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Nutritional assessment of asylum seekers' children in The Netherlands

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CHAPTER 1

General introduction and outline of this thesis

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1 Introduction

The growth and nutritional status of children is influenced by genetic and environmental factors. Children of migrants are exposed to changing environmental factors. Nutritional practise among migrants is correlated with their traditional and cultural habits, socio-economic status, the availability and affordability of food products and their integration status.¹⁻³ In the last decennia in Western Europe the number of new migrants has increased of which many were asylum seekers. The nutritional status and growth of asylum seekers' children may be influenced by the altered living conditions. It has remained unclear to what extent the growth and nutritional status of asylum seekers' children are at risk. The studies described in this thesis aim to evaluate the growth and nutritional status of asylum seekers' children living in The Netherlands. First, this introductory chapter describes the background of the asylum seekers, the asylum procedure in The Netherlands and the health risks of asylum seekers' children. Second, a short introduction is provided on adequate nutrition and on monitoring techniques of the nutritional status. Finally, the scope of this thesis is described.

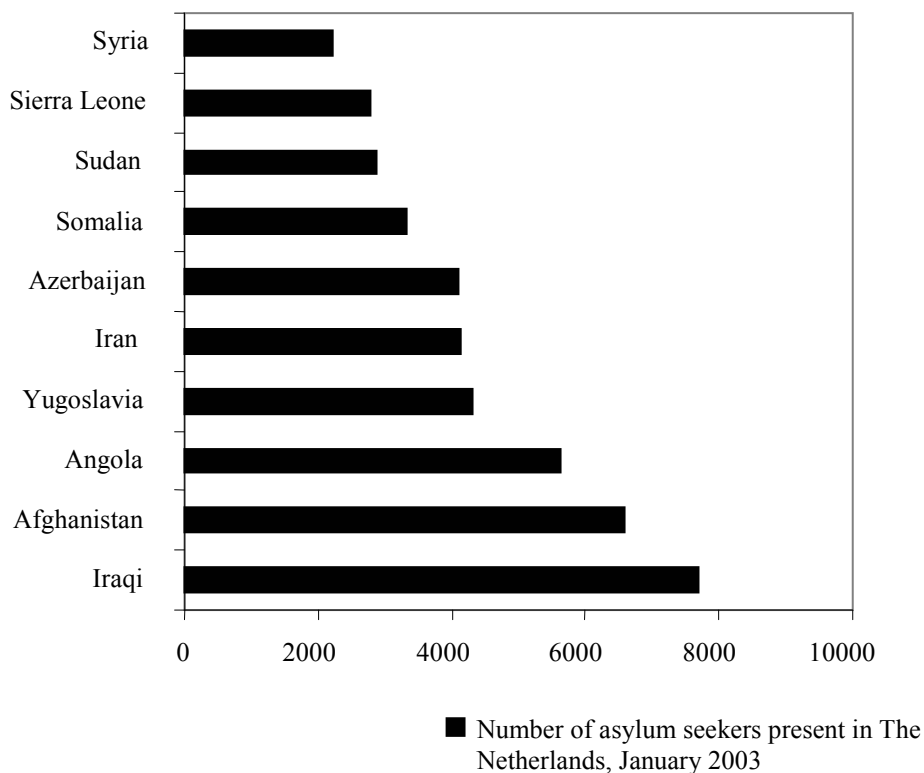
2 Asylum seekers in The Netherlands

Millions of people worldwide migrate from their home countries because of war, armed conflicts, famine, human rights violations and natural disasters or to escape from poverty. Thousands of those people from all over of the world are requesting asylum in The Netherlands.⁴ An individual who has left his or her country of origin and has requested asylum, but for whom it has not yet been established whether he or she qualifies for an asylum residence permit is called “asylum seeker”. An asylum seeker who has qualified for an asylum residence permit is called a “refugee”. According the covenant of Geneva (1951) the criteria for a person to be considered a “refugee” are a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion. Is outside the country of his or her nationality and is unable, or owing to such fear, is unwilling to avail himself or herself to the protection of that country; or who, not having a nationality and being outside the country of his formal habitual residence as a results of such events, is unable or, owing to such a fear, is unwilling to return to it. (www.UNHCR.org) Refugees are mainly accommodated in their geographic region of origin, but, on request of the United Nation High Commissioner for Refugees (UNHCR), some groups are accepted in other countries. The Netherlands accept annually 500-700 of these refugees. (www.ind.nl) Apart from these accepted refugees the number of asylum seekers requesting a residence permit in The Netherlands increased at the end of last Millennium up to almost 40.000 on annual bases. Since that period parallel to more restrictive alterations in the asylum procedure in 2001 the number of asylum seekers has decreased.

