CATÓLICA
FACULTY OF BIOTECHNOLOGY
PORTO

EARLY FEEDING PATTERNS, NUTRITIONAL STATUS AND GROWTH IN PORTUGUESE CHILDREN 12-36 MONTHS: A NATIONAL REPRESENTATIVE STUDY

Thesis submitted to Universidade Católica Portuguesa to attain the degree of PhD in Biotechnology, with specialisation in Food Science and Engineering

Maria Margarida Lobo Machado Sousa Nazareth Almeida Sampaio

June, 2023

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Maria Margarida Lobo Machado Sousa Nazareth Almeida Sampaio

Supervisor: **Prof. Doutora Carla Rêgo**

Co-supervisor: **Prof. Doutora Elisabete Pinto**

June, 2023

A todas as crianças,

e de forma particular as que têm um lugar especial no meu coração:

à Constança e aos manos que estão no Céu,

aos meus afilhados e sobrinhos, os de sangue e os emprestados.

UMA CRIANÇA/ UMA PLANTA

A Criança
É como uma Planta,
Bela no seu porte,
frágil na sua existência.

Como a Planta precisa de ser regada,
a Criança carece de alimento,
do mesmo modo que o murchar de uma Planta
é como a morte de uma Criança.

Como a Planta precisa de Sol,
garante da sua existência sadia e radiosa,
a Criança precisa de Amor,
Carinho e Apoio.

Como a Planta,
a Criança é vulnerável ao Frio, à Intempérie,
Ao Vento, à Solidão, ao Desespero,
e à Marginalização.

Como a Planta precisa de um Vaso,
a Criança precisa de um Berço,
de uma Cama, de um Tecto, de um Abrigo
que a proteja até ao seu desabrochar.

Como a Planta,
a Criança não pode ser Pisada,
Destroçada,
Porque a sua Fragilidade é também
a sua Riqueza.

Como a Planta,
a Criança cresce, desenvolve-se, transforma-se,
mas nunca perde a Identidade.

Como cada Planta,
Cada Criança é Diferente,
mas, como cada Planta,
Cada Criança tem a sua Beleza,
Os seus Desejos, a sua Vontade,
os seus Objectivos.

Como a Planta precisa de um Jardineiro
que olhe pela sua existência,
a Criança necessita de uma Família,
onde se sinta enquadrada, realizada
e naturalmente Feliz.

Como a Planta precisa de oxigénio para Viver,
a Criança precisa de Espaço
para dar livre expressão às suas Ideias,
Actividades e Criações…

Como a Planta,
a Criança é um Dom da Natureza
que Deus criou, daí o encontro,
tão Feliz,
de cada Criança com cada Planta.
Na verdade,
sempre que nasce uma Criança,
enche-se de Plantas
esse maravilhoso recanto que é o seu Berço.

E, só as agruras do Tempo,
ou a ausência de condições,
é que obrigaram a Planta a assumir
formas mais agrestes, formas híbridas
que a natureza criou para as proteger.
E foi assim que nasceu o Cacto!

Quando a infância de uma criança
é marcada por experiências que a magoam,
ela mostra se menos receptiva,
menos sociável, mais dura,
e necessita então de mais Amor,
maior Protecção
e de uma Enorme Compreensão.

É que as Crianças são como as Plantas!
E, se as Plantas são maravilhosas,
as Crianças, essas,
são a Consagração da obra Suprema da Criação.

Luis Nazareth

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fct Fundação para a Ciência e a Tecnologia

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RESUMO

A programação metabólica resulta da influência de experiências ambientais precoces, particularmente nutricionais, na expressão futura do binómio saúde-doença, nomeadamente de doença não comunicável. O período antes da conceção, a gravidez e os primeiros anos de vida constituem uma janela de elevada sensibilidade relativamente ao efeito do ambiente sobre a plasticidade genética, com repercussões sobre a saúde em geral e particularmente o estado nutricional futuro. O conhecimento sobre cada fator modificável é essencial para o estabelecimento de recomendações para a idade pediátrica, mas também para os adultos em idade reprodutiva.

O EPACI Portugal 2012, Estudo do Padrão Alimentar e de Crescimento na Infância, teve como objetivo estudar o padrão alimentar e o estado nutricional das crianças portuguesas. Tratou-se de um estudo representativo nacional que incluiu 2230 crianças entre os 12-36 meses e decorreu em 2012-2013, em 128 Unidades de Saúde de Portugal Continental, aleatoriamente selecionadas.

Com recurso a uma equipa de entrevistadores treinados, foi aplicado um questionário, que incluiu a recolha de dados sociodemográficos dos progenitores, antecedentes de saúde, práticas alimentares e dados antropométricos das crianças em diferentes marcos temporais com base na consulta do Boletim de Saúde Infantil e Juvenil, bem como a medição do peso, comprimento/estatura e perímetro cefálico no momento da avaliação. Foi posteriormente calculado o índice de massa corporal (IMC), sendo o estado nutricional caracterizado com base nos critérios da Organização Mundial de Saúde (OMS). A informação relativa à alimentação atual foi obtida através de um diário alimentar de três dias.

Foi analisada uma subamostra de 2009 crianças de termo para descrever as práticas alimentares precoces. A maioria iniciou aleitamento materno (AM), mas a prevalência diminuiu ao longo do tempo. Apenas cerca de 20% cumpriram as recomendações da OMS relativamente ao aleitamento materno exclusivo durante seis meses. A maior parte dos lactentes cumpriu as recomendações da Sociedade Europeia de Gastroenterologia Pediátrica, Hepatologia e Nutrição (ESPGHAN) relativas ao momento de introdução da diversificação alimentar (DA). Os alimentos introduzidos e a idade de introdução de cada um respeitaram as recomendações, com a exceção dos alimentos ricos em açúcar, que foram precoce e excessivamente consumidos. Nenhuma associação foi encontrada entre o AM ou momento da DA e a expressão do excesso de peso (EP)/obesidade (OB).

Para analisar a prevalência de inadequação nutricional, e na ausência de recomendações nacionais ou da adoção oficial de uma referência, procedeu-se à análise das recomendações nutricionais existentes. Após a revisão das recomendações mais usadas e à sua sistematização, foi efetuada a comparação das três principais recomendações internacionais: *Food and Nutrition Board/Institute of Medicine* (FNB/IOM), *Food and Agriculture Organization of the United Nations/World Health Organization* (FAO/WHO) e *European Food Safety Authority/European Commission* (EFSA/EC). As recomendações da EFSA, estabelecidas para a realidade europeia, são as mais recentes e apresentam uma grande solidez metodológica, tendo sido as escolhidas para quantificar a adequação nutricional das crianças portuguesas. Para o efeito, foram avaliadas a ingestão e a inadequação nutricionais e os principais fornecedores de energia, macronutrientes e alguns micronutrientes, numa subamostra de 853 crianças, correspondente às que preencheram os diários alimentares. Observou-se que a maior parte das crianças excedia as recomendações para a energia, mas consumia uma baixa proporção de energia fornecida pela gordura. A média de ingestão diária de proteína era cerca de cinco vezes superior ao recomendado, sendo o leite o principal fornecedor de energia e proteína. A maior parte das crianças excedia a ingestão de sódio e nenhuma atingia a ingestão recomendada para a vitamina D.

À data da avaliação, 32.0% das crianças encontravam-se em risco de EP, z-score de IMC (zIMC) >1, e mais de metade dos progenitores apresentavam EP/OB. A idade materna mais elevada e um ganho de peso gestacional (GPG) abaixo das recomendações relacionaram-se com um menor zIMC na descendência, enquanto a OB materna no momento da avaliação e um elevado IMC antes da gravidez se associaram com um maior zIMC nos filhos. Cerca de metade das mães com EP ou OB tiveram um GPG acima das recomendações.

Torna-se crucial desenvolver ferramentas de identificação e intervenção precoce no ciclo de vida, visando a prevenção da doença não comunicável em idade adulta e em particular a transmissão transgeracional da OB.

Palavras-Chave: padrão alimentar precoce, estado nutricional, obesidade, programação, crianças portuguesas de pouca idade.

ABSTRACT

Metabolic programming results from the influence of early environmental experiences, particularly nutritional, on the future expression of the health-disease binomial, notably of non-communicable diseases. The period before conception, pregnancy and the first years of life constitutes a window of high sensitivity in respect of the environmental effect on genetic plasticity, with repercussions on general health and especially future nutritional status. Knowledge about each modifiable factor is essential for the establishment of recommendations for paediatric age, as well as for adults of reproductive age.

