Assessment of diet, physical activity, biological, social and environmental factors in a multi-centre European project on diet- and lifestyle-related disorders in children (IDEFICS)

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Abstract

Obesity is a major public health problem in developed countries. We present a European project, called Identification and Prevention of Dietary and Lifestyle induced Health Effects in Children and Infants (IDEFICS), that focuses on diet- and lifestyle-related diseases in children. This paper outlines methodological aspects and means of quality control in IDEFICS. IDEFICS will use a multicentre survey design of a population-based cohort of about 17,000 2- to 10-year-old children in nine European countries (Belgium, Cyprus, Estonia, Germany, Greece, Hungary, Italy, Spain and Sweden). The project will investigate the impact of dietary factors such as food intake and food preferences, lifestyle factors such as physical activity, psychosocial factors and genetic factors on the development of obesity and other selected diet- and lifestyle-related disorders. An intervention study will be set up in pre-school and primary school settings in eight of the survey centres. Standardised survey instruments will be designed during the first phase of the project and applied in the surveys by all centres. Standard operation procedures (SOPs) will be developed, as well as a plan for training the personnel involved in the surveys. These activities will be accompanied by a quality control strategy that will encompass the evaluation of process and result quality throughout the project. IDEFICS will develop comparable Europe-wide health indicators and instruments for data collection among young children. Establishment of a new European cohort within IDEFICS will provide a unique opportunity to document the development of the obesity epidemic in the current generation of young Europeans and investigate the impact of primary prevention in European children populations.

Keywords **Diet** **Lifestyle** **Children's** **health** **Europe** **Methods**

Introduction

There has been a strong increase in diet- and lifestyle-related diseases and disorders in children in Europe in the last decades (Bundred et al. 2001). Even early analyses indicated that direct and indirect costs attributable to an unfavourable diet and a sedentary lifestyle may exceed those attributable to tobacco use in the European Union (EU) (National Institute of Public Health 1997). Obesity, as one of the most important diet- and lifestyle-related diseases, results in enormous financial costs being borne by the health care systems and communities and is thus one of the most important challenges of public health in developed countries. However, international experiences on community-wide intervention programmes on coronary heart disease have shown that reduction of overweight and obesity in adult populations within such frameworks is hard to achieve. These programmes do not seem to be effective for the prevention of obesity. Therefore, specific programmes should be developed that mainly target children and adolescents. Published studies report prevalences of diet- and lifestyle-related diseases in children that vary between most European countries. It is, however, not clear, whether these disparities result from methodological artefacts due to differences in measurement and classification methods or whether they represent true findings. Moreover, comparability of results concerning the aetiology of diet- and lifestyle-related diseases may be limited because dietary and lifestyle habits are culturally influenced and can differ even between neighbouring countries. To fill this research gap, a multi-centred European project called Identification and Prevention of Dietary and Lifestyle-induced Health Effects in Children and Infants (IDEFICS) has been designed. This paper focuses on aspects relating to assessment and quality control in the project. The general study design has been described elsewhere (Ahrens et al. 2006).

Background

IDEFICS is planned as an Integrated Project (IP) within the Sixth Framework Programme of the European Commission (EC) to take place from autumn 2006 to 2011. The core of IDEFICS consists of population-based intervention studies to be set up in pre- and primary school settings. Two major surveys (baseline and follow-up) will be conducted in nine European countries, namely, Belgium, Cyprus, Estonia, Germany, Greece (no intervention), Hungary, Italy, Spain and Sweden, delivering comparable data of 17,000 children aged 2–8 years at baseline. Besides the planned intervention studies, the surveys will serve as the basis for aetiological studies on overweight, obesity, metabolic syndrome and scoliosis using epidemiological case-control and cohort designs. Moreover, they will provide detailed insight

into the distribution of diet- and lifestyle-related disorders in children and of their key risk factors. Although not necessarily representative for their countries, the study populations represent typical areas that will provide data on variability and regional, ethnic and gender-specific variations of the disorders in question. Inclusion of different European populations is vital to capture the influence of various cultural and genetic backgrounds, social environments and dietary habits.

