Project no. 016181

IDEFICS

Identification and prevention of Dietary- and lifestyle-induced health EFfects in Children and infantS

Instrument: Integrated Project

Thematic Priority: Food Quality and Safety

Publishable Final Activity Report

Period covered: from September 2006 to February 2012
Date of preparation: May 7th, 2012

Start date of project: 01.09.06 Duration: 66 months

Project coordinator:
Prof. Dr. Wolfgang Ahrens
University of Bremen (UNIHB), Bremen Germany

Revision 1.0

Publishable Final Activity Report

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www.ideficsstudy.eu

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Identification and prevention of Dietary- and lifestyle-induced health EFfects In Children and infantS

Publishable Final Activity Report

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Members of the Consortium attending the last General Assembly in Bremen, November 2011

CONTENTS

PROJECT OBJECTIVES

The IDEFICS study (Identification and prevention of Dietary- and lifestyle-induced health EFfects In Children and infants) commenced in September 2006 and ran to February 2012. It was coordinated by Professor Wolfgang Ahrens at the Bremen Institute for Prevention Research and Social Medicine, at the University of Bremen in Germany. The study was funded by the European Commission under the 6th Framework Programme. 22 research groups and small/medium enterprises from eleven countries participated in the IDEFICS study (see Figure 1; survey countries/centres coloured in green/red).

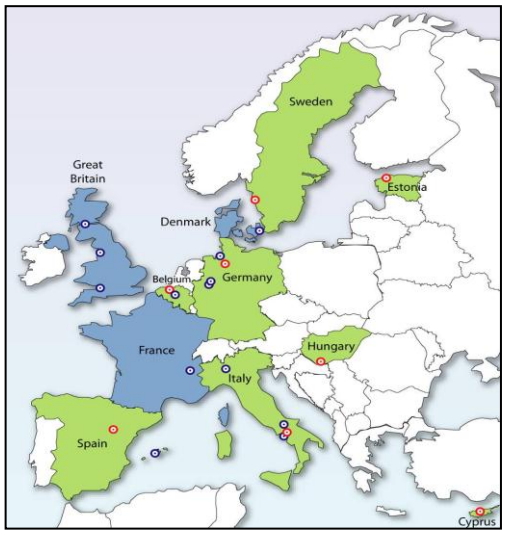


Figure 1: Map of participating countries and study centres

Overview

This multi-centre project consisted of two elements. The first element was a prospective cohort study in a large diverse sample of children. This investigated the aetiology of diet- and lifestyle-related diseases and disorders with a strong focus on overweight and obesity. It assessed the prevalence of overweight and obesity, related co-morbid conditions and major risk factors, according to a highly standardised protocol. The study measured weight status and related health outcomes such as blood pressure and insulin resistance, direct behavioural determinants such as physical activity and diet, and indirect determinants such as social/ psychological factors and consumer behaviour. In this way, it analysed the complex interplay of factors acting at different levels to disentangle the causal pathways leading to obesity and other health outcomes. It described the prevalence and trajectory of childhood obesity across a diverse range of European cultures, climate zones and environments represented by eight countries.

Second, the IDEFICS study developed, implemented and evaluated community-oriented intervention programmes for primary prevention of obesity in a controlled study design. This intervention part of the IDEFICS study examined feasibility, effectiveness and sustainability of a coherent set of intervention modules addressing diet, physical activity and coping with stress. The study will contribute substantially to the evidence-base of primary prevention strategies. Figure 2 gives an overview of the major study components and their relationship.

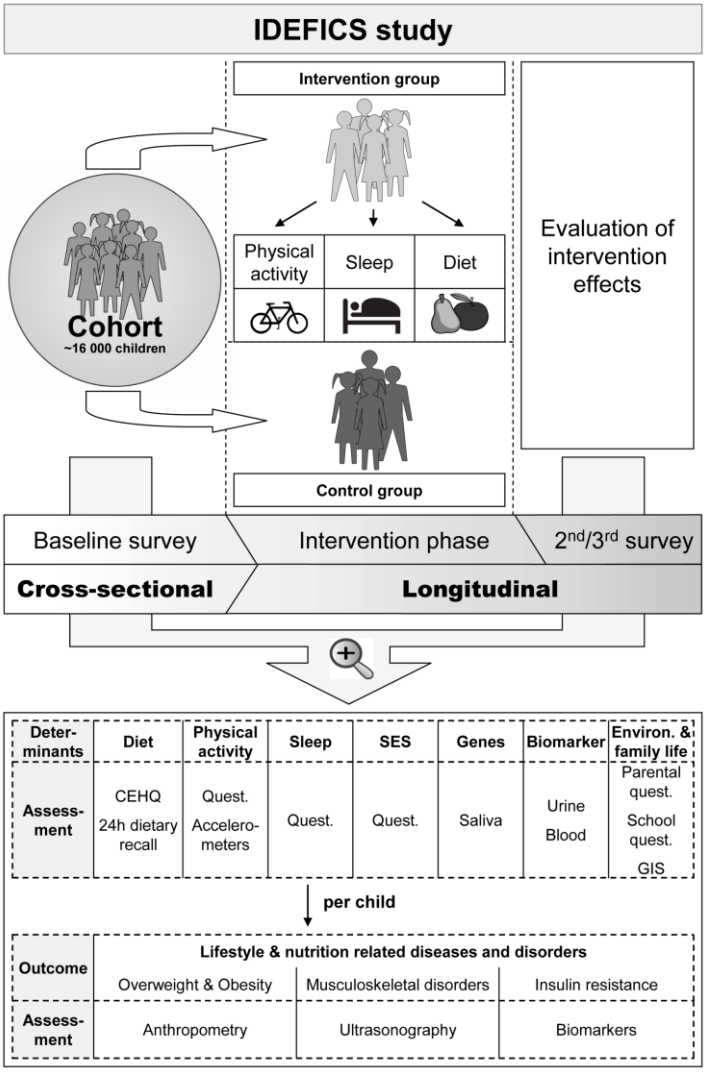


Figure 2: Design and major components of the IDEFICS study

A baseline survey (T_0) was the starting point of the prospective cohort study with the largest European children's cohort established to date and also represents the baseline measure for the intervention. A second survey (T_1) reassessed the children two years later to determine the aetiological associations between baseline predictors and selected follow-up endpoints. It also assessed short-term effects of the intervention, comparing children from control and intervention areas. Finally, a selection of morbidities observed at baseline (T_0) was used for three retrospective case-control analyses in relation to overweight, insulin resistance (HOMA) and bone stiffness. Finally, a mailed questionnaire was completed by parents at T_2 to assess the sustainability of the intervention. The timeline is given as Figure 3.

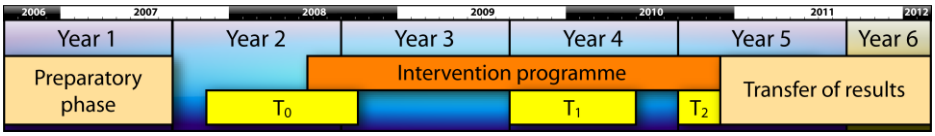


Figure 3: Timeline of the major study components
(T_0 = baseline survey; T_1 = full follow-up; T_2 = mail survey)

General project objectives

The project pursued two strategic objectives: first, the enhancement of the knowledge of the health effects of a changing diet and an altered social environment and lifestyle of infants and children in Europe; second, the development, implementation and validation of specific intervention approaches to reduce the prevalence of diet- and lifestyle-related diseases and disorders in the EU, focusing on 2 to 9 year old children. These general objectives were specified in five further project objectives.

Specific project objectives and relation to the state-of-the-art

Objective 1

The strategic objectives were pursued in the face of a strong increase in overweight, obesity and metabolic disturbances in children in Europe in the last decades, where the magnitude of the problem remains uncertain since comparable data is still missing. The IP provides **detailed insight into the distribution of important diet- and lifestyle-related diseases and disorders in children and their key risk factors**. Comparable data were obtained by standardised methods in Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain and Sweden to identify regional and cultural-specific variations for both sexes in the distribution of the above disorders and their risk factors.

Objective 2

The effects of diet, lifestyle, psychosocial and genetic factors and of their interaction are still not well understood. The IP helps to **understand the effects of diet, lifestyle and social environment on children's health and the causal pathways to diet- and lifestyle-related diseases and disorders**. The intended research analysed and continues to analyse modifiable and non-modifiable factors. Dietary factors, like food intake and food preferences, lifestyle factors, like physical activity, psychosocial factors and genetic factors are being considered simultaneously.

Objective 3

Current prevention programmes mainly target overweight and obesity, and most of them have a strong focus on diet, neglecting the complex interplay with physical activity, stress and the social environment. In addition, the effectiveness of primary programmes is often neither evaluated nor well documented and the evidence for effective interventions to reduce overweight and obesity is scarce. Most prevention programmes aim at the general population but they mostly fail since they do not consider the particular situation of the individual and the different barriers to participation. The IP **provides and validates prevention programmes sensitive to different cultures, social settings, gender and age to reduce diet- and lifestyle-related diseases in children**. Preference was given to effective strategies that are easy to implement on a large scale in European populations. The programme was centred on the setting of pre-schools and primary schools and reaches out to both the community and the individual level. Special effort was made to reach vulnerable groups like single parents, lower social classes and migrants.

Objective 4

In order to promote its products, the food industry commonly measures whether and how much eating behaviour is influenced by sensory perception and food preferences. However, this has not yet been investigated from a consumer's perspective. It is also largely unclear whether overweight/obesity in children can be explained by differences in sensory perception and the individual effect of external and internal factors on food choices and whether these can be changed and become subject to interventions. The IP **investigates the impact of sensory perception and food preferences in young children**. It addresses the question to what degree sensory perception and the effect of individual factors on food choices varies in European children and whether they are modifiable. The role of sensory perception and taste sensitivity and their relation to genetic factors was investigated in sub-samples of children who were offered test solutions in an experimental setting. Triggers of food choices were investigated in more detail from a **consumer science perspective**.

Objective 5

Dietary and lifestyle habits are culturally influenced and may differ even between neighbouring countries. But no systematic data is available that shows similarities, differences or even contradictions among dietary and lifestyle guidelines for children in European countries. The IP **proposes knowledge-based standard sets of guidelines on dietary and lifestyle activities for health promotion and disease prevention in children** addressing health professionals, stakeholders, channels, and consumers. Based on the knowledge gained from the IP, action plans for policy makers have been proposed, including detailed consideration of relevant ethical and policy dimensions.

CONTRACTORS INVOLVED

1. UNIHB: Bremen Institute for Prevention Research and Social Medicine, University Bremen, Germany (coordinator)
2. UGENT: Department of Public Health/ Department of Movement and Sport Sciences, Faculty of Medicine and Health Sciences, University Gent, Belgium
3. REF: Research and Education Institute of Child Health, Strovolos, Cyprus
4. UJF: Laboratory of Nutrition, Ageing and Cardiovascular Diseases, University Joseph Fourier, Grenoble, France
5. TTZ: Sensoriklabor, Technologie-Transfer-Zentrum Bremerhaven, Germany
6. UGLW: Institute of Biomedical and Life Sciences, University Glasgow, UK
7. ULANC: Institute for Philosophy and Public Policy, University Lancaster, UK
8. UPE: Medical Faculty, Department of Paediatrics, University Pécs, Hungary
9. UCSC: Laboratory of Genetic and Environmental Epidemiology, Research Laboratories, Centre for High Technology Research and Education in Biomedical Sciences, Catholic University del Sacro Cuore, Campobasso, Italy
10. ISA-CNR: Institute of Food Sciences, Unit of Epidemiology and Population Genetics, National Research Council, Avellino, Italy
11. INT: Nutritional Epidemiology Unit, National Cancer Institute, Milan, Italy
12. UNIMI: Department of Pharmacological Sciences, University Milan, Italy
13. UZAZ: University Saragossa, Spain
14. UIB: Laboratory of Molecular Biology, Nutrition and Biotechnology, University Illes Baleares, Palma de Mallorca, Spain
15. UGOT: Department of Paediatrics, Queen Silvia Children's Hospital, Göteborg University, Department of Community Medicine and Public Health, Sahlgrenska Academy, Göteborg University, Sweden:
16. NIHD: National Institute for Health Development, Tallinn, Estonia
17. CBS: Copenhagen Business School, Copenhagen, Denmark
18. EUFIC: The European Food Information Council, Brussels, Belgium
19. EBERH: Laboratoriumsmedizin Dortmund, Eberhard und Partner, Dortmund, Germany
20. GD: Gockel Design, Wuppertal, Germany
21. BIOTEL: BioTel Ltd, Clifton, Bristol, UK
22. AMED: Agorà Med srl, Naples, Italy.

WORK PERFORMED AND END RESULTS

Overarching activities and achievements

Establishment of an organisational structure and a communication platform

The IP was organised in eight working areas (WA) and 25 workpackages. The workflow and interrelationship between the WAs is depicted in Figure 4.