EPACI Portugal 2012, *Estudo do Padrão Alimentar e de Crescimento na Infância* (Study of the Childhood Feeding Patterns and Growth)'s purpose was to study Portuguese children's dietary patterns and nutritional status. It was a nationally representative study that included 2230 children between 12-36 months and took place in 2012-2013, in 128 randomly selected Health Units of mainland Portugal.

Through a team of trained interviewers, a questionnaire was applied, which included the collection of data on the parents, health history, dietary practices and anthropometric data of the children at different time milestones based on the consultation of the Child and Youth Health Bulletin, as well as the measurement of the weight, length/height and head circumference at the assessment moment. The body mass index (BMI) was afterwards calculated, and the nutritional status was characterised based on the World Health Organization (WHO) criteria. Information regarding the current diet was obtained through a 3-day food diary.

A sub-sample of 2009 full-term children was analysed to describe early feeding practices. Most started breastfeeding (BF), but the prevalence decreased over time. Only about 20% met the WHO recommendation regarding exclusive BF for six months. Most infants complied with the European Society of Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) recommendations regarding the timing of introduction of complementary feeding (CF). The foods introduced and the age of introduction of each respected the recommendations, with the exception of foods rich in sugar, which were early and excessively consumed. No association was found between the BF or timing of CF and the expression of overweight (OW)/obesity (OB).

To determine the prevalence of nutritional inadequacy, and in the absence of national recommendations or the official adoption of a reference, the existing nutritional recommendations were analysed. After the review of the most commonly used recommendations and its systematisation, the comparison of the three main international recommendations – Food and Nutrition Board/Institute of Medicine (FNB/IOM), Food and Agriculture Organization of the United Nations/World Health Organization (FAO/WHO) and European Food Safety Authority/European Commission (EFSA/EC) – was made. EFSA's recommendations, established for the European reality, are the most recent, and present a great methodological robustness, were chosen to assess the nutritional adequacy of Portuguese children.

For such purpose, nutritional intake and inadequacy and main suppliers of energy, macronutrients and some micronutrients were assessed in a sub-sample of 853 children, corresponding to those who filled in the food diaries. It was observed that most of the children exceeded the recommendations for energy but consumed a low proportion of energy provided by fat. The average daily protein intake was about five times higher than recommended, milk being the main supplier of energy and protein. Most children exceeded their sodium intake and none reached the recommended intake for vitamin D.

At the time of the interview, 32.0% of children were at risk of OW, BMI z-score (zBMI) >1, and more than half of the parents were OW/OB. Higher maternal age and gestational weight gain (GWG) below recommendations were associated with lower zBMI in the offspring. In contrast, maternal OB at the time of assessment and high BMI before pregnancy were associated with higher zBMI in the offspring. About half of the mothers with OW or OB had a GWG above the recommendations.

It becomes crucial to develop tools to identify and make early interventions in the life cycle aiming at preventing non-communicable diseases in adulthood, particularly the transgenerational transmission of OB.

Keywords: Early feeding patterns, nutritional status, obesity, programming, toddlers.

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AESAN – *Agencia Española de Seguridad Alimentaria y Nutrición* (Spanish Agency for Food Safety and Nutrition)

AI – Adequate Intake

AMDR – Acceptable Macronutrient Distribution Range

ANSES – *Agence Nationale de Securité Sanitaire de L'Alimentation, de L'Environement et du Travail* (Agency for Food, Environmental and Occupational Health & Safety)

APN – *Associação Portuguesa de Nutrição* (Portuguese Nutrition Association)

ARS – *Administração Regional de Saúde* (Regional Health Administration)

BLISS – Baby-Led Introduction to Solids

BLW – Baby-Led Weaning

BMI – Body Mass Index

CDRR – Chronic Disease Risk Reduction

CINTESIS – *Centro de Investigação em Tecnologias e Serviços de Saúde* (Health Technologies and Services Research Centre)

COMA – Committee on Medical Aspects of Food Policy

COSI – Childhood Obesity Surveillance Initiative

DACH – Germany, Austria, and Switzerland

DGS – *Direção Geral da Saúde* (General Health Directorate)

DNA – Deoxyribonucleic acid

DOHAD – Developmental Origins of Health and Disease

DRI – Dietary Reference Intake

DRV – Dietary Reference Values

EC – European Commission

EFSA – European Food Safety Authority

EPACI – *Estudo do Padrão Alimentar e de Crescimento na Infância* (Study of the Childhood Feeding Patterns and Growth)

ESN – Nutrition and Food Systems Division

EsNuPI – *Estudio Nutricional en Población Infantil Española* (Nutritional Study in Spanish Paediatric Population)

ESPGHAN – European Society for Paediatric Gastroenterology Hepatology and Nutrition

FAO – Food and Agriculture Organization

FESNAD – *Federación Española de Sociedades de Nutrición, Alimentación y Dietética* (Spanish Federation of Nutrition, Food and Dietetics Societies)

FFQ – Food Frequency Questionnaire

FITS – Feeding Infants and Toddlers Study

FNB – Food and Nutrition Board

FSVO – Federal Safety and Veterinary Office

GRETA – German Representative Study of Toddler Alimentation

IAN-AF – *Inquérito Alimentar Nacional e de Atividade Física* (National Food, Nutrition, and Physical Activity Survey)

IDEFICS – Identification and prevention of dietary and lifestyle-induced health effects in children and infants

IGF-1 –Insulin-like Growth Factor 1

IOM – Institute of Medicine

LARN – *Livelli di Assunzione di Riferimento di Nutrienti ed energia per la popolazione italiana* (Reference Intake Levels of Nutrients and Energy for the Italian Population)

MJ – Megajoule

NASEM – National Academies of Sciences, Engineering, and Medicine

NDA – Panel on Nutrition, Novel Foods and Food Allergens

NHD – Department of Nutrition for Health and Development

NUTS – Nomenclature of Statistical Territorial Units

OB – Obesity

OW – Overweight

PAL – Physical Activity Level

PNNS – *Program National Nutrition Santé* (National Programme on Nutrition and Health)

SACN – Scientific Advisory Committee on Nutrition

SINU – *Società Italiana di Nutrizione Umana* (Italian Society of Human Nutrition)

SPADE – Statistical Program to Assess Dietary Exposure

SPEO – *Sociedade Portuguesa para o Estudo da Obesidade* (Portuguese Society for the Study of Obesity)

SPP – *Sociedade Portuguesa de Pediatria* (Portuguese Paediatric Society)

SPSS – Statistical Package for the Social Science

TE – Total Energy

UAE – United Arab Emirates

UK – United Kingdom

UL – Upper Limit

UNICEF – United Nations Children's Fund

UNU – United Nations University

US – United States of America

WHO – World Health Organization

zBMI – Body Mass Index z-score

I. General Introduction

i) Framework

The first years of life are critical in modulating behaviour, training tastes and textures, structuring eating habits and programming growth pattern for life. During the first two years of life the greatest growth occurs: infants triple their weight and double their length.

These first years and even intrauterine life are also years of great genetic and metabolic sensitivity and plasticity, that can condition the future health-disease binomial. Early food practices and growth pattern are determinants in future health through metabolic programming. In recent years, particular focus has been placed on the first 1000 or even 1100 days of life (from about three months before conception until the end of the second year of life), including not only child behaviour and growth pattern, but also the parental nutritional status (especially of the mother) and diet before conception, which may also condition and program the child's future health.

The first year of life is a period that is closely supervised and monitored by health professionals, with the Portuguese General Health Directorate (*Direção Geral da Saúde*, DGS) providing six routine health monitoring consultations. Later, when children start preschool, the dietary care is structured again; however, in Portugal, there is a knowledge gap regarding dietary practices for children between 12 and 36 months of age and total absence of guidelines that should be followed by those responsible.

In fact, no representative data are available on these early years of life in Portugal. The EPACI Portugal 2012 *Estudo do Padrão Alimentar e de Crescimento na Infância* [Study of the Childhood Feeding Patterns and Growth], a nationally representative study, brought new knowledge about Portuguese infants' and toddlers' dietary intake and nutritional status.

ii) Critical review of the state of the art

The last few decades have seen a major change in how we view children. Infant mortality, erstwhile more frequent and therefore "more accepted", is now almost unspeakable and seen in a completely different way. The low birth rate recorded nowadays adds to this. We have moved from an era of diseases, malnutrition and infections to an era of abundance, justified by changes in family structure, lifestyles, health care provision and available resources.

