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The implementation of early nutrition programming in scientific publications, nutrition policies and parental infant feeding information in Europe

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This work is dedicated to my parents,

my constant source of love, confidence and support,

and to my grandmother, who would have been very proud and delighted.

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List of Abbreviations

BF	breastfeeding
CF	complementary-feeding
CVD	cardiovascular diseases
GOV	government
IND	industry
MF	milk-feeding
PROF	professional associations
RCT	randomised controlled trials
SIG	special interest groups

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1. Introduction

In contemporary science it is widely acknowledged that metabolic influences during critical time windows of pre- and postnatal development have persisting modulating effects on health in later life, a concept often referred to as nutrition or metabolic programming *(Koletzko, 2005)*. In an extensive review of study findings in humans Dörner (*1975)* concluded that environmental influences during critical periods of development are capable to determine functions of metabolic processes in adult life and the term programming has been introduced into scientific literature to describe the finding that hormones, metabolites and neurotransmitters during critical early periods of development are capable of pre-programming brain development and up to human adulthood functional disturbances, diseases as well as syndromes of reproduction and metabolism. More recently, Lucas *(1991, 1994)* and Barker *(1992, 1994)* rediscovered the concept and the former coined the well-established definition of metabolic programming as “either the induction, deletion, or impaired development of a permanent somatic structure or the setting of a physiological system by an early stimulus or insult operating at a sensitive period, resulting in long-term consequences for function” (*Lucas, 1991*). Strong evidence could be obtained from animal models (*Martin-Gronert, 2005; Symonds, 2006*), but also from intervention and observation studies in humans *(Decsi, 2005; Krauss-Etschmann, 2007; Hibbeln, 2007*), confirming early origins of adult morbidity *(Buckley, 2005; Gluckman, 2005; Miles, 2005)*. Of major public health relevance are preventive long-term effects towards pandemic diseases, like obesity and allergies (*von Kries, 1999; Koletzko, 2006; Miles, 2007*). Facing the substantial burden of diseases attributable to diet (*Yach, 2004*) the concept embeds an immense preventive potential towards adverse health

outcomes with increasing prevalences all over Europe, like obesity *(Wilson, 1998; von Kries, 1999)*, allergies *(Marini, 1996)*, diabetes *(Virtanen, 2003)*, and CVD *(Fall, 1992; Singhal, 2003)*.

For about 50 years the scientific community has been aware of nutrition induced long-term programming effects on health, but there is little systematic comparison of the various scientific publications. Furthermore it is not surveyed to which extent this concept is implemented in contemporary feeding policies in Europe and communicated to consumers. The British politician Benjamin Disraeli *(1804-1881)* already stated *"the most successful man in life is the man who has the best information"* and regarding the impact of informed choices towards good health and quality of life the message is still as relevant today as years ago. In Europe there are several governmental and non-governmental consumer protection organisations and associations aiming at the appropriate consideration of consumer rights on the political agenda. The European Commission itself sent a clear signal about the meaning of consumer needs in the area of food quality and safety by funding the present evaluation and underlying consumer science studies. These studies have been conducted in five European countries representing the different parts of the European Union.

The aim of the dissertation is to compose a profound overview of the current standard of evidence of early nutrition programming reflected from scientific publications, provide a base-line analysis of the reflection of early nutrition programming in infant feeding policies and a comparative evaluation of the reflection of early nutrition programming in infant feeding information.

2. Reflection of early nutrition programming in scientific publications

Physiology, epidemiology and clinical science contribute to the progress in the field of programming, which has been summarized in recent reviews *(McArdle, 2006; Symonds 2006; Simmons, 2005)*. The focus of the following overview on scientific publications addressing nutritional programming is on results which seem to be meaningful regarding the composition of infant feeding policies and parental feeding information respectively.

In medical history inheritance played for a long time a dominant role regarding the aetiology of diseases. This is different today, because the importance of environmental influences could be convincingly demonstrated. The association between low birth weight and increased risk of impaired health in later life, for example, may be explained at mainly by an influence of early nutrition, whereas former publications tend to point out the genetic influence. In a study of 64 years old monozygotic twins with different glucose tolerance, birth weights were lower in the twins with abnormal glucose tolerance: In the non insulin dependent diabetics and impaired glucose tolerance groups the birth weight was both significantly lower than in twins with normal glucose tolerance *(Poulsen, 1997)*. Since twins are genetically identical, this finding indicates that the association between birth weight and non insulin dependent diabetes mellitus is at least partly independent from the genotype and may result from an influence of intrauterine nutrition and early postnatal diet. Already in the 1950ies, Widdowson and McCance *(1963)* showed that alteration of early growth by manipulation of feeding conditions during sensitive pre- and postnatal

periods predetermined the weight of rats in adulthood. In humans high birth weight has been proposed as a risk factor for later overweight *(Eriksson, 2003)*, which could reflect both the roles of genetics and of early programming by intrauterine environment. Recent studies also pointed to further programming of childhood overweight in the first months and years of life by a high postnatal weight gain (Stettler, 2005; Ekelund, 2006). It has long been known that infants fed breast milk differ in their growth kinetics from formula fed infants who show higher weight and length gains *(Kramer, 2004)*. Based on a systematic review of 19 studies in affluent populations, Dewey concluded that by the age of 12 months, the cumulative difference in body weight amounts to approximately 400 g in infants breast-fed for 9 months and as much as 600-650 g in infants that are breast-fed for 12 months *(Dewey, 1998)*. Given this very large effect of the mode of feeding on early weight gain, it is likely to assume that breast-feeding might confer protection against later obesity risk.

2.1. Association of early nutrition and later obesity

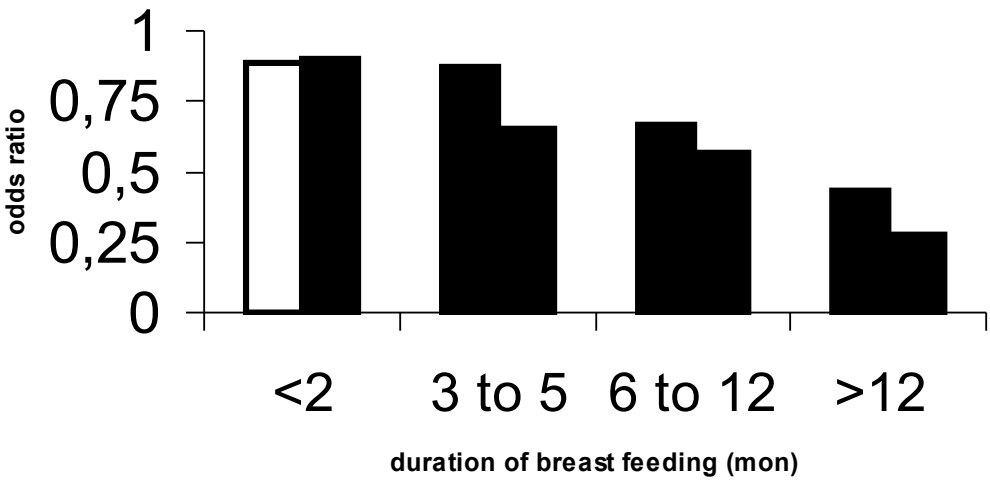
Childhood obesity is considered a global epidemic in view of the alarming increase of its prevalence and severity, not only in affluent but also in less privileged childhood populations worldwide *(Janssen, 2005)*. Serious short and long term consequences of childhood obesity arise in terms of damage to quality of life, performance, health and life expectancy. In addition, the size of the obesity epidemic is estimated to create huge costs for society due to loss of productivity and ensuing costs for health

care and social security. Faced with the size of the problem, widely available and effective medical management of children that are already obese is needed, but at present the results of available treatment concepts are far less than satisfactory *(Summerbell, 2005)*. Thus, in the present situation the emphasis must be put on development, evaluation and implementation of effective primary prevention of obesity. Several indications exist that modification of infantile nutrition, such as promotion of breast-feeding, may contribute to decreasing later obesity risk *(Schack-Nielsen, 2006)*.

In a cross sectional survey in Bavaria, Germany, the impact of breast-feeding on the risk of obesity and the risk of being overweight in children at the time of school entry has been assessed *(von Kries, 1999)*. Routine data were collected on the height and weight of 134.577 children participating in the obligatory school entry health examination. In a sub sample of 13.345 children, data on early feeding, diet and lifestyle factors were obtained using a questionnaire completed by parents. Data of 9.357 children aged 5 and 6 who had German nationality were included in the final analysis. Being overweight was defined as having a BMI above the 90th centile and obesity was defined as BMI above the 97th centile of all 134,577 enrolled German children. The prevalence of obesity in children who had never been breast fed was 4.5% as compared with 2.8 % in breastfed children. A clear dose-response effect was identified for the duration of breast-feeding on the prevalence of obesity: the prevalence was 3.8% for 2 months of exclusive breast-feeding, 2.3 % for 3-5 months, 1.7 % for 6-12 months and 0.8 % for more than 12 months. Similar relations were found with the prevalence of being overweight. The protective effect of breast-feeding was not attributable to differences in social class or lifestyle.

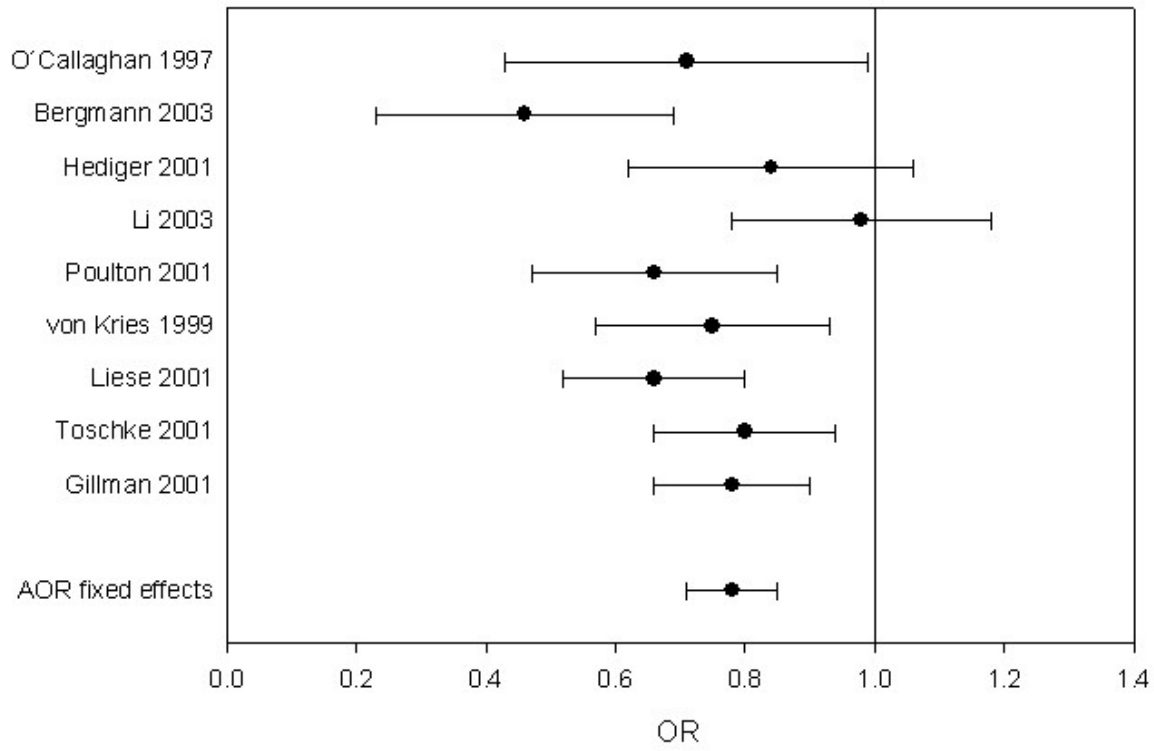
After adjusting for potential confounding factors, breast-feeding remained a significant protective factor against the development of obesity (odds ratio 0.75, 0.57 to 0.98) and being overweight (0.79, 0.68 to 0.93), again with a clear dose-response relationship between duration of breast-feeding and later risk of overweight and obesity, respectively (Figure 1).