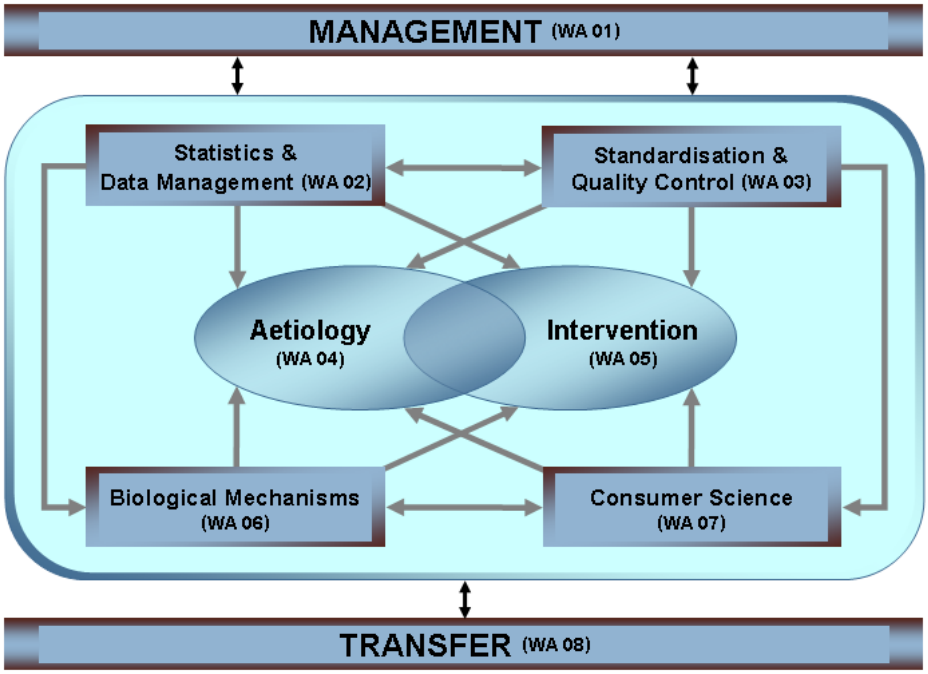


Figure 4: Workflow and interrelation of the working areas of the IDEFICS study

To make the project visible to the public a corporate design including the IDEFICS logo and a leaflet was developed by GD and the public website www.idefics.eu was established by AMED and UNIHB. A visibility plan including a public relations strategy was made available to all partners by UNIHB. Simultaneously, efficient communication networks inside the project were built up including an internet communication platform on a closed access internal website.

The General Assembly (GA) was the principal decision-making body of this project and comprises all parties with one voting representative each. The organisational structure of the project included further bodies: a Steering Committee (SC) with one representative from each WA that communicated at least monthly and a Stakeholder Advisory Board that met once per

year. Ad hoc expert panels addressing specific tasks were established to organise scientific exchange and to facilitate the scientific work. Major panels were established for the following research areas: dietary assessment methods, physical activity, genetic markers, gender balance, survey methods, intervention methods and health promotion guidelines. In order to promote career development of young scientists, a young researchers panel was also founded.

Quality management

As a milestone in the first year approval to conduct the survey was obtained from national/local ethics committees and data protection authorities. In addition, survey centres made agreements with local authorities and institutions to obtain access to study groups. In addition, all instruments for the first survey, to start in September/ October 2007, were developed in English, tested, translated and re-translated in eleven languages. They included a survey questionnaire for baseline and follow-up surveys (Figure 5, left), modules on dietary patterns (Figure 5, second left), medical history, physical activity, social environment, media consumption and internal and external factors affecting food choice. In addition to questionnaires, specific measurements, e.g. skinfold measurement (Figure 5, second right - bottom), and measurement devices, e.g. accelerometers (Figure 5, second right - top), ultrasonograph (Figure 5, right), sphygmanometer, were tested, standardised and deployed.

Figure 5: Survey instruments (from left to right): parental core questionnaire, dietary habits questionnaire, Actigraph GT1M accelerometer (top); Holtain calliper (bottom); Achilles ultrasonograph

These instruments were accompanied by standard operation procedures (SOPs), a field work manual and a quality plan. Procedures for the collection and management of biological material were established. Measurement devices were purchased centrally by UNIHB. All instruments and measurement procedures were implemented on the basis of central training in Bremen and locally in each survey centre. UNIHB conducted site visits during the field work in order to assure compliance with SOPs by all local survey teams. In addition, repeat measurements and exchange of survey staff between survey regions within a country were performed to assure comparability of measurements between control and intervention groups. A central IDEFICS biobank hosted by UNIHB was established for storage of blood, urine and DNA samples.

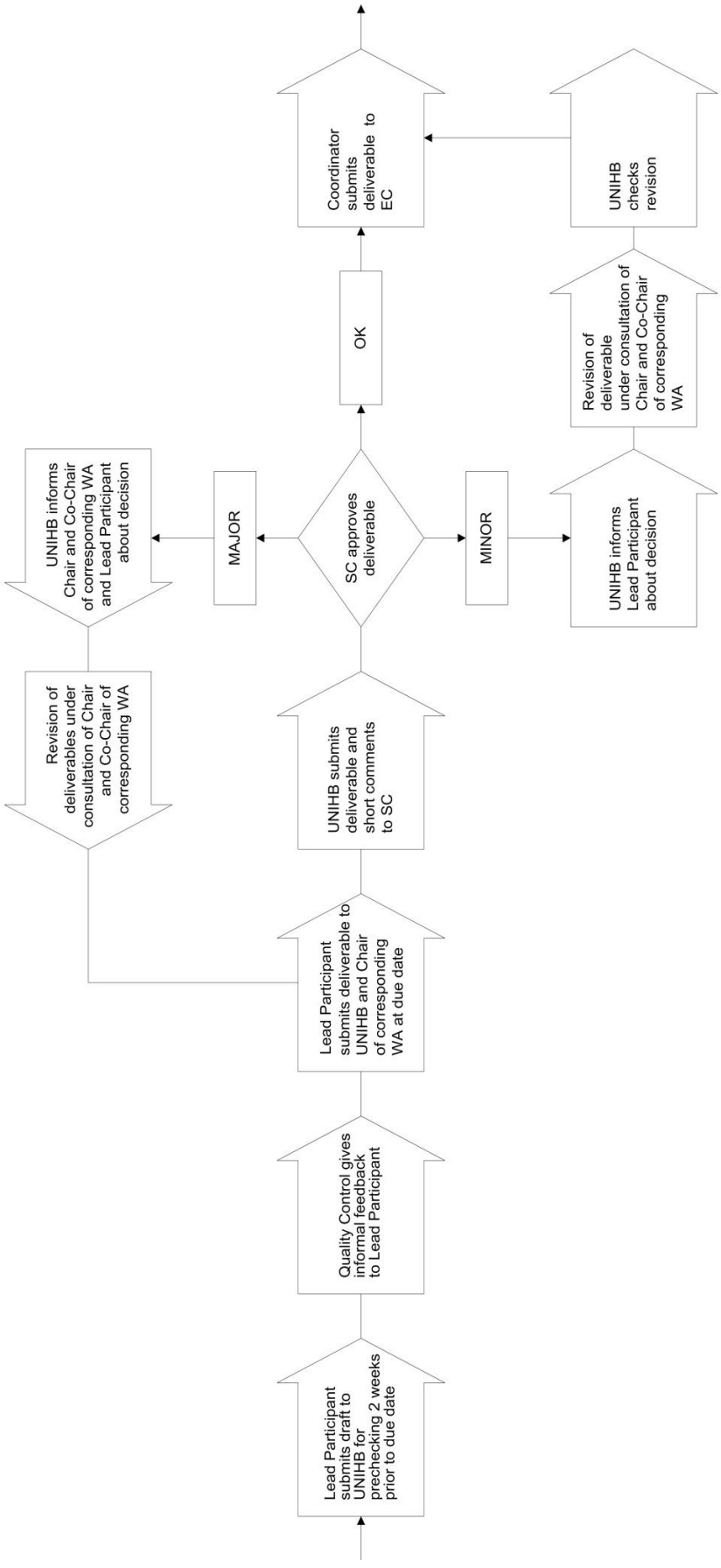


Figure 6: Flowchart of deliverable review

A quality control procedure was established to organise the internal review process of IDEFICS deliverables which is illustrated in Figure 6. All deliverables had to be approved by the SC after a pre-check by the quality control unit (QC) at UNIHB. If the deliverable was approved with minor changes by the SC the revised deliverable had to be re-submitted to QC, which checked the requested changes. If the deliverable was rejected the complete review process had to be rerun after a major revision.

Data management and statistics

All databases and procedures for data transfer from the survey centres to the central database were established by UNIHB. For instance, in the first year databases for local data entry, an electronic appointment system and a computer-assisted 24-hour dietary recall (SACINA) in national languages were developed and provided to all partners. The SACINA data were linked to country-specific food composition tables.

At the end of 2009 a central data server was created and tested by UNIHB. In parallel the SC established rules for remote access to the server by members of the consortium. SAS, SPSS, STATA and specific software tools for the analysis of genetic data were installed and study data were provided in all corresponding data formats. After systematic plausibility checks and data cleaning, the data from the surveys at T_0, T_1 and T_2 as well as laboratory and accelerometer data were subsequently uploaded to the central data server and merged. The resulting analysis dataset was updated regularly by virtue of a continuing and reiterative process of data cleaning since – as is usual in such studies – errors that slipped through the systematic plausibility checks were encountered during data analysis and were then corrected.

The provision of the cleaned datasets allows the longitudinal analysis of the cohort and thus facilitates the full exploitation of the whole study. The wealth of data generated by the project will allow the members of the Consortium to continue the scientific exploitation of the study well beyond the funding period.

UNIHB also provided support in statistical data analyses. A toolbox was provided to all partners. Depending on the research question investigated and the variables involved, a huge variety of statistical methods was applied, among others analysis of (co)variance (ANOVA, ANCOVA), linear regression, logistic regression, generalized linear models, multi-level models allowing for cluster effects, random effects models, cluster analysis, structural equation models, factor analysis, and the classical statistical approaches such as t- and F-tests as well as their non-parametric counterparts and Pearson´s correlation coefficient and Spearman´s rank correlation coefficient.

Dissemination

Besides numerous presentations at scientific conferences and several IDEFICS symposia organised by the Consortium, a supplemental volume of the *International Journal of Obesity* describing the methodological aspects of the study was published in 2011. Additional

manuscripts addressing the aetiological research questions, as e.g. the association of obesity with sleeping behaviour and with taste preferences as well as articles describing novel transcriptional biomarkers or the association of salivary cortisol with negative life events were published in high ranking peer reviewed journals. As of spring 2012, the Steering Committee of the Consortium had approved 183 publication proposals by members of the Consortium, of which 49 have been accepted for publication by peer reviewed journals. A total of 164 presentations were given at national and international conferences, symposia and workshops.

Furthermore, a book on the epidemiology of overweight and obesity in children and adolescents, published in 2011 by Springer Publishers, was edited by three members of the Consortium (Luis Moreno, Iris Pigeot, Wolfgang Ahrens) with contributions by further members and external scientists. Another book on the IDEFICS instruments, edited by Karin Bammann and Wolfgang Ahrens, will be published by Springer Publishers in 2012.

Objective 1: Standardised assessment of the distribution of diet- and lifestyle-related diseases and disorders and their risk factors, focusing on the prevalence of overweight and obesity as major components of the metabolic syndrome and associated disorders (bone health and diabetes) in European children

Baseline survey (T_0)

The baseline survey formed the basis for the establishment of a cohort of more than 16,000 2 to 9 year old children in eight European countries. As described above an extensive set of measurements and questionnaires was applied by standardised procedures in eight European countries between September 2007 and May 2008 (T_0). The extensive examination protocol at T_0 (and also at T_1) included parental questionnaires, anthropometric measurements (circumferences, height, weight, skinfolds, etc., see Figure 7), blood pressure measurement, accelerometry, measurement of bone stiffness (see Figure 8), collection of biomarkers (saliva, urine, capillary/venous blood), SACINA (24-hour dietary recall), fitness tests (see Figure 9), food tasting experiments, and a setting questionnaire.