Fortunately, at least in developed countries, society is increasingly more protective of children, we have more information and access to better physical and mental health care and nutrition. We are currently witnessing a valuing of children and viewing each one as unique. A significant focus is placed on them, even before they are born. There is a growing awareness that we must invest in children: each child is a treasure, a seed that should blossom in the best conditions we can ensure. Children are the future, and it is therefore in our hands to do our best to secure such a future.

It is increasingly known that what is done in early life, particularly about behaviour and especially nutrition, is reflected in the health-disease binomial throughout life.

a) Programming

Metabolic programming describes the influence of environment, notably nutrition and other lifestyles, at an early age (from preconception period to the first years of life) on children's future health and disease, including the risk of non-communicable diseases in adulthood, such as obesity (OB) and others (Koletzko *et al.*, 2005; Berthold Koletzko, Godfrey, *et al.*, 2019; Langley-Evans, 2022; Robertson *et al.*, 2022).

Lucas approached programming in humans after a first evidence was identified in animals a few years earlier (Lucas, 1991). The identification and comprehension of the factors that influence and impact future health are crucial and may help to establish and disseminate specific guidelines to prevent OB and other non-communicable diseases. As is well known, OB is the most prevalent non-communicable disease, is associated with other chronic diseases, has a negative impact in public health worldwide, and OB treatment is a challenging, expensive and arduous task. As such, prevention strategies are essential.

There have been several attempts to study these programming mechanisms (Zhu *et al.*, 2019), the Early Nutrition Project being an example thereof (Koletzko *et al.*, 2017).

This project studied the programming effects of early nutrition and other lifestyles (which occurred since preconception), explaining how metabolic mechanisms in these stages determine future health, notably regarding overweight (OW)/OB and related diseases (Berthold Koletzko, Godfrey, *et al.*, 2019).

This concept of metabolic programming may also be referred to as the Developmental Origins of Health and Disease (DOHAD) hypothesis, postulated by Barker (Barker, 1998) at the end of the 20th century, sustaining the existence of early exposures that program health/disease events in adulthood (Fall and Kumaran, 2019). These exposures could condition physiological adaptations in fetuses, infants or young children, through epigenetic modifications, in face of a new condition (Gluckman *et al.*, 2007, 2011; Zhu *et al.*, 2019; Langley-Evans, 2022). The Dutch Famine Birth Cohort Study (Bleker *et al.*, 2021; Rooij *et al.*, 2022) allowed the study of the DOHAD hypothesis and, thus, these issues of metabolic programming. During the second world war, more precisely at the end of 1944-1945, a lack of food, which became known as the Dutch Famine, occurred in the Netherlands, which affected millions of people and caused many deaths. The Dutch Famine Birth Cohort Study investigated the health effects of acute maternal undernutrition on their offspring in early or late pregnancy. Results from this and other studies found that these children were more likely to develop OB (Ravelli *et al.*, 1999), cardiovascular disease (Roseboom *et al.*, 2000; Painter *et al.*, 2008), diabetes (de Rooji *et al.*, 2006; Lumey *et al.*, 2011) and other chronic diseases. It was also noted that undernutrition of the mother in early pregnancy was related to a normal weight birth of the children, being, however, related to OB, diabetes, and dyslipidaemia incidence later in life. Otherwise, in late pregnancy, undernutrition was linked to lower birth weight (about 200-300g) and type 2 diabetes incidence in later life (Bleker *et al.*, 2021). Literature also shows that low birth weight is associated with a higher probability of coronary heart disease in adulthood (Barker, 1995). The Dutch Famine findings and the monitoring of these children's descendants suggests that exposure to famine causes transgenerational epigenetic changes (such as DNA methylation) (Fall and Kumaran, 2019; Zhu *et al.*, 2019), which are responsible for the vicious circle of OB and cardiometabolic diseases (Painter *et al.*, 2008).

b) Obesity

OB is a chronic disease with a pandemic expression and a severe problem for public health worldwide. According to the World Health Organization (WHO), OB rates continue to rise in adults and children (WHO, 2021a). OB has almost tripled worldwide since 1975. In this sense, WHO/UNICEF's Plan on Maternal Child Nutrition, outlined in May 2012 by the 65th World Health Assembly, includes the issue of OB as one of the child nutrition targets for 2025, having subsequently been extended to 2030. This specific objective was intended to ensure that no increase in childhood OW occurs during this period (WHO/UNICEF, 2019).

In 2020, almost 2 billion adults, more than 340 million children and adolescents (aged between 5 and 19) and about 39 million children under five were OW or obese (WHO, 2021a).

In the WHO European Region, almost one child out of three at school age is OW or obese (WHO, 2022) and data from the COSI (Childhood Obesity Surveillance Initiative) showed that OW and OB prevalence is higher in Mediterranean countries in children 6-9 years old (Rito *et al.*, 2019).

For many years, it was thought that the causes of OB were only related to genetics and environment after birth. However, more recently, it has become clear that many other factors and events occur, even before pregnancy, during pregnancy and during the first years of the child's life, which also impact future OB and other diseases' incidence. In fact, beyond behaviour and environment, individual genetic susceptibility is increasingly receiving more attention.

The first years of life are a determining period of growth and development and can leave their fingerprint for the rest of one's life. The importance of this period of life has led to the dissemination of the concept of the first thousand days of life (which encompasses the period of pregnancy and the first two years of life), as a critical period in metabolic and behaviour programming in childhood and the disease's prevention later in adulthood (Beluska-Turkan *et al.*, 2019).

In the last years, preconception has already been perceived as a sensitive period. Environment and nutrition can affect the gametes that will generate a newborn baby and cause modifications in growth, metabolic trajectory and future health (Hanson *et* *al.*, 2015). To include this pre-conceptional period (at least three critical months before conception), some authors proposed the concept of the first 1100 days (Stephenson, 2018) instead of the first 1000 days.

This early life programming can occur at stages as early as those described and arise through epigenetic mechanisms. One example is DNA methylation. The epigenetic mechanism occurs without genomic transmission: some events or experiences trigger a non-genetic transfer of information to subsequent generations through an altered gene expression (Gluckman *et al.*, 2007; Hanson *et al.*, 2015).

Adequate nutrition is crucial for future growth and development, but also for programming future health. Optimal nutrition of the mother is essential not only for her health but also for the next generations'. The female germ cells are already present since the fetal phase, meaning that during pregnancy a woman carries not only her children's cells but also her grandchildren's cells (Hanson *et al.*, 2015), and all associated information.

Further to the maternal influence, it is also central to understand the paternal influence in this process, including nutritional status, eating and lifestyle habits at different stages.

The mother and father's nutritional status partly determine their children's nutritional status, not only because of the associated genetic susceptibility but also because of the environmental factor of shared habits that will be transmitted to the child. The environment has a more critical role in health than genetics, being responsible for 80% of future chronic diseases (van Dijk *et al.*, 2015; Zhu *et al.*, 2019). For example, regarding obesity, if the mother or the father have a body mass index (BMI) above 25 kg/m^2, the risk of OB for children doubles. It triples when one of the parents has a BMI above 30 kg/m^2, and the risk of OB in the offspring is five times higher when the parents' BMI is above 40 kg/m^2. When both parents are obese, the likelihood of the child being obese is even higher (Whitaker *et al.*, 2010). The stability of OB is known and well documented, from childhood to adulthood. Obese children and obese adolescents are five times more likely to remain obese in adulthood (Simmonds *et al.*, 2016). The OB tracking prevalence to adulthood increases with age: around 55% of obese children maintain OB in adolescence, and about 80% of obese adolescents maintain OB in adulthood (Simmonds *et al.*, 2016).

Pregnancy is a vulnerable period due to intrauterine nutrition effects, such as the fetal overnutrition hypothesis (Robertson *et al.*, 2022). According to that, maternal size during pregnancy affects the offspring's BMI, whereby a greater maternal adiposity results in increased offspring OB in the future (Sørensen *et al.*, 2016; Robertson *et al.*, 2022). The consequences of mother undernutrition were described above about the Dutch Famine Study (Bleker *et al.*, 2021; Rooij *et al.*, 2022).