>>> Include Figure 1 about here

IDEFICS is structured into eight working areas (WA), as depicted in Fig. 1. The intervention studies are organised in WA 04 “Aetiology” and WA 05 “Intervention”. Besides WA 04, two other WAs will mainly concentrate on aspects relating to the aetiology of the above disorders: WA 06 “Biological Mechanisms” will explore biological markers, physiological regulation, selected genetic markers and early outcome measures. WA 07 “Consumer Science” will investigate factors of food preferences, actual food choice and children’s consumer behaviour. WA 08 “Transfer” will communicate results to stakeholders and the public, develop guidelines and investigate ethical aspects. WA 02 “Statistics & Data Management” will provide statistical consulting and establish standard procedures for data handling and analysis. Management of the IP is organised in WA 01 “Management”.

The objectives of WA 03 “Standardisation & Quality Control” comprise development and continuous evaluation of a quality plan, provision of instruments, coordination of training activities and monitoring of compliance with ethical aspects. Activities of this WA are further elaborated in the following.

Quality control

Maintaining a high standard for all components of IDEFICS is a challenging task in this complex project. A quality plan will be set up that provides standards and procedures for quality control, such as tools for the organisation and documentation of field work or for quality assurance of laboratory procedures. Adherence to the quality plan will be continuously monitored. Process and result quality will be evaluated and whether ethical and gender aspects are appropriately considered in the research process will be examined. Standard operating procedures (SOPs) will be worked out and integrated into a central operations manual. Compliance with good scientific practice in general and the agreed SOPs in particular

will be ensured by regular reporting schemes. Quality control will also encompass documentation and validation of databases and software routines for data warehousing and analysis. All deliverables of the project will be pre-checked by the quality control unit before further processing.

Questionnaires and measurements

Standardised age-specific instruments for children and their parents will be developed and used by all centres for assessment of dietary habits; social, environmental and family factors; energy expenditure; physical activity and anthropometric indices (see Table 1). The surveys will include a parental questionnaire, physiological measurements and physical examinations for assessment of outcomes and key risk factors. A general survey manual containing detailed survey procedures and field-work instructions will be developed. Recording and measurement sheets for all examination procedures, such as body composition, physical fitness, food tasting and use of accelerometers, will be integrated into an examination manual. A set of all questionnaires, measurement sheets and selected SOPs will be compiled and translated and re-translated in the respective national languages. All survey centres will perform local pre-tests of instruments and measurements. Re-interviews for selected instruments are planned in sub-samples of about 50 children per survey centre. General considerations on central questionnaire modules are described below.

>>> Include Table 1 about here

Dietary patterns

Increasing evidence suggests that food frequency questionnaires (FFQ) have strong limitations in the assessment of detailed dietary information (Kristal et al. 2005). Various studies have shown poor agreement between different types of instruments (Park et al. 2005; Bingham et al. 2003a,b; Potter 2005; Schatzkin et al. 2003). Dietary assessment in small children is especially challenging because they may not be able to give the relevant information themselves. In IDEFICS, children's diet will be assessed by parental questionnaires. Beyond this, IDEFICS represents an ideal framework to test and apply innovative instruments in a large-scale epidemiological study. One of the activities of the IP will be to develop computer-administered questionnaires and food records that can be

completed via the Internet. These instruments will be used to collect additional qualitative and quantitative information on dietary habits and food consumption and to estimate macro- and micro-nutrients intake, both from children (when feasible) and from their parents. Where feasible, information from caretakers and teachers on school/day-care food will be collected. Additionally, the project will seek collaboration with other European networks, such as the EPIC Nutrient Database (ENDB), to make use of harmonised food composition tables across Europe.