Figure 7: Anthropometric measurements (left to right): neck circumference, height, skinfold thickness

Figure 8: Examinations and measurement of physical activity (left to right): blood pressure, attachment of Actigraph accelerometer and Polar belt, Achilles ultrasonography of heel bone

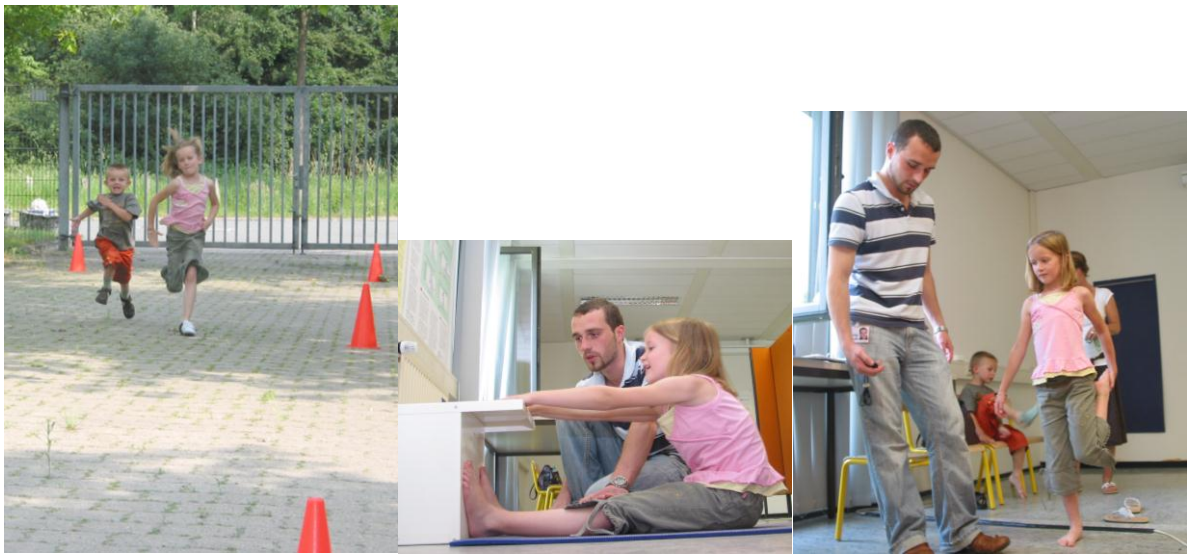


Figure 9: Fitness tests (left to right): shuttle run, sit and reach, flamingo

The time and pace of recruitment was synchronised between countries to allow for seasonal variation. The number of recruited children by country is given in Table 1. The total number resulted after elimination of all non-eligible study subjects and non-valid records.

Table 1: Study groups and sample size by country at baseline (T_0)

Country	Intervention	Non-Intervention	TOTAL
Germany	1,179	887	**2,066**
Sweden	902	907	**1,809**
Estonia	793	926	**1,719**
Spain	798	709	**1,507**
Cyprus	1,373	1,007	**2,380**
Italy	1,155	1,095	**2,250**
Hungary	1,277	1,290	**2,567**
Belgium	976	950	**1,926**
TOTAL	**8,453**	**7,771**	**16,224**

First results regarding the prevalence of overweight and obesity stratified by sex and country are displayed in Figure 10 and Figure 11. These results reveal a substantial variation of the corresponding prevalence values across study regions, with higher values in the South of Europe as compared to the North. Our data show a sex difference in that girls show a slightly higher prevalence in all countries. The same difference is seen in pre-school and in primary school children (data not shown).

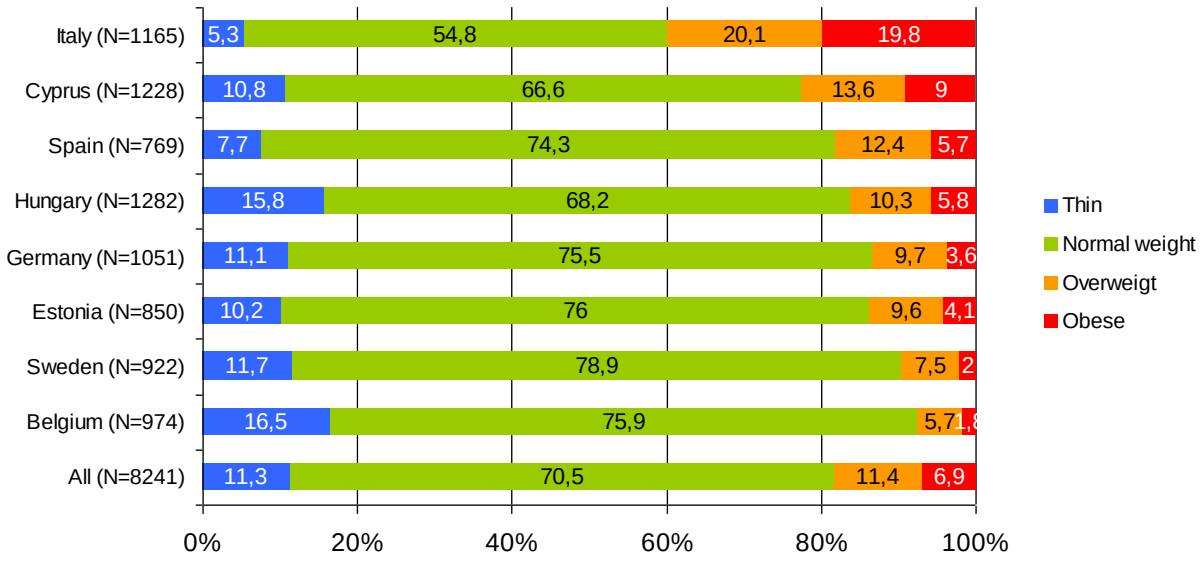


Figure 10: Prevalence of overweight and obesity in 2- to 9-year old boys (N=8,241) in the IDEFICS study (IOTF criteria)

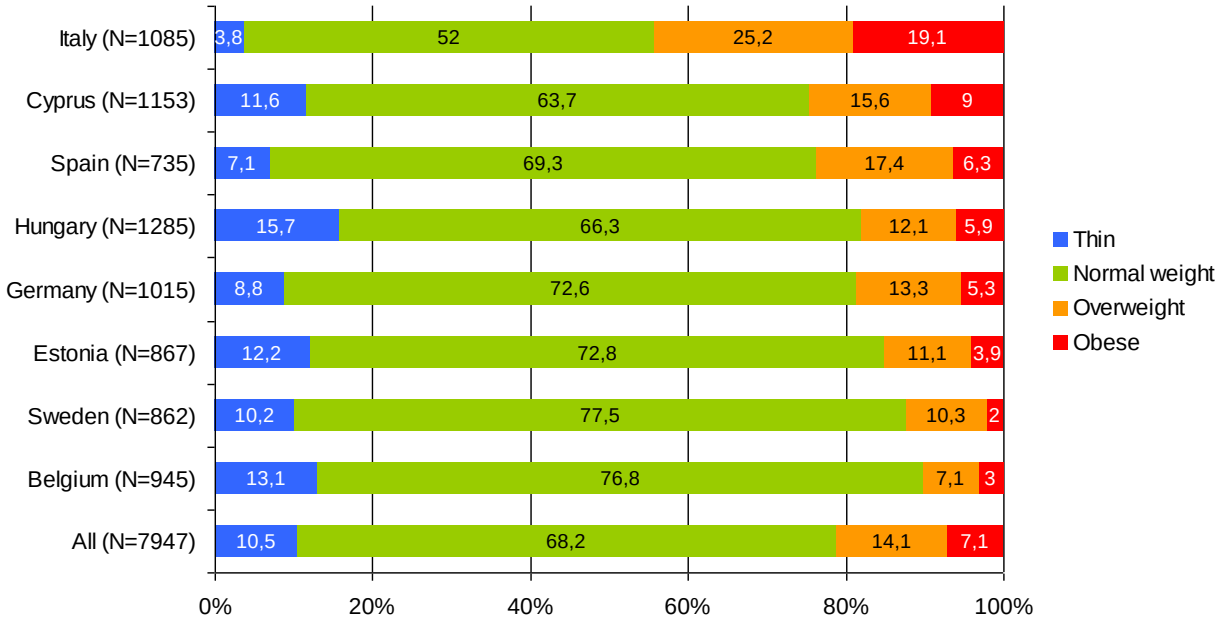


Figure 11: Prevalence of overweight and obesity in 2- to 9-year old girls (N=7,947) in the IDEFICS study (IOTF criteria)

Follow-up survey (T_1)

The instruments that had been developed for the baseline survey were used for the follow-up survey (T_1) that started in September/October 2009, two years after T_0, and lasted until May/June 2010. In order to control for seasonal effects, children were invited in the same order as at T_0. A deviation of the examination at T_1 ±1 month of the corresponding month at T_0 was considered as tolerable. By the end of T_1 69% (=11,189) of the children who participated at T_0 had participated, plus 2,433 new children who entered the corresponding schools or classes between T_0 and T_1. The country-specific breakdown of children recruited during T_0 and followed-up in T_1 as well as children which were newly recruited in T_1 is displayed in Figure 12.

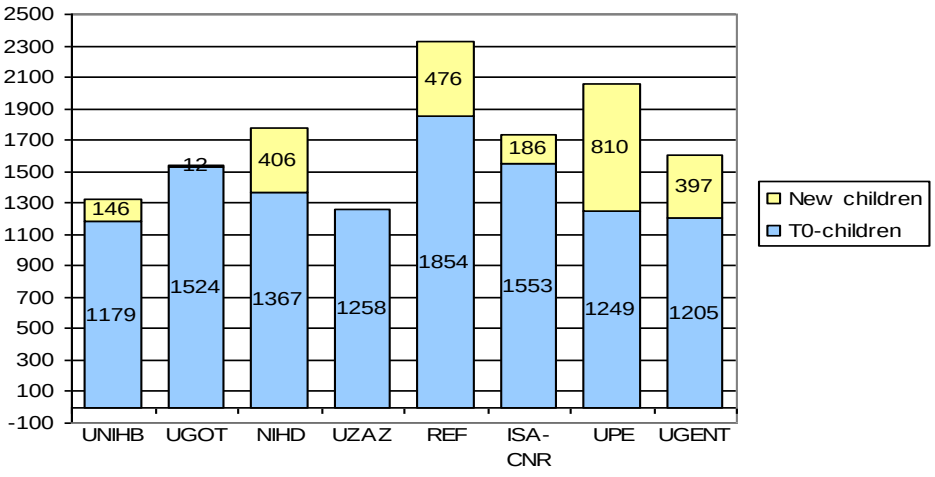


Figure 12: Number of children recruited at T_1 by country

The proportion of children providing urine (T_0 86%; T_1 82%) and venous blood (T_0 57%; T_1 52%) was comparable between baseline and follow-up survey. The same is true for the proportion of children for whom bone stiffness measurements were obtained (T_0 47%; T_1 52%) and who wore accelerometers to assess physical activity (T_0 56%; T_1 52%). However, the proportion of children for whom a 24-hour dietary recall was obtained dropped from 67% in T_0 to 45% in T_1.

Mail survey (T_2)

The follow-up mail survey (T_2) started in September 2010 and lasted until January 2011. Both the baseline survey in T_0 as well as the follow-up survey two years later (T_1) included the same extensive examination protocol. By contrast, the follow-up at T_2 only involved a mailed parental questionnaire on a few selected key variables to assess the sustainability of the intervention. Since some parents had complained about the burdensome questionnaires they had to respond to during T_0 and T_1 it was decided to combine T_2 with the final assessment of the process evaluation in order to minimise the burden for participants. For the same reason the questionnaire was kept as short as possible. As an optional addendum three centres measured weight and height of the children at T_2.

Table 2: Number of children eligible for analysis by country and time of examination; the last two columns give the number of children for whom measurements are available for the first two and for all three examinations, respectively

Study centre	Country	T_0	T_1	T_2	T_0 & T_1	T_0 & T_1 & T_2
ISA-CNR	Italy	2,250	1,738	1,827	1,548	1,311
NIHD	Estonia	1,719	1,765	1,840	1,334	1,223
REF	Cyprus	2,380	2,333	1,004	1,743	680
UGENT	Belgium	1,926	1,725	1,204	1,253	930
UGOT	Sweden	1,809	1,533	915	1,511	886
UNIHB	Germany	2,065	1,341	654	1,195	522
UPE	Hungary	2,569	1,920	1,815	1,247	891
UZAZ	Spain	1,507	1,241	1,009	1,207	971
TOTAL		**16,225**	**13,596**	**10,268**	**11,038**	**7,414**

Table 2 gives an overview of the number of children participating in the three surveys. As minimal requirement for a child to be included in the analysis the parental core questionnaire and the measurement of weight and height of the child had to be completed. As can be seen from Table 2 data on all three surveys are available for less than 50% of the children being enumerated in the baseline survey. However, this only weakens the analysis of the sustainability of the intervention, which was the main purpose of the follow-up survey at T_2. As about 68% of all children who participated in T_0 also took part in T_1, the longitudinal analysis of the study and the evaluation of intervention effects are still equipped with sufficient statistical power. Tables 3 and 4 summarise the number of children for whom core information and dietary behaviour were collected by parental questionnaires and for whom

examination sheets (fasting and non-fasting) were completed, stratified by country and survey.

