epidemiological Study (GENESIS)[9] aimed to evaluate the food and nutrient intakes and growth and development of a representative sample of Greek toddlers and preschool children. 1218 boys and 1156 girls aged one to five years old, stratified by parental educational level were examined from 105 nurseries. Demographic, lifestyle, physical activity, dietary, and anthropometry data were recorded.

The NutWell study[10, 11] investigated the relationship between educational attainment and specific psychological variables, and quality of diet in 372 women living in Southampton, UK and attending, over a 6-month period, children's play sessions and baby clinics run by Sure Start Children's Centres in the city. Data were collected using a structured questionnaire.

## Analytical methods

The outcomes considered for the six studies, where available were: dietary quality, fruit and vegetable consumption, glycaemic load, breast feeding initiation and duration, complementary feeding at 6 months, and physical activity. The influences on these outcomes that were considered included ethnicity, level of educational attainment, socio-economic position, household income, receipt of benefits, deprivation, and maternal age,

household composition, psychological factors, BMI, and smoking. For analyses of children, parity/birth order and child's gender were considered. Four target groups were identified for these analyses, namely non-pregnant women, pregnant women, infants, and children up to age 5 years.

A narrative synthesis of the published findings from the studies was conducted. The contribution of the various studies to the particular components of the narrative is given in Table 1. For assessment of dietary quality, three studies used principal components analysis and then considered the major principal components as measures of diet quality. Other studies have used the Healthy Eating Index[12] or an adaptation for use in pregnancy.[13, 14]

### Focus groups

Focus groups conducted in Southampton aimed to explore lifestyle and other factors that influenced the food choices of young women with differing educational attainment and how these women could best be supported to improve their food choices. Eleven focus group discussions were held in total: eight with women of lower educational attainment (42 women) and three with women of higher educational attainment (14). All the women were white Caucasian.

Transcripts of the audio-recordings of the discussions were read and re-read and subjected to a thematic analysis. Comments from participants were coded under pre-defined and emerging themes, using constant comparative method.[15] A further analysis was conducted of data from four focus groups, two from each of the lower and higher educational attainment groups,[16] to examine the concept of food involvement and its influence on the way women fed themselves and their children. Food involvement indicates the level of importance of food in a person's life. Five predefined areas of food involvement: acquisition, preparation, cooking, eating and disposal of food were explored.[17]

## Results

### Non-pregnant women

**Dietary quality**—Data from the SWS, SIH and Nutwell contributed to these analyses. All three studies used a dietary quality measure known as a 'prudent diet score' in a full form[18] or an abridged version based on 20 food items.[19] Higher scores indicate a greater conformity with healthy eating recommendations. The prudent diet score was strongly positively associated with the women's educational attainment.[18] Women without children tended to have higher scores than parous women, as did older women, even after adjustment for education. Clustering of poor health behaviours was evident, with women who smoked and took less exercise also having poorer quality diets. A woman's sense of control was strongly positively associated with her dietary quality, but the effect was confined to women with lower levels of educational attainment.[11] The education effect was partly mediated by the woman's food involvement. In women with lower educational attainment, self-efficacy was also associated with dietary quality but this was largely mediated through perceived control and food involvement. Furthermore, diets were found to

be of poorer quality in those with a more negative affect, suggesting that mood plays a role in dietary quality.[17]

**Physical Activity**—In the SWS mothers who wore Actiheart monitors, BMI and working full time were positively associated with average sedentary time, while there was a negative association with duration of schooling. Conversely, lower BMI and not being in work were associated with light physical activity. Having more than one younger child at home was positively associated with mothers' average daily light physical activity, but there were no significant associations with moderate or vigorous physical activity.[20]

### Pregnant women

**Dietary quality**—In the SWS, the women's prudent diet score changed little from before pregnancy to during pregnancy.[21, 22] Not surprisingly, the influences on the score in pregnancy were similar to those seen for the non-pregnant women, described above.

**Glycaemic load**—The UPBEAT pilot trial examined differences between obese pregnant women who were allocated to intervention or control arms of the study. The intervention provided behaviour change support and recommendations, with feedback on progress. Reductions in glycaemic load were seen in the women in the intervention arm, indicating that support for changing behaviour has a beneficial effect on the diets of such women during pregnancy.[6]

### Infants

**Breastfeeding**—In GENESIS, CHOP and SWS, mothers with higher pre-pregnancy maternal BMI, lower educational attainment, smoking in pregnancy and multiparity were less likely to breastfeed their infants.[7, 23, 24] In GENESIS, mothers of premature babies (<37 weeks' gestation) were less likely to initiate breastfeeding,[23] and in both SWS and GENESIS, a shorter duration of breastfeeding was found in women who were either underweight before pregnancy, or had lower BMI or smoked during pregnancy.[23, 24] In GENESIS, multiparous women breast-fed their children for about 7 weeks less than uniparous women.[23]

**Introduction of solid food**—In the CHOP study, the median age of introduction of solid food was 19 weeks, with almost all children (97%) taking solids by 6 months.[25] Solids tended to be introduced earliest in Poland and latest in Germany ((91% vs 66% introduced by 22 weeks of age). Boys were introduced to solids earlier than girls, (also reported in the SWS [26]) as were infants born to less well educated parents, or to mothers who smoked in pregnancy. Formula-fed infants and those with a higher birth weight or born to mothers with a higher BMI tended to start eating solid food at a younger age.