Physical activity

Physical activity is a complex behaviour that varies with age, gender, season, week day and time of the day and is also influenced by biological, sociological, psychological and environmental factors. This makes it difficult to assess, especially in children who constantly change their activity. In IDEFICS, parameters of physical activity will be subjectively assessed by the parental questionnaire. Additional information, e.g. on media consumption, will be derived from the questionnaire module on consumer behaviour. Objective measurements of the amount of physical activity and its patterns will be obtained by application of accelerometers in a 20% sub-sample in the surveys. Accelerometry is a user-friendly method that can directly assess the amount and the patterns of intensity and duration of physical activity. To date, no other method can be used with such reliability and validity on a large scale to assess physical activity behaviour. Other objective methods, such as heart-rate monitoring and pedometers, were decided against for several reasons. Heart-rate monitoring is limited by the fact that the heart-rate response tends to lag behind changes in physical activity and can be influenced by other factors, such as emotional stress and body position. Pedometers only count the number of steps taken and cannot capture the intensity and duration of physical activity, which makes their data difficult to interpret. Accelerometers were initially uni-axial (measuring only one dimension of movement). However, the development towards more complicated instruments is rapid, and there is currently no consensus about the optimal equipment to use. In IDEFICS, a validation study will be carried out in which two accelerometers (1-dimensional vs. 3-dimensional) will be tested against doubly labelled water. IDEFICS will be the first large-scale study to assess physical activity among pre-school and primary school children. It will be a challenge not only to handle and interpret the data but also to improve acceptance in small children to wear an accelerometer for 3 or even more days.

Social factors

Social epidemiology offers various concepts when investigating social factors related to health and disease. Classically, socio-economic status measures are based on household income, educational level and/or occupation. Children are typically assigned to the same socio-economic status as their parents. However, in practice, methodological problems arise, e.g. it is not clear how to determine the socio-economic status of children from so-called patchwork families or families with status-heterogeneous members. Other important social factors to be included in the consideration derive from sociological role theory or can be grouped as cultural and ethnic factors (Ball and Crawford 2005) or as factors leading to social vulnerability, such as migration, unemployment or lacking social support (Marmot and Wilkinson 2006). It is largely unclear to what extent children are influenced by social factors attributed to their (psychological) parents and from which age on their own social roles and/or cultures potentially have an effect on health and disease. The two most challenging questions regarding the assessment of social factors in IDEFICS will be: (a) which social factors are important for children's health and (b) to find instruments and methods that can be applied in different European countries in the same manner. The questionnaire module on social factors in IDEFICS will consider findings from European initiatives, such as, e.g. the European Socio-Economic Classification (ESeC) scheme (Harrison and Rose 2006), as well as from European multi-centre projects and projects specifically on children, such as, e.g. the Health Behaviour in School-aged Children Study (HBSC, see <http://www.hbsc.org>).

Consumer behaviour

Research has shown that children's food preferences, knowledge and behaviour have multiple determinants. According to recent literature reviews (Story et al. 2002; Livingstone and Helsper 2004), these can be grouped at four distinct levels: individual, interpersonal, community, societal. IDEFICS looks at aspects of all four levels: The parental questionnaire will comprise questions concerning the individual level, such as: children's food preferences and knowledge, the meaning of food, the role of health and nutrition in the family, the observed influence of brands, the strength of "pester power" (including availability of children's money) and children's television exposure. Additionally, sensory data (see "Sensory perception and food testing") is data on an individual level. The parental questionnaire will cover interpersonal factors, such as family food styles, costs, meal patterns,

food availability, dieting, exercise, parental weight, food preferences and nutritional knowledge. A short questionnaire for caretakers and teachers will be developed to investigate the influence of school/day-care food socialisation and the observed role of conformity to peer norms. Data on the community level will be assessed with recording sheets. Global positioning system (GPS) data will be used to characterise the outer school environment, e.g. opportunities for physical activity and buying fast food (see “Recording sheets for settings”). Small-group research with children will be conducted in order to study food advertising effects and evaluate media literacy.

Medical history and drug use

A thorough medical history of the child and his or her siblings and parents will be included in the survey both for the sake of identifying potential aetiological factors and for the purpose of adjustment for potential confounding effects when studying associations between lifestyle and outcomes of interest. The medical history will include data on pregnancy (weight changes, duration, complications, etc.) and pregnancy outcome, the child’s feeding pattern during the first months of life, growth pattern, vaccination schemes and any relevant medical problem or medical/surgical intervention in the child’s history. A list of relevant documented genetic disorders or inherited traits in the parents’ families will be developed for inclusion in the questionnaire. A broad enquiry with respect to current or past use of drugs, supplements or other compounds administered to the child for health reasons will be envisaged through both questionnaires and interview. Information on medication and supplements will be stored according to a standardised coding system. An overall protocol for standardisation of retrieval and storage of data on medical history and drug use will be elaborated, taking into account the cultural differences in modalities of medical information storage and exchange in the IDEFICS partnership.