Figure 1: Dose-response relationship between duration of breast-feeding and later risk for overweight (striped bars) and obesity (light bars) *(von Kries, 1999)*



Following this publication, a number of other investigators studied this relationship in data from various cohorts around the world. A systematic review and meta-analysis of published epidemiological studies (cohort, case-control, and cross-sectional studies) comparing early feeding-mode and adjusting for potential confounding factors showed that breast-feeding reduced the risk of obesity in childhood significantly (Arenz, 2004). The adjusted odds ratio of nine studies with more than 69.000 participants was 0.78, (0.71 to 0.85) in the fixed model (Figure 2).

Figure 2: Effect of breast-feeding vs. formula feeding on obesity: covariate-adjusted odds ratios of nine studies and pooled adjusted odds ratio *(Arenz, 2004)*



The assumption of homogeneity of results of the included studies could not be refuted (Q-test for heterogeneity, p>0.3), stratified analyses showed no differences regarding different study types, age groups, definition of breast-feeding or obesity and number of confounding factors adjusted for. A dose dependent effect of breast-feeding duration on the prevalence of obesity was reported in four studies. Funnel plot regression gave no indication of publication bias.

A meta-analyses, published in 2005, confirmed a protective effect of breast-feeding on the risk of becoming obese by reporting an odds ratio of 0.87 (0.85 to 0.89) after analysing 61 studies including almost 300.000 subjects (Owen, 2005a). In the same year Harder et al. *(2005)* looked at the relationship between the duration of breast-feeding and the risk to become overweight and identified a 4% decrease in the risk of becoming overweight per month of breast-feeding in their meta-analysis.

In a further meta-analysis the inclusion of additional unpublished studies and the considering of later BMI instead of obesity risk as outcome variable only revealed a difference of 0.04 kg/m2 (0.05 to 0.02) in mean BMI between formerly breast fed and formula fed subjects *(Owen, 2005b)*. Even this small effect was abolished, if only the 11 studies were considered, where simultaneous adjustment for maternal BMI, socio economic status and maternal smoking during pregnancy was possible. Although the conclusion is that promotion of breast feed would not be likely to reduce mean BMI, the authors state it might nevertheless reduce the prevalence of obesity if weight distribution is affected. Mean BMI would not change, if both prevalence of obesity and prevalence of underweight would be decreased by breast-feeding compared to formula feeding.

As indicated correction for confounding by socio economic factors, while comparing breast fed and formula fed subjects with respect to weight evolution in later life, is important and residual confounding can hardly be excluded. Thus, the possibility remains that both the decision to breast feed and the obesity risk are influenced by a common socio economic factor. Gillman et al. (2006) performed a within-family and an overall analysis in their data set on former infant feeding and later BMI at age 9 to 14 years. They identified 2.372 siblings in their cohort with different breast-feeding experience. The siblings were divided into two groups either receiving breast milk longer or shorter than the respective family mean value, which corresponded to average difference in breast-feeding duration of 3.7 months. After inclusion of co-variates, e.g. age, birth weight, Tanner stage, an odds ratio of 0.92 (0.76 to 1.11) to be overweight was found in the longer breast fed siblings compared to the less breast fed group.

This is very similar to the odds ratio of 0.94 (0.88 to 1.00) computed for a 3.7 month increase in breast-feeding duration in the overall analysis, after inclusion of maternal BMI, maternal smoking and household income as co-variates (which can all be considered identical between siblings). This indicates that the apparent protective effect of breast-feeding is unlikely to be only simulated by a non accounted socio economic factor.

A number of hypotheses can be raised on potential causes for a protective effect of breast-feeding. Since one cannot randomise healthy babies to feeding breast milk or formula for ethical and practical reasons, undisputable proof for a protective effect of breast-feeding can hardly be obtained. A detailed elucidation of mechanisms mediating the protective effect of breast-feeding would further support the concept.

2.2. Association of early nutrition and neurodevelopment

Besides the investigation of programming effects in relation to later obesity risk, cardiovascular disease and the metabolic syndrome several other long term outcomes of early nutrition have received considerable attention during the last years, amongst them the long term effects of the availability of LCPUFA during the perinatal and early postnatal period.

Human milk contains n-3 and n-6 LCPUFA, which have been absent from many infant formulae until recently *(Koletzko, 2001)*. The perinatal period is a time of intense accretion of these fatty acids in foetal and infant brain and other nervous

tissues *(Clandinin, 1999)*. While it has been observed in many clinical trials that biochemical measures of LCPUFA status can be improved by exogenous supplementation with LCPUFA *(Fleith, 2005)*, it is a matter of ongoing debate whether there is a long term neurological benefit for the infants from optimizing their fatty acid supply during pregnancy or early postnatally *(Szajewska, 2006)*. However, almost all studies have investigated the neurological development during the first two years of life, which implies that longer term effects could not become obvious and the examinations were done during a period of life, when minor neurological dysfunctions might not have become detectable yet *(Hadders-Algra, 2005)*.

2.3. Conclusions

Although the underlying mechanisms of nutrition programming remain to be further elucidated, numerous recent studies indicate that, in addition to genetic disposition, environmental factors strongly influence lifelong health and the risk of development diseases. The potential impact of programming on public health can be exemplified by considering the observation that 13 to 16 year old teenagers, who were breast fed showed an significant lower arterial blood pressure (81.9±7.8 mm Hg) than those who had received infant formula (86.1±6.5 mm Hg) *(Singhal, 2001)*. The authors point out that this difference is greater than the effects of other blood pressure lowering measures, such as weight loss, salt restriction and physical exercise.

A 2 mm reduction of blood pressure has been estimated to correspond to 17 % and 6 % reductions in the prevalence of hypertension and coronary heart disease, respectively. Early growth pattern has been shown to be related to abdominal obesity, atherogenic dyslipidemia, elevated blood pressure, insulin resistance and unfavourable LDL/HDL cholesterol ratio, which are major components of the metabolic syndrome *(Hales, 1991; Barker, 1993a; Barker, 1993b)*.

This further highlights the importance of the inclusion of the current status of scientific knowledge into infant feeding policies and parental infant feeding information, because adverse health outcomes, like metabolic syndrome and obesity, show dramatically increasing prevalence in developed and developing countries and represent major health risks *(Ford, 2004)*.

3. Reflection of early nutrition programming in policy documents on infant feeding: comparative analysis of five European countries

The aim of this study was to show to what extent and how the health consequences of early nutrition are integrated into infant feeding policies in 5 European countries (Finland, Germany, Hungary, Spain, and United Kingdom).

3.1. Background

As shown in Chapter 2 there is a general understanding in scientific publications on the importance of early nutrition for later health, but there is little research identifying how these findings are adopted and transformed into national infant feeding policies and recommendations. The burden of diseases attributable to nutrition is substantial (*Yach, 2004*) as well as the preventive potential of appropriate infant feeding and both has to be expressed in nutrition policies and recommendations.

Ideally, scientific results should be represented in sound and sustainable policies providing sources of information for health professionals and subsequent be communicated to parents (Figure 3).

Figure 3: Communication flow from scientific results to parental knowledge

A well-established communication flow is one of the primary goals of health education, because it enables parents to make informed decisions how to best feed their infants.

There is evidence from other health care areas, that the content of policies do not reflect scientific results properly (*Garvin, 2001*) and there are suggestions that this may also be the case with infant feeding (*Stover, 2006*) - a phenomenon called "science-policy-gap" *(Levi, 2002)*.

Scientific bodies and policy makers can differ in their approach to communication: on the one hand scientists often fail to include practical, to-the-point conclusions in their publications and to actively market their most important results, thus hindering the communication flow towards decision makers, who are not used to scientific language and do not have the resources to access associated scientific literature *(Choi, 2003)*. On the other hand decision makers may be less comfortable with scientific uncertainty. While scientists are familiar with uncertainty, this is more difficult for decision makers, who need to work towards solutions that are preferably based on certainty and deterministic in nature (*Bradshaw, 2000)*. Thus, it is likely that the meaning of early nutrition for lifelong health may not be reflected in infant feeding recommendations properly.

This hypothesis will be surveyed in the present review of early nutrition programming statements in infant nutrition policy documents comparing five member states of the European Union. The aim is to show trends regarding the reflection of the metabolic programming concept, the specification of the health outcomes and related time perspective, and corollary information on feeding behaviour, like the incorporation of the WHO recommendation on exclusively breastfeeding for 6 months *(WHO, 2001, 2002)*. In addition it has been evaluated if the recommendations were based on scientific evidence.

3.2. Material and Methods

National infant feeding policy documents were identified and reviewed between July and October 2005 in Finland (FI), Germany (DE), Hungary (HU), Spain (ES) and United Kingdom (UK). Particular emphasis was placed on documents covering the relationship between early nutrition and lifelong health. Via a standardized searching procedure websites of government bodies and professional associations and colleges have been contacted to locate relevant stand-alone documents on infant nutrition. These should have policy-like characterisations (i.e. feeding policies, public health recommendations, and guidelines) and targeting towards health professionals.

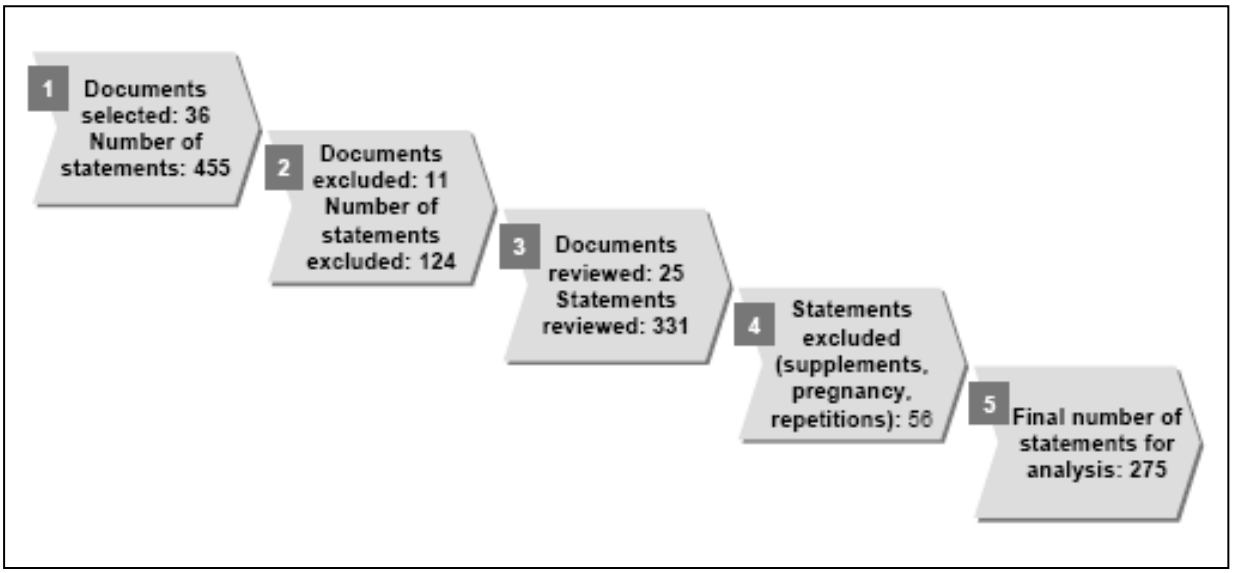
We included documents on national level about breastfeeding and formula feeding, the introduction of solids and complementary feeding of healthy infants aged 0-12

months. Documents targeting non-healthy infants, representing research and literature reviews, and information not provided as stand alone have been excluded.