Table 3: Number of children with parental core and diet questionnaires fulfilling the inclusion criteria by country and time of examination

Study centre	Country	T_0		T_1		T_2*
		Core	Diet	Core	Diet	Core + Diet
ISA-CNR	Italy	2,250	2,250	1,738	1,738	1,827
NIHD	Estonia	1,719	1,666	1,725	1,712	1,840
REF	Cyprus	2,313	1,672	2,267	1,670	854
UGENT	Belgium	1,905	1,862	1,725	1,506	1,179
UGOT	Sweden	1,808	1,759	1,419	1,405	915
UNIHB	Germany	2,065	2,013	1,314	1,164	654
UPE	Hungary	2,569	2,506	1,683	1,674	1,649
UZAZ	Spain	1,484	1,468	1,205	1,179	1,009
TOTAL		**16,113**	**15,196**	**13,076**	**12,048**	**9,927**

* Abbreviated parental questionnaire including only key variables on lifestyle and dietary behaviour

Table 4: Number of children with fasting and non-fasting examinations fulfilling the inclusion criteria by country and time of examination

Study centre	Country	T_0		T_1		T_2*
		Fasting	Non-fasting	Fasting	Non-fasting	
ISA-CNR	Italy	2,250	2,250	1,738	1,738	0
NIHD	Estonia	1,719	1,719	1,765	1,765	0
REF	Cyprus	2,380	2,380	2,333	2,333	458
UGENT	Belgium	1,926	1,926	1,725	1,725	1,002
UGOT	Sweden	1,809	1,809	1,533	1,533	0
UNIHB	Germany	2,065	2,065	1,341	1,341	0
UPE	Hungary	2,569	2,569	1,920	1,920	1,681
UZAZ	Spain	1,507	1,507	1,241	1,241	0
TOTAL		**16,225**	**16,225**	**13,596**	**13,596**	**3,141**

* In T_2 assessment of anthropometric measures was optional

While the overall levels of participation should be considered quite good when compared to similar surveys, it turned out to be below average in centres with a high proportion of participants with low socio-economic status or migrant background like Germany. It should be borne in mind, however, that there are hardly any longitudinal studies of children spanning the age from 2 to 10 with such an extensive examination protocol as the one deployed in the IDEFICS study. Thus, in consideration of the burden to both children and their parents, the observed adherence of 68% can be considered as good. However, the analysis of the factors influencing the drop-out of study participants revealed some selection effects: children with a migrant background, with a low well-being score and living in one-parent families were less

likely to stay in the cohort. A high proportion of missing values at baseline was a positive predictor of loss to follow-up. The corresponding selection effects need to be considered in the interpretation of longitudinal analyses.

Objective 2: Identification of the effects of diet, lifestyle, psychosocial and genetic factors and of their interaction to understand causal pathways to overweight, obesity, metabolic syndrome and bone health in children

The cross-sectional analysis of the study's baseline data has already unveiled some significant findings. For example, we have found that about 1 in 5 children is overweight or obese, with a higher prevalence in Southern countries (see Objective 1). The data also revealed the well known social gradient with higher prevalence values in lower income groups (Figures 13 and 14). In general, the prevalence of overweight and obesity was higher in families from disadvantaged groups, i.e. families with low income, low education, migrant background or single parent families.

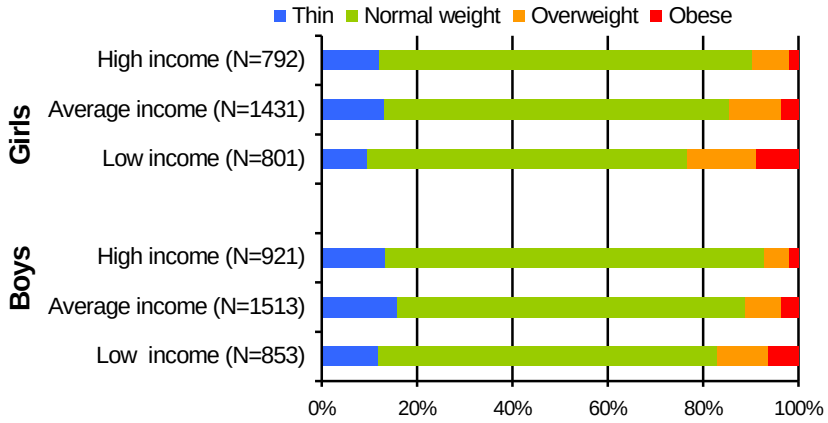


Figure 13: Prevalence of overweight and obesity in 2 to 5 year old children by sex and income group (IOTF criteria)

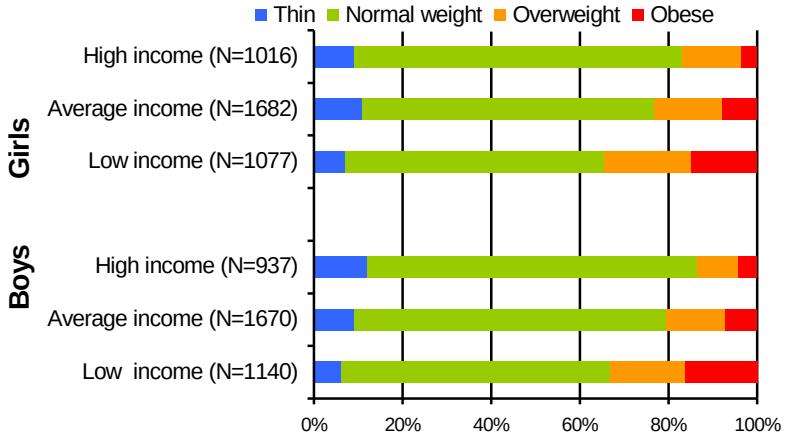


Figure 14: Prevalence of overweight and obesity in 6 to 9 year old children by sex and income group (IOTF criteria)

The study confirmed the well-known clustering of obesity in families, i.e. the prevalence of overweight and obesity was higher in children with obese parents than in those of lean parents. More in-depth analysis of the cross-sectional baseline data and in part also of the longitudinal data revealed the following associations.

A 'moveability index' for children was developed to inform urban planning for healthy environments for children. This index integrated characteristics of the built environment such as playgrounds, green spaces, street connectivity, foot paths and cycle lanes, sports grounds, sports facilities, population density and land use mix for which the so-called Kernel density was estimated using geocodes (Figure 15). Physical activity levels were affected by how easily children are able to move around their surroundings.

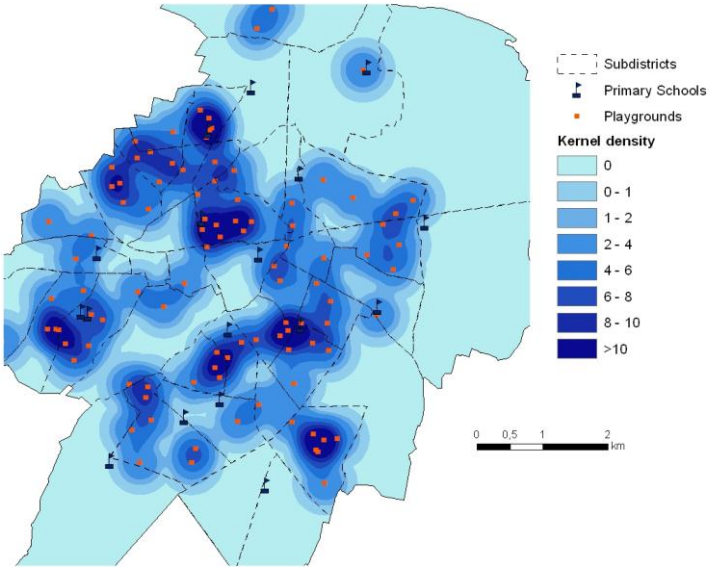


Figure 15: Kernel density estimation based on characteristics of the built environment in the German intervention community Delmenhorst

The analysis of physical activity concentrated on its effect on bone stiffness and weight status. The duration of moderate to vigorous physical activity (MVPA) showed huge variations across Europe (Figure 16) and had a protective effect against overweight and obesity, in particular in school-age children. The prevalence of obesity was highest in children exercising less than the recommended 60 minutes moderate to vigorous physical activity per day (Figure 17). Some of the latest findings published demonstrate the bone health benefits of exercise. Children who ran faster, jumped further, and were more active every day, had stronger bones as indicated by the ultrasonographically assessed bone stiffness of the heel.

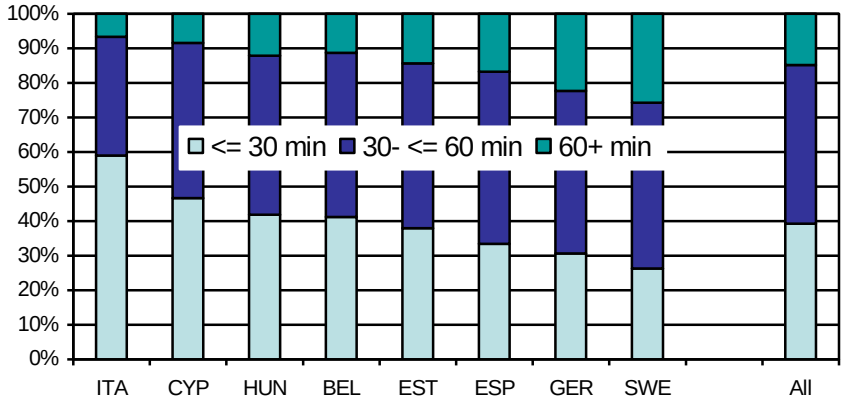


Figure 16: Variation of the duration of MVPA (60 sec. interval, Evenson) across Europe

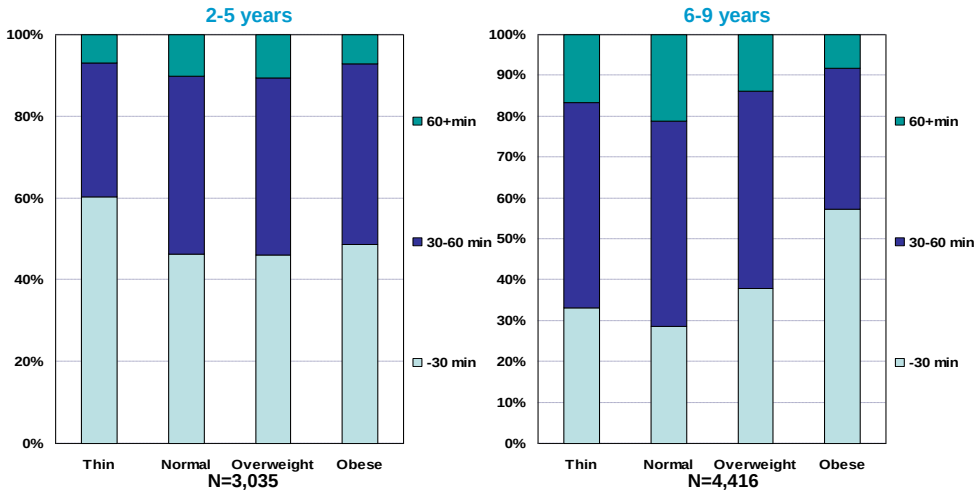


Figure 17: Duration of MVPA (60 sec. interval, Evenson) by age and weight

Sleeping behaviour was investigated with respect to the factors influencing sleep duration, the association of sleep duration and obesity, and the physiological changes involved in this association. Sleep duration showed marked variation across Europe (Figure 18), but exhibited an ecological correlation with the prevalence of overweight/obesity. This association was confirmed by individual level analysis as sleep duration was negatively associated with weight status, particularly in school-age children (Table 5).

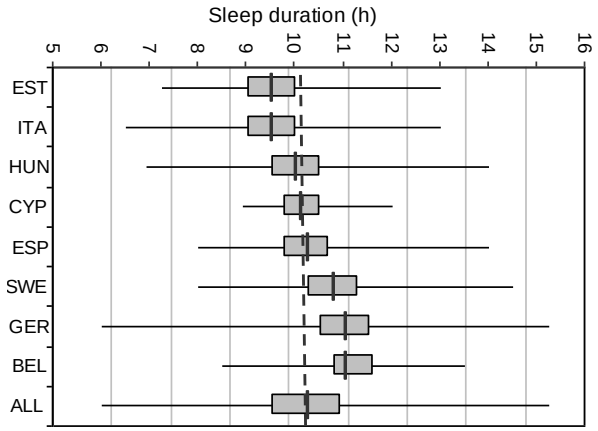


Figure 18: Box plots of nocturnal sleep duration by country (24-hour recall; N = 8,542)

Table 5: Odds ratios (OR) and 95% confidence intervals (CI) for the association between sleep duration and overweight/obesity (reference >11 hours)

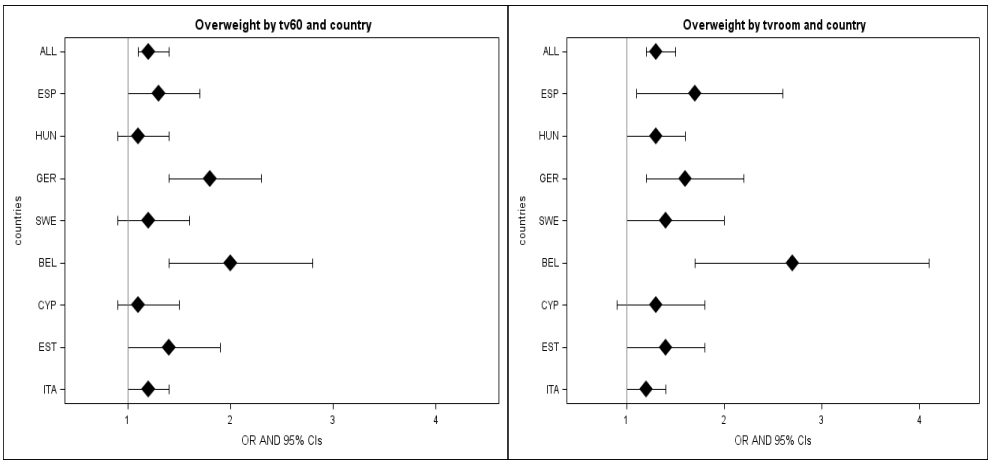
Adjusted OR*	>10h to ≤ 11h	>9h to ≤ 10h	≤ 9 h
Pre-school	1.0 (0.7; 1.3)	1.1 (0.8; 1.5)	1.2 (0.9; 1.8)
School	1.4 (1.1; 2.0)	1.7 (1.3; 2.4)	3.0 (2.2; 4.4)
TOTAL	**1.1 (0.9; 1.4)**	**1.3 (1.1; 1.7)**	**1.9 (1.6; 2.5)**

* Adjusted for sex, age, parental education level, screen time, country

Multivariate linear regression and quantile regression models confirmed an inverse relationship between sleep duration and measures of overweight/obesity. The estimate for the association of sleep duration and body mass index (BMI) was approximately halved after adjustment for fat mass (FM), but remained statistically significant. The strength of this association was also markedly attenuated when adjusting for insulin mainly for the upper BMI quantiles. This means that the inverse relationship between sleep duration and BMI is mainly explained by the association between sleep duration and FM. Insulin may explain part of this association, in particular at the upper tail of the BMI distribution.