In The Netherlands since 1994 the Ministry of Justice has been responsible by law for the service provided to asylum seekers. The Central Organisation of Asylum seekers (COA) provides accommodation and coordinates facilities such as education for children less than 18 year of age and leisure activities. In March 2003 more than 12.000 children aged 2-12 years were living in a reception center for Asylum seekers in The Netherlands. (www.coa.nl) Asylum seekers accommodated by the COA predominantly originate from Iraq, Afghanistan, Angola, Somalia, Azerbaijan, former Yugoslavia and Iran. (Fig 1)

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Figure 1



In 2002 more than a thousand babies were born to asylum seeker parents in The Netherlands. Altogether a third of the asylum seekers were under 19 years of age.

2.1 Asylum procedure

Every foreign national has the right to apply for asylum; “asylum” is considered a form of protection. When somebody applies for asylum the Immigration and Naturalisation Service (IND) investigates whether or not he or she qualifies for an asylum residence permit. People who are refused asylum in The Netherlands must leave the country as quickly as possible. The IND assesses asylum requests based on the Alien Act. (www.justitie.nl) In general, an alien qualifies for an asylum residence permit:

- if he or she fears persecution because of his or her race, religion, nationality, political convictions;

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- if he or she belongs to a specific social group in his country of origin;
- if he or she runs the risk of being subjected to inhumane treatment (such as torture) in his or her country of origin;
- if he or she suffers specific, traumatic experiences in his or her country of origin and/or
- if the Minister for Alien Affairs and Integration considers the situation in a person's country of origin not safe enough for him or her to be repatriated.

A person has no right to asylum:

- if another country is responsible for processing the asylum application (Dublin procedure regulation of the European Council EU 3432003) and/or
- if a previous asylum request in The Netherlands has been rejected and no new evidence has been produced or new circumstances have arisen that would justify reversing that decision.

The Dublin procedure means that an asylum application cannot be dealt with in The Netherlands in case the asylum seeker has entered the European Union through a third country that has issued the asylum seeker a visa, or the partner or child of the asylum seeker has already been granted official refugee status in that country. (www.europa.eu.int) An asylum request will also be rejected under The Netherlands Alien act if the IND has clear indication that the asylum seekers have committed a public order offence in The Netherlands or some third country (by committing a crime for example). Article 1F of the 1951 Geneva Convention on Refugees states that people who have committed war crimes or are a terrorist is not entitled to asylum protection.

An asylum application in The Netherlands has to be submitted at an application center (AC) The AC procedure starts with an interview; investigating an asylum seeker's identity, nationality and travel itinerary. After the first interview the IND decides whether the asylum application can be processed further at the AC or whether more time is needed for investigation. If the application merits further processing the asylum seeker will be interviewed further at the AC. During the subsequent interviewing a counsellor (legal assistance) may be present at the interview. If an asylum seeker applies together with his or her wife/husband or partner they will be interviewed separately by an officer of the IND. Children 15 year of age or older who are accompanied by their parent(s) are also interviewed separately. The procedure in the AC takes a maximum of 48 (office)-hours, spread over a number of working days. In general this means asylum seekers stay in the AC for four to six working days. If, after the first interview, more time is needed to decide on an asylum request, the asylum seeker will be referred to a reception center that is organized and controlled by the Central Reception Organisation for Asylum Seekers (COA) and travel from there to the IND screening office for appointments. (www.immigratiedienst.nl)