3.2.1. Inclusion and exclusion criteria of programming statements

The selected documents were screened for statements on nutritional programming. At the outset statements on non-nutritive substances including alcohol and all toxicological substances and non-feeding related behaviour as smoking were excluded. Retrospectively statements referring to supplements, pregnancy or non-programming related diseases like botulism, food poisoning, sudden infant death or chocking were excluded. In case of a health outcome was being repeated in consecutive sentences only the first occurrence was included for analysis. The selection procedure is shown in Figure 4.

Figure 4: Flow-chart of the selection procedure



3.2.2. Classification of the statements

In total, 275 nutrition programming statements were selected and classified into 15 health outcome categories (Table 1).

Table 1: Categories of health outcomes and examples

Health outcome category	Included outcomes	Examples from the database
Risk of disease	diseases, sickness, illness, morbidity	*…the occurrence of illnesses increases with formula feeding…*
Risk of infection	infections as general, gastrointestinal, chest, respiratory, ear, urinary infections and meningitis.	*…breastfed babies are less likely to develop gastrointestinal, respiratory and urinary infections…*
Obesity	obesity, overweight	*…breast-fed children were less likely to be overweight at school age…*
Gastrointestinal diseases	Gut function, celiac disease, Crohn's disease, inflammatory bowel disease, necrotizant enterocolitis,	*.. benefits from breastfeeding may also be a reduced risk of gastro-intestinal disorders in later life such as Crohn's disease and celiac disease…*
Diabetes	Diabetes type I, type II, unspecified, insulin resistance	*…breastfeeding has a protective role in relation to juvenile diabetes…*
Allergy	atopic disease, atopic dermatitis, asthma, allergic rhinitis, food allergy, eczema	*…introducing solids too early can increase the risk of the development of allergies such as eczema and asthma…*
Cardiovascular disease (CVD)	coronary heart disease, stroke, blood cholesterol, blood pressure	*…breastfeeding has also been associated with lower blood pressure in childhood and adolescence…*
Cancer	leukaemia, malign lymphoma, breast cancer (in offspring)	*…breastfeeding has protective effects against the leukaemia…*
Bone disease	osteoporosis, bone formation, osteomalazia, rickets	*…the abundant and unfavourable composed nutrition is the most important cause of diet-related diseases like osteoporosis…*
Health in general	health advantages, benefits, survival, positive health effects	*…breastfeeding improves the health of the baby*
Growth and development	development in general, growth in general, physiological functions	*…nutrition in the early years of life is a major determinant of growth and development…*
Immune function	body's defenses, antibodies	*…breast milk contains antibodies which are important for the development of child's immunity…*
Eating habits	sweet or salty food preferences, taste	*… infants who had not been given sugar solutions had less preferences for sweet tasting foods later on…*
Mental development	neurodevelopment, brain and cognitive development, IQ, behaviour, visual function, mental and emotional stability	*…a study shows a better neurological development among 9 year old children who has been breast-fed compared to non-breastfed…*
Others	metabolism, thyroid hormones, anaemia	*…the diet during the development has influences in the long-term*

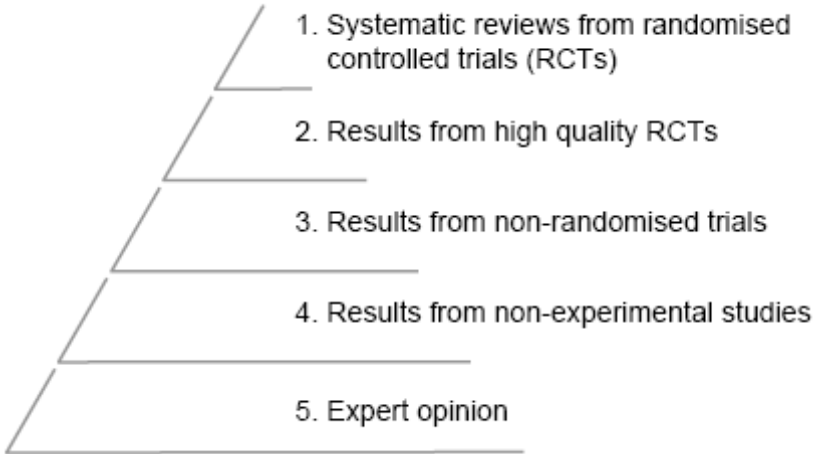
In addition to stated health outcomes the programming statements were further characterized as follows:

- duration of health effect
    - short-term, from 0 to 5 years of age *(…breastfed babies are less likely to suffer from infections…)*
    - medium-term, between 5 and 15 years of age *(…earlier introduction of solids has been associated with an increased probability of wheezing during childhood and an increased percentage of body fat and weight at 7 years of age…)*
    - long-term, from 15 years of age to adulthood *(…infancy and childhood are critical stages in the development of eating habits that will affect the individual health in later years…)*
- health outcome related feeding behaviour
    - breastfeeding in general *(…breastmilk protects the baby from infections…)*
    - breastfeeding exclusively for 6 months *(…infants who are exclusively breastfed for six months experience less allergic reactions…)*
    - formula feeding *(…probiotics in formula could have preventive long-term effects, like stimulation of the immune system…)*
    - complementary feeding *(…food that holds a high allergen potential should be avoided in the first year of life; that includes: cow milk, hen egg, fish, soy, nuts*…)
    - feeding in the first year of an infant, covering both, the milk feeding and complementary feeding stage *(…appropriate feeding practices are of fundamental importance for the growth and development of infants…)*

- specified reference base

  If any citation or reference was given within the programming statement the evidence was assigned according to the Cochrane Library ranking in order of type and strength of evidence (Figure 5).

Figure 5: Ranking in order of type and strength of evidence *(adapted from CRD training materials, 2003)*



3.2.3. Statistical analysis

Quantitative comparisons were made between countries and publishers, i.e. government (GOV) and professional associations (PROF), using SPSS statistical software package *(SPSS for windows, versions 14.0, USA)*.

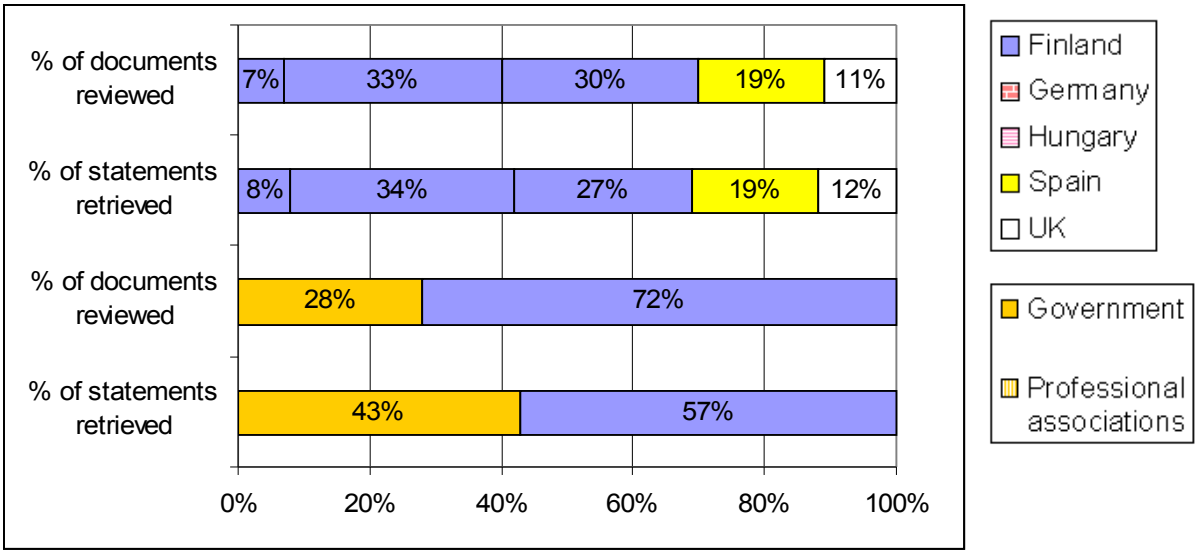
3.3. Results

In total 25 (FI: 2, DE: 9, HU: 7, ES: 5, UK: 2) policy and recommendation documents have been included of which 7 (FI: 2, DE: 3, UK:2), were published by government bodies and 18 (DE: 6, HU: 7, ES: 5) from professional associations. The details of the documents are listed in the appendix.

3.3.1. Origin of statements

A total of 275 programming statements (FI: 25, DE: 97, HU: 52, ES: 48, UK: 53) were identified for analysis. The percentage of statements retrieved is proportionate to the percentage of documents reviewed per country, whereas comparison between publishers shows an inverse relation in that government policies contained more statements than those from professional associations (Figure 6).

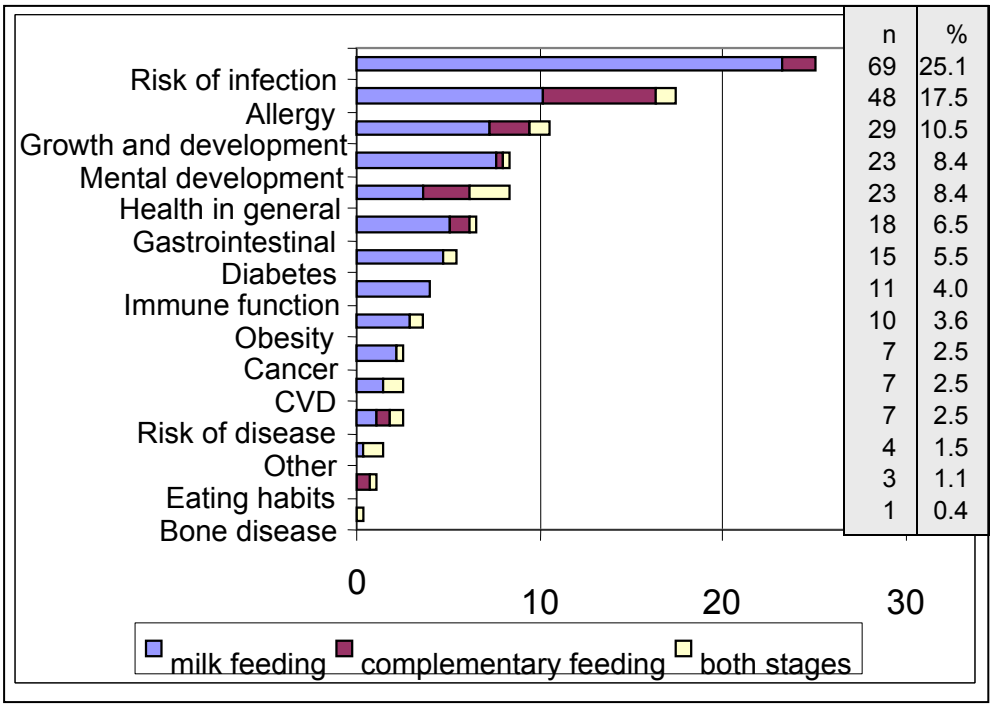
Figure 6: Proportion of documents reviewed and statements retrieved



3.3.2. Frequency and stage of cited health outcomes

Overall the most frequently cited outcomes were risk of infections (25.1%), followed by allergies (17.5%) and growth and development (10.5%). Most statements reflect the milk feeding period; however, for certain health outcomes complementary feeding was more important, e.g. eating habits (Figure 7).