Moreover, it is not only nutrition and its adequacy during pregnancy that can program the children's future health. It is known that the weight gain recommendations during pregnancy are determined by the nutritional status of the mother before conception (Rasmussen *et al.*, 2009) and that insufficient or excessive weight gain during pregnancy can have a long-term effect. The literature shows that insufficient weight gain during pregnancy is associated with small for gestational age newborn (Perumal *et al.*, 2022). Nevertheless, excessive weight gain and/or preconception OB are associated with increased pregnancy and birth complications, as well as fetal macrossomia (Perumal *et al.*, 2022).

During pregnancy, in the uterine environment, modulation of food preferences begins. The first contact of the fetus with the flavours from the maternal diet occurs through the deglutition of amniotic fluid (Gerrish and Mennella, 2001; Spahn *et al.*, 2019). These prenatal experiences enhance and facilitate taste acceptance when introducing complementary feeding, reinforcing the importance of a varied diet of the mother and its impact on the child's health (Spahn *et al.*, 2019).

The type of delivery is another event that can impact future health: cesarean delivery is associated with a higher risk of OB in childhood and adolescence when compared to vaginal birth (Słabuszewska-Józwiak, Aneta *et al.*, 2020; Dal'Maso *et al.*, 2022), one of the possible causes being different microbiota (Azad *et al.*, 2013).

Birth weight is also an indicator that reflects the intrauterine environment and is also associated with the nutritional status of the children. An infant with low birth weight born at term with less than 2500g has a higher risk of cardiometabolic disease (Alexander *et al.*, 2015); conversely, a macrosomic child (≥ 4000g) has a higher risk of OB and diabetes in the long term (Kamana, 2015; Czarnobay *et al.*, 2019).

c) Breastfeeding

Breast milk is the ideal food during the first six months of life (EFSA, 2019), since it supplies nutrients that meet the infant's nutritional needs, being therefore recommended exclusively during this stage of life by different committees (WHO, 2002; ESPGHAN, 2009; AAP, 2022).

WHO recommendations suggest that breastfeeding should continue until 24 months of age (WHO, 2002), with non-exclusive breastfeeding from six months of age, when complementary feeding must begin. The American Academy of Paediatricians recommends that breastfeeding continues until one year or beyond, if the mother and child so desire (AAP, 2022). According to European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN), besides exclusive breastfeeding until six months, partial breastfeeding is also encouraged, and the prolongation of breastfeeding is promoted while the mother and child desire so (ESPGHAN, 2009; AAP, 2022).

In addition to being a nutritionally complete food, with good digestibility and bioavailability of nutrients, breast milk has other benefits for the mother and infant. It promotes faster recovery of the mother's body weight after birth (Ms and Kakuma, 2012), facilitates uterine involution (Del Ciampo and Del Ciampo, 2018), reduces the risk of developing ovarian and breast cancer (Ho, 2013; Chowdhury *et al.*, 2015; Prentice, 2022), and prolongs the lactational amenorrhea (Ho, 2013). Furthermore, it has the practical benefits (always ready and at the right temperature, without the need to use a bottle or to sterilise it) and the economic advantage of being a completely free food, and also allows taste training. A systematic review showed that flavours from the maternal diet during lactation were transmitted to breast milk (Spahn *et al.*, 2019), constituting opportunities for the children to contact with and learn to appreciate these flavours (Forestell, 2017).

Breast milk has also several other benefits for infants, conferring immunity or reducing the severity of some diseases and protecting infants from acute otitis, and respiratory and gastrointestinal infections (Ho, 2013; WHO, 2013; Davisse-Paturet *et al.*, 2020).

Although less robust, literature shows that breast milk is associated with a reduction in the incidence of asthma, atopic dermatitis and eczema, and also necrotising enterocolitis and the occurrence of sudden infant death (Ip *et al.*, 2007; AAP, 2012;

Ho, 2013; Lodge *et al.*, 2015). Furthermore, it reduces the risk of celiac disease while gluten is introduced, diabetes and inflammatory bowel disease (Güngör *et al.*, 2019). Several studies also show the impact of breastfeeding on OB risk (Horta *et al.*, 2015; Rito *et al.*, 2019; Qiao *et al.*, 2020).

In natural breastfeeding, the amount of milk the infant takes in is not counted, except in cases where the milk is withdrawn and fed in a bottle. The infant regulates intake according to its needs, appetite, and satiety. It is much easier for the adult to respect this self-regulating mechanism than when milk is fed from a bottle. This is one of the reasons why breastfeeding may play a protective role against OB since, in terms of energy value, breast milk and infant formulas do not differ greatly. However, the increased OB risk has been related to the amount of protein in infant formulas, even if its content has recently been adjusted. The literature describes that a high protein intake is positively associated with rapid weight gain, which can lead to OB in the future, according to the Early Protein Hypothesis (Koletzko *et al.*, 2005; Damianidi *et al.*, 2016; Berthold Koletzko, Demmelmair, *et al.*, 2019). This is probably due to an increase in circulating amino acids that, in turn, stimulate insulin secretion and insulin-like growth factor 1 (IGF-1), promoting weight gain (Tang, 2018; Berthold Koletzko, Demmelmair, *et al.*, 2019).

Despite the recommendations of exclusive breastfeeding until six months, according to WHO data, only 44.0% of children worldwide were exclusively breastfed during the first semester of life between 2015-2020 (WHO, 2021b). The WHO/UNICEF Plan on Maternal Child Nutrition, which was extended to 2030, established as a child nutrition target an increase in the exclusive breastfeeding rate of at least 50% (WHO, 2014).

Several countries have a high initiation rate of breastfeeding, yet the prevalence of exclusive breastfeeding is falling sharply, and some countries have low breastfeeding rates (Theurich *et al.*, 2019). Only one-quarter of children in the WHO European Region were exclusively breastfed during the first six months of life (WHO, 2013), in line with data from Spain (González *et al.*, 2018) and from our country (Lopes *et al.*, 2017), which prevalence is slightly lower (22.0%). The scenario is even more discouraging in some Nordic countries (Denmark, Norway and Sweden), and

Switzerland, where exclusive breastfeeding rates for the first six months are 13.0%, 17.0%, 14.0% and 10.0%, respectively (Theurich *et al.*, 2019).

d) Complementary feeding

Evidence shows that breast milk is sufficient to meet infants' energetic and nutritional needs up to six months of age (WHO, 2002; ESPGHAN, 2009; AAP, 2022). For this reason, European Food Safety Authority (EFSA) has not established any nutritional recommendation until this age, recommending the consumption of breast milk only (EFSA, 2013b).

After six months, it is necessary to introduce other foods to ensure that the infant's needs are met (WHO, 2002). This introduction of new foods other than milk until the introduction in the family diet model is called complementary feeding. It should occur between 17 and 26 weeks of the infant's life (ESPGHAN, 2017a).

The beginning of complementary feeding before four months or after six months can have some consequences and/or risks. In the first case, maternal milk production decreases (if the mother is still breastfeeding), and neuromotor and intestinal immaturity for digesting new foods, gastrointestinal infections (Schinglia *et al.*, 2015) and excess energy consumption can occur, and lead to an increased OB risk (Mannan, 2018; Gingras *et al.*, 2019). In a later introduction of complementary feeding, a deficient energy intake and a possible compromise of some micronutrients (such as iron) may affect growth and increase anaemia risk (Hassan *et al.*, 2016; Koletzko *et al.*, 2020) and affect some developmental skills related to chewing training, new textures and tastes.

Complementary feeding should consider aspects such as cultural practices and habits, and individual factors, such as the infant's neuromotor development, socioeconomic characteristics and nutritional status.

There are no definitive recommendations regarding the foods' selection, the choice of the first food and the introduction scheme of the following foods, as cultural, socioeconomic and individual factors are determinants. There are some suggestions for food introduction schemes, often based on experts' opinions, but they serve as guidelines to help parents and caregivers in this new and transitional phase.

Regarding allergens, the restrictions in healthy children are minimal. According to (ESPGHAN, 2017a), no evidence exists to delay or avoid introducing novel foods because they are thought to be potentially allergenic, as done from a long time to prevent food allergies. There is no evidence that such elimination or delay contributes to a decrease in allergies in children, with or without allergenic risk. On the contrary, recent studies show that delaying the introduction of these foods may increase the risk of allergy (Hicke-Roberts *et al.*, 2020), so the introduction of these allergic foods (i.e., eggs, fish, shellfish, cows' milk products, wheat, soybeans, peanuts, tree nuts and seeds) should be done at the same time as other foods, during complementary feeding (ESPGHAN, 2017a).