Physical examination

Children in the IDEFICS surveys will undergo a standardised physical examination. This examination will be done according to protocols to be defined in the first year of the project. Collected anthropometric data will include measurement of body weight and height, waist and hip circumferences and skin-fold thickness. BMI will be calculated and compared to

alternative measures of obesity assessed in the study and to cut-offs from reference populations (Cole et al. 2000; McCarthy et al. 2006). Blood pressure will be measured with an automatic oscillometer using international reference values (National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents 2004). Visual inspection of the child will cover the skin of the neck and under the arms (for presence of acanthosis nigricans) and evaluation of musculoskeletal aberrations. Knees will be inspected for bowleg or knock-knees and the spine for scoliosis using a scoliometer. All necessary measuring devices will be purchased centrally to ensure comparability between all study centres.

Body composition

Body composition is a key indicator of obesity. Accurate techniques for its assessment are essential for IDEFICS. However, most field and methodological studies have been carried out in adults, and there is a clear need for development and validation of assessment methods in small children. Apart from traditional anthropometry, bioelectrical impedance analysis (BIA) is the most adequate method for large-scale epidemiological studies. Hydro-densitometry and dual-energy X-ray absorptiometry (DEXA) are considered to be reference methods but are too cumbersome and expensive to use in field studies. Air-displacement plethysmography (ADP) is a relatively new method of body composition assessment that has been shown in crosssectional studies to be reasonably precise, accurate and easy to use in both adults and older children (Fields and Goran 2000; Lockner et al. 2000). This method is recommended for subjects over 40 kg but only a minor bias was observed in a subgroup of children with a lower age limit of 6 years (Nunez et al. 1999). In IDEFICS, ADP measurements using the BodPod will be compared with traditional skin-fold measurements and BIA. Regression equations for BIA will be developed in close collaboration with another European project called Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) (<http://www.helenastudy.com>), which provides the opportunity to expand the age ranges from 2 to 16 years and to estimate the validity and reproducibility of the methods in IDEFICS and HELENA.

Biological markers from urine and blood

Population-based studies within IDEFICS comprise the analysis of biomarkers associated with overweight/obesity and its co-morbid conditions and biomarkers of different diets and lifestyles. Differences in the level of biomarkers will be compared between various European populations and before and after the intervention. The project aims to delineate pathways that lead to diet- and lifestyle-related diseases and disorders in childhood. Children in the surveys will be asked to donate blood and urine samples with informed consent by themselves and their parents. Depending on the obtained volumes, different sets of biomarkers will be analysed by a central laboratory. This includes routine clinical parameters such as blood lipids, glucose and insulin; selected hormones related to energy balance and satiety and markers of diet and bone metabolism. Expression analyses will be performed for selected genes in blood cells. The most essential markers for metabolic syndrome will be measured on site, with a point-of-care analyser from one drop of blood. Immediate feedback will be given on these markers. As part of the quality management, a database system for logistics of the biological material will be developed, and SOPs will be established for collection, shipment and analysis of biological samples. It is envisaged to establish a bio bank, which will be managed with the help of the logistics database system. Blood lipids from capillary blood Fatty-acid (FA) profiles of blood lipids mainly depend upon fat intake and are also modulated by physiological states (e.g. infant development, ageing) and lifestyles. Polyunsaturated FAs, especially omega-3 FA, modulate various biological functions. Food composition tables are not very reliable for rare FAs. Data on the relationship between fat intake, blood FA and pathophysiological conditions are obtained by FA analysis of circulating lipids. Since the conventional procedure is rather complex and difficult to apply on a large scale due to limitations regarding sample collection, storage, shipment and preparation for analysis, an innovative analytical methodology was developed (Marangoni et al. 2006). It involves measurement of FA profiles in a single drop of blood absorbed on a strip of chromatography paper and transmethyated for gas chromatography analysis. It has shown several relevant advantages (applicability, time and costs) in various studies (Agostoni et al. 2005; Marangoni et al. 2004). This new method will be applied on a large scale in the IDEFICS surveys and will be validated in a sub-set of blood samples using classical techniques.