Figure 7: Frequencies of cited health outcomes / all countries



Differences of countries are reflected in Table 2: Germany and Hungary have similar patterns, i.e. high frequency of risk of infections (DE: 22.7%, HU: 23.1%) and allergies (De: 17.5%, HU: 28.8%), whereas the most frequent health outcome in Finland and the UK after risk of infections (FI: 20.0%, UK: 18.8%) was mental development (FI: 24.0%) and health in general (UK: 20.8%) respectively. In Spain the risk of infection category was with 41.8% most dominant.

Certain health outcome categories were completely neglected (i.e. =0%) in particular countries (FI: health, eating habits, bone disease, DE: eating habits HU: immune function, cancer, bone disease, ES: risk of disease, CVD, eating habits, bone disease, UK: immune function, cancer, bone disease).

Table 2: Frequencies of cited health outcomes per country

	Finland		Germany		Hungary		Spain		UK	
	n	%	n	%	n	%	n	%	n	%
Risk of infection	**5**	**20.0**	**22**	**22.7**	12	23.1	**20**	**41.7**	**10**	**18.9**
Allergy	3	12.0	17	17.5	**15**	**28.8**	5	10.4	8	15.1
Mental development	6	24.0	9	9.3	4	7.7	2	4.2	2	3.8
Gastrointestinal diseases	3	12.0	4	4.1	2	3.8	4	8.3	5	9.4
Diabetes	1	4.0	4	4.1	4	7.7	4	8.3	2	3.8
Immune function	1	4.0	8	8.2	0	.0	2	4.2	0	.0
Obesity	1	4.0	3	3.1	4	7.7	1	2.1	1	1.9
Cancer	1	4.0	3	3.1	0	.0	3	6.3	0	.0
CVD	1	4.0	2	2.1	2	3.8	0	.0	2	3.8
Eating habits	0	.0	0	.0	0	.0	0	.0	3	5.7
Bone disease	0	.0	1	1.0	0	.0	0	.0	0	.0

bold = dominant category, data of more general outcome groups not shown

Comparisons between publishers showed that beside risk of infections (GOV: 24.4%, PROF: 25.6%) mental development, immune function, eating habits, and CVD are stronger focused within governmental releases and allergies, diabetes, and obesity within those from professional associations (Table 3).

Table 3: Frequencies of cited health outcomes per publisher

	Government		Professional associations	
	n	%	n	%
Risk of infection	**29**	**24.4**	**40**	**25.6**
Allergy	13	10.9	35	22.4
Mental development	14	11.8	9	5.8
Gastrointestinal diseases	9	7.6	9	5.8
Diabetes	4	3.4	11	7.1
Immune function	7	5.9	4	2.6
Obesity	3	2.5	7	4.5
Cancer	2	1.7	5	3.2
CVD	4	3.4	3	1.9
Eating habits	3	2.5	0	.0
Bone disease	0	.0	1	0.6

bold = dominant category, data of more general outcome groups not shown

3.3.3. Health outcome related feeding behaviour

The feeding behaviour reflected in most of the statements was breastfeeding (69.5%) more specifically breastfeeding in general (43.3%, n=119), exclusively breastfeeding (20.4%, n= 56) and exclusively breastfeeding for 6 months (5.8%, n=16). Breastfeeding was mainly related to prevention of all kind of infections and promotion of mental development, all above intelligence and emotional stability.

Formula feeding was addressed in 3.6% (n=10) and complementary feeding in 16.0% (n=44) of the statements. Further 10.9% (n=30) referred to feeding of an infant in the first year, not specifying a certain feeding stage. Feeding advices towards the prevention of allergies aimed at exclusively breastfeeding and the role of HA formula respectively in the milk feeding stage and at the avoidance of certain foods and a too early introduction of solids in the complementary feeding stage.

There was, however, considerable variety among the countries: In Finland and Spain all statements referred to breastfeeding, with the Finnish not specifying the duration, whereas the Spanish referred quite often at exclusively breastfeeding for 6 months. A similar emphasis of the 6 months exclusivity was observed in UK documents and complementary feeding related statements were also prominent. Hungarian documents mainly focused on complementary feeding. Concerning breastfeeding the Hungarian advices demonstrated the benefits of exclusive breastfeeding, even though not explicitly for 6 months. Besides complementary and formula feeding the German statements aimed at breastfeeding in general and if exclusively rather unspecified than for 6 months.

Overall the WHO recommendation for 6 month exclusively breastfeeding was similarly reflected within governmental and health professional documents.

3.3.4. Documented reference base

Fewer than half of the statements (44.7%, n=123) made reference to an evidence base, whereas reviews of RCT's, the highest category according to the Cochrane pyramid, were only cited in policies coming from Finland (3.2%). RCTs build 14.0%, non-randomised trials 19.0%, non-experimental trials 13.2%, and expert opinions 50.4% of cited references. There is further considerable variation across countries with regard to the proportion of statements citing evidence and the quality thereof, with most statements (91.7%) citing evidence in Spain, followed by the UK (60.4%), Finland (48.0%), and Germany (34.0%) to Hungary, with 5.8% of statements reference based, all of them expert opinions.

The origin, i.e. country in which evidence gathered, of cited studies was given in 39.1% (n=108) of the total references: the majority (63.8%, n=69) coming from European member states (Germany, United Kingdom, Sweden, Norway, Netherlands, Finland, Lithuania, Belarus), 11.1% (n=12) from the United States and 25.1% (n=27) were published in other countries, e.g. Canada, Australia, Honduras and United Arab Emirates. A number of key publications were cited in more than one country, e.g. Lucas 1994 (DE, ES, UK), Howie 1990 (DE, ES, UK), von Kries 1999 (FI, DE), Dewey 2003 (FI, ES), and Koletzko et al. 1998 (DE, ES).

Documents produced by governments tended to contain more references to evidence (57.1%) compared to documents from professional associations (35.9%).

3.3.5. Duration of health effects

In half of the statements (50.2%, n=138) the duration of health effects was not reflected. Of the remaining statements, 26.9% (n=74) referred to short-term, 10.5% (n=29) to medium-term, and 12.4% (n=34) to long-term effects. The latter both categories are most interesting because they correspond to the intrinsic definition of programming, i.e. health effects that persist or appear in later life. The direct term "programming" was rarely used (e.g. *…there is a growing number of hints that the defence system of the child is being programmed for its entire life...*) and no document included a definition of the concept. However, the functions of programming were often been described in detail (e.g. *…breast milk contains cytokines which stimulate unspecific and specific immune responses and so influence the long-term reactions of the immune system of the child…*).

Cross-country comparisons reflected different patterns with regard to the specification of duration of health effects: in Finland there was no mention of long-term effects, whereas 24.1% were linked to medium-term effects. In Germany 40% of the statements were linked to either medium- or long-term perspectives, whereas in Spain and the UK the focus was more on long-term (ES: 32.4%, UK: 20.6%) than medium-term perspective (ES: 17.2%, UK: 6.9%). Hungarian statements were less likely to mention the duration (3.4% medium-term, 5.9% long-term effects).

Documents produced by governments tended to emphasize the medium-term, whereas those produced by health professional associations emphasized the long-term consequences (Table 4).

Table 4: Ranking of health outcomes associated with medium-/ long-term duration

	Health outcome					
	medium-term	n	%	long-term	n	%
1.	Risk of infection	6	24.0	Risk of infection	4	12.9
2.	Obesity	5	20.0	Eating habits	4	12.9
3.	Mental development	3	12.0	Health in general	4	12.9
4.	Diabetes	3	12.0	Allergy	4	12.9

It was also found that particularly those statements that reflected a long-term perspective were not linked to evidence of a high quality (i.e. Cochrane level 1.-3.= 0%).

3.4. Discussion

3.4.1. Framework of the study

The study's focus on policy documents reflects their importance in influencing the knowledge of health professionals *(Bleakney, 1996)*, and more indirectly the advice ultimately given to parents and resulting practices in feeding, such as breastfeeding duration and weaning practices. Documents satisfying the general definition of a policy "a plan or course of action, as of a government, political party, or business, intended to influence and determine decisions, actions, and other matters" *(The American Heritage Dictionary, 2007)*, or more specific, documents, which express nutrition related goals at a higher, national decision-making level *(Solomons, 2005)* clearly distinguishing between actions to be effected and results to be achieved (*Caulfield, 2004)* were included. With respect to early nutritional influences, the period of pre-natal development and infancy are obvious frameworks (*Mannan, 2004*) and it was decided to focus on infant feeding information rather than pregnancy, because this period implies a broad spectrum of varying advice and information due to the changing needs of an infant within the first year of life.

The five included European member states represent different geographic regions (Nordic-, Western European- and Southern European countries, and Central and Eastern Europe) with differing cultural, socio economic and political contexts. There are however already some common procedures established, e.g. all participating countries make use of advisory bodies to support the government with the development and monitoring of nutrition policies and of administrative structures responsible for the implementation of food and nutrition policies (*WHO-Europe, 2006*).

Furthermore the cross-European comparison enables the identification of trends, similarities, and differences, a further important step towards development of more harmonised policies.

3.4.2. Limitations

The methodological approach in the present paper calls for some caution when interpreting the results. Because of the different languages the statements had to be identified in the corresponding countries. Even though there were standardised procedures to increase the objectivity and reliability, including repeated evaluation of a certain percentage of documents, statements and categorizations by different reviewers, selection bias may have occurred, due to the qualitative nature of the data. However, the results do not claim to reflect an exhaustive census, but they are useful for revealing meaningful trends. The practicability of such a design was shown in previous studies (*Rostgaard, 2002; Mannan, 2004; Lachat, 2005*).

3.4.3. Reflection of early nutrition programming

The aim was to select all statements on nutritional programming including characteristics such as the related feeding behaviour, time perspective of health effect and references. It was reasonable to consider all statements on nutrition related health outcomes to be able to indirectly evaluate the reflection of programming, since the term programming was rarely used.

The quantitative analyses of programming statements revealed that the density of statements per document was similar across countries. The assumption that documents produced by health professional bodies be more aligned to the scientific literature was not confirmed, neither in terms of the number of programming statements identified nor the number of references specified. This might be due to the governmental collaboration with advisory bodies mentioned before.