Apart from the timing of initiation of complementary feeding, the only rules established until 12 months concern the proscription of salt, sugar, honey, sweetened beverages and cow's milk (ESPGHAN, 2017a). Their consumption may be associated with future problems, such as high blood pressure, OB, diabetes and botulism.

The first food offered and even the food introduction scheme varies widely between countries and cultures, according to the specialists' opinion that accompanied the infant and with the knowledge of some parents, who are increasingly taking a more active and participatory stance.

For many years, it was common in Portugal to begin complementary feeding with cereal-based food. This practice has been changing over the years and increasingly more people start with vegetable soup, as described by the National Food, Nutrition and Physical Activity Survey (*Inquérito Alimentar Nacional e de Atividade Física*, IAN-AF) (Lopes *et al.*, 2017) data, which shows that about two-thirds of infants had vegetable soup as their first food. As a first food, vegetable soup has the advantages of promoting vegetable consumption, the acceptance of flavours that are not as innately accepted as sweetness, and enabling the intake of vitamins and minerals through a low-calorie food.

Vegetable soup is not usually the first food in other countries, partly because it is not a food that has the preponderant role it has in our gastronomic tradition. Still, it is consensual that the first food given should be pureed (based on cereals, vegetables and/or fruits). In Sweden, potatoes, vegetables, fruits/berries and porridges have been mentioned as the first food (Klingberg *et al.*, 2016); in Poland (Kostecka *et al.*, 2021), most infants start with vegetables (mainly carrot puree), and in Italy with fresh fruit (Carletti *et al.*, 2017). In South Asia (Aguayo, 2017), foods made from grains are the leading complementary foods in almost 80% of infants.

Traditionally, food from complementary feeding was spoon-fed. About two decades ago, in the early 2000s, the baby-led weaning (BLW) method, which consists of offering the infant food presented in a whole form, allowing the child to feed itself, choosing, grasping and exploring the food, appeared, and had a boom in 2008 when Gil Rapley (considered a pioneer of this technique) published a book about it (Rapley *et al.*, 2015). Its popularity began to increase in countries such as the United Kingdom (UK), Canada, the United States of America (US), and New Zealand (Cameron *et al.*, 2013; Bocquet *et al.*, 2022) and is now increasingly widespread. BLW promotes greater autonomy for the infant and, as with breastfeeding, encourages the self-regulation of the appetite (Bocquet *et al.*, 2022), allowing the child to adjust the energy intake. Furthermore, since the food is offered whole, it promotes greater chewing and consequent satiety in the infant, greater development of fine motor skills (Rapley *et al.*, 2015) and less conflict during feeding time (Bocquet *et al.*, 2022). However, BLW presents a risk of energy and nutritional imbalance, as it is not well-established what type of foods should be offered in a meal or in a full day.

Nevertheless, the medical community is generally still slightly resistant to the BLW practice, since there are few studies regarding its nutritional safety, as it is a more recent practice. The reluctance of a large part of medical professionals to suggest this method has to do with the risk of choking and possible nutritional deficits (Cameron *et al.*, 2013), and furthermore this method is not yet referenced by international societies, such as ESPGHAN, due to lack of scientific support. Some parents are also a little resistant to adopting this technique for the reasons above, and because this method implies greater freedom of movement of the infant (even when sitting in a proper seat), ending up making the whole environment much dirtier (Brown and Lee, 2013).

On the other hand, it is increasingly more common to see more informed and up-to-date parents, who want to play an active role in all stages and decisions regarding their children's diet. And although there is still not much scientific evidence, there are many websites and informatics applications, where parents can find much information about BLW.

Alpers *et al.* evaluated the differences between standard complementary feeding and BLW, and concluded that the latter foods are higher in fat and sodium and lower in iron, but less free in sugar (Alpers *et al.*, 2019).

In recent years, a more targeted version of BLW, called Baby Led Introduction to Solids (BLISS) (Daniels *et al.*, 2015; Erickson *et al.*, 2018) has emerged, with the aim of minimising the possible negative effects of BLW, such as iron deficiency, the risk of choking and growth failure. This technique suggests that parents introduce iron-rich, energy-dense and even fruit and vegetable foods to prevent nutritional deficiencies that could more easily occur in the free form of the original BLW. The specific reference to iron relates to the need to compensate for the depletion of iron reserves at around six months and its importance for health, growth, development and cognitive function.

The Committee on Nutrition of the ESPGHAN showed that in healthy full-term infants, different timings of complementary feeding (between 4 and 5 months versus 6 months) were not associated with different body compositions (ESPGHAN, 2017a). A study by Verga *et al.* has also not found differences in weight, length, BMI z-score (zBMI) at 12 months and OW/OB at three years old in children with differences in complementary feeding ages (4 versus between 4-6 versus 6months) (Verga *et al.*, 2022).

e) Toddlerhood

Toddlerhood corresponds to the period between the end of the first year of life and the beginning of preschool age, more precisely between 12 and 36 months of life (Fraser *et al.*, 2021). At 12 months of age and after diversifying the diet and gradually introducing different foods throughout the second semester of the first year, it is time for the child to integrate the family diet, which means it can eat the same as the rest of the family (*Comissão de Nutrição da SPP*, 2012; ESPGHAN, 2017a). Consequently, the family must establish a healthy, varied, balanced and complete diet, to ensure that the transition to the family’s diet occurs under the best conditions possible.

Toddlers' years are crucial to developing the children's motor skills (such as walking, talking, eating, etc.) and promoting feeding autonomy (Allen and Myers, 2006; Riley *et al.*, 2018). This stage is characterised by an increase in physical activity and a decrease in growth speed.

Toddlerhood is also a period in which children present great plasticity and considerable susceptibility, where modelling of eating habits, and tastes and preferences' development occurs (Riley *et al.*, 2018). The practices acquired at this time of life are more effective and long-term maintained throughout life, impacting growth, development and future health (Craigie *et al.*, 2011; Koletzko *et al.*, 2017; B Koletzko *et al.*, 2019).

f) Nutritional Recommendations

Nutritional recommendations aim to meet the nutrients or energy requirements of an individual or a population group, considering age and gender, to promote individuals' health and protect them from disease (EFSA, 2010b). Nutritional recommendations behave as a guide for the development of dietary recommendations, are given in percentage (%), grams (g), or grams per kg (g/kg) of bodyweight, and are therefore challenging to put into practice and directly incorporated into the population's dietary patterns. Thus, these recommendations are converted into dietary recommendations, which include foods and dietary practices and are therefore more concrete and accessible to the population, with a view to healthy eating.

Currently, there are nutritional recommendations issued by various international organisations, such as the Food and Agriculture Organisation (FAO) and WHO (WHO/FAO, 2003; WHO/FAO, 2004; WHO/FAO, 2007), the Dietary Reference Intake (DRI) recommended by the Food and Nutrition Board of the Institute of Medicine (FNB/IOM) (IOM, 2011; USDA, 2020) adopted by the US and Canada, and also other recommendations for European countries, such as those of the European Food Safety Authority (EFSA) (EFSA, 2017) and the Nordic Nutritional Recommendations (NNR, 2014), serving as a nutritional guide for Denmark, Sweden, Finland, Iceland and Norway. The DACH reference values were issued for Germany, Austria and Switzerland (DGE, 2017). Nonetheless, the Federal Safety and Veterinary Office (FSVO) also published specific recommendations for the Swiss people in 2022 (FSVO, 2022). There are also other countries with national recommendations. The

Superior Health Council of Belgium (CSS, 2016) provided updated nutritional recommendations for its population in 2016, based on the latest scientific knowledge and the nutritional recommendations of other committees, including those of EFSA. Public Health England published Government Dietary Recommendations in 2016 for the UK population, based on recommendations from the Committee on Medical Aspects of Food Policy (COMA) and the Scientific Advisory Committee on Nutrition (SACN) (PHE, 2016). In France, the dietary guidelines of the National Programme on Nutrition and Health (*Program National Nutrition Santé,* PNNS) were updated by the Agency for Food, Environmental and Occupational Health & Safety (*Agence Nationale de Securité Sanitaire de L'Alimentation, de L'Environement et du Travail,* ANSES) in 2016, for adults and, later, a separate opinion for children aged 0-3 years, was carried out, considering the specific characteristics of this age group (ANSES, 2017). The Italian Society of Human Nutrition (*Società Italiana di Nutrizione Umana*, SINU) conducted the 4th Revision of Reference Intake Levels of Nutrients and Energy for the Italian Population (*Livelli di Assunzione di Riferimento di Nutrienti ed energia per la popolazione italiana,* LARN) in 2014, to which about one hundred Italian experts contributed (SINU, 2019). In the case of Spain, the Spanish Agency Food Safety and Nutrition (*Agencia Española de Seguridad Alimentaria y Nutrición*, AESAN) updated on 2019 the Dietary Reference Intakes issued by the Spanish Federation of Nutrition, Food and Dietetics Societies (*Federación Española de Sociedades de Nutrición, Alimentación y Dietética*, FESNAD) on 2010, and these new references have taken into consideration other reference intakes from official international organisations. EFSA's energy and macronutrient intakes were adopted, and vitamins and mineral references were based on the FESNAD references using a specific algorithm (AESAN, 2019).

