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Executive summary: Dietary habits in preschool children as a basis for the development of a methodological framework for future dietary surveillance

by

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In young children, dietary intake is not only linked to growth, development, and nutrition-related diseases (such as deficiencies and toxicities), but also to risk factors for chronic diseases such as obesity, increased cholesterol levels and hypertension. In these first years of life children acquire many of the physical attributes and the social and psychological structures for life and learning. Because unhealthy lifestyle patterns might continue into adulthood, it is important to strive as early in life as possible for a high-quality diet with optimal levels of food and nutrients to help maintain optimal health.

Because detailed information on dietary habits among preschool children in Flanders was still lacking, the Ghent University (Belgium) started a first Flanders preschool dietary survey in 2002-2003. The primary aim of this dietary survey in preschool children was to monitor the nutritional adequacy and toxicological safety of the diet among Flemish preschoolers (2.5-6.5 years old). A secondary aim was to develop and validate a quick and accurate tool for use in future dietary studies aiming to assess preschoolers' diet quality, calcium, and food intake.

Although the data derived from this survey are already broadly and internationally being used for different purposes (e.g. by the European Food Safety Authority (EFSA)), this thesis focused at some well-defined aims and objectives. The *primary aim* of this thesis is to describe the methods used in the Flanders preschool dietary survey and to discuss the nutritional adequacy and safety of Flemish preschoolers' dietary intake. A *secondary aim* of this thesis was to develop and validate an accurate and easy tool for estimating preschoolers' diet quality, calcium, and food intake.

To reach these two aims three study samples were drawn by means of cluster-sampling, using (pre)schools as primary sampling units and classes as secondary sampling units.

1. In the largest study sample, which contained 50 schools randomly selected within the five Flemish provinces, 2426 children were invited to participate in this Flanders preschool dietary

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study. The parents of these children were asked to complete a general questionnaire and a food frequency questionnaire (FFQ) about their preschoolers' dietary habits.

2. Within this larger sample of preschool children, a sub-sample of 43 schools could be motivated to distribute 3d estimated diet records (EDR) one week after collection of the FFQ. This subsample included 2095 children of the 2426 preschoolers who were invited in the larger study sample. This latter subsample of children recording 3d EDR was needed to examine nutrient intakes and the contribution of food groups to daily nutrient intakes in Flemish preschoolers. In addition these data could be used to estimate the relative validity of the newly developed FFQ for estimating the diet quality, calcium, and food group intakes among Flemish preschoolers. From the 2426 preschoolers invited in the Flanders preschool dietary survey, 1847 children could be included in the final sample for data analyses. From the 1052 children who returned a 3d EDR, only 696 could be included in the analyses of the 3d EDR.

3. In a third and separate convenience sample of three nursery schools in the province of East-Flanders, 244 children were invited to participate in a reproducibility study in order to test the reproducibility of the questionnaire used in the Flanders preschool dietary survey. The second FFQ was distributed five weeks after collection of the first FFQ. In total the parents of 124 children returned two FFQ.

Based upon some doubtful results of parentally reported weight and height values derived from this reproducibility study, a *third aim* was set to investigate the validity of parentally reported weight and height values in preschool-aged children.

4. For this latter aim, a fourth study sample including seven preschools in the region of Ghent was also drawn on the basis of a multistage cluster sampling technique. This sampling procedure yielded a sample of 448 eligible preschoolers of whom 297 children were useful for the validity analyses. This additional study (Chapter 3) confirmed our primary doubts from the reproducibility study and showed only low accuracy of BMI values calculated from parentally reported weight and height values. Based on these findings and the fact that weight and height were parentally reported in the Flanders preschool dietary survey, BMI categories have not been used for further analyses based on this dietary survey.

Answers to the first aim of the Flanders preschool dietary survey were handled in Chapter 4, where nutrient and food intakes and the contribution of foods and dietary supplements to Flemish preschoolers' nutrient intakes are discussed, using data from the 3d EDR. Although diets in Flemish preschoolers were found to be adequate in most nutrients, important deficits were found for vitamin D, fibre, and water intakes (Chapter 4.1). While iron intakes were found to be insufficient when comparing with our Belgian recommended dietary allowances (RDA) recommendations, comparison with the estimated average requirements (EAR) recommendations from the Institute of Medicine (IOM) revealed adequate iron intakes among almost all

Flemish preschoolers. Furthermore, our Flemish preschoolers' diets were characterized by excessive saturated fatty acid (SFA) and sodium intakes and inadequate polyunsaturated fatty acid (PUFA), monounsaturated fatty acid (MUFA), and potassium intakes.

Comparison between food group intakes by Flemish preschoolers with the food-based dietary guidelines (FBDG) revealed that, except for potatoes and meat products, an important group of Flemish preschoolers had inadequate to marginal daily intakes of all other food groups (beverages, cereals and bread, vegetables, fruit, milk, and spreadable fat) in comparison with the FBDG (Chapter 4.2). Thus the gaps in nutrient intake shown in the previous paragraph might possibly be explained by these pitfalls in Flemish preschoolers' food intakes.

Therefore, in Chapter 4.3, the bottlenecks in nutrient intakes among Flemish preschoolers are being discussed together with the major pitfalls in their food intakes, while taking into account the major nutrient sources. In summary, bread, sweet snacks, milk, sugared milk drinks, and meat products were the top five energy contributors among Flemish preschoolers. Sweet snacks are among the top contributors to almost all micronutrients because of a high consumption of fortified biscuits, but they are also main contributors to SFA and simple carbohydrate intakes. Although fruit juices (mainly industrial) are the main contributor to total vitamin C intakes, they are also a major contributor to simple carbohydrates. Butter and margarine are the main source of vitamin D and PUFA intakes.