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An independent legal assistance counsellor [usually someone who works for the Asylum Seekers' Legal Aid Foundation (SRA)] helps asylum seekers to prepare for further detailed interview. Asylum seekers do not have to pay for this form of legal assistance. After the detailed interview has been completed the asylum seeker returns to the reception center to wait for the decision on his or her application. Asylum seekers receive a report of their detailed interview. If they do not meet the criteria in the Aliens Act they will be given written notification of the intended decision to reject their asylum application. The written notification states the reason for rejection. Asylum seekers are given time to read the report and the intended decision with their legal assistance counsellor. Subsequently they may submit their responses (views) on the intended decision. Based on this response the IND decides whether the intended decision should remain in effect or whether the asylum procedure has to be continued by the screening office. If, based on, the detailed interview the IND concludes that further investigation is needed the asylum seeker will receive a written report, but will not be informed about the intended decision. This means that the asylum application has to be processed further by the screening office. In general, a decision on an asylum request must be made within six months after the application has been submitted. In some cases however more time may be required. The Minister for Alien Affairs and Integration may also invoke a statutory provision for postponement of the decision for certain categories of asylum seekers because of a "specific general" safety situation in their country of origin, or because of a large number of asylum applications having been received from a particular country or region. A statutory provision for postponement is not related to a specified period of time when it covers groups of asylum seekers. The asylum procedure has two possible outcomes: 1. The asylum application will be granted. If the application has been granted asylum seekers may stay in The Netherlands for the time being. In principle an asylum residence permit is always issued for a fixed period. After this period an application may be submitted for conversion into a permanent permit of residence. In some cases this will not be granted, for example when someone constitutes a danger to public order. If this is the case the asylum seeker must leave The Netherlands. 2. The asylum application has been rejected. If the application has been rejected asylum seekers have the right to appeal against the decision. Asylum seekers may not stay in The Netherlands while their appeals are being processed, except when they request the court for an interim provision. They may usually stay in The Netherlands while such an interim provision is being considered. If the court rejects the appeal all legal remedies are exhausted and they must leave The Netherlands within the period of time stated in the written decision and return to their country of origin. If they do not leave independently within the stipulated period they may be deported or repatriated under supervision. By law the IND is not entitled to inform the authorities of a person's country

of origin that they have applied for asylum in The Netherlands. For assistance with repatriation rejected asylum seekers may turn to the international Organisation for Migration (IOM). The IOM will inform them about financial and other support to which they might be entitled on returning to their country of origin. (www.iom.int)

2.2 Health of asylum seekers

To study the health of the increasing number of people who migrate from their home countries because of war, armed conflicts, famine, human rights violations, natural disasters or poverty and request asylum in a foreign country is of public health interest. Many asylum seekers in The Netherlands come from countries where infectious diseases such as AIDS, tuberculosis and hepatitis B are endemic. Epidemiological studies show that asylum seekers, refugees and other displaced people are prone for health problems such as mental health problems, drugs use, positive HIV status and nutritional problems.⁵⁻¹³ These health risks usually stem from exposures or experiences in their country of origin and during their migration, which can influence their health and well-being. Beside these experiences the length of stay in a reception center, the uncertainty and the prospect of perhaps being sent back to the situation they have been forced or decided to flee from, also affects their health and well-being. Some asylum seekers have been traumatized by these experiences. Several European publications reported about those specific health problems of asylum seekers including female mutilation, post traumatic stress syndrome (PTSS).¹⁴⁻¹⁹ Information on the health problems of asylum seekers in The Netherlands has focussed on the health care use of asylum seekers in this country, on age screening with bone or teeth development, on psychological problems, on infection diseases such as parasites and tuberculosis and on causes of mortality.²⁰⁻³⁰ Studies specific among refugee and asylum seekers' children show growth and nutritional disorders such as caries, iron deficiency, bowel parasites, stunting and obesity among them.³¹⁻³³ Children of migrants in general show to be vulnerable for several nutrient deficiencies.³⁴⁻³⁸ Nutritional deficiencies occur when people do not have access to micronutrient rich food such as vegetables, fruits, animal products and fortified foods, usually because they are not affordable or locally not available. Asylum seekers, who's financial means are based on regulations of the Ministry of Justice, have a limited budget. Until the end of 2004 the food allowance for asylum seekers who had to organize their own food was stipulated at €7.26 per week for a child below 11 year of age. Since 2004 these allowances are being increased, to reach the minimum necessary food allowance estimated by the Dutch budget institute in 2009. Whether the nutritional status of asylum seekers' children in The Netherlands is threatened or not is unknown. Information on the nutritional practice and dietary (in)adequacy of asylum seekers' children in The

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Netherlands is not available. In practice the nutritional status of asylum seekers' children in The Netherlands is monitored with a physical examination after arrival and follow-up of the anthropometrical parameters according the Dutch preventive Youth Health programme. The value of the follow up of growth of asylum seekers' children of many different nationalities with the use of the Dutch national references growth-curves has not been evaluated. Specific dietary assessment will not be performed and information on the micronutrient status of asylum seekers' children in The Netherlands is not available. With the studies described in this thesis nutritional aspect of health of asylum seekers' children are investigated.