Portugal is one of the few European countries which does not have its own recommendations. Still, a work conducted within this research suggests the adoption of EFSA's (Nazareth *et al.*, 2016), as they are European recommendations, are more recent, and have a robust methodology, including a review of existing recommendations. However, the term DRI is still widely used, instead of Dietary Reference Values (DRV) from EFSA, probably because of the long period it has been used for.

All these European nutritional recommendations have been updated in recent years. Many of the updates followed the updating of the EFSA's recommendations, that occurred between 2010 and 2019 in response to the request of the European Commission (EC) to update the existing recommendations, dating from 1993 (EC, 1993). The recommendations from EFSA were the starting point for the recommendations in many European countries. In Belgium (CSS, 2016) and Spain (AESAN, 2019), some reference values have inclusively been adopted from EFSA (EFSA, 2017).

It was not only the nutritional recommendations of European countries and organisations that have been updated. In 2022, the working group of DRI of the US and Canada asked the National Academies of Sciences, Engineering and Medicine (NASEM) to review and update the reference values, and requested the appointment of a committee for future DRI updates. In addition, the reference values for sodium and potassium were already updated in 2019 (DRI, 2019). The Nutrition and Food Systems Division (ESN) of the FAO and the Department of Nutrition for Health and Development (NHD) of the WHO have also established a group of experts to update nutrient requirements for children aged 12-36 months. In 2021, new values were already published for vitamin D and calcium, while reference values for zinc, folate, vitamin A, magnesium and iron are also expected to be updated (FAO/WHO, 2023).

The importance of what happens during the early years of life of children (Beluska-Turkan *et al.*, 2019) has led to more and more study and attention on this issue. As such, some of the nutritional recommendations' updates were focused explicitly on the early years of life.

Moreover, from 2020, nutrition guidelines from birth and up to 24 months were included in the Dietary Guidelines for Americans, for the first time (USDA, 2020).

Table 1: Nutritional Recommendations of Different Entities for Toddlers

	EFSA 2010-2022	**FAO/WHO 2003-2019**	**FNB, IOM 1997-2019**	**NNR 2012**	**DACH 2000-2021**	**CSS, Belgium, 2016**	**UK, PHA, 2016**	**AESAN FESNAD, Spain 2010-2019**	**ANSES, France 2016-2021**	**SINU, Italy 2014**
Protein PRI/RDA/RNI (g/kg/d)	1 y:**1.14**; 2 y: **0.97**;	1 y:**1.14**; 2 y: **0.97**;			**1.0**	1 y:**1.14**; 2 y: **0.97**;		1 y:**1.14**; 2 y: **0.97**;		**1.0**
(g/d)			**13**				**14.5**			
RI/AMDR (%)			2-3 y: **5-20%**	12-23 months: **10-15%** From 2 y: **10-20%**					**6-15%**	
Carbohydrates RI/AMDR (%)	**45-60%**	**55-75%**	2-3 y: **45-65%**	**45-60%**	**>50%**	**50-55%**	**50%**	**45-60%**	**40-50%**	**45-60%**
(g/d)			**130**				2-3 y: **145g m, 134g f**			
Fibre (g/d)	**10g***	**>25g**	**19*** 2-3 y: **14**		**-**	**10***	2-3 y**: 15** (< 2 y but consumption of grain, pulses and vegetables should be encouraged)	**10g***	**-**	
(g/MJ**)**				From 2 y: **2-3g/MJ**						**8.4g /1000 Kcal**
Sugar (%)	Added and free sugars should be **as low as possible**		**<25%** 2-3 y: **<10%** added sugars **(**DGA 2020-2025)	From 2 y: added sugars **<10%**	-	max. **10%**	(max. **5%** free sugars)	-	-	**<15 %**
(g/d)							15g m; 13g f			

Total Fat RI/AMDR (%)	**35-40 %**	↓gradual of **40-60%** dependent on PA up to 24 months 2 y: **25-35%**	**30-40%**	12-23 months: **30-40%** From 2 y: 25-40%	**30-40%**	**35-40%**	**35%** max.	**35-40 %**	**45-50%**	**35-40%**
SFA (%)	**As low as possible**	From 2 y: <10% (strong recommendation) 2018	**As low as possible** 2-3 y: **<10%** (DGA 202-2025)	From 2 y: < **10 %**	max. **10%**	**8-12%**	**11%**	**As low as possible**	-	**<10%**
Water (ml/d)	1 y: **1100-1200** 2-3 y: **1300**		**1300**	2-13 y: **1000**	**820**		-	1 y: **1100-1200** 2-3 y: **1300**	-	**1200***
Vitamins										
(PRI/RNI/RDA/AI*)										
Vitamin A (µg/d)	**250**	**400**	**300**	12-23 months: **300** RE From 2 y: **350** RE	**300 ug RE**	**250**	**400**	**350**	**250 ug RE**	**300**
Folate (µg/d)	**120 DFE;**	**150**	**150**	12-23 months: **60** From 2 y: **80**	**120**	**100**	**70**	**120**	**120**	**140**
Vitamin C (mg/d)	**20**	**30**	**15**	12-23 months: **25** From 2 y: **30**	**20**	**60**	**30**	**30**	**20**	**35**
Vitamin B6 (mg/d)	**0.6**	**0.5**	**0.5**	12-23 months: **0.5** From 2 y: **0.7**	**0.6**	**0.6**	**0.7**	**0.6**	**0.6**	**0.5**
Vitamin B_{12} (µg/d)	**1. 5***	**0.9**	**0.9**	12-23 months: **0.6** From 2 y: **0.8**	**1.5***	**1.5**	**0.5**	**0.9**	**1.5**	**0.9**
Vitamin D (µg/d)	**15***	**15**	**15**	12-23 months: **10** From 2 y: **10**	**20 ***	**10**	**10**	**10**	**15***	**15**

Minerals										
(PRI/RNI/RDA/AI*)										
Calcium (mg/d)	**450**	**700**	**700**	**600**	**600**	**450**	**350**	**600**	**450**	**700**
Phosphorus (mg/d)	**250***	**n.a**	**460**	**470**	**500**	**360**	**270**	**460**	**250***	**460**
Selenium (µg/d)	**15***	**17**	**20**	12-23 months: **20** From 2 y: **25**	**15***	**15***	**15**	**19**	**15***	**19**
Iron (mg/d)	**7**	**4.8**	**7**	**8**	**8**	**8**	**6.9**	**8***	1-2 y: **5**; 3-6y: **4**	**8**
Iodine (µg/d)	**90***	**90**	**90**	12-23 months: **70** From 2 y: **90**	**100**	**90**	**70**	**90**	**90***	**100***
Zinc (mg/d)	**4.3**	**4.1**	**3**	12-23 months: **5** From 2 y: **6**	**3**	**4**	**5**	**4.1**	**4.3**	**5**
Magnesium (mg/d)	1-2 y:**170*** 3-9 y: **230***	**60**	**80**	12-23 months: **85** From 2 y: **120**	**170 ***	**170**	**85**	**85**	**180 ***	**80**
Potassium (mg/d)	1-3 y: **800***	n.a	**2000***	12-23 months: **1400** From 2 y: 1**800**	**1100***	**800 -1000**	**800**	**1100**	**800***	**1700***
Sodium (mg/d)	**1100 †**	n.a	**800***	2-3 y: **0.5 g/MJ**	**400***	**225-500**	**800**	**700**	**800 ***	**700 ***

*AI, Adequate Intake; †, safe and adequate intake.