Within the cited health outcomes, there was a strong focus on diseases related to nutrition intake, including the well-established associations between breastfeeding and infections *(Howie, 1990; Golding, 1997)* and that of breast- and complementary feeding and allergies *(Marini, 1996; Oddy, 2002)*. Furthermore, non-specific statements relating the wellbeing of the infant, such as growth and development or health in general, were frequent. Other nutrition-related health outcomes that are becoming more and more prevalent, such as obesity *(Swinburn, 2004),* diabetes *(Steyn, 2004*), CVD *(Reddy, 2004)*, and certain types of cancer *(Bener, 2001; Key, 2004)* were reflected much less frequently. According to an extensive report of the WHO *(WHO-Europe, 2003)*, CVD and cancer form major causes of death in Europe. Links to early nutrition exist for both outcomes (*Singhal, 2001, 2003; Uauy, 2005),* but the reflection in the policies was weak (range 10 for cancer and 11 for CVD out of 15 outcome categories).

Furthermore it is remarkable that obesity, which has already reached pandemic proportions in Europe *(WHO, 2003a)* and what about numerous studies stating potential preventive effects of breastfeeding (*Dewey, 2003; Arenz, 2004; Koletzko, 2006),* could only reach range ninth in the overall ranking of health outcomes. Beside CVD and cancer the country specific disease variability *(WHO-Europe, 2003 -no data for Spain available)* was reflected as follows: In Finland the incidence of mental

health disorders has increased markedly over the past ten years and this category was stronger reflected in the Finnish statements, whereas bone diseases were considered less. In Germany the prevalence of osteoporosis is comparable and bone health was reflected, but obesity was under-represented within the statements. In Hungary, where there are recognized increased levels of diabetes and obesity, there was evidence of this being reflected in the health outcomes related to infant nutrition at proportionally higher levels than in the other countries. Finally the high prevalence of CVD in the UK was reflected through a relatively high number of corresponding statements. Other constitutional functions which benefit from certain food components, like immune and gut function (in category “gastrointestinal diseases”) *(Hanson, 1999; ILSI, 2003)*, have to a considerable extent been reflected in the statements.

3.4.4. Health outcome related feeding behaviour

Regarding the feeding stage covered the finding of Fewtrell et al. *(2003)* could be confirmed: about 74% of the statements focused on milk feeding and effects and timing of complementary feeding have been strongly neglected. This is disappointing, because there the short-, medium- and long-term health implications significantly associated with the age of solid food introduction are well-established (*Forsyth, 1993; Morgan, 2004*) and there is extensive evidence that consumption of certain types of food in the weaning diet may have positive health promoting effects (*Morgan, 2003*).

Overall only 5.8% of the statements (0% of Finnish, 1.6% of Hungarian, 4.1% of German, 9.4% of English, and 10.4% of Spanish) pointed to the recommendation of "exclusively breastfeeding for 6 months". A possible explanation for the unconvincing implementation of the "Global Strategy on Infant and Young Children feeding" recommendations *(WHO, 2002)* may be that policy makers are just beginning to accept universally recognised best practice criteria for breastfeeding and points out again the need for monitoring the up-date of policy documents in terms of emerging evidence.

3.4.5. Documented evidence base

Research evidence is more influential in central policy than local policy, where policy making is marked by negotiation and uncertainty *(Black, 2001).* As a consequence a high percentage of citations was expected with the reviewed national documents. However, statements on nutritional programming in the present study were only partially (45.0%) supported by evidence. The highest categories of the Cochrane system have been cited only in Finland. High quality studies exist and it is unfortunate that the majority of the cited publications correspond with the lower levels of evidence, e.g. expert opinions. Approximately 64% citations came from European studies, i.e. the evidence base should reflect the populations for which policies have been created. The further incorporation of US and international studies reflects an international approach. Even though some key publications have been cited by several countries they were sometimes used to support different messages.

This corresponds with Garvin's finding *(2001)* that the same set of information or facts is framed differently according to nationally defined needs and situations. Again, more centralised monitoring structures following the example of the United States *(Briefel, 1996)* could be supportive of the goal of harmonised policies for Europe.

3.4.6. Health outcome related time perspective

Interestingly, in association with the specification of the medium- or long-term duration of programming related health outcomes, such as obesity, diabetes, and CVD, has already been integrated into the policies. However, the long-term duration was rejected with regard to health outcomes with later onset, such as cancer or bone disease. In light of the large number of scientific publications relating to nutritional programming, the frequency of cited references was relatively low.

3.5. Conclusions

In summary, the concept of nutritional programming has been integrated to a considerable extent in infant nutrition policies among the five European countries. However, the relevance of nutrition for long-term health, particularly chronic diseases, could have been more apparent and reference based. Research on nutrition programming is still ongoing and the mechanisms and critical windows are not yet clearly established.

This might be perceived by policy makers as lack of consensus and evidence, due to complexity and scientific controversy. An improvement of the dialogue between science and policy makers would be helpful: researchers need a better understanding of the policy process and policy makers should become more involved in the conceptualisation and conduct of research (*Black, 2001)*. Having access to adequate information on nutrition is a basic right of the public *(Brom, 2000; FAO, 2003)* and especially in light of the well-acknowledged *(WHO, 2003a, 2003b)* preventive potential of early nutritional influences on the genesis of non-transmissible diseases in adult life the urge for action becomes evident.

4. Reflection of early nutrition programming in parental information of infant feeding

The profound effects of early nutrition on lifelong health are widely acknowledged in contemporary science. The purpose of this review conducted in five European countries (Finland, Germany, Hungary, Spain, and United Kingdom) is to show the extent to which this association is reflected in parental information about infant feeding.

Background

According to international declarations food is one of the three priority areas of essential concern for health and the right to be informed, i.e. to be given the facts needed to make informed choices, is one of the eight basic consumer rights *(United Nations, 1986)*. Written decision aids which communicate possible benefits and harms of certain health treatments are perceived supportive from recipients *(O'Connor, 1999)*. Practical impact of leaflets and magazine articles has been documented in the area of maternity care and infant feeding *(Oliver, 1996; Foss 2006)*. Furthermore, this kind of written information holds some advantages towards dissemination: they are easily accessible, e.g. provided from physicians, inexpensive, and have a good readability and focussed contents.

This may help to encourage and support healthy feeding particularly with parents, who have difficulties to identify the most appropriate choices *(Hobbie, 2000; Flacking, 2007)* and tend to consult health professionals other sources of information, like books, less. However, it has been shown that leaflets and pamphlets, which are being produced by both non-profit and commercial sources in increasing quantities, do not always reflect contemporary scientific knowledge appropriate *(Valaitis, 1997; White, 2004).*

On the one hand infant feeding practices in Europe are not yet optimal *(Hobbie, 2000, Erkkola, 2004, Pall, 2006)* and on the other hand written information available to parents has the potential to influence feeding patterns, therefore it is of major public health relevance that international policies and the latest standard of knowledge is included in this documents.

The purpose of this study conducted in five member states of the European Union (Finland, Germany, Hungary, Spain, and United Kingdom) is to show the extent to which the association between early diet and lifelong health is reflected in leaflets and magazine articles about infant feeding.

Material and Methods

4.2.1. Assessing infant feeding leaflets

Between July and October 2005 a standardized web-based research procedure for assessing stand alone leaflets on infant nutrition referring to feeding of healthy infants aged 0-12 months was conducted in the five participating countries Finland

(FI), Germany (DE), Hungary (HU), Spain (ES), and United Kingdom (UK). Websites from national and regional government bodies, professional associations, special interest groups and the retailing and manufacturing industries were visited to locate materials covering the area of infant feeding using the key words: nutrition, diet, breastfeeding, bottle feeding, formula feeding, weaning, complementary feeding, infant feeding, and baby. Stand alone materials were either collected electronically or printed. Leaflets published after 2000 targeting parents were included. Materials targeting pregnancy, older children and health professionals or focusing on legal and practical aspects were excluded.

4.2.2. Assessing articles and notes in parenting magazines

The most popular monthly parenting magazine for each country was selected based on annual average circulation per issue figures. All 12 issues from January until December 2005 were screened for articles and notes on infant feeding, i.e. about feeding of and nutrition for babies aged 0-12 months. Most popular was defined by the annual average circulation per issue (Table 5).

Table 5: Magazine details

	Finland	Germany	Hungary	Spain	UK
Title of Magazine	Two plus	Living & Education	Mother's Magazine	My Baby and Me	Mother & Baby
Price per Issue	1,00 €	1,99 €	1,99 €	1,95 €	3,11 €
Annual subscription rate	10,90 €	23,88 €	18,20 €	19,80 €	27,28 €
Average annual circulation per issue	34.423	134.858	133.000	627.000	79.932
Average annual circulation per issue per 1.000 inhabitants	6.6	1.6	13.1	14.8	1.3
Average number of pages	100	83	100	120	180

4.2.3. Selection of programming statements

Materials were screened for statements on nutrition related programming in relation to milk and complementary feeding. As it was not expected to come across the term “programming” itself all statements on regular feeding of a healthy infant resultant in certain health outcomes have been considered as relevant. Statements on non-nutritive substances (e.g. alcohol) and toxicological substances (e.g. mercury), non-nutrition related behaviour (e.g. smoking), as well as nutrient absorption and supplementation (e.g. of folic acid), non-metabolism related outcomes (e.g. mouth-tooth-decay), and adverse health effects due to a special diet (e.g. vegan) or severe malnutrition were excluded from the database.

Each statement was characterized as follows:

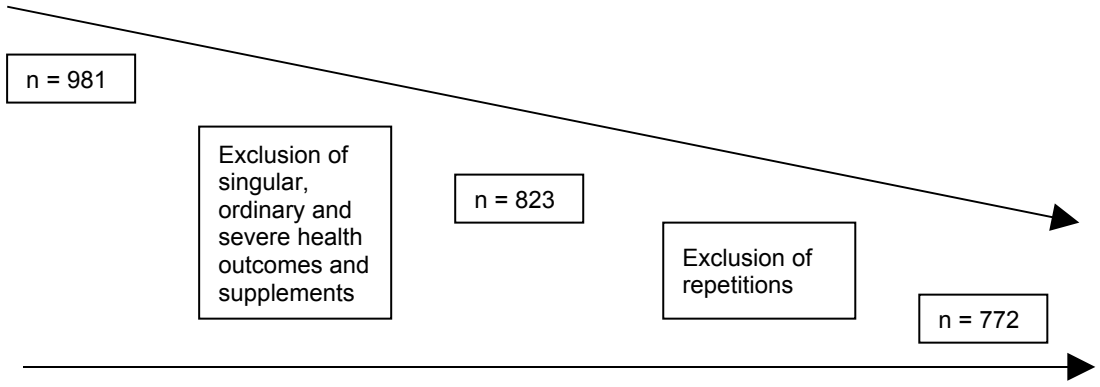
- duration of health effect
    - no duration mentioned, or short-term perspective, i.e. duration of effect less than 5 years
    - medium-term perspective, i.e. duration of effect from 5 to 15 years
    - long-term perspective, i.e. duration of effect more than 15 years
- programming related feeding behaviour

  Coded as milk-feeding, complementary feeding, either period, or general statements on infant feeding. Milk-feeding was further divided in breastfeeding in general, exclusively breastfeeding without further specification, exclusively breastfeeding for 6 months, and formula feeding.
- reference base of the statement

  It has been evaluated if a scientific reference was cited within the health outcome or not.