3 Nutrition

Food provides the energy and nutrients needed for activity, growth and development of children. The quantity and composition of the dietary intake is important to meet the various requirements of the body. Adequate nutrition contributes to the well-being of children and their potential learning ability. Nutrition in childhood needs to be taken seriously in order to improve health and optimise neurodevelopment outcome.³⁹ In recent years many studies showed that an unfavourable nutritional practice can be correlated with illnesses such as obesity, arteriosclerosis, rachitis and caries or even preventable chronic diseases.⁴⁰⁻⁴² To prevent those nutritional disorders nutritional education that informs people about the hazards of food habits is important. Guidelines on good nutritional practice in The Netherlands are based on the dietary reference intake formulated by the Dutch Health Council (Gezondheidsraad). The Dutch Health Council formulates dietary reference intakes for infants, children and adults; the recommended daily allowances for children are shown in table 2.^{43,44} The term “dietary reference intake” is a collective term for the estimated average requirement, recommended dietary allowance, adequate intake and tolerable upper intake level. The requirement for a nutrient is the intake that prevents symptoms of deficiency and keeps the risk of chronic diseases as small as possible. Given a requirement with a normal distribution, the estimated average requirement is the level of intake that is adequate for half of the population. The recommended dietary allowance is calculated as the estimated average requirement plus twice the standard deviation of the requirement. This intake is adequate for virtually all of the individuals in this group. Where the estimated average requirement is unknown the determined sufficient level of intake for the entire population is called ‘adequate intake’ and the tolerable upper intake level specifies the level above which there is a chance that adverse effect will occur.

Table 1 Dutch Recommended daily allowances

| Age (years) | Gender | Nutrients | | | | | | | | |
|-------------|--------|-------------|---------------|-----------|---------------------|---------------------|-------------|-----------|--------------|------------------|
| | | Energy (KJ) | Protein (EN%) | Fat (EN%) | Saturated fat (En%) | Carbohydrates (En%) | Calcium (g) | Iron (mg) | Retinol (µg) | Calciferol (µg)* |
| 1-3 | M | 4500 - 5000 | 20 | 25-40 | 15 | 45 | 0.5 | 7 | 400 | 5.0 |
| | F | 4200 - 4700 | 20 | 25-40 | 15 | 45 | 0.5 | 7 | 400 | 5.0 |
| 4-8 | M | 6200 - 7200 | 25 | 20-35 | 10 | 45 | 0.7 | 7 | 500 | 2.5 |
| | F | 5700 - 6500 | 25 | 20-35 | 10 | 45 | 0.7 | 7 | 500 | 2.5 |
| 9-13 | M | 9400 -10600 | 25 | 20-35 | 10 | 45 | 1.2 | 10 | 700 | 2.5 |
| | F | 8600 - 9500 | 25 | 20-35 | 10 | 45 | 1.1 | 11 | 700 | 2.5 |

*RDA needs to be doubled by no exposure to sun or dark pigmented skin

*M=*male, *F=*female allowances for protein and saturated fat are upper limit.

3.1 Macronutrients

The macronutrients fat, protein and digestible carbohydrates are the compounds in the diet that provide energy for which the body has a physiological requirement for proper growth and development. Whether the proportion of fat, protein and carbohydrates of the total energy intake makes a difference for growth and health of the body has been the topic of several studies.⁴⁵⁻⁴⁷ No simple direct forward conclusion can be made however the fat percentage of the total energy intake and the composition of the fat intake is in general considered the most important nutrition health indicator for children.⁴⁸ The Dutch dietary guidelines recommend a moderate fat diet consisting of < 30% energy from total fat and <10% from saturated for every one over the age of 2 year. In order to prevent overweight and undesirable weight gains the daily composition of a recommended diet is assigned for individuals to a calorie level based upon their gender, age and the physical activity level. A high dietary fat intake is associated with the serum levels of high-density lipoprotein, cholesterol and triglycerides. High serum levels of blood lipids are correlated with abdominal fat distribution, systolic blood pressure and left ventricle mass.⁴⁹ Elevated blood