AESAN, *Agencia Española de Seguridad Alimentaria y Nutrición*; AMDR, Acceptable Macronutrient Distribution Range; ANSES, *Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail*; AR, Average Requirement; CSS, *Conseil Supérieur de la Santé*; d, day; DACH, Germany (D), Austria (A), and Switzerland (CH); DFE, Dietary Folate Equivalents; DGA, Dietary Guidelines for Americans; EFSA, European Food Safe Authority; FAO/WHO, Food and Agriculture Organization; f, female; FESNAD, *Federación Española de Sociedades de Nutrición, Alimentación y Dietética;* FNB, Food and Nutrition Board; IOM, Institute of Medicine; m, male; Max., Maximum; MJ, MegaJoule; n.a., Not Available; NNR, Nordic Nutrition Recommendations; PA, Physical Activity; PRI, Population Reference Intake; RDA, Recommended Dietary Allowance; RE, Retinol Equivalents; RI, Reference Intake; RNI, Recommended Nutrient Intake; SFA, Saturated Fatty Acids; SINU, *La Società Italiana di Nutrizione Umana*; UK, United Kingdom; PHA, Public Health Agency; WHO, World Health Organization; y, year/years.

g) Dietary Recommendations

Recognising the importance of the early years and their impact on future health, some countries such as France, Italy, Sweden and the US have developed specific dietary recommendations for the early years of life. In other countries (like Switzerland, Belgium, the UK and Spain), food-based dietary guidelines are available for the adult population but there are no recommendations for specific groups such as toddlers.

In most of these countries, however, there are extensive or non-extensive guides/brochures or other support materials containing information about feeding at these ages (FAO, 2023). In some cases, the information provided does not include quantitative recommendations on food portions, but only qualitative recommendations suggesting the food groups that should be consumed. In other situations, there are only behavioural recommendations for this age group (FAO, 2023).

The dietary recommendations of each country are generally based on a food guide, which serves as a guide to what the population should eat daily and consists of a graphic image that varies from country to country (FAO, 2023). Austria, Greece, Ireland, Spain, Belgium and Switzerland use the food pyramid. The Spanish food pyramid considers the principles of the Mediterranean diet, and Belgium, in addition to the food pyramid used by the French community, uses the food triangle as a food guide for the Flemish community. In addition to the pyramid, Switzerland also uses a food plate and food disk (for children from 4 years of age) as a food guide. Finland's food triangle and food plate also guide the population's choices. In Iceland, the food guides are the food circle and plate; in the UK, the eat well guide (a circle) is used, whereas in the US, MyPlate is used. Countries such as France, Italy and Norway have no established food guides. Sweden uses a simple graphic model with three key messages, and Denmark uses a representation with six different coloured boxes. Finally, in Germany, the food guide used is a food circle very similar to the food wheel adopted as a guide for the Portuguese population (Rodrigues *et al.*, 2006).

Fig. 1. Examples of different Food Guides (from left to right, top to bottom): United Kingdom, Belgium, Sweden, United States and Denmark.

The Portuguese food wheel was created in 1977 and updated in 2003 (Rodrigues *et al.*, 2006). Subsequently, in 2016, a Mediterranean version of the food wheel was published (Rodrigues *et al.*, 2021), where particular emphasis is given to the characteristic foods of this dietary pattern, considering its benefits.

Fig. 2. Portuguese Food Guides per year: 1997 (left), 2003 (middle) and 2016 (right), the Mediterranean version of the 2003 Portuguese Food Guide.

The Portuguese food wheel recommends that the diet should be complete (including foods from all the groups), varied (varying the foods within each group), and balanced (respecting the proportion of each group). It also presents the foods that should be part of a healthy and daily diet, distributed in seven groups (apart from water, which is represented in the centre), with the remaining foods (sugary foods and drinks, salty and ultra-processed foods) only reserved for exceptional or festive days (Rodrigues *et al.*, 2006). Although this food guide has been produced for the Portuguese adult population, it can also be used for children. It is an excellent tool for food education and an essential basis for parents, health professionals and educators. For this age group (one to three years of age), the authors suggest using the lower limits of each range as the recommended portion in each group of the food wheel, except for the dairy products group, which recommendation for children and adolescents should be regulated by the upper limit (Rodrigues *et al.*, 2006).

It is essential to provide parents and educators with dietary recommendations in this age group, since it is precisely at this age that the child integrates the family diet. It is, therefore, an excellent time for readjusting habits and rethinking the choices of the whole family.

h) Nutritional Adequacy

The comparison between nutritional intake and recommendations allows to determine the nutritional adequacy of the diet for populations. This evaluation is crucial, especially in these first years of life, a period that has a critical role and impact in the future nutritional status and health.

Several studies in different European countries, such as Spain (children aged 0-36 months) (Dalmau *et al.*, 2015), Ireland (children aged 1-4 years) (Walton *et al.*, 2017), UK (toddlers aged 21 months) (Syrad *et al.*, 2016), Italy (children aged 6-131 months) (Verduci *et al.*, 2019), Greece (children aged 1-5 years) (Manios *et al.*, 2008), Belgium (children aged 6-36 months) (Huysentruyt *et al.*, 2016), Switzerland (toddlers aged 1-3 years) (Brunner *et al.*, 2018), Germany (children aged 10-36 months) (Hilbig *et al.*, 2015) and Finland (children aged 1-6 years) (Kyttälä *et al.*, 2010), evaluated the nutritional adequacy of young children's diet according with the nutritional recommendations adopted in each country.

In some countries, such as the UK (Syrad *et al.*, 2016), Belgium (Huysentruyt *et al.*, 2016) and Greece (Manios *et al.*, 2008), the mean energy intake of the children was higher than the respective nutritional recommendations. Switzerland data (Brunner *et al.*, 2018) found an energy intake below the recommendations, contrary to the previously mentioned studies. It should be noted, however, that this result must be related to the energy cut-offs of the DACH recommendations (DGE, 2017), which were reviewed in 2015, and that are higher than the used by EFSA (EFSA, 2013a) or WHO (FAO/WHO, 2005), since the absolute value of energy intake is just like the earlier studies.

Data for the Portuguese paediatric population are also available, although not specifically for toddlerhood. Valente *et al.* (Valente *et al.*, 2010) studied the inadequacy prevalence of Portuguese children aged between 7 and 9 years, and the Generation XXI study (Lopes *et al.*, 2014) evaluated children of 4 years. The Portugal IAN-AF Survey, which took place in 2015-2016, evaluated different population groups (children, adolescents, adults and elderly) and presented data from a group of children older than 1 and younger than 10 years old (Lopes *et al.*, 2017).

In the Generation XXI study (Lopes *et al.*, 2014), the mean energy intake was 1618 kcal per day, which is above the average requirement (AR) considering a physical activity level (PAL) of 1.4, 1.6 or 1.8, for boys and girls (EFSA, 2013a). In the IAN-AF, the mean energy intake was 1646 kcal. However, this group includes children of a wide range of ages, aged 2 to 9 years (Lopes *et al.*, 2017). This large age interval has very different energy needs, considering the children's age, gender and PAL, so it is difficult to determine how many children have excessive energy intake. The energy needs for this group vary from 946 kcal for 2-year-old girls with a low active (sedentary) lifestyle, corresponding to a 1.4 PAL, to 2165 kcal for 9-year-old boys with an active lifestyle, corresponding to 1.8 (EFSA, 2013a).

Successive excessive daily energy intake can lead to future OW. According to the Irish Department of Public Health, an excess of 100 kcal per day can lead to an increase of 4.5 kg in bodyweight in a year (PHA, 2012).