Genetic markers from mouth mucosal cells

DNA will be obtained from buccal cell samples by mouth wash or cytology brush. Choice for this method was made because it is non-invasive and may be better accepted by children and their parents than donation of blood samples for this purpose. All samples will be sent to a

central laboratory where DNA will be extracted. Quality and quantity of DNA will be increased by whole-genome amplification. In IDEFICS, a candidate gene approach is foreseen for all children enrolled in the case-control studies. The genes to be tested will be selected on the basis of (1) biological plausibility for the gene to have an functional influence on the development of disease; (2) significant statistical evidence that single nucleotide polymorphisms (SNPs) in the gene are consistently associated with variation in intermediate phenotypes (e.g. protein levels) or endpoints; (3) adequate frequency of the polymorphisms of the selected candidate gene in the population to allow meaningful statistical analysis. The minimal subset of SNPs required to extract the maximum amount of information regarding the haplotype will be determined by computational approaches based on allele frequency, linkage disequilibrium and position on the gene (Carlson et al. 2004).

Sensory perception and food testing

IDEFICS will investigate the role of sensory perception and taste sensitivity, their relation to obesity and their interplay with genetic factors in sub-samples within the surveys. It will be investigated whether sensory perception and preferences vary across European children populations with their different diets and lifestyles as well as between obese and non-obese children and whether they can be changed and become subject to interventions. Standardised methods [according to International Standards Organisation (ISO) 3972] commonly used in the food industry will be adapted for IDEFICS. The children will be offered test solutions and foodstuff in an experimental setting. The taste threshold value will be assessed for different age groups using the taste stimuli sweet, sour, salty and umami in table water [based on Deutsches Institut für Normung (DIN) 10959]. Milk solutions in different concentrations will be developed to assess fat and sugar perception and preference of children. Measurement of food preferences will also include a newly developed and adapted foodstuff with varying contents of sweet, salty and aromatic taste components. Sensory data will be recorded twice (at baseline and follow-up) to detect a possible effect of the intervention.

Recording sheets for settings

It is planned to develop a comprehensive instrument designed to measure environmental opportunities for playing, walking and cycling in school and pre-school neighbourhoods. Geo-coded databases will be combined to examine geographical characteristics of the environment and to assess distribution of, e.g., fast-food restaurants. Fast-food restaurants or kiosks may be concentrated within easy walking distance of elementary and high schools (Austin et al.

2005). The instrument will be adapted from existing tools in combination with additional measures that are gathered through Geographical Information Systems (Pikora et al. 2002). Streets inside a critical radius around paths, buildings, and food supplies, considering the following features:

- Road characteristics: road length, road condition, number of lanes, parking restriction signs, traffic control devices, type of crossings, presence of streetlights
- Walking and cycling paths: path type, path width, path location, slope, path condition, lane type (on-road cycling)
- Buildings: transport infrastructure, housing, convenience stores, other retail, industries, services, natural features (i.e. parks, outdoor sporting centres)
- Fast-food outlets: type of chain, type of independent restaurant (Italian, Indian, Thai, etc), range of foodstuff (chips, burgers, pizzas, curry, kebabs)

Training

To guarantee standardisation of field work, training activities are planned as a two-step procedure. Central training sessions will take place on all major components of the survey followed by local training sessions in each study centre. To further enhance standardisation and compliance with the respective operations manuals, site visits for quality control and identification of need for re-training will be done. These activities will be supported by the development of training manuals and the production of videos for teaching purposes on special topics. Additionally, counselling will be provided on ethical issues. This will encompass practical aspects relating to existing laws and regulations as well as the research process, e.g. advice will be given on different dimensions of socio-economic or gender bias and how these biases can be avoided. A joint education programme will be organised in which postgraduate students and other personnel will be exchanged and trained at different institutions in the consortium. Workshops will be organised on selected research topics on demand. A mentoring programme for young researchers will be offered. IDEFICS will build links to related projects to promote the use of common methodologies and common training of scientists and staff members to ensure comparability of data and results.