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lipids in childhood predict a continuing high level of lipids in adulthood.^{50,51} Beside appropriate fat intake sufficient intake of complex carbohydrates, for example through whole-wheat and other whole-grain cereals, fruits and vegetables, has been emphasized to reduce the risk on colic cancer, diabetes and cardiovascular diseases related to arteriosclerosis.⁵² A varied selection of vegetables, legumes, meat and diary products usually suffices to meet all protein needs while increasing complex carbohydrate consumption and reducing fat intake.⁵³

3.2 Micronutrients

Micronutrients are needed only in small amounts; these substances enable the body to synthesize and/or activate enzymes, hormones and transport proteins essential for proper growth and development. Despite the small amounts needed the consequences of insufficient availability can be serious. Micronutrients can be classified according to the response in children to their deficiencies. Type I nutrients manifest their deficiency by alterations in specific biomarkers and by relatively early clinical signs and symptoms. Anthropometrics may contribute little to the recognition of these deficiencies. The administration of the deficient nutrient may correct all or most of the alterations, underlining reversibility. All water-soluble and all lipid soluble vitamins and several minerals among which iron and calcium are classified type I.⁵⁴ Type II nutrient deficiencies lack specific biomarkers for identification remain unrecognized until they are severe or growth falters. Micronutrient deficiencies in general may not result in readily identifiable clinical symptoms at a functionally important level.^{55,56} Micronutrient deficiencies, particularly involving iron, zinc, vitamin A-B11-B12-D, remain a major problem for children in many countries. Nutritional intervention programs like food fortification, supplementary feeding and nutritional education have shown to be of great value to reduce micronutrient deficiencies among children.

4 Monitoring nutritional status

The goal of nutritional monitoring in childhood is to prevent nutritional disorders and to minimize associated morbidity and mortality. Nutritional assessment is the quantitative evaluation of nutritional status. A comprehensive nutritional assessment has three components: dietary assessment, growth monitoring including physical examination, anthropometrical measurements and laboratory investigations

4.1 Dietary assessment

Dietary assessment aims to determine the quantity and quality of the food that is consumed by the infant or child and the eating behaviours of the family. The thus obtained information on nutrient intake is compared to age-specific recommended intake to assess the likelihood of either under nutrition or overeating. Short- and long-term assessment methods are available to estimate the dietary intake in children. Short-term dietary assessment methods collect dietary information on current intake. They vary from recalling the intake from the previous day to keeping a record of the intake of food and drinks over one or more days (dietary record). Long-term dietary assessment methods collect information on food intake over previous months (dietary history or food frequency questionnaires). Each method has its own strengths and weakness and there is no single ideal method. To assess the average intake of a group or population a single 24hr recall has been advised.^{57,58} Disadvantage of the method is that the size of the nutritional portion is difficult to estimate accurately. To overcome this, a picture book including country specific dishes with additional household measures and other relevant measurements has been recommended.⁵⁹ A single 24h recall does not represent the usual individual intake due to intra-individual variability but characterizes the intake of a group fairly well. The 24h recall which is applicable for broad populations of different ethnicity, does not require literacy and the “burden” for the respondent is relatively small. The 24h recall can be used with acceptable internal and external validity in children who are 10 years or older. Among children below 10 years, the help of parents or guardians is necessary to obtain an accuracy of reporting that is comparable to that found in adults.⁶⁰ The investigator asks the respondent to enumerate the foods and beverages consumed in the preceding full day, including their quantity. The reliability of the interview depends on the skills of the interviewer to get detailed and complete answers and to control the accuracy of data.

4.2 Growth monitoring

Growth measurements are important components of the nutritional assessment of children by which clinicians assess the health and well-being of children. Height and weight are in the primary health clinic the most regularly used anthropometrical measurements. To increase the accuracy of the anthropometrical measurements a protocol is necessary to minimize the chances of technical mistakes. More recently the calculated body mass index (BMI) is added. The BMI is calculated by the height in centimetres divided through the quadrate of the weight in kg. These measurements are useful only if the clinician is able to correctly interpret them by converting absolute values to relative standards for the

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appropriate reference population.⁶¹ For the BMI international references have been developed to identify individual children or populations at risk for overweight and obesity.⁶² The international criteria for overweight and obesity based on the BMI strongly correlate with the amount of body fat.⁶³ The estimation of the body fat content can be accomplished by anthropometrical measurements such as mid-upper-arm circumference (MUAC), triceps skin fold thickness (TSFT), waist circumference (WC), hip circumference (HC) and the waist-hip ratio (WHR). The measurements of skin fold thickness are widely used because the techniques are non-invasive, inexpensive and easy to perform in clinical settings.⁶⁴⁻⁶⁷ Measurements of skin fold thickness are often less accurate than measurement of height and weight. However, skin fold thickness may be useful in prospective estimation of body fat content, for example in obese children.⁶⁸ Overweight and obesity correlate with an increased risk of cardiovascular disease in children like in adults.⁶⁹⁻⁷⁵ Growth in general is considered the best indicator for general health of children. Monitoring growth and nutritional status can be useful to provide tailored nutritional education that can limit the hazards of nutritional inadequacy.