Further analyses addressed the development of a youth healthy eating index characterising healthy eating habits, the development of a well-being score, the assessment of parental attitudes regarding responsibilities for preventive action, the identification of markers characterising children at high cardiometabolic risk. In addition, the association between (1) well-being, (2) social factors as well as (3) sedentary behaviour and obesity was investigated. Having a TV in the child's bedroom (Figure 19, right) as well as a duration of TV consumption of more than 60 minutes per day (Figure 19, left) showed a positive association with the weight status of children in all countries.

Figure 19: Odds ratios* (OR) and 95% confidence intervals (CI) for the association between duration of TV consumption (TV60) and presence of a TV/video/DVD in the child's bedroom (TVROOM) and overweight/obesity



* Adjusted for sex, age and parental education

The analysis of the FTO gene (Ref.-SNP 9939609) showed that the odds ratio for overweight/obesity was elevated by 40% among children carrying the AA-allele as compared to the TT-allele. Similar positive associations were found for waist circumference, waist-height ratio and the sum of skinfold thicknesses. These associations were confirmed in the longitudinal analysis even after adjustment for age, sex, country, intervention group and BMI at T_0. The analysis of transcriptional biomarkers in peripheral blood showed the following: high expression levels of CPT1A, SLC27A2, INSR, FASN, or PPARα were indicative of a lower risk for the insulin-resistant or dyslipidemic state associated with obesity, whereas low LEPR mRNA levels appeared as a marker of high low-density lipoprotein cholesterol, independently of body mass index.

Overweight and obese children exhibited multiple signs of risk for developing heart disease in later life, thus highlighting the need for prevention of obesity in children to start early. As displayed in Figures 20 to 22, overweight and obesity in small children was associated with co-morbid conditions like elevated blood pressure, elevated serum lipids and decreased insulin sensitivity (HOMA).

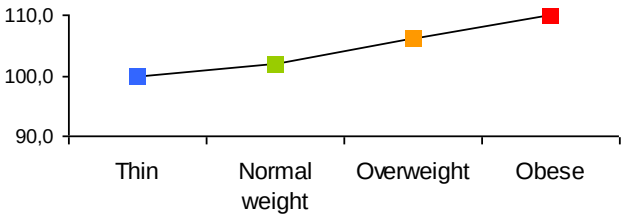


Figure 20: Mean systolic blood pressure [mmHg] in 6-9-year-old children by weight

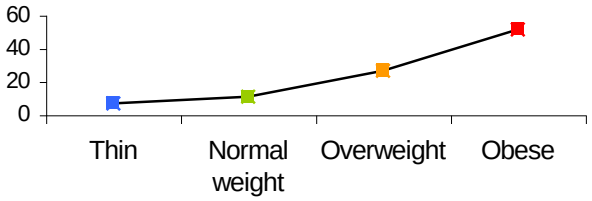


Figure 21: Percentage of 2-9-year-old children with elevated HOMA index (> 85%-perc.)

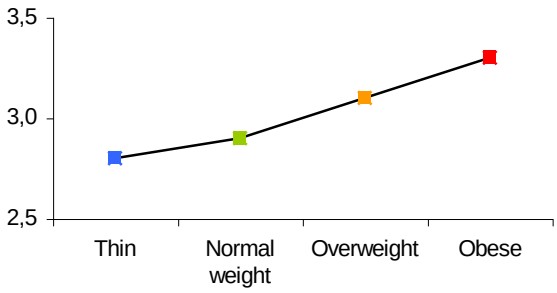


Figure 22: Mean total/HDL cholesterol ratio in 6-9-year-old children

Objective 3: Development, implementation, and evaluation of effective evidence-based strategies for the primary prevention of overweight and obesity as major target and metabolic syndrome as secondary target in pre-school and primary school children

The project has been concerned with the prevention of childhood obesity among pre-school and early school-age children. It has involved the design and evaluation of a setting-based community-oriented intervention programme in communities in eight European countries. Over 8,000 children, as well as their parents, participated in the intervention activities. A similar number of children participated in control regions, so that the effects of the IDEFICS interventions could be gauged. As part of its programme of work, the project also examined the ethical and policy issues connected with the rise of, and prevention of, childhood obesity.

Preparation of intervention

Intervention modules were developed in an interactive way based on the Intervention Mapping Protocol by all intervention centres under the lead of UGENT. The intervention centres also conducted focus group research with parents, teachers, children and community leaders in order to assess facilitators and barriers towards community intervention. The results provided input for the development of intervention modules addressing diet, physical activity and stress coping. The IDEFICS intervention modules were designed to involve and promote a series of common key messages and activities across the eight intervention regions. The following key messages were conveyed:

- **Diet**
  - Enhancing daily consumption of water
  - Enhancing daily consumption of fruit and vegetables
- **Physical activity**
  - Reducing TV viewing
  - Enhancing daily physical activity
- **Stress, coping and relaxation**
  - Spending more time together
  - Ensuring adequate sleep time

During the intervention, these messages were promoted by window posters (see Figure 23), by flyers (see Figure 24 for an example) and by targeted healthy weeks (see Figure 25). In addition, a cookery and activity book and three podcasts explaining these messages have been produced. The podcasts are available on the IDEFICS website.†

† URL is http://www.idefics.eu/Idefics/news?cmd=view&path=documentale/News/Podcast_News.

Figure 23: Overview of three key messages communicated by flyers and supported by intervention activities during targeted healthy weeks

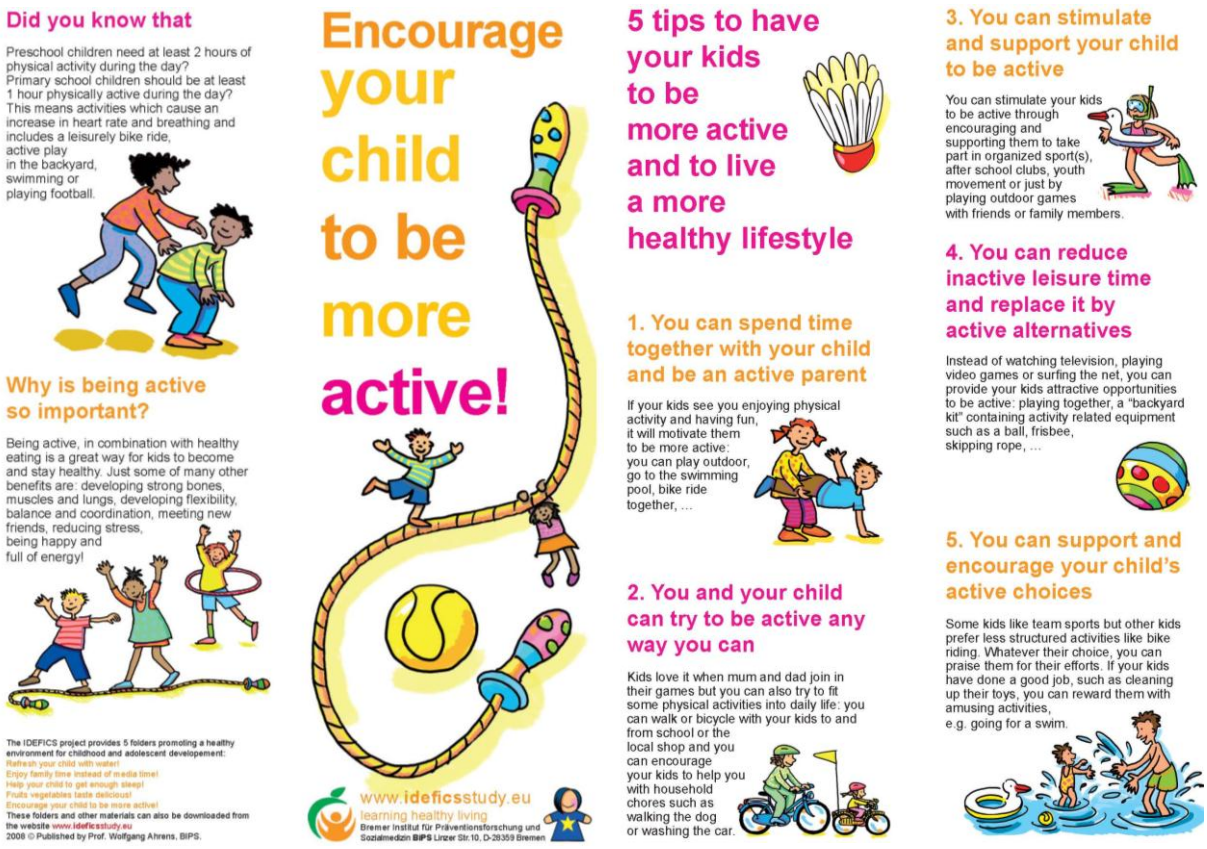


Figure 24: Flyer promoting the improvement of physical activity levels

However, the intervention programmes were not meant to be, nor were they, strictly uniform. The activities were community-oriented: they were designed to allow for cultural variation, differences in the educational and community infrastructures in each region, and to invite local initiative.

Conduct of the intervention

Intervention modules were implemented in a participatory way involving all local actors and stakeholders who were organised in community intervention platforms (one per community) and a round table in each school and kindergarten. The local community platforms were responsible for the further development and implementation of all the intervention modules at the community level. Table 6 gives an overview of the IDEFICS intervention modules that were implemented at the community, school, family and/or individual level.

Table 6: Overview of intervention modules

	Community	School	Family	Individual
Diet	Module 1 Module 2 Module 3	Module 4 Module 8 Module 9	Module 10	Module 5
Physical activity	Module 1 Module 2 Module 3	Module 4 Module 6 Module 7	Module 10	Module 5
Stress, coping and relaxation	Module 1 Module 2 Module 3	Module 4	Module 10	Module 5

- Module 1: Involvement of community partners
- Module 2: Long term media campaign and public relation strategy
- Module 3: Lobbying for community environmental and policy interventions
- Module 4: Building partnerships
- Module 5: Education of children
- Module 6: Environmental changes related to physical activity – The Active Playground
- Module 7: Health related physical education curricula
- Module 8: Environmental changes and school policy related to water consumption
- Module 9: Environmental changes and school policy related to fruit and vegetables
- Module 10: Education of parents

As part of the intervention an international competition involving all intervention communities was launched to collect the best recipes and the most exciting traditional games involving physical activity. The winners' contributions were compiled in a cookery and activity booklet that was published in eight languages by a well-known German publisher of educative material, Westermann Verlag, Braunschweig. The publisher sponsored the study by providing 1,000 complimentary copies that were distributed to the participants in each intervention region.

Figure 25: Healthy weeks (left to right): promoting consumption of fresh fruits and vegetables on the market, water consumption at the water works and physical activity on the school yard

Process evaluation

Process evaluations study the implementation of interventions at all stages from their initial planning. In comprehensive multi-component interventions, the process evaluation can help disentangle the effects of each of the specific factors in the intervention and explain differences in intervention effects. The first aim of the IDEFICS process evaluation was to obtain insight into the differences in implementation of the IDEFICS intervention at the school level, the community level, and the provision of IDEFICS material as reported by the parents after one year of IDEFICS intervention. A higher level of parental exposure to the intervention messages is assumed to be related to better intervention effects. Therefore the second aim of the present study was to analyse whether parents who report higher levels of exposure to the IDEFICS intervention at the school and community level have children with more favourable changes in BMI z-scores between baseline and after one year of intervention. Numerous questionnaires for settings and parents were applied during year two of the intervention, the so-called intervention adoption period, as part of the regular process evaluation.