Discussion

In a recent review of school-based interventions for prevention of childhood and adolescent obesity, it was concluded that the clear majority of published studies were able to document some positive outcomes (Doak et al. 2006). However, when attempting to synthesise existing evidence on intervention effects, a number of problems were demonstrated. Because the interventions used different methods and targeted different aspects of obesity-related behaviours, it could not be concluded which type of intervention would be most likely to succeed on a large scale. Regarding the choice of anthropometric outcome measures, it was pointed out that a programme focusing on increased physical fitness cannot exclusively use BMI as a measure of obesity; however, very few studies have used both skin-fold thicknesses and weight-for-height as outcome variables. This type of methodological decision will be particularly important in view of the different height distributions of children from different European countries. Finally, the failure of many previous studies to consider effects of population distributions is apparent; for instance, while focusing on changing prevalence of overweight and obesity, interventions rarely report on whether underweight rates also increased in the population. In summary, lessons learned from the most recent systematic reviews on obesity interventions unanimously point to the importance of comprehensive yet standardised survey methodology for international studies on childhood obesity and thorough evaluation of their effectiveness. Besides internal standardisation of measurements, instruments, procedures for data collection and laboratory work, data management and statistical analyses, the IP will provide SOPs to apply uniform criteria on a European level for a gender-sensitive assessment of physical constitution, metabolic syndrome and the standardised measurement of obesity in large-scale surveys of children. The IP will establish European and national standard methods and instruments to assess in a validated way dietary intake concerning food items and micronutrients, level and pattern of physical activity as well as external and internal factors for food choices. Furthermore, the project will enhance standardisation and improve comparability of health-related data in Europe. One of the general objectives of the Public Health Programme of the European Community is to develop comparable information on health, which will be based on Europe-wide health indicators [European Community Health Indicators (ECHI); see http://www.ec.europa.eu/health/ph_information/information_en.htm], and of instruments for collecting the necessary data. This work is done by the Directorate General for Health and Consumer Affairs (DG SANCO) Health Information Strand, DG Research and the Statistical Office of the European Communities (EUROSTAT) of the EC, in cooperation with the World Health Organisation

(WHO). The work has so far been focused on adults and the elderly. Corresponding health indicators and instruments for data collection among children have now urgently to be developed. To facilitate this work, IDEFICS will work closely with the Working Party on Lifestyle of DG SANCO (<http://www.publichealth.tu-dresden.de/eu/>) to ensure communication and interaction with other relevant project activities. A liaison group has been established between IDEFICS and HELENA, a European project on lifestyle and obesity in adolescents (<http://www.helenastudy.com>). Focus points for close collaboration between the two projects are: (a) standardisation/harmonisation of methods and measurements by exchange of instruments, SOPs, experience and knowledge in accordance with both consortium agreements; (b) pooled data analyses to describe key variables over a broader age range, if feasible; (c) joint workshops and scientific symposia; (d) exchange and training of young researchers; and (e) joint dissemination activities. The establishment of new international cohorts with standardised data covering a range of environmental and biological influences will provide a unique opportunity to document the natural history of the epidemic in the current generation of young Europeans and to investigate the impact of primary prevention in European children populations facing an obesity epidemic of historical proportions. Both IDEFICS and HELENA will establish European cohorts that can be followed into adulthood, when the risk of developing obesity and related health problems increases. In this context, quality control remains an essential prerequisite to future development. As IDEFICS undertakes a harmonised implementation of surveys and interventions in eight European countries, this broad approach becomes a special challenge. In the above-cited review (Doak et al. 2006), it was observed that broader interventions were not more likely to be proven successful; in fact, one highly specific intervention consisting of modifying children's television habits was rather consistently effective. This does not imply that a broad approach should be avoided but that it will require greater efforts to document, implement and evaluate. This situation underscores the importance of standardisation of survey measures and methodologies in interventions targeting multiple obesity-promoting behaviours and environments. The study will not be able to cover all potentially influencing factors since the questionnaire will have a maximum length and cannot be extended at will. Moreover, the possibilities of using standardised instruments may be difficult in some areas. Food behaviours and preferences, for example, belong to a culturally sensitive area that will not allow simple translations of questionnaires and may even require country-specific questionnaire modules. In any case, the pitfalls of cross-cultural research regarding wording of questions and interpretation of the data must be kept in mind in IDEFICS.