4.3 Laboratorial investigations

Dietary history has shown to be insufficiently sensitive to detect micronutrient deficiencies.⁷⁶ Instead, biochemical tests on plasma or serum samples have been proven useful for assessment of micronutrient status.

4.3.1 Iron

Iron is an essential nutrient in humans. Hem-bound iron is important for the transport of oxygen in red blood cells and in mitochondria of nucleated cells. During childhood the body iron stores are primarily determined by dietary iron intake. Common factors leading to an imbalance in iron metabolism include: insufficient iron intake, decreased absorption due to poor dietary sources of iron or increased iron loss (usually by blood loss). The first grade of iron deficiency is called latent iron deficiency, in which low iron intake is compensated by enhanced absorption efficacy without depletion of the storage. More enhanced iron deficiency implies a depletion of the iron stores and a reduced ferritin level in the serum (grade 2). Finally, in the third grade the hem content in the red blood cells is reduced and a microcytair anemie develops.⁷⁷ Only third grade iron deficiency gives clinical symptoms such as paleness, tiredness, growth reduction, anorexia and sensibility for infections starts) to develop.

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The cornerstone of the biochemical identification of Iron Deficiency (ID) is a low serum ferritin concentration.⁷⁸ However, ferritin is an acute-phase reactant and may be elevated during infectious or inflammatory illnesses, independent of ID. To account for “false positive” elevation of serum ferritin levels because of inflammation, determination of complement reactive protein (CRP) concentration in plasma is needed. Prevention or early detection and treatment of ID are of great importance since ID adversely affects the cognitive performance behaviour and growth of infants, pre- and school aged children.⁷⁹⁻⁸⁴ In the United States the prevalence, of Iron deficiency anemia (IDA) in children, has been declining due to improved iron supplementation.^{85,86}

4.3.2 Vitamin D

Vitamin D is important for calcium absorption bone accretion and growth. Calcium is a major component of the skeleton and plays important metabolic, cellular and organ functions. Calcium is essential in chemical signalling within cells, promoting transmission of nerve impulses, inducing muscle contraction, initiating blood-clotting participating as a cofactor for many enzymes and hormones regulating cellular proliferation and maturation. Vitamin D and calcium are required for bone health.⁸⁷ The intake of both calcium and vitamin D, throughout all stages of life, likely affects the risk of osteoporosis and bone fractures in later life.⁸⁸ The fat-soluble vitamin D is absorbed from the small intestine and incorporated into chylomicrons. Nutritional sources of vitamin D (cholecalciferol) are limited and endogenous non-enzymatic biosynthesis in the skin from 7-dehydrocholesterol under the influence of ultraviolet radiation of sunlight constitutes a major source of the vitamin. In the liver calciferol is metabolised to hydroxycholecalciferol (25-OH D). Parathormone stimulates the formation of the metabolically active compound, 1,25 dihydroxy vitamin D from 25-OH D in the kidney, 1,25 OHD enhances the absorption of calcium from the diet in the intestine. A mildly compromised vitamin D status may increase the susceptibility for infections, dental caries and autoimmune disorders such as diabetes.⁸⁹⁻⁹¹ Early signs of inadequate bone mineralization are growth reduction, pain, bone shape disturbance, muscle weakness. Symptoms of inadequate bone mineralization are strongly age dependent. Children at a young age can develop crania tabes, extremely round legs and chicken breast. At school age, children may complain of pain on the knees, hand or ankles. Rickets is a late and severe grade of vitamin D deficiency. Biochemical Vitamin D deficiency (VDD) is defined as serum 25 hydroxycholecalciferol [s25(OH)D] below 30 nmol/L and hypovitaminosis D as s- 25(OH)D below 50 nmol/L. The use of vitamin D supplements has shown to be effective to prevent vitamin D deficiency.