The results showed that the intervention 'dose' received by parents was considerably higher through schools than through the community. A possible explanation could be that it is easier for schools to deliver health materials and engage parents in a direct (real involvement) and/or indirect (through folders, posters, …) way because they are better able to target and direct their activities than communities. Moreover, schools have a much more direct contact with children and their parents, and have an explicit educational remit that includes health issues. The frequency of parental exposure to the IDEFICS messages through the community but also through the schools was lower than planned. The programme aimed at engaging parents at least once a month and preferably more but only a very small proportion of parents, less than 10% with the exception of Italy (34%), reported having heard about IDEFICS at least once a month or more often through the school of their child.

Exposure of parents to intervention messages at the school and the community level could not be shown to be related with a favourable effect on BMI z-scores of children. Our next steps in

analysing the intervention process will need to add process data from teachers, headmasters, school working groups, community platforms, and local coordinators in each country to get a more thorough picture of the overall implementation of the IDEFICS intervention in all countries.

Endpoint evaluation of the intervention

The endpoint evaluation compares the pre- and post-intervention prevalence of overweight and obesity and corresponding mean values over two years of follow-up using different indicators of body weight and body composition like BMI, BMI z-score, percent body fat and waist-height ratio. Mixed models with an additional random effect for the study centre were used to account for the clustered study design. Furthermore, behaviour change and changes of metabolic parameters were assessed after two years.

In total 16% of the overweight children became normal weight in the intervention region as compared with only 12% in the control region. In both regions 9% of the non-overweight became overweight. In investigating intervention effects at the individual level a significant intervention effect was only observed when looking at the BMI z-scores in girls. Figure 27 shows the result of the calculation of adjusted means using generalised linear regression models to compare BMI z-scores between T_0 and T_1 in the control and intervention region (means were adjusted for age and parental ISCED level, where the maximum of both parents as indicator for socio-economic status was used). No other significant intervention effects were observed that showed a positive health effect due to the intervention, nor were any that showed a negative effect. For most of the lifestyle variables under study no intervention effects could be observed, except from sedentary behaviour that increased less in some intervention regions when compared to the control regions.

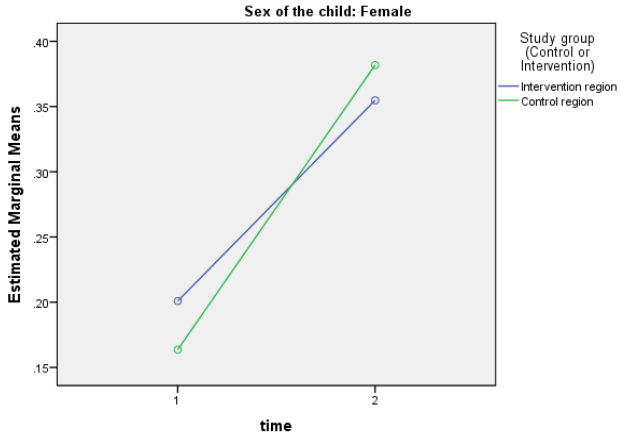


Figure 27: Intervention effect for BMI z-scores in girls

The lack of strong intervention effects is not unexpected. A possible reason could be the lack of a naïve control group. In most participating countries, both the intervention and the control groups had previously been educated about healthy lifestyles in the course of local initiatives dating back before the commencement of the IDEFICS intervention. For regions that were

possibly less exposed to previous interventions like Estonia (see Figure 28 (a) and (b)), minor intervention effects were observed.

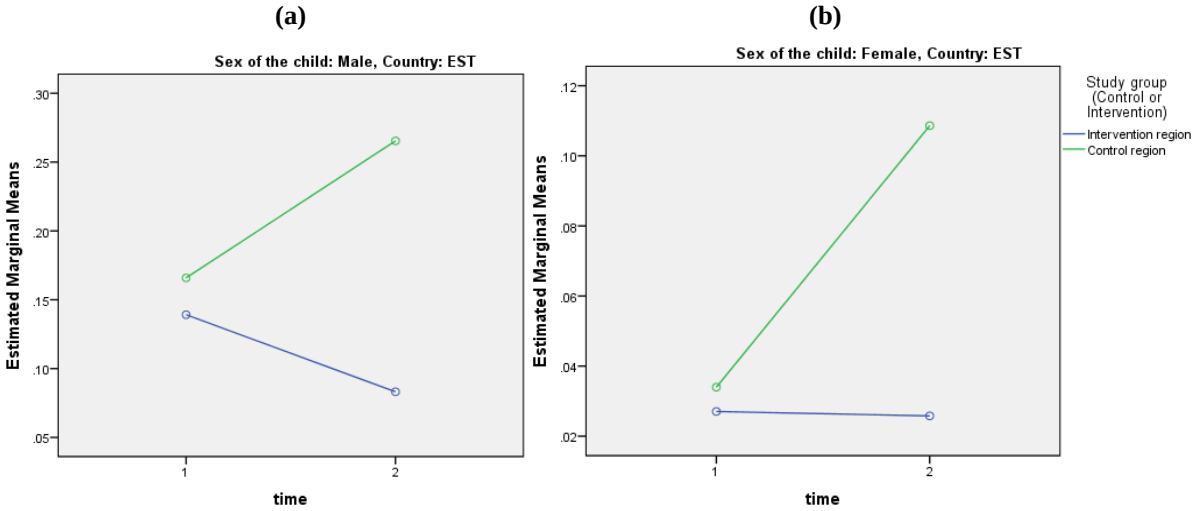


Figure 28: Intervention effect for BMI z-scores in boys (a) and girls (b) in Estonia

Any intervention effects may be negligible in regions where the prevalence of obesity is low, such as in Belgium or Sweden. In addition, baseline differences between the intervention and control group in some of the regions could also attenuate any possible intervention effects. Finally, a possible reason why the expected intervention effects on lifestyle behaviour do not show up could be due to the fact that the analysis is so far limited to subjective self-reports of lifestyle behaviour which may be less sensitive to subtle changes than objective measures like accelerometry. Although no strong intervention effects were found for physical activity assessed via the physical activity questionnaires, further analyses are being performed to investigate possible intervention effects when using the more objective measurements derived from the accelerometer data.

As already discussed during the active intervention phase, the Consortium was afraid that the time window for the intervention would be too short to achieve significant intervention results, especially with respect to health effects on body composition. Although only few intervention effects were found from this 2-year large-scale intervention effort, the descriptive results suggest that these efforts might contribute slowly but significantly to the prevention of childhood obesity in Europe (see below). However, continued follow-up of this study population is needed to confirm long-term effects (beyond a two-year follow-up) of this primary prevention programme.

Success stories

Although our evaluation so far did not reveal strong and consistent effects of the intervention, we observed a number of positive initiatives at the level of communities and settings which may serve as good practice examples:

A core element of IDEFICS was the advocacy for community environmental and policy interventions that would promote physical activity. This activity comprised both short and longer term measures to help prevent childhood obesity. Within the **Italian intervention regions** this was accomplished through the development and implementation of **Healthy Walks** (Figure 29). Each Healthy Walk consisted of a special route within each town, with signs reporting the number of steps done, the corresponding number of calories consumed and the equivalent in food portions for the defined energy expenditure. The ideal Healthy Walk in a town is roughly 4000-5000 steps long; each route is structured in order to give the possibility to walk it in total or in part, according to personal preferences and fitness level. The success of the Healthy Walks can be seen in their ease of implementation, cost-effectiveness and sustainability. The walks are also concrete, visible examples of how to make lifestyles healthier. Also, because they are applied at the population level, they are available to the whole community; they do not discriminate or target certain groups and can be used by children, families, and older persons.

Figure 29: Sign indicating Healthy Walks in an Italian intervention region

Another approach was taken to increase time spent in moderate to vigorous physical activities during recess at school. Politicians, representatives from the municipality, a property manager, teachers, pedagogues, children and the IDEFICS team in **Sweden** collaborated together with school architects from the region to create an **inspiring school yard** in a municipality in west Sweden. The architect had regular meetings with school children of all age groups where they talked about how the school yard was being used. Subsequently they discussed how the school yard could be used and improved and developed new ideas about how to change the school yard environment. After three months of work a list of proposals was generated and the feasible proposals implemented. Key to the success was the active engagement with different stakeholder groups, particularly the children, the end users of the development. This not only ensured their appropriateness for children, but should also promote use of the facilities. The impact has also been felt beyond the immediate school. The architects have been involved in the development of additional schemes across the municipality and beyond the IDEFICS intervention areas.

One goal of the IDEFICS intervention has been to improve diet and nutrition through changes to school policy relating to fruit and vegetables. Specifically the project aimed to make fruit

and vegetables available at least once a week during recess. In **Cyprus** the school day for primary schools ends at 13:05. The **Open School Child Health** programme was devised to keep school yards open for children and parents on Wednesday and Saturday afternoons. Parents and family members were encouraged to attend and activities were inclusive of both children and families. A central focus was to educate children and families with regard to healthy eating and nutrition. Activities included cooking classes for children and parents, crossword puzzles and performances, as well as teaching parents relaxation techniques and giving advice on how to make vegetables more attractive. An important element of this activity was the inclusion of both children and parents. This will hopefully mean that the key messages are sustained beyond the classroom and into the future. Indeed, the activities have been seen to be such a success that the municipality has now taken the event under their auspices, taking financial responsibility for the four physical education teachers involved.

A further specific aim of the IDEFICS study was to discourage the consumption of sugar sweetened beverages. Rather than focussing on a negative message, the study attempted to encourage an increase in the consumption of plain water within the school environment. Through close contact with the schools and kindergartens increased access to water was negotiated, e.g. in **Germany**. Whilst the initiatives varied, in almost all participating kindergartens and some schools new provision for **drinking water sources** was created. This was not only implemented during recess, but throughout the day – even during classes. Part of the success of this activity may be attributed to the close contact with schools/kindergartens which was needed for these activities. A further factor influencing the success was the existing structures that were in place. For example, most classrooms have sinks installed so the basic structures are in place through which to provide tap water. The activity was also felt to be relatively easy to implement by teachers due to the lack of cost implications. One knock-on effect has been that kindergartens are now trying to implement a healthy breakfast, too.

Some activities also sought to engage traditionally hard to reach communities, with a focus on groups from lower socio-economic backgrounds. As part of the activities taking place in the **Spanish intervention regions** the **gypsy community** was approached and between March and August 2009 thirteen cookery courses took place with its members. These classes took a collaborative approach – as opposed to a deficit model of health promotion and education (where the assumption is that people lack knowledge and need to be given relevant knowledge by experts). In discussion with the community, traditional recipes were reviewed and modified so as to improve their nutritional value whilst maintaining their cultural identity. The impact on participants' dietary habits was higher, as dieticians were not trying to introduce new dishes that did not correspond to existing eating habits. A key to the success was the creation of an inclusive community platform that actively engaged with the gypsy community. The "Secretariado gitano de Huesca" (Huesca gypsy secretariat) helped to spread the intervention messages to the gypsy families in addition to through the schools.

Objective 4: Investigation of the association of sensory perception, of internal and external factors of food choices, of children's consumer behaviour with overweight, obesity and metabolic syndrome

Data on food knowledge, food preferences, sensory taste preferences, sensory taste thresholds, as well as actual food choice of children were collected via several quantitative and qualitative instruments, most of them created and assessed within the project. The instruments included: a parental survey, a setting questionnaire for schools and child care centres (including the institution's nutritional and health policies and adults' model behaviour), a children's questionnaire (Figure 30), food tasting experiments with standardised drinks (Figure 31) and tasting crackers as well as an experimental study on knowledge and food preferences with primary school children. We also looked into how these variables are related to influences of commercial communication (in particular, television food advertising), length of exposure and choice of audio visual media (in particular, television programmes), parental attitudes towards advertising, as well as regular exposure to healthful vs. unhealthful food in the different life settings.

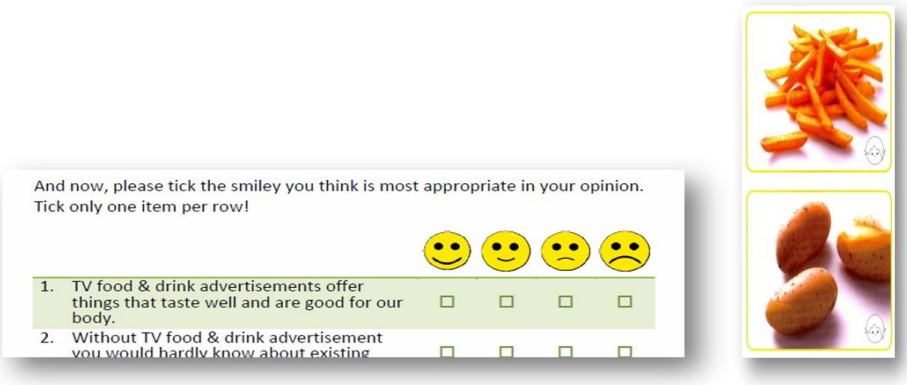


Figure 30: Excerpt from the children's questionnaire and choice booklet

Figure 31: Assessment of sensory taste perception:
taste preference (left) and taste thresholds (middle and right)

Sensory taste perception

A unique feature of the IDEFICS study was the assessment of taste thresholds and taste preferences in order to reveal possible associations with overweight and obesity in a population-based approach with a large number of subjects. The cross-sectional analysis of the baseline survey showed that both fat and sweet taste preference were independently associated with weight status. Children with a taste preference for added fat and those with a taste preference for added sugar had significantly higher odds for being overweight or obese after adjusting for possible confounders. The positive associations with overweight/obesity were seen in all age groups and both sexes (Figure 32), particularly in girls.