In the first instance 981 statements were entered to the database. After review it has been decided to further exclude: singular health outcomes (e.g. allergic shock, chocking, sudden infant death, vitamin K deficit blood clotting), typical indispositions, like stomach pain, colic, and constipation and rare or severe health outcomes with uncertain origins, like Parkinson, chronique fatigue syndrome, pylorus stenosis. If a certain health outcome was mentioned repeated in consecutive paragraphs, it has been counted first expression only. The selection procedure is shown in Figure 8.

Figure 8: Selection of programming statements



Finally 772 valid programming statements remained for analysis and have been classified in 15 health outcome categories corresponding to Chapter 3 (Table 1).

All analyses were carried out with the software package SPSS (SPSS for windows, versions 13.0, USA).

Results

4.3.1. Description of leaflets

In total, 120 leaflets from the five countries (FI=8, DE=13, HU=38, ES=26, UK=35) published between 2000 and 2005 have been reviewed for analyses. Table 6 shows the characterization of the material per country.

Table 6: Country profiles of leaflets

		FI	DE	HU	ES	UK	all
Publisher	GOV			**0**		**X**	
	PROF				**X**		
	SIG			**X**			**X**
	IND	**X**	**X**				
Number of pages	1	**0**	**0**	**X**			
	>1-3						
	4	**0**	**0**			**X**	
	5-10	**X**					
	>10		**X**		**X**		**X**
Price in Euro	free	**X**	**X**	**X**	**X**	**X**	**X**
	1	**0**	**0**	**0**	**0**		
	>1			**0**	**0**		
	>5	**0**		**0**	**0**	**0**	
Presentation type	text only	**0**		**X**	**X**		
	predom. text		**X**		**X**		**X**
	text and illustration	**X**					
	predom. illustration	**0**	**0**	**0**			
Stage covered	MF	**0**		**X**	**X**		**X**
	CF	**X**	**0**			**X**	
	MF and CF	**X**	**X**				
	infant feeding						

X = predominant category, 0 = vacant category

Half of the Finnish leaflets are in the 5-9 pages category and published by industry, most of them are available free of charge and the dominant presentation style is half text, half pictures. In contrary to the other countries there is no leaflet focusing only on milk-feeding, but in combination with complementary-feeding and infant feeding in general.

The German leaflets are also mainly published from industry, three-fourths of which are over 10 pages long and almost all for free, but it is the only country where leaflets costing more than 5,- Euro were also available. The dominant presentation style is predominant text. In Hungary there are no leaflets published from government, but two-thirds were from special interest groups and the one-page leaflets are most frequently. Only free leaflets have been included. The presentation style is predominant text and text only respectively. Hungarian and Spanish leaflets focus on milk-feeding. Most Spanish leaflets are published by special interest groups and a third is over 10 pages. As in Hungary all leaflets are free of charge and the presentation style is balanced between predominant text and text only. Spain and the UK also included leaflets with predominantly illustrations. Most leaflets in the UK a published by government, a third of which is available for free and half are of a half text / half illustrations style. Most of the leaflets cover the complementary-feeding period.

The contributions are of 20% (n=24) from government bodies, 18% (n=21) from professional associations, 35% (n=42) from special interest groups, and 28% (n=33) from baby-food industry (Table 7).

Table 7: Publisher profiles of leaflets

		GOV	PROF	SIG	IND
Number of pages	1				
	>1-3			**X**	
	4	**X**			
	5-10		**X**		**X**
	>10				
	free	**X**	**X**	**X**	**X**
Price in Euro	1				**0**
	>1	**0**			**0**
	>5	**0**	**0**		**0**
Presentation type	text only		**X**		
	predom. text	**X**		**X**	**X**
	text and illustration	**X**			**X**
	predom. illustration				**0**
Stage covered	MF	**X**	**X**	**X**	
	CF				
	MF and CF				**X**
	infant feeding	**X**	**X**		

X = predominant category, 0 = vacant category

In summary, 78% of the leaflets contained programming statements, with considerable variation between the countries: all German leaflets contained programming statements, 96% of the Spanish, 74% of the Hungarian, 66% of the UK and 63% of the Finnish leaflets. The pattern of density of statements differs: in Germany there was an average of 14.3 statements per leaflet, Spain 4.3, Finland 4.25, Hungary 3.2 and the UK 3.0. Comparing publishers showed that most leaflets of professional associations were containing programming statements (91%), followed by special interest groups (83%), government bodies (71%) and finally industry (70%).

Pricing and presentation style had no influence on the likelihood to find programming statements, whereas the length of the document did. Less than a quartile of leaflets (20%) are reference based, i.e. they contain reference to details of relevant studies or experts. There is a significant range between the countries from Spain (36%) to Finland (8%) and most of the references could be found in leaflets released from

professional associations (33%) and special interest groups (29%) whereas the number in government and industry leaflets is comparable low (8% and 9%).

4.3.2. Description of magazines

In total, 160 nutrition related articles (n=100) and notes (n=60) emerged from the 60 magazine issues. Table 8 shows the characterization of the material per country.

Table 8: Country profiles of articles and notes

		FI	DE	HU	ES	UK	all
Number of articles		12	27	14	14	33	100
Number of notes		4	21	0	3	32	60
Country contribution		10%	30%	9%	11%	40%	100%
Number of pages (articles)	<1			**0**	**0**	**0**	
	1		**X**	**0**		**X**	
	>1-2					**X**	
	>2-7	**X**		**X**	**X**		**X**
Number of words (notes)	1-100	**X**		**0**	**X**	**X**	
	>100-200	**X**	**X**	**0**			**X**
	>200	**0**	**0**	**0**			
Stage covered	MF	**X**			**X**	**X**	**X**
	CF			**X**	**0**		
	MF and CF				**0**		
	infant feeding		**X**	**0**	**X**		

X = predominant category, 0 = vacant category

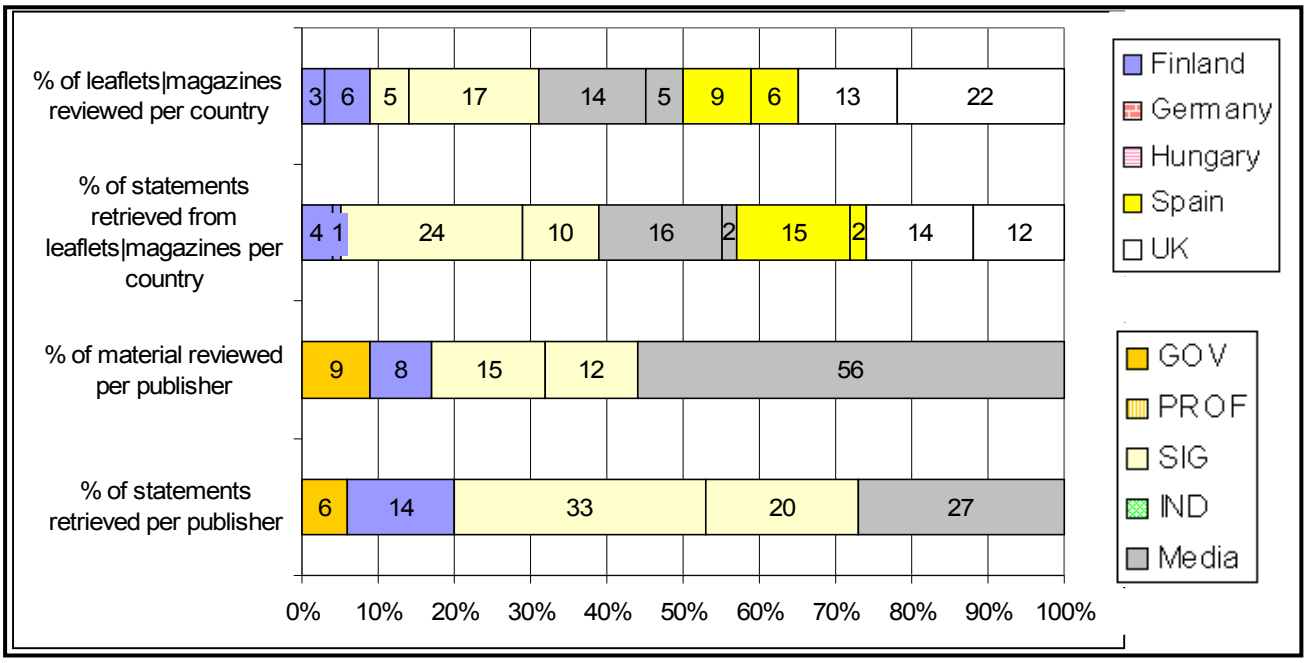
Finnish contributions covered all above the milk-feeding period, and German articles and notes aimed at infant health. In Hungary there were no notes included, but particularly long articles covering complementary-feeding. Spain combined long articles and small notes on milk-feeding or infant health, but no complementary-feeding. The contributions from UK concentrate on milk-feeding in articles and small notes.

Approximately 48% (n=76) of the magazine articles and notes included programming statements, although this varied across countries: in Spain 94.1% (n=16) of the magazine pieces contained relevant information, 54.2% (n=26) in Germany, 50% (n=7) in Hungary, 37.5% (n=6) in Finland, and 32.3% (n=21) in the UK. The density of statements gave a somewhat different pattern: in the UK there was an average of 2.6 statements per piece, 1.1 in Germany and Hungary, 0.9 in Spain, and 0.4 in Finland. Articles were more likely to contain statements (52%) than notes (40%), whereas length of piece did not have an effect. Seasonal variation was observed with most of the statements found in pieces published in spring (33%), followed by winter (26%), summer (24%), and autumn (17%). Only 2% of the magazine pieces (from Finland and Germany) were reference based. Hungary, Spain and the UK contained no references at all.

4.3.3. Analysis of programming statements

In total, 772 programming statements were identified. Figure 9 shows the proportional contribution of material reviewed and statements retrieved per country and publisher.