From the major nutrient sources and the gaps in nutrient and food intakes among Flemish preschoolers, some recommendations to pursue the designated nutritional goals could be drawn: the intake of sweet snacks and sugar rich drinks should be discouraged, while the consumption of fruits, vegetables, water, bread, and margarine on bread should be encouraged. Furthermore, a variety of foods should be recommended above the consumption of fortified foods (Chapter 4.3).

Given the important consumption of dietary supplements and fortified foods among Flemish preschoolers, an additional chapter (Chapter 4.4), investigating the contribution of dietary supplements in the diet of Flemish preschoolers was included. The results in this latter chapter revealed that although these dietary supplements may contribute to the adequacy of some particular nutrient intakes like vitamin D for instance, they might also increase the possible risk of toxic intakes of some nutrients. Therefore, health promoters should inform parents and caregivers about these possible risks and should stress that intake of a wide variety of foods is preferred over nutrient supplementation as a method for obtaining adequate vitamin and mineral intakes.

When considering the different gaps in our Flemish preschoolers' dietary habits described above, it is clear that nutrition education and interventions are needed to motivate and implement the dietary guidelines among preschool children in Flanders. Although for infants and

toddlers, the most influential aspect of the immediate social environment is the family, when children grow up and start attending preschools, their teachers, peers, and other people at school may become more important. Therefore, data from a school questionnaires asking information about school food policies were used to evaluate the impact of schools on the consumption of different food items, using multilevel regression analyses (Chapter 5). No substantial between-school variation was found for water, snacks, and sugared soft drinks, while between-school variation was significant for fruit-juice, sugared milk drinks, and fruit, indicating that schools might play a role in the food consumption of the children.

To answer the second aim of this thesis, a new 47-item semi-quantitative FFQ was developed to estimate preschoolers' diet quality, calcium intake, and food group intakes. In Chapter 6 this newly developed FFQ has been relatively validated by comparison with the results derived from the 3d EDR, considering the limitations of this latter instrument (day-to-day variability) as well. In addition its reproducibility for estimating preschoolers' diet quality, calcium, and food group intake was investigated in this chapter. From Chapter 6.1 it could be concluded that although the FFQ underestimated mean calcium intakes, it showed good repeatability and fairly good ability to classify subjects into extremes of calcium intake. The results from Chapter 6.2 showed good repeatability of the FFQ for almost all food groups, but large differences in validity between the different food groups. The largest Spearman correlations and weighted kappa (κ) statistics were found for the intake of fruit, cheese, milk, water, and soft drinks, while the lowest correlations and agreements were found for snacks, meat products, fish, and bread products. For different food groups the Bland and Altman plots showed increasing bias of the food intakes estimated by the FFQ with increasing mean daily intakes.

In Chapter 6.3, a diet quality index for preschool children (DQI-P), to be calculated from the new FFQ, has been developed as a tool for assessing in a quick and accurate way the compliance of Flemish preschoolers with our Flemish FBDG. In the study described in this chapter, the validity of this DQI-P was assessed by comparing the results of this FFQ-based DQI-P with a 3d EDR-based approach and by comparing these results with nutrient intake profiles. This study showed good repeatability of the FFQ-based DQI and high correlations between the FFQ-based approach and the dietary record approach. Increasing scores were associated with decreasing consumption of added sugars, and increasing intakes of for instance fibre, water, calcium, and most of the micronutrients. From this study it could be concluded that this newly developed FFQ-based DQI-P can be used to rank individuals with sufficient accuracy with respect to diet quality.

In most of the studies described and discussed above, 3d EDR were used to calculate usual diet intakes and to relatively validate the new FFQ. Since day-to-day variability adversely affects the statistical precision and accuracy of intake assessments, day-to-day variability must be taken into consideration in the interpretation of the results. Therefore, within- and between-individual variability in nutrient intakes among our preschool population has been evaluated in Chapter 6.4.

In addition the number of record days required for estimating 'usual' nutrient intakes was estimated. These results have shown that in general 7d dietary records were sufficient for accurately estimating 15 of the 23 nutrients. Overall micronutrient intakes had smaller within- over between-individual variance ratios and consequently less number of days required than macronutrients. The largest variance ratios and number of days required were found for cholesterol, followed by fat, fatty acids, and sodium intakes. Since most variance ratios are ≥ 1 for nutrient intakes in children at least four years old, it may be more difficult to find associations with other variables among these children because associations are difficult to detect when within- over between-variance ratios exceed unity.

At last, in the general discussion of this thesis (Chapter 7), some suggestions to improve the current FBDG and food policies with regard to young children have been formulated. In addition, the results and experiences from the studies described in this thesis were used to investigate methodological requirements and bottlenecks for nutritional surveys in this young population. Furthermore, a general conclusion, strengths and limitations, directions and practical implications for future dietary surveillance in young children have been formulated.

In conclusion, the results from this thesis revealed that the dietary pattern of our Flemish preschoolers importantly complies with a typical Western affluent diet, increasing the possible risk for CVD and other chronic diseases in later life. Therefore, comprehensive nutrition policies placing emphasis on the first years of life should be developed in order to avert preventable deaths. Since dietary habits are changing over time, nutritional monitoring and surveillance are crucial in this vulnerable age group to stay aware of the major bottlenecks and to allow well-founded prevention strategies early in life. The recommendations and practical implications highlighted in this thesis can be used in the development of future preschool dietary surveys.

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