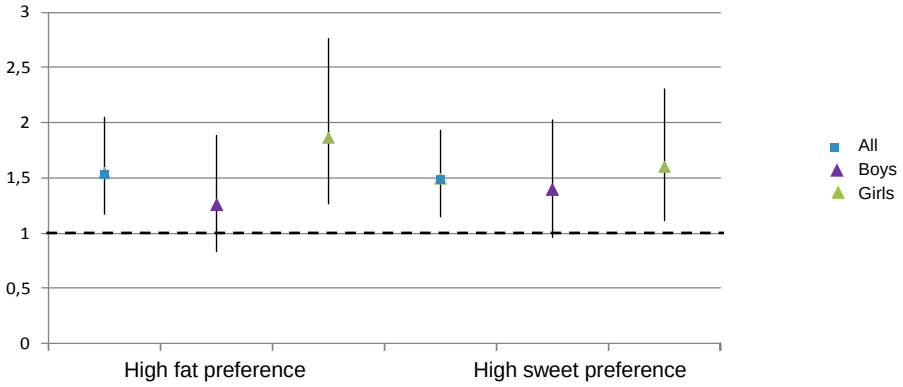


Figure 32: Taste preferences: odds ratios for overweight/obesity by sex (ORs adjusted for country and age; reference category: preference for the non-added food alternative; bars indicate 95% confidence intervals)

Analyses of the combined effect of fat and sweet taste preferences showed that children with a taste preference for both fat and sweet had the highest odds ratios for overweight/obesity, followed by children that had either a fat or sweet preference relative to children who preferred the basic food sample (Figure 33). Linear regression analyses with continuous BMI z-score as dependent variable confirmed the results of the logistic regressions.

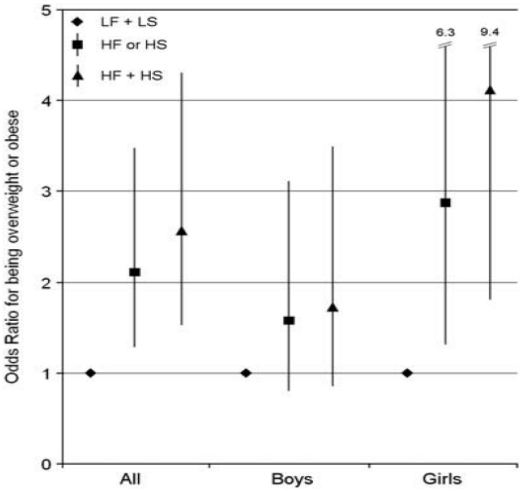


Figure 33: Adjusted odds ratios and 95% confidence intervals for overweight or obesity in children with low-fat and low-sweet (LF+LS, reference), with either high-fat or high-sweet preference (HF or HS), and with high-fat and high-sweet preference (HF+HS)

Based on the food frequency questionnaire, dietary fat propensity was calculated as the ratio of fried potatoes, whole fat milk, whole fat yoghurt, fried fish, cold cuts/sausages, fried meat, fried eggs, mayonnaise, cheese, chocolate- or nut-based spread, butter/margarine on bread, nuts/seeds/dried fruits, salty snacks, savoury pastries, chocolate-based candies, cake/pudding/cookies and ice cream to total frequencies/week, i.e. the ratio of the consumption of all the listed items relative to the total number of all items recorded. Dietary sugar propensity was calculated analogously based on the frequency of consumption of fresh fruit with added sugar, fruit juice, sugar sweetened drinks, diet soft drinks, sweetened breakfast cereals, sweetened milk, sweetened yoghurt, jam/honey, chocolate- or nut-based spread, chocolate-based candies, non-fat candies, cake/pudding/cookies and ice cream. Independent of taste preferences, children who watched more TV had a higher propensity to consume fatty and sweetened food.

Food preferences and triggers of food choice

A range of quantitative and qualitative studies (i.e., choice experiments, children questionnaires, ethnographic studies and parent-child-interviews) investigated the role of television commercials on children's food knowledge and food preferences; these studies were performed in sub-samples of the IDEFICS cohort and only in selected countries.

Frequent television (TV) viewing was associated with obesity in children, but the pathways leading from high levels of TV viewing to obesity are far from clear. As regards the role of commercial food communication, our data support the suggestion that watching advertising – which across Europe overwhelmingly promotes fatty, salty or sugary foods, drinks and snacks – generally leads to lower food knowledge in children. Moreover, while the children in our sample had quite a good idea about the relative healthfulness of foodstuff there was no direct relationship between knowledge and food preferences, i.e. knowledge as to what is healthier does not translate into choice preferences for these healthy food items. Food choice preferences rather seem to be formed by the influence of many external and internal factors, of which health-related knowledge and advertising are only two. In our study, moreover, food knowledge and food preferences were in fact unrelated to actual diet.

While good food and health knowledge remains an unquestioned and important goal, our research supports the claim that it is not sufficient to influence food preferences in order to guide behaviour in a healthier direction. Rather, recent research explicitly questions the assumption that knowledge generally leads to food preferences and that food preferences generally guide behaviour. Empirical work shows that behaviour is strongly influenced by the immediate choice context of the environment, i.e. the affordability, the availability and accessibility of healthful foods. Indeed, food preferences can also be shaped by first creating healthy food practices and habits that in turn influence norms, values and preferences.

To shed more light on the interrelatedness of influencing factors, we designed a study with a threefold aim: (a) to investigate the effects of individual factors on diet quality, (b) to analyse

the association between diet quality and weight status, and (c) to study this topic across eight European countries using a sophisticated methodological approach. To achieve these aims, we adopted a human ecological approach which assumes that individual biological, social-psychological, and lifestyle factors influence diet quality, which is in turn associated with weight status. The IDEFICS study provides information on all three factors, as well as on diet quality and weight status. Methodologically, our use of structural equation modelling (SEM) allowed us to include all factors simultaneously in order to gauge their relative importance for diet, i.e. to systemise and identify the factors that influence children's health behaviour in terms of diet quality and weight status (Figure 34).

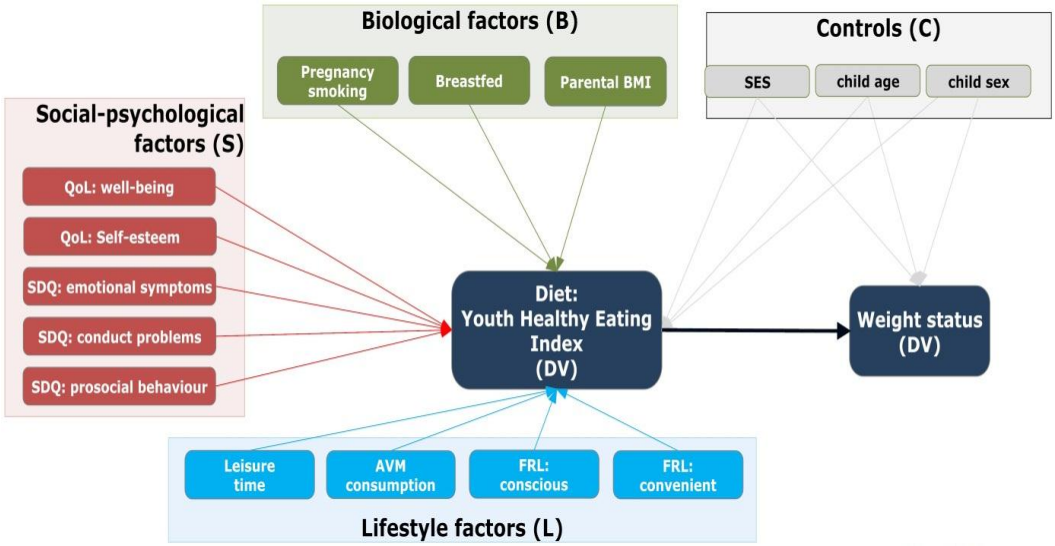


Figure 34: Overview of factors influencing children's diet and diet's impact on weight status
(QOL = health-related quality of life; SDQ = strengths and difficulties questionnaire; AVM = audio visual media; FRL = food-related lifestyle; SES = socio-economic status)

Our primary findings are that there exist significant associations between diet quality and (a) biological factors (breastfeeding); (b) social-psychological factors (emotional well-being, self-esteem, and personality); and (c) lifestyle factors (leisure time activities, sedentary behaviour, and food exposure). Sedentary behaviour and food exposure at home (the familiarity effect) had the strongest effects on children's diet: children who were more exposed to convenience food had an unhealthier diet, whereas children exposed to healthier food had a healthier diet. This observation holds true independent of socio-economic status, geographic region, sex, and age, implying that the handling and choice of food at home – its availability and access – may gently but permanently "nudge" children into either healthful or unhealthful diets. These learned patterns may then develop into habits that are carried through adolescence into adulthood.

One expected outcome of a healthy lifestyle is a healthy weight status. Hence, at first glance, the seemingly non-existent association between healthy eating and weight status is surprising. Nevertheless, it is in line with previous observations that a general diet quality index might be too generic. We therefore carried out further analyses using sub-indices, and these results do indeed suggest that healthful food consumption decreases future weight. This finding offers a

valuable insight for intervention strategies concerning the need to promote healthy eating habits.

Our findings on food exposure and healthful food consumption also seem to provide positive support for intervention strategies like smart choice architectures for food environments that promote healthy eating, such as "smart canteens". Likewise, the opposite effects of leisure time activity and sedentary behaviour imply the wisdom of enhancing non-obesogenic environments by offering playgrounds, biking lanes, safe recreation areas, and sports facilities to promote increased leisure time activity. As described above (see Objective 2) our study showed a positive effect of a children-friendly built environment – as expressed by the moveability index – on the physical activity of children. Thus our study provides more evidence of children's dependency on the stimuli and contexts provided by their socialisation and built environment.

The added value that comparative multi-country approaches have for consumer research became once again obvious from our study because such studies can reveal the effects of contextual factors that influence the health status of children. For instance, the presence of obligatory healthy school lunches based on the latest dietary guidelines and a strict regulation of advertising to children might be decisive in the relatively healthy weight status of Swedish children. The IDEFICS study adds to the understanding of the complex interdependencies between the individual and larger societal and cultural factors.

Impact of the built environment

We collected and analysed data from geographic information systems (GIS) which were complemented by direct observation of the built environment to assess the school environmental exposure of children to unhealthy food and their opportunities for (outdoor) physical activity. For this purpose we developed a moveability index and validated it in a pilot study in three study regions (Germany, Sweden, Italy). First results are described above (see Objective 2). A corresponding index has been developed to assess the quality and geographic density of food outlets.

Objective 5: Development of nutritional, behavioural and ethical guidelines for scientists, policy makers, health insurances, stakeholders and channels

With childhood obesity rates increasing across the world, policy makers face difficult challenges in deciding which policy measures to adopt and how to implement them, alongside many other goals. A range of complex, ethical and practical issues must be taken into account when debating and adopting policy responses to the increase in childhood obesity. We hope that the IDEFICS study will complement ongoing empirical research that serves as the foundation for the development of obesity interventions and policies. However, the creation

and implementation of policies regarding childhood obesity does not merely involve 'applying' this knowledge. Rather, it also requires an awareness of the social complexity of the problem and an acknowledgement that there are a wide range of social values and perspectives that must be brought to bear on the issues.

The presentation of scientific findings, especially in popularised forms, is often affected by simplification and confusions. Problems include the presentation of greater certainty than actually exists, a tendency to apply population level analyses to the individual, and the misinterpretation of tentative results or propositions as facts. Such simplifications may seem superficially helpful, but they undermine effective policy-making. Thus there needs to be an awareness of the uncertainties that exist so that policies can take steps to account for these. As the study data discussed above, some correlations and even causal links are becoming clearer, but there is still much room for further analysis and investigation. Moreover, as indicated by the difficulties that exist in clearly demonstrating the effects of even such a comprehensively monitored intervention as that undertaken in the IDEFICS study, there remain significant difficulties in locating clearly effective interventions, not to mention in demonstrating their cost-effectiveness and absence of side-effects.

For these reasons, we have not, in our consideration of the policy issues raised by the IDEFICS study, laid claim to any simple or incontrovertible 'solutions.' In part, this reflects the complexity of the scientific and social questions just mentioned. But it also reflects the fact that how to act here is ultimately a political question, concerning the proper allocation of responsibilities to many different actors, and the balancing of many different goals. Nonetheless, we would like to suggest two broad arguments that are important for those debates.

On the one hand, the often favoured option of informational and educational campaigns that target individual consumers does not recognise the complexity of the issues. (See also 'Food preferences and triggers of food choice' above.) Beyond the fact that these measures seem to be relatively ineffective, they may have undesirable side-effects (for example, the misperception that weight loss is a desirable goal in itself, or an unfair blaming or 'responsibilisation' of children or parents) and do not address a broader spectrum of issues. Such measures are politically attractive because they promise to target the problems of obesity and less healthy behaviours very directly. Their relative ineffectiveness in doing so, as well as possible side-effects, arises just because individual behaviour is formed in a very complex context, as set out in the ecological model discussed above. People are already trying to navigate a range of opportunities and obstacles; parents are already trying to do their best in such a situation. In general, it is not a lack of information that generates less healthy behaviours, so much as the balance of obstacles and opportunities that are open to people.