Acknowledgements

IDEFICS will be supported by the European Commission, 6th Framework Programme, Food Quality and Safety (contract no. 016181). We gratefully acknowledge the financial and personal support of the University of Bremen and of the German National Contact Point during the development of the IDEFICS proposal.

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Figure 1: Workflow and interrelation of the Working Areas of IDEFICS

Table 1: Variables and age-specific instruments to be used in IDEFICS

Assessment method	Exposure or outcome	Variables
Core variables to be assessed in all children		
Parental questionnaire	Dietary patterns	Breastfeeding, eating habits/eating-out habits a) Foods b) Macro-nutrients c) Micro-nutrients
	Medical history	Medical conditions, birth weight and height
	Drugs	Use of pharmaceuticals (inspection of drug packages)
	Physical activity	Hours of physical activity per week
	Social environment	Socio-economic status, family size and structure
	Media consumption	Time spent watching TV/playing videogames
	Psychological factors	Attitudes, parental knowledge, child behaviour
Child interview (if feasible)	24-hours dietary recall	Total energy uptake, macro- and micro-nutrients (linked with food composition tables)
Recording sheet for pre-school and primary school settings	(Social) environment	Unemployment rates, social welfare etc.
	Exposure to advertisement	Vending machines with snacks and soft drinks, promotional material supplied by food producers etc.
Physical examination	Anthropometry	Weight, height, BMI according to IOTF criteria (Cole et al. 2000), waist/hip circumference, waist/hip-ratio, skinfolds (to be discussed), bioelectric impedance analysis (BIA), body fat distribution,
	(Automated) sphygmomanometer	Blood pressure (RR) ^{##} , Hypertension
	Visual inspection	Musculoskeletal disorders: postural deformity, scoliosis
Noninvasive biological samples	Mouthwash samples	Genetic markers, selected gene polymorphisms (see WA 06)
	Morning urine	Glucose, u-albumin, u-kreatinin, selected micronutrients (Na, Mg, P, Ca)
Invasive biological samples	Venous blood	Blood lipids (cholesterol, triglycerides, HDL/LDL) (with point of care analyser); Blood glucose (with point of care analyser); HbA1c; Insulin, cortisol, C-reactive protein (CRP); Complete blood count (CBC) ⁺⁺
	Capillary blood ^{**}	Blood lipids (cholesterol, triglycerides, HDL/LDL with point of care analyser); Blood glucose (with point of care analyser); FA profiles: n-3 and n-6 FA
Additional variables to be assessed in sub-groups of children		
Invasive biological samples	Venous blood ♦	Fatty acid profile (FA in plasma and RBC membrane: validation purposes only); Peripheral hormones (leptin, adiponectin, ghrelin: in case-control studies only); Markers of bone metabolism (Vit D, Calcium, β -crosslaps: in case-control study on scoliosis); Gene expression analysis for selected genes with systemic activity: in a subset of blood samples
Special examinations	Age-specific motor tests (Bos et al. 2002), aerobic fitness	Hand-grip strength, strength of back muscles, hip flexibility test, motor skills (e.g. zig-zag running, body stability test)
	Body composition	BIA
	Bodpod (to be used in validation study only)	Body composition
	Food tasting (to be used in subsample)	Sensory perception, food preference
	3-D accelerometers (to be used in validation study only)	Physical activity, calories burned
	1-D accelerometers (to be used in subsample)	Physical activity, calories burned
	Food tasting	Food preference, taste sensitivity (age-specific assessment methods to be developed and validated)

^{##} National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents (2004).

^{**} Only applies if no venous blood is taken.

♦ Parameters rank from top to bottom in case donated blood is not sufficient

⁺⁺ Analysis of complete blood count has to be done immediately which will not be possible in all survey centres