Figure 9: Proportion of materials reviewed and statements retrieved



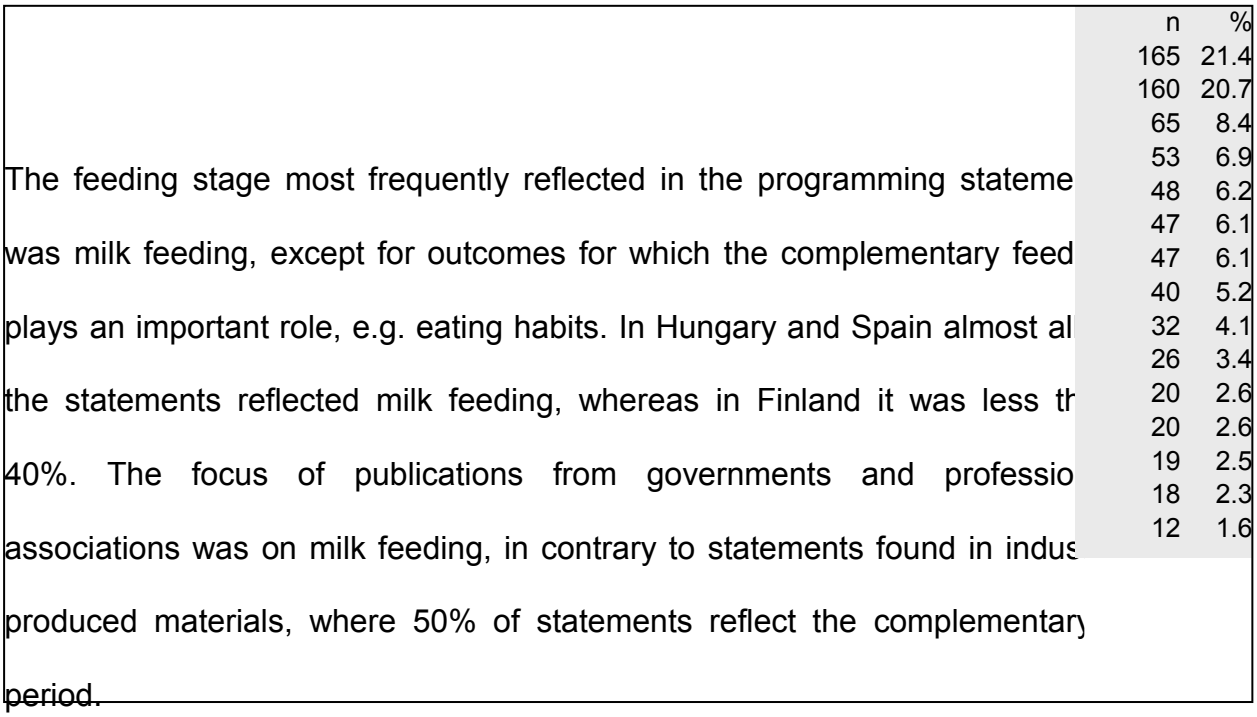
In principle the amount of screened material reflects the number of emerged programming statements. Finland, Hungary and the UK have proportional more documents that include programming statements, whereas this relationship is reversed in the other countries. German and Spanish leaflets contained more programming information than the magazines.

The ratio of volume of screened materials per publisher to number of programming statements varies across publisher types. Fifteen percent of the documents from special interest groups provided 33% of the programming statements, whereas 56% of media pieces (= magazine articles and notes) provided 27% of the statements.

4.3.4. Frequency and stage of cited health outcomes

The frequencies of cited health outcomes are shown in Figure 10.

Figure 10: Frequencies of cited health outcomes / all countries



The feeding stage most frequently reflected in the programming stateme was milk feeding, except for outcomes for which the complementary feed plays an important role, e.g. eating habits. In Hungary and Spain almost al the statements reflected milk feeding, whereas in Finland it was less th 40%. The focus of publications from governments and professio associations was on milk feeding, in contrary to statements found in indus produced materials, where 50% of statements reflect the complementary period.

Overall, allergy (21.4%) and risk of infection (20.7%) are the predominant categories. However, cross-country comparisons (Table 9) reveal allergies to be more predominant in Germany, Hungary and the UK, whereas less so in Finland and Spain.

Table 9: Frequencies of cited health outcomes per country

	FI		DE		HU		ES		UK	
	n	%	n	%	n	%	n	%	n	%
Allergies	3	7.5	**73**	**27.3**	**33**	**24.1**	10	7.8	46	23.0
Risk of infection	2	5.0	19	7.1	29	21.2	**45**	**35.2**	**65**	**32.5**
Mental development	1	2.5	13	4.9	12	8.8	11	8.6	11	5.5
Immune function	1	2.5	24	9.0	8	5.8	5	3.9	9	4.5
Obesity	6	15.0	12	4.5	8	5.8	11	8.6	10	5.0
Eating habits	**7**	**17.5**	23	8.6	0	.0	0	.0	2	1.0
Diabetes	0	.0	4	1.5	8	5.8	7	5.5	7	3.5
CVD	3	7.5	3	1.1	4	2.9	3	2.3	7	3.5
Gastrointestinal diseases	1	2.5	9	3.4	4	2.9	4	3.1	2	1.0
Cancer	0	.0	4	1.5	7	5.1	3	2.3	5	2.5
Bone disease	3	7.5	11	4.1	0	.0	4	3.1	0	.0

bold = dominant category, data of more general outcome groups not shown

Risk of infection is most often mentioned in Spain and the UK, less so in Hungary and rarely in Finland and Germany. In Finnish statements there are two further categories that are frequently mentioned: eating habits and obesity, whereas mental development, immune function, and gastrointestinal diseases are rarely mentioned and diabetes and cancer not at all. The health outcomes reflected in German materials were more distributed and included immune function, eating habits, mental development, obesity, cancer, and CVD. In Hungary mental development was followed by immune function, diabetes, and obesity, whereas bone disease and eating habits were not mentioned at all.

A neglected category in Spain was eating habits, whereas mental development and obesity were relatively strong. UK statements showed a similar distribution regarding mental development and obesity, whereas gastrointestinal diseases and eating habits were almost and bone disease completely neglected.

Comparisons between publishers (Table 10) reveal that allergies were more often reflected by magazines, special interest groups, and industry, whereas risk of infections was reflected in documents from professional associations, governments, and special interest groups. Obesity was mainly covered in government leaflets and in media pieces and immune function was mainly covered in industry leaflets. Health outcomes including gastrointestinal diseases, cancer, bone diseases, and immune function were not covered in government leaflets.

Table 10: Frequencies of cited health outcomes per publisher

	GOV		PROF		SIG		IND		Media*	
	n	%	n	%	n	%	n	%	n	%
Allergies	3	6,1	14	13,3	55	21,3	**28**	**18,5**	**65**	**31,1**
Risk of infection	**15**	**30,6**	**35**	**33,3**	**65**	**25,2**	14	9,3	31	14,8
Mental development	3	6,1	9	8,6	15	5,8	6	4,0	15	7,2
Immune function	0	0	2	1,9	10	3,9	19	12,6	16	7,7
Obesity	4	8,2	6	5,7	12	4,7	6	4,0	19	9,1
Eating habits	3	6,1	1	1,0	10	3,9	9	6,0	9	4,3
Diabetes	2	4,1	7	6,7	11	4,3	1	0,7	5	2,4
CVD	2	4,1	3	2,9	5	1,9	3	2,0	7	3,3
Gastrointestinal diseases	0	0	5	4,8	6	2,3	8	5,3	1	0,5
Cancer	0	0	3	2,9	6	2,3	1	0,7	9	4,3
Bone disease	0	0	2	1,9	1	0,4	8	5,3	7	3,3

bold = dominant category, data of more general outcome groups not shown *Media=Magazines

4.3.5. Health outcome related feeding behaviour

The period most frequently related to health effects was milk feeding (71.6%, n=553), divided in breastfeeding (57.4%) and formula feeding (14.2%). Breastfeeding was above all linked with risk of infections. Among the breastfeeding statements 86.5% (n=386) referred to breastfeeding in general, exclusivity without further specification was mentioned in 2.2 % (n=10) and exclusively breastfeeding for 6 months in 11.2% (n=50). The latter category was found mainly in media pieces (44.0%) and in special interest group leaflets (42,0%), followed from government (8.0%), industry (4.0%), and professional body produced leaflets (2.0%). When comparing countries, exclusively breastfeeding for 6 months was reflected in 16.7% (n=22) of the UK, 16.0% (n=13) of German, 13.3% (n=3) of Finnish, 11.5% (n=2) of Spanish and 11.5% (n=11) of Hungarian materials. In principle, statements in relation to breastfeeding tended to emphasize positive health effects (e.g. *…breast-fed children are less likely to be obese later on than formula fed children…*). Within statements relating to formula feeding, positive associations were described in industry leaflets (e.g. ... *nucleotides in formula milk help boost your baby's immune system…*), whereas statements from the other publisher groups were more cautious (e.g. *…just one dose of formula may already cause allergies…*).

4.3.6. Documented reference base

Scientific references were cited in 10.8% (n=83) of the statements, most of which were found in German materials (48.2%, n=40), followed by the UK (25.3%, n=21), Spain (14.5%, n=12), Hungary (9.6%, n=8), and Finland (2.4%, n=2).

Comparisons between publisher revealed that special interest groups were more likely to reference statements (41.0%, n=34) and governments least likely to (3.6%, n=3).

4.3.7. Duration of health effects

The majority of statements (88.1%, n=680) referred to short-term health effects or did not mention a specific time perspective with only 4% (n=31) referring to the medium- and 7.9% (n=61) to the long-term health effects of infant feeding (Table 11).

Table 11: Ranking of health outcomes associated with medium-/ long-term duration

	Health outcome					
	medium-term	n	%	long-term	n	%
1.	Obesity	11	35.5	Obesity	13	21.3
2.	Allergy	5	16.1	Eating habits	10	16.4
3.	Mental development	3	9.7	CVD	11	12.0

The explicit term programming was used only once: “too much sugar in complementary food leads not only to bad teeth, but can programme the eating habits on sweet taste as well”. However, the long-term aspect of programming was reflected in phrases such as “later in life” and “in adulthood”. Such statements were found in 41.3% (n=34) of leaflets from special interest groups, 29.2% (n=27) of media pieces, 11.5% (n=12) professional association, 10.6% (n=11) of industry and 7.4% (n=6) of government leaflets. Cross-country comparisons revealed medium- and long-term related health outcomes to be reflected of 12.5% (n=5) of Finnish, 13.5% (n=36) of German, 6.6% (n=9) of Hungarian, 13.2% (n=27) of Spanish, and 12.5% (n=25) of the UK statements.

4.4. Discussion

4.4.1. Framework of the study

A statement taken from one of the screened leaflets: “The feeding of your baby in the first year of life has a central meaning which is not comparable to any other period in life” is indisputable. This importance is recognized by decision makers, who place infant nutrition in the top three priorities on the food and nutrition policy agenda *(WHO-Europe, 2006)*. This is further reflected by the fact that there is probably more research conducted on infant nutrition than any other area of paediatric sciences *(Lucas, 1998)*. Facing the well-acknowledged *(WHO, 2003a, 2003b)* preventive potential of early nutritional influences on the genesis of non-transmissible diseases in adult life the profound consumer right to access adequate information on nutrition should be taken seriously in the field of infant feeding *(Brom, 2000; FAO, 2003)*. However, comparable studies have already shown that information available to lay persons does not always appropriately reflect contemporary scientific knowledge *(Valaitis, 1997; White, 2004).* The aim of this review was to survey to which extent the concept of early nutrition programming is being communicated to parents in written information. The focus was on leaflets, because of their important role as a source of advice for parents *(Department of Health, 2000).* Magazines were included as they have also been recognized as having a practical impact on parental decision making *(Foss, 2006)*.

4.4.2. Limitations

The methodological approach in the present paper calls for some caution when interpreting the results. Because of the different languages the statements had to be identified and categorized in the corresponding countries. Even though there were standardised procedures to ensure objectivity and reliability (i.e. repeated evaluation of documents, statements and categorizations from different reviewers), selection bias may have been occurred because of the qualitative character of the data. However, the results do not claim to be representative for the level of accuracy of Europe-wide feeding information, but intend to show meaningful trends of what kind of messages are being transferred to parents. The practicability of such a design has been proofed in comparable studies (*Meister, 2004; Fox, 2006*).