On the other hand, public policy needs to take account of many ends: measures to prevent childhood obesity, and to improve health more broadly, are only two of the aims that public policies must pursue. In many cases, however, this point actually provides a stronger

argument for action than might be given by the sometimes inconclusive evidence concerning childhood obesity. This is because some policy options promise to be relatively successful in meeting many uncontroversial ends of public policy, even if we presently lack clear evidence that they will reduce rates of childhood obesity. For example, as indicated above, our findings suggest that higher moveability indexes for children are associated with lower obesity levels and other desirable health outcomes. In itself, this may not be enough to constitute a compelling argument for such policy measures that aim to increase the child-friendliness of our built environments. However, if such policies can promise benefits on many different dimensions – for example, in terms of traffic safety and the pleasantness of built environments, as well children's health and obesity levels – then this suggests that a very strong case can be made for them, even if some uncertainty must remain as to how effective they will be as regards childhood obesity. Taken in this way, we believe that the cumulative findings of studies such as IDEFICS support further policy measures that aim to address childhood obesity as one of their goals.

Specific guidelines based on the IDEFICS data

Although to date there is a lack of conclusive evidence with regard to the effectiveness of most obesity interventions, some favourable results have recently been described. Australia, China, England, France, Germany, The Netherlands, New Zealand, Sweden, Switzerland and the USA have all shown flattening trends in childhood overweight and obesity. Among the potential explanations the impact of intervention measures is ranked in top position: following the recognition of childhood obesity as a major public health concern, large-scale measures have been adopted in prevention and intervention and in the promotion of healthy energy-balance. This reinforces our efforts going ahead in this direction. Still, the question is how to approach policy-making for childhood obesity given the many empirical uncertainties remaining. In this regard, we would also like to highlight a final aspect of the IDEFICS project, which consists in the elaboration of guidelines. These have three potential aims and levels:

- targeted to professionals, formulating the state of the art in a way easily implemented in professional practice (mainly for professionals of health and educational system);
- targeted to lay populations, translating nutrients to foods, thus directing people in the simplest way to certain basic nutritional knowledge;
- targeted to the media with easily understandable messages, aiming to balance messages from the food industry and contributing to the remodelling of public opinion.

Such simple but evidence-based messages can easily be incorporated in any kind of preventive efforts or intervention programmes. While we have noted that informational measures are inadequate by themselves, it is important that messages from widely various channels should reinforce each other, effectively supporting behaviour modification, and promoting public support for wider measures that address our obesogenic environment.

The guidelines recommended by the IDEFICS Consortium aim at preventing obesity-related diseases and/or increasing the proportion of "healthy" obese children, that is, children who may be classified as obese but are otherwise metabolically healthy. Thus the IDEFICS project has formulated guidelines/recommendations based on its results. This is also because available national guidelines did not cover the breadth of our intervention key messages and partly because the scientific literature contains contradictory results and has frequently issued in quite soft and over-general recommendations. On the one hand, our recommendations go beyond dietary behaviour since they incorporate physical activity and stress coping. On the other hand, they are more specifically targeted than available food-based guidelines because they only address water (sugary drinks) and vegetable consumption, since it is for these that the evidence is most unequivocal.

Recommendations

1. Sugar-sweetened drinks

The consumption of water instead of sugar-sweetened drinks can reduce total daily calorie intake. In the IDEFICS cross-sectional sample the consumption of sugary drinks, sweetened milk in particular, was associated with an increased relative risk of overweight and obesity. The lowest intake of sweetened beverages was observed in countries with the lowest prevalence of overweight and obesity.

> *On the basis of the IDFICS results a reduced consumption of sugar sweetened drinks, especially that of sweetened milk, should be emphasised and promoted in future recommendations and interventions. Plain water should be promoted as the main source of liquid for children.*

2. Fruit and vegetable consumption

Fruit and vegetable consumption is very low in the European countries. The recommendations (5 and 3 times/day) were reached by less than 16% and 50% of the children, respectively, even in the countries with the highest consumption of fruits and vegetables. Fruit and vegetable consumption was not associated with overweight or obesity in the cross-sectional analysis. The detailed analysis of the 24-h dietary recall (SACINA) will provide further information concerning the association of fruit and vegetable intake with obesity as well as concerning the recommended frequency and quantity of intake.

> *On the basis of the available data, we can only state that plant food consumption should be promoted in Europe since its consumption is low and it is the main contributor to a well-balanced diet.*

3. Physical activity

There is no doubt that the number of children spending more than 1 hour/day in moderate to vigorous physical activity (MVPA) is very low on the European level: in Sweden this proportion is less than 30% and 20% among school and kindergarten children, respectively, while in Italy it is even lower (less than 5% in school children and 10% in kindergarten children). The negative association between physical activity and obesity is clearly demonstrated by the IDEFICS cross-sectional data.

> *Since MVPA is extremely low in European children and its association with obesity is known, the enhancement of MVPA should have an outstanding place and role in any health-related recommendation. The present results suggest that 1 hour/day MVPA may be an unrealistically high target for preschool children.*

4. Screen time

Total screen time, as an indicator of sedentary behaviour, showed significant association with overweight and obesity. Total screen time increased significantly by age (higher in school children than in pre-school children) and showed large variation between countries.

> *According to the present data the recommendation of <1 hour/day screen time for kindergarten children and <2 hours/day screen time for school children seems to be reasonable.*

5. Well-being stress score

Since it was assumed that high quality of life indicates lower stress level and the ability to cope with stress, the IDEFICS guideline panel took a well-being stress score as an indicator of stress coping. The percentage of children with a high score value (=high well-being) was highest in countries with low obesity prevalence (Estonia, Belgium and Sweden) and much lower in countries with high obesity prevalence (Italy, Cyprus and Spain). In agreement with this ecological correlation, the relative risk of overweight and obesity was significantly lower in children with a high score value.

> *Although our findings suggest a beneficial effect of children's well-being on their weight status, a recommendation, e.g. to improve the stress coping capacity in children, will require further in-depth analyses and an independent confirmation of this new finding.*

6. Sleep duration

Our results confirmed previous observations that shorter sleep duration is associated with a higher probability of being overweight. However, the association appeared to be much stronger in school children than in pre-school children. School children sleep on average 0.33 hours less than pre-school children. It was demonstrated that sleep duration differs between regions within Europe: children from Southern Europe sleep less than children from Northern

countries. The age-specific percentile curves of sleep duration enable us to give more accurate recommendations concerning sleep duration.

> *The results of the IDEFICS cross-sectional survey enable us to recommend 11 hours or more sleep for pre-school children and 10 hours for school children (6-10 years). Promotion of sufficient sleep should be part of any health-related recommendations.*

7. Observance of the IDEFICS key messages

The results demonstrated that the distribution of the compliance score values as an expression of observing the six IDEFICS key messages differed significantly by country. The score value significantly decreased with age, while the prevalence of obesity increased with age. The compliance score was strongly associated with overweight and obesity: children with a high compliance score had a markedly reduced risk of being overweight or obese.

> *These results underline the importance of health-related recommendations/guidelines and make clear that guidelines are effective only if individuals in the targeted population follow them. The proportion of young children observing health-related recommendations is very low, indicating a great potential for improvement.*

8. Suitable time window for prevention efforts in small children

The prevalence of overweight/obesity doubles in school children as compared to pre-school children, with a sharp increase in the prevalence of overweight/obesity during the early school years which directs our attention to this critical period. The real causes will probably be revealed only by the longitudinal analysis but the cross-sectional data already provide some hints concerning possible factors playing a role in the surge of obesity prevalence during the early school years. Total screen time increased, while fruit and vegetable consumption, sleep duration and the well-being score significantly decreased in school children as compared to pre-school children.

With the exception of Hungary and Cyprus the distribution of the compliance score differed significantly between pre-school and school children. The decreasing observation of lifestyle recommendations by age may contribute to the observed increment in obesity prevalence in school age.

> *This observation of the IDEFICS study suggests that the age before school entry is a critical period regarding the development of obesity. Primary prevention programmes should target this age group.*

To make the guidelines meaningful to the general public, they should be short, simple, clear, easily remembered and culturally appropriate. They should be communicated well through a variety of media addressing all relevant community groups and ages.

Input coming from the intervention study and from the T_2 survey will improve and refine the IDEFICS recommendations. After formulating the final recommendations an important further step will be to decide how and where to communicate them.

The IDEFICS Charter

A first step beyond the study period that has already been taken was the ratification of the 'IDEFICS charter.' This was developed in consultation with local policy makers who have been involved in the IDEFICS intervention. The charter was formally launched at a second IDEFICS policy dissemination meeting held in Partille, Sweden in May 2011, to which politicians and policy makers from the IDEFICS intervention regions were invited. This 'IDEFICS charter' (see below) has been signed by mayors and their representatives from the intervention regions. The charter is an important symbol of local policy makers' commitment to carry on with the many different initiatives that parents, schools, and civil servants have taken within the IDEFICS study.

IDEFICS CHARTER

The high prevalence of overweight and obesity in children today is a major public health challenge. The sharp increase in childhood obesity, starting in the 1980 's, has been characterized as "epidemic" in nature. As the epidemic continues non-communicable diseases related to obesity are expected to increase globally. Therefore several European expert panels and policy platforms have already called for urgent action aimed at tackling this problem.

The **IDEFICS study** was selected by the European Commission for the purpose of studying this issue carefully and to search for ways of counteracting the epidemic. This study has shown that the prevalence of overweight and obesity varies in Europe from 8 % in areas with the lowest prevalence to 40 % in areas with the highest prevalence rates.

The **IDEFICS intervention** campaign has from 2007 onwards laid the basis for intensified actions in **eight European IDEFICS cities** aimed at the generalized adoption of more healthy lifestyles in children and their parents – in particular focusing on healthy diet, health enhancing physical activity and a stress reducing lifestyle. The first results of this IDEFICS intervention show a favorable trend in children's health behavior and physiology.

The philosophy of IDEFICS is mainly that a change in the health behavior of the population can largely be brought about by a **change in the environment** and that this change should be steered by the **local public authorities** and broadly endorsed by supportive initiatives taken by **all stakeholders** in the community that can play a role in this process of change.

The IDEFICS study offers a unique opportunity for policy makers to explore a model for obesity prevention in Europe. This model has been outlined and studied in a first phase in the IDEFICS study. **It now needs continuation to study long term effects and sustainability issues**.
The work that has been done so far in IDEFICS and the information that has been voluntarily made available by the participating children, parents, school teachers and community actors, allows to explore this further.

By doing this, precious time can be gained in the battle against the obesity epidemic in Europe

The IDEFICS coordinators, Work package leaders and principal investigators have jointly launched an **IDEFICS mayors' platform** for the purpose of continuation of the IDEFICS initiative into the future. The main objectives of this platform are to further explore and promote the IDEFICS intervention model as a sustainable approach for obesity prevention in Europe. These objectives will be elaborated in consultation and collaboration with European expert panels and international organizations such as WHO and with European policy making and policy supporting bodies.

With the support of the **World health Organization** and the **European Commission**, the mayors and their representatives from eight European communities have taken a new and ground breaking initiative for the further enhancement of children's health. In their meeting in the community of

PARTILLE

(IDEFICS Intervention area in Sweden)
on May 13th and 14th, 2011

they have discussed ways for further elaboration of the IDEFICS intervention and IDEFICS concept in their communities and populations with a view to exploring the implementation of sustainable changes in the health environment and to monitor and investigate the effect of such changes on the health of the population, in particular children.

The mandated community representatives and policymakers (hereafter referred as "mayors") have agreed to endorse the following points of commitment and action:

- The mayors of the IDEFICS communities **fully support the objectives, structure and concept of the IDEFICS intervention**. They will continue to give logistic and public relations support to the IDEFICS intervention and will help in pursuing the mobilization of structural support and resources that are needed for the continuation of the IDEFICS intervention.

- The mayors of the IDEFICS communities commit to **the important role of public authorities in the political governance of changing the environment to facilitate and support healthy lifestyle**.
  In particular they will commit in this regard to their roles as
  * political leaders with central responsibility in governance of child health
  * drivers for fund raising activities and initiatives in this regard
  * pursuers of the political process towards change in the political and societal commitment of other local actors and stakeholders

- The mayors of the IDEFICS communities accept the membership in the **European IDEFICS mayors' platform** and agree to integrate and visualize this membership in their local public relations network and activities.
  This membership encompasses the commitment to participate in future meetings of the IDEFICS mayors' platform and to help in elaborating the objectives of this platform, in particular its role in supporting future research on the public health effect of community interventions. The IDEFICS mayors' platform membership will also be materialized in ways of publicly declaring their city as an **IDEFICS city**.

Name and position	Place and date	Signature