**Quality of infant diets**—Although half of all complementary foods in the CHOP trial came from commercial infant food (CIF) sources, there were major differences among the different European countries in the quantity of CIFs consumed; parents in Germany reported >90% of complementary food from CIF while those in Belgium reported <10%. A higher proportion of formula-fed infants received CIF during the first year of life than those who

were breastfed.[27] There were also considerable differences between countries and between breastfed and formula-fed children in intakes of energy-providing liquids, such as sugared teas and fruit juices; for example, during the first year of life, instant teas were consumed by 70-88% of formula-fed infants in Poland compared with < 5% in Belgium.[28]

Within the SWS, infant dietary quality scores at 6 and 12 months of age were derived in a similar way to the prudent diet scores used for the mothers' data.[29] They were named 'infant guidelines scores', as they indicated the extent to which mothers followed the current infant feeding recommendations. The strongest predictor of the scores at both 6 and 12 months was the mother's prudent diet score before she became pregnant. Mother's educational attainment was also strongly positively associated with the infant guidelines score, but a negative association was seen with birth order. At 6, but not 12 months, the infant guidelines score increased with maternal age, decreased with increasing maternal BMI and was lower for infants whose mothers smoked.[29]

## Children

**Diet quality**—In the GENESIS study, 80% of participants aged 2-5 years had a Healthy Eating Index score <50 indicating a poor diet. Scores were significantly higher among boys, children aged 4 to 5 years, those who participated in moderate to vigorous physical activities for more than 3 hours per week, those who lived in rural or small towns, or those whose mothers were employed or had more years of education.[30]

In the SWS, the key influence on the quality of the children's diets at age 3 years was the quality of their mothers' diets before pregnancy (the prudent diet score); alone it accounted for almost a third of the variance in child's dietary quality.[31] There were no gender differences in diet quality. Better-quality diets were more common in children of mothers with higher educational attainment, who lived in a less-deprived area, had a lower BMI and were non-smokers. Children who were of a lower birth order, who spent less time watching TV per day or ate more meals (in comparison with nibbling throughout the day) were also more likely to have a more prudent diet.[31]

**Fruit and vegetable consumption**—In the GENESIS study, few associations were found with vegetable consumption in the children. In those aged 1-3 years, boys tended to be less likely to achieve the recommended intake than girls, while in children aged 3-5 years, "urban" dwelling children were less likely to meet the recommended intake than those living in "large urban" areas. Children born to mothers who were smokers during the time they breastfed the children were less likely to meet the recommendations.

There were inconsistent relationships between fruit consumption and type of area of residence: compared with those living in "large urban" areas, children aged 1-3 years living in "urban" areas were less likely to achieve the recommended fruit intake, whereas children aged 3-5 years in "urban" areas were more likely to do so. Also in those aged 3-5 years, those living in rural areas were more likely to meet the recommendations, but there was no evidence for this in the younger age group. In both age groups, there was a suggestion that those children whose mothers had been exposed to cigarette smoke in pregnancy were less likely to eat sufficient fruit. Children aged 1-3 years were more likely to achieve the

recommended intake if their mothers were more highly educated, whereas, for children aged 3-5 years, those born premature (< 37 weeks' gestation) were more likely to meet the recommendations than those born at term.

**Physical Activity**—In the GENESIS study, in both age groups, (1-3 years, 3-5 years), compared with a baseline group of those living in “large urban” areas, children living in “small towns” and “rural” areas were more likely to meet physical activity recommendations, but those in “urban” areas were less likely to meet them. Also, women who took folic acid during pregnancy were less likely to have active children than those who did not. In those aged 1-3 years, boys were more active than girls, and those whose mothers who were of normal weight before pregnancy were more active than those with overweight or obese mothers. In the 3-5 year age-group, children born to mothers who had gestational diabetes were more active, possibly indicating that these mothers became more health conscious following the diagnosis of diabetes, and so encouraged their children to be more active.

Objective measurements of physical activity were made on 593 SWS children at age 4 years, [32] using an Actiheart monitor. On average, children were active for two-thirds of each day, but nearly 90% of active time was spent in light physical activity. There were no differences in children's average daily levels of sedentary and light physical activity by temporal and demographic factors, but differences emerged when activity was segmented across the day. Sex differences were largest in the morning, with girls being more sedentary and less active than boys. Children were more sedentary and less active in the morning if they attended childcare full-time compared with part-time, and on weekend mornings compared with weekdays. The reverse was true for weekend afternoons and evenings. Children with more educated mothers were less active in the evenings. During summer rather than winter evenings children were less sedentary and did more moderate or vigorous activity.[32] Children's and mothers' activity levels were positively associated at all activity intensities.[20]