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4.4 Bone mineral density

Bone mineral density (BMD) increases during childhood until the peak bone mass is achieved, around the age of 18 to 20 years.⁹²⁻⁹⁶ During growth the accretion of bone is called bone modelling. Bone modelling is achieved both through appositional growth along periosteal surfaces and through calcification of cartilage in the growth plate.⁹⁷ The mineral content of the bone can be estimated with a dual X ray absorptiometry (DEXA). DEXA is a non-invasive method to measure the hydroxyapatite of the bone. DEXA is the method of choice to measure the BMD because it uses a low dose gamma radiation (<0.05SVI) and offers profound accuracy and is suitable for children.⁹⁸⁻¹⁰⁰ The BMD (g/cm^2) reflects an area density derived from the bone mineral content (g) divided by the protected bone image (area, cm^2) of the region. The correction for areas removes some, but not all, of the dependency on bone size. Given a fixed volumetric density, large vertebrae have greater BMD values than small vertebrae.¹⁰¹ To interpret the DEXA measurement appropriate reference data are needed. Dutch paediatric lumbar spine BMD (LSBMD g/cm^2) reference values have been determined.¹⁰² To correct for bone size, volumetric bone mineral apparent density can be calculated according to several models.¹⁰³ The Dutch reference uses a validated cylindrical model using the formula lumbar spine bone mineral apparent density (LSBMAD) (g/cm^3).

$$\text{LSBMAD} = \text{BMD} \times [4/\pi \times \text{width}] \text{ with width} = \text{mean width of } L_2 - L_4.$$

However, this model has been validated on a previous version of the Hologic scanner. Recently UK reference values were published using the current Hologic 4500 DXA scanners: the lumbar spine BMAD is calculated as

$$\text{BMAD} (\text{g}/\text{cm}^3) = \frac{\text{BMC1} + \text{BMC2} + \text{BMC3} + \text{BMC4}}{\text{V1} + \text{V2} + \text{V3} + \text{V4}}$$

In which V is the volume of the single lumbar vertebra and BMC the Bone Mineral Content of each individual vertebra body.

This equation allows calculating individual standard deviation scores:

$$Z = \frac{(\text{y}/\text{M})^2 - 1}{\text{L} \times \text{S}}$$

In which Lambda represents the skewness, Sigma the variation coefficient, Mu the median curve derivate from the reference centile curve and Z the calculation of the individual standard deviation score of the LSBMAD for age.¹⁰⁴ Early detection of children at risk for impaired bone mineralization seems to be of great value because the peak bone mass provides optimal reserve for later life.¹⁰⁵

5 Scope of the thesis

The overall aim of the studies reported in this thesis was to monitor the growth and nutritional status of asylum seekers' children in The Netherlands, to evaluate the determinants used to monitor growth and health of asylum seekers' children and to identify potential nutritional risks in this unique group of children. It is of public health interest to determine the health risks of specific populations, for example those living in uncommon socio-economic circumstances. As described above, several health threats can theoretically be expected for children of asylum seekers who live in asylum seekers centres for a long-standing period. The background, cultural habits, limited budget, unfamiliarity with Dutch food guidelines or supplement advices and the extra-ordinary circumstances can make them vulnerable for negative influences on their growth and nutritional status. Although growth and development of asylum seekers' children is regularly monitored, the influence of the different backgrounds or nutritional habits on their health while resident in an asylum center in The Netherlands has never been evaluated. To provide quality care and to optimize the health care service for asylum seekers' in The Netherlands scientific research and epidemiological data are necessary to clarify the health threats and needs. These studies could provide tools for the development of guidelines, standards and protocols to recognize nutritional vulnerability and to improve tailored education, support and treatments. The general objective is approached by separate projects, including:

- Estimation of quality of the dietary intake of asylum seekers' children in The Netherlands in relation to age, gender and origin of the children (chapter 2);
- Evaluation of the Dutch growth reference to monitor the growth and nutritional status of asylum seekers' children in The Netherlands (chapter 3);
- Determination of the prevalence of Iron Deficiency in asylum seekers' children in The Netherlands and describing the iron status in relation to demographic variables and dietary intake of iron (chapter 4);
- Determining the vitamin D status of Asylum seekers' children in The Netherlands in relation to the season and supplement use and to describe the vitamin D status of asylum seekers' children in relation to demographic variables and dietary intake of vitamin D and calcium (chapter 5);
- Measuring the effect of VDD on the bone density of the spine in relation to the calcium intake (chapter 6).

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