4.4.3. Reflection of early nutrition programming

The material was screened for statements on nutritional programming including related feeding behaviour, time perspective of health effect and references. The assumption that one will not come across the direct term “programming”, was proved afterwards and the approach to consider all statements on nutrition related health outcomes to evaluate the reflection of the programming concept indirectly was reasonable. The descriptive analysis showed that not every leaflet targeting infant nutrition reflected the concept of programming (programming yes=78%) with considerable variety among the countries (63%-100%) and publishers (70%-91%). The probability to come across suggestions of the association between early nutrition and lifelong health were highest in Germany and Spain and within materials

produced by professional associations and special interest groups, institutions more likely to employ scientifically literate staff. Within the magazines the reflection of programming was even less (programming yes=48%), with substantive country differences from 94.1% (ES) to 32.3% (UK), whereas UK materials showed a high density of statements, if the article was about nutritional programming.

Nevertheless, the under representation of programming in the UK is striking, because the majority of scientific evidence has its origin there *(Barker, 1992, 1994; Lucas, 1991, 1994).*

The frequency of cited health outcomes with a strong focus on diseases with onset close to the feeding period was clear: the well-established associations between breastfeeding and infections *(Howie, 1990; Golding, 1997)* and breastfeeding or introduction of certain foods and allergies *(Marini, 1996; Oddy, 2002)* were responsible for 42.1% of all health outcomes. Statements on the prevention of allergies also caused the seasonal peak within the spring issues of the magazines.

Further developmental benefits for mental development and immune function, which are related to both, short-term *(Morrow-Tlucak, 1988; Vestergaard, 1999; Wold, 1998)* and long-term *(Anderson, 1999; Horwood, 2001; Hanson, 1999)* duration, were also frequent, whereas certain health outcomes with increasing prevalences in well-developed countries, like diabetes *(Steyn, 2004*), CVD *(Reddy, 2004)*, and certain types of cancer *(Bener, 2001; Key, 2004)* were considered less. According to an extensive report of the WHO *(WHO-Europe, 2003)*, CVD and cancer are major causes of death in Europe. Links to early nutrition exist for both outcomes (*Singhal, 2003; Uauy, 2005),* but the reflection in the documents was weak among all countries (range 11 (2.6%) for CVD and 12 (2.5%) for cancer out of 15 outcome categories; particularly low in Finland and Germany).

A gratifying finding is that obesity, which has already reached pandemic proportions in Europe *(WHO, 2003a)* and whereat numerous studies stating potential preventive effects of breastfeeding (*Dewey, 2003; Arenz, 2004; Koletzko, 2006),* was overall ranked sixth (6.1%) and especially emphasized in Finland (15.0%) and Spain (8.6%), and within government and media materials.

4.4.4. Health outcome related feeding behaviour

Approximately 72% of the statements focused on milk feeding and, except in those leaflets published by industry, effects and timing of complementary feeding were strongly neglected, especially in Hungary and Spain. This corresponds with work by Fewtrell et al. *(2003)* and is not advantageous, because several short-, medium- and long-term health implications are significantly associated with the age of solid food introduction (*Forsyth, 1993; Morgan, 2004*) and there is extensive evidence that consumption of certain types of food in the weaning diet has positive health promoting effects (*Morgan, 2003*).

There were 553 statements on breastfeeding and the WHO recommendation for "exclusively breastfeeding for 6 months" *(WHO, 2001, 2002)* was only communicated within 50 of them (=11,2%), most frequently in the UK (n=22) and releases from media and special interest groups and least in Spain and Hungary and releases from industry and professional associations. It is obvious that even if the benefits of breastfeeding were clearly pointed out from all publisher groups, the feeding advice given did not fully comply with international policies.

4.4.5. Documented reference base

Even when including vague references to an evidence base such as “a study has shown” or “following the advice of the research institute for child nutrition” the proportion of links to an evidence base for programming is low (20%). The Hungarian, Spanish and UK magazines did not include references at all, possibly reflecting a particular writing style rather than a necessarily negative attitude towards scientific evidence.

4.4.6. Implementation of long-term health effects

Notably, the long-term perspective was more often reflected than the medium-term perspective in statements mentioning a certain duration. Obesity and CVD, which are both targets of scientific research towards long-term effects, were to a greater extent integrated into the leaflets from all countries. On the other hand, health outcomes with intrinsic later onset, like cancer, were not associated with a long-term duration. It was most likely to come across the reflection of long-term effects in materials from special interest groups and the media and less likely in materials from industry and government.

4.5. Conclusions

In summary, the concept of nutrition programming and related long-term health outcomes, like obesity, has to a considerable extent been integrated in infant feeding information targeted at parents. However, the focus is on the description of the feeding process and options rather than the potential health consequences. Some publisher groups may hesitate to include programming in their materials, because the responsibility associated with lifelong health effects may be perceived as burden for parents and lead to uncertainty and anxiousness. On the other hand the concept strongly contributes to the improvement of health and quality of life for future generations and research findings can only be implemented if they are made available to public. As a result, emphasis should be placed on the dissemination of practical, achievable and realistic advice that clearly explains the possible long-term health benefits of appropriate feeding behaviour *(Raats, 2005)*. The considerable variety of number and nature of the statements among different publishers expresses that the institutional background contributes to the selection of contents to be forwarded to recipients *(Entwistle, 2000)*. The variation across countries reflects Garvin's findings *(2001)* that the same set of information or facts is framed differently according to nationally defined needs and situations. It might be reasonable to have the country specific diversities reflected in the recommendations; nevertheless a fundamental harmonisation on European level seems to be the preferable strategy *(WHO-Europe, 2001,ILSI, 2003; Lachat, 2005)*.

5. Summary (English)

The purpose of the dissertation was to give an overview on the implementation of early nutrition programming in scientific publications, nutrition policies and parental feeding information.

The overview on contemporary scientific literature showed that the concept of early nutritional programming and relevance of the preventive potential of appropriate nutrition early in life are supported from strong study evidence.

Nutrition related health consequences were also reflected to a considerable extent in the policy documents evaluated, but the true sense of early programming for life long health is not yet widely implemented. Furthermore there are still considerable differences between the surveyed European countries. Consequently, the potential impact towards frequent serious diseases, like cancer and CVD, as well as steadily increasing adverse health outcomes, like obesity, should be included appropriately.

To close the gap between science and policies, and meet the goal of more harmonised European policies, there is the need for enhanced communication between scientists and policy makers and a wide spread monitoring system to ensure regular reviews and up-dates. This is of major public-health relevance, because sound and sustainable policy documents build the informed basis for the dissemination of preventive and health promoting infant feeding behaviour.

In the reviewed parental information from different European countries there is a tendency that contents focus more on the description of the feeding process and options than the explanation of possible consequences for lifelong health. With regard to the immense preventive potential of early nutrition programming it is worth to further promote the exchange and dialogue between the different bodies engaged

in food and nutrition and European member states to ensure the appropriate dissemination of current scientific knowledge in a format that is accurate, relevant and comprehensive. This will enable parents to obtain informed feeding choices and is therefore of major public health relevance.

In summary, this evaluation highlights the strengths and weaknesses of the dissemination procedures of European member states and provides a basis for a blueprint for action, aiming at harmonised, sound and, sustainable decision aids for consumers. The infant is reliant on the feeding behaviour of the caretakers, who are consequently the critical link in the prevention of food related deficiencies and should be empowered by adequate sources of advice and information. This can effect a change in health expectations and quality of live for future generations.

6. Summary (German)

Ziel dieser Arbeit war es, die Implementierung der gesundheitlichen Prägung durch frühkindliche Ernährung, genannt metabolische Programmierung, in wissenschaftlichen Veröffentlichungen, Ernährungsempfehlungen und Elterninformationen zu überprüfen. Der Review aktueller Publikationen konnte zeigen, dass die Evidenz des Konzepts der metabolischen Programmierung sowie des präventiven Potentials adäquater Ernährung von aussagekräftigen Studienergebnissen gestützt werden.

Die von Ernährung beeinflussten Folgen für die Gesundheit wurden ebenfalls zu einem beachtlichen Grad in den untersuchten Richtlinien und Empfehlungen zur Ernährung von Säuglingen reflektiert, wobei jedoch der per Definition immanente Zusammenhang zwischen Prägung und Langzeitfolgen vernachlässigt wurde. Zudem kann bestätigt werden, dass auch heute noch inhaltliche Unterschiede in den Ernährungsempfehlungen der verschiedenen Ländern der Europäischen Union, exemplarisch untersucht an den fünf Mitgliedsstaaten Deutschland, England, Finnland, Spanien und Ungarn, bestehen. Es wäre wünschenswert, dass der mögliche Einfluss von frühkindlicher Ernährung auf häufige und oftmals schwer verlaufende Krankheiten, wie Krebs, und auf kontinuierlich häufiger auftretende Zivilisationskrankheiten, wie Übergewicht, in angemessenem Ausmaß berücksichtigt wird.

Um die Diskrepanzen zwischen wissenschaftlichen Forschungsergebnissen auf der einen Seite und Richtlinien auf der anderen Seite zu beseitigen und zugleich Angleichungen für europaweit harmonische Empfehlungen zu unternehmen ist eine gesteigerte Kommunikation zwischen Wissenschaftlern und Gesundheitspolitik sowie ein umfassendes System zur regelmäßigen Überprüfung und Aktualisierung von Nöten. Dies ist von hoher Relevanz für die öffentliche Gesundheit, da verlässliche und nachhaltige Richtlinien die informative Basis für die Verbreitung von präventiver und gesundheitsförderlicher Ernährung der Säuglinge bilden.

Bei Untersuchung des angebotenen Informationsmaterials für Eltern der untersuchten fünf Ländern fällt auf, dass sich die Inhalte stärker auf den Prozess des Fütterns und die verschiedenen Alternativen zur Ernährung von Säuglingen fokussieren, als auf die Bewertung derer im Hinblick auf mögliche Langzeitfolgen für die Gesundheit. Im Hinblick auf das beachtliche präventive Potential der metabolischen Programmierung scheint es eine lohnendes Bestreben, den europaweiten Austausch und Dialog zwischen den verschiedenen Instanzen im Bereich der Säuglinsernährung zu intensivieren, um die angemessene Verbreitung relevanter wissenschaftlicher Ergebnisse in einem akkuraten und verständlichen Format zu realisieren. Das wird es zukünftigen Eltern ermöglichen informierte Entscheidungen bezüglich der optimalen Ernährung ihrer Kinder zu treffen.

Durch die Evaluation der Umsetzung eines relativ neuen, wissenschaftlichen Phänomens in den drei Bereichen Fachliteratur, Richtlinien und Elterninformation konnten die Stärken und Schwächen der Weitergabe und Aufbereitung von Information verschiedener europäischer Mitgliedsstaaten aufgezeigt werden. Dies kann die Basis für einen Aktionsplan zur Harmonisierung und Aktualisierung von Entscheidungshilfen für die Öffentlichkeit sein. Der Säugling ist auf das Füttern angewiesen, daher ist es besonders wichtig, den Eltern bestmögliche Informationen zukommen zu lassen. Dies kann dazu beitragen, den Gesundheitszustand und die Lebensqualität zukünftiger Generationen entscheidend zu verbessern.

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Appendix: Selected infant nutrition policy documents

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