### **Focus groups discussions with women of lower and higher educational attainment**

The aim of these focus groups was to explore the differences between women of lower and higher educational attainment in relation to influences on their diets.[17] The key theme underlying the focus group discussions with women of lower educational attainment was their sense that they lacked control over food choices for themselves and their families, with partners and children giving them little support for making healthy food choices and exerting a high degree of control. Healthy food was perceived to be expensive and they felt they could not afford to buy food that might not be eaten. Having limited skill and experience with food further undermined the ability of these women to feed their families as they felt they should. Women of higher educational attainment felt far more in control, received more social support, were less constrained by the environment in which they lived and tended to have a greater store of skills and experience with food than women of lower educational attainment. There were also clear differences in their level of food involvement, demonstrated by the way they spoke about cooking and eating. Women of lower educational attainment spoke almost entirely about the importance of feeding their children and partners,

and appeared to demonstrate lower overall food involvement largely because they were generally less interested in eating and cooking for themselves, than women of higher educational attainment. This did not appear to apply to cooking for their families, to which they gave higher priority. Women of higher educational attainment, on the other hand, described engaging in cooking and eating for themselves, as much as for their partners and children.

## Discussion

It is apparent that older women and those with higher educational attainment have better diets for themselves and for their children. Children's diets appear highly influenced by those of their mothers and indeed reflect their mothers' diets before the children were even conceived. Women who smoked had poorer quality diets before and during pregnancy, and so did their children. Living in more disadvantaged circumstances was associated with poorer diets, and mothers in such circumstances appear to have lower levels of food involvement.

Infant feeding practices varied considerably between different countries in Europe, with infants in some countries being fed little in the way of commercial foods while in others such foods are used extensively. Within Greece, there appeared to be differences in both physical activity levels and fruit and vegetable consumption between children living in large urban versus rural areas or small towns. Compared with large urban areas, those in rural areas tended to be more likely to achieve recommendations, but for those in urban areas the findings were more mixed.

Both the quantitative and qualitative work in the UK showed that psychological factors in the women appeared to influence their and their children's diets. Women with a greater sense of control and who have higher levels of food involvement were empowered to eat more healthily and to feed their children better.

### Strengths and weaknesses

Data from seven EU countries contributed to these analyses. Differences were seen between the countries in the diets of the children, but the data on women, both non-pregnant and pregnant, come solely from the UK, making it hard to generalise the findings. Uniquely, the SWS allowed influences to be tracked from before conception. The UPBEAT trial provided insights into the behaviours of pregnant women who are obese, while SIH and Nutwell examined the psychological influences on health behaviours. The CHOP study provided comparisons across national boundaries, while GENESIS gave greater insights into diets and lifestyles of young children, and could be compared with the SWS. The GENESIS study also allowed comparisons between those living in various types of area of residence.

### Pointers for development of interventions

Education is clearly associated with better health behaviours, but while improved educational attainment is a worthy goal, this is challenging to implement. Other influences such as age and parity of the mother cannot be modified. However, empowering mothers to improve their sense of control and self-efficacy is indicated. The UPBEAT pilot trial



showed promising results of an approach to improve psychological factors, and similar methods were used in SIH. The SWS has shown that diets in women track from before pregnancy and influence their children's diets, pointing to interventions that operate before pregnancy. This suggests that greater effort should be invested in accessing groups of women pre-conceptionally, however challenging this is, since investment in this phase of the lifecourse would appear to pay dividends. School-based interventions aimed at adolescents offer scope for this,[33] though for most school students, child-bearing will be many years hence. Interventions during pregnancy or targeting families with young children are also important if the cycle of poor health behaviours across generations is to be broken.

The variation seen in infant feeding across countries in the European Union is of interest, but insights from this work are limited to certain aspects of feeding. Greater uptake and longer duration of breastfeeding is strongly encouraged already. The urban/rural differences noted in GENESIS, may point to interventions in relation to the physical environment. Extending some of the single country work to other countries would be informative.

Future work within the studies described here will add to evidence base. The SWS and CHOP studies are continuing follow-ups of the children at older ages, and further analyses of the GENESIS study are being conducted. In Southampton, additional focus groups with mothers of young children have been conducted and are being analysed. Also two new intervention studies have commenced, one in pregnant women, incorporating the behaviour change approaches used in SIH, and another aimed at improving health behaviours in teenagers, before they embark on having their own children. The UPBEAT trial has completed recruitment, and the results of the full trial will provide extensive information on a behaviour change intervention in obese pregnant women; follow-up of the infants will provide insights into the impact of the intervention on infant feeding and the infants' health, development and body composition.

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**Table 1**  
**Contribution of studies to the different components of the synthesis of findings**

Study <sup>2</sup>	Non-pregnant women		Pregnant women	Infants	Children	
	Diet	PA <sup>1</sup>	Diet	Diet	Diet	PA <sup>1</sup>
<i>Cohort study</i>						
SWS	✓	✓	✓	✓	✓	✓
<i>Intervention studies</i>						
UPBEAT			✓			
CHOP				✓		
SIH	✓				✓	
<i>Cross-sectional studies</i>						
GENESIS				✓	✓	✓
Nutwell	✓					

<sup>1</sup>Physical Activity

<sup>2</sup>Full study names and details are given in the text.