Also, the protein intake exceeded the recommendations in several European countries (Switzerland, Italy, Germany, Ireland, the UK, France and Spain), where toddler's protein intake is at least three or even four times higher than the recommendations

(Dalmau *et al.*, 2015; Hilbig *et al.*, 2015; Syrad *et al.*, 2016; Walton *et al.*, 2017; Brunner *et al.*, 2018; Verduci *et al.*, 2019; Chouraqui *et al.*, 2022). In the United Arab Emirates (UAE), 2.0% of toddlers also exceeded the acceptable macronutrient distribution range (AMDR) for protein (Ismail *et al.*, 2022). These data are contrary to American (Butte *et al.*, 2010; Bailey *et al.*, 2018), Lebanese (Jomaa *et al.*, 2022) and Dutch data for toddlers (Steenbergen *et al.*, 2021), for whom the protein intake is within the recommendations. However, despite the excess protein consumed, Chouraqui *et al.* indicated that the average daily protein intake in France toddlers had fallen in recent decades, due to the lower formula protein content and compliance with the guidelines (Chouraqui *et al.*, 2022).

Evidence shows that excess protein intake during the first years of life can lead to increased growth and BMI in the future, as postulated by the early protein hypothesis (Koletzko *et al.*, 2009; Hornell *et al.*, 2013; Michaelsen and Greer, 2014; Weber *et al.*, 2014) and may overload renal function (Kamper and Strandgaard, 2017).

According to the FAO/WHO/UNU (WHO/FAO, 2007) publication, the percentage of protein about the total energy (TE) value is relevant. Some authors (Rzehak *et al.*, 2013; Damianidi *et al.*, 2016) advocate long-term effects in increasing the risk of future OB from protein intake above 15% of TE value. An upper limit of 20% for toddlers was proposed by the Health Council of the Netherlands (Health Council of the Netherlands, 2001). Then, Agostoni *et al.* proposed a limit of 14%, since data from several studies indicate that a positive association between protein intake at 12-24 months and OB was not found with protein intake below 15% (Agostoni *et al.*, 2005). Later, Hornell *et al.* suggested a limit of 15% of TE for protein intake at 12 months, since a superior value might be associated with later OB (Hornell *et al.*, 2013).

In Belgian toddlers, the protein intake is very high (Huysentruyt *et al.*, 2016). All children had a protein intake above the recommendations, and more than one-third (38.3%) had a protein intake above this tolerable upper limit of 15% of TE intake. Swiss toddlers also reached the limit of 15% of protein (Brunner *et al.*, 2018). Data from the GENESIS study about Greek toddlers and pre-schoolers showed an increase in the percentage of protein intake relative to TE, from 15.0% to 17.1% since the previous study, which occurred ten years earlier (Roma-Giannikou *et al.*, 1997; Manios *et al.*, 2008). Italian toddlers also consumed a high protein content, with a median protein intake of 15.9% of the TE (Verduci *et al.*, 2019). Irish children consumed a very high quantity of protein, with a median intake of 15-16% of TE and 2.8 g/kg/day. However, this median intake decreased from 3.3 to 2.6g/kg/day, from one to four years old (Walton *et al.*, 2017).

Portugal also showed this global trend. Valente *et al*. found that about two-thirds of the children (7-9 years old) consumed protein in excess (Valente *et al.*, 2010), according to the WHO recommendations (WHO/FAO, 2007). The Generation XXI study also observed a high protein intake in children aged four (Lopes *et al.*, 2014). The mean protein intake was 4.2g/kg/day, more than four times the recommendations, and the percentage of protein relative to the TE was 18.7%. Data from IAN-AF (2-9 aged children) showed that, like the data of the Generation XXI study, the TE protein rate was 18.6%, which was too high (Lopes *et al.*, 2014, 2017). In addition, more than 83% of the children consumed above 2 grams of protein per kilogram of bodyweight per day, further above the recommendations (Lopes *et al.*, 2017).

Most European children complied with carbohydrate recommendations, and data about children's nutritional intake from Belgium, Switzerland, Italy, Germany and Ireland reported this (Hilbig *et al.*, 2015; Huysentruyt *et al.*, 2016; Walton *et al.*, 2017; Brunner *et al.*, 2018; Verduci *et al.*, 2019). In the US, Butte *et al.* also found that the carbohydrate intake was according to nutritional recommendations (Butte *et al.*, 2010). In Greece, almost all children had a carbohydrate intake above the estimated average requirement (Manios *et al.*, 2008).

The existing Portuguese data reveals a carbohydrate median intake of 49.0%, and 51.2% of the TE in the Generation XXI study (7-9 aged children) and in the IAN-AF 2015–2016 (2-9 aged children), respectively (Lopes *et al.*, 2014, 2017). Furthermore, data from IAN-AF 2015-2016 (Lopes *et al.*, 2017) also showed that about 16% of the children are below the lower limit of the EFSA recommendations (45.0%) and about 7% above the upper limit (60.0%) (EFSA, 2010a). These results are better than those found a few years earlier by Valente *et al.*, where only 22.0% of children had a carbohydrate intake according to the WHO recommendations (Valente *et al.*, 2010). However, the large differences in the cut-offs of recommendations used in the two studies could justify these differences.

Fibre intake is often lower than recommended in children, as noted in Belgium, where more than 80% of the toddlers had a fibre intake below the recommended adequate intake (AI) (Huysentruyt *et al.*, 2016). Also, in Switzerland (Brunner *et al.*, 2018), Italy (Verduci *et al.*, 2019) and Finland (Kyttälä *et al.*, 2010), fibre consumption is low at these ages. Data regarding the US (Bailey *et al.*, 2018) of the Feeding Infants and Toddlers Study (FITS), conducted in 2016, described that very few toddlers met the recommendation for dietary fibre: only 3.2% of children aged 12-23.9 months and less than 10% of children with 24-35.9 months. The same does not happen in Ireland (Walton *et al.*, 2017). Although the mean fibre intake (11 to 13g per day) was lower than the recommendations, almost 80% of the Irish children had an intake above the 2g per Mega Joule (MJ), the AI established by EFSA (EFSA, 2010a).

In Portugal, data also revealed a low intake of fibre among children. Valente *et al.* showed that almost 90% of the children (7-9 years old) had a low intake of fibre according to the recommendations (Valente *et al.*, 2010), and data from the Generation XXI study (children aged four) showed that the median fibre intake was 12.7g (Lopes *et al.*, 2014), which is lower than the recommendation (19g). More recent data collected in IAN-AF (2-9 aged children) showed a low prevalence of inadequacy of fibre (Lopes *et al.*, 2017).

Another critical issue is the high intake of sugar in toddlerhood, which has a positive and recognised association with the development of dental caries (Chi and Scott, 2019) and with a moderate level of evidence of OB and dyslipidemia (Stanhope, 2016). Literature shows that European children's sugar consumption exceeded the recommendations (ESPGHAN, 2017b). Data from IDEFICS Study, which included 8 European countries, described that less than 20% and 5% of the children (2-9 years old) met the recommended sugar intake of less than 10% and 5% of the TE value, respectively (Graffe *et al.*, 2020). Data from Italian Children (6.4-131 months) showed that more than 80% of the children had a sugar (natural, added or free) intake above the recommendations (Verduci *et al.*, 2019), and in the UK (21 months aged children) (Syrad *et al.*, 2016), 27% of the TE intake was provided by sugars. In Germany, many children consumed added sugars above 10% of the TE (Hilbig *et al.*, 2015); in Ireland, the mean intake of free sugars was 12% (increasing from 9% at 1 year old to 15% at 4 years old) (Walton *et al.*, 2017) and in Spain, only 27.4% of the boys and 37.2% of the girls had sugar intake below 10% of the TE (Redruello-Requejo *et al.*, 2022), according to recommendations. EFSA could not establish an upper limit (UL) or a safe sugar intake, but recognised that the consumption of added and free sugars should be as low as possible (EFSA, 2022). However, sugar recommendations are available for other organisations. ESPGHAN established that, for children aged 2 years or older, the intake of free sugars should be equal to or less than 5% of the TE intake (ESPGHAN, 2017b). Likewise, the SACN of the UK recommended less than 5% of the TE intake in children under the age of 2 (SACN, 2015). WHO defined a maximum of 10% or even 5% of free sugars of TE for the general population (children and adults) (WHO, 2015).

Portuguese studies also indicated a high intake of sugar (Valente *et al.*, 2010; Lopes *et al.*, 2014, 2017). Valente *et al*. found that almost 100% of the children (7-9 years old) ate sugar above recommendations; in the Generation XXI study, all children (aged 4 years) had a sugar intake above the 10% of TE and, more recently, data from IAN-AF (2-9 year old children) revealed a slight improvement in the results: more than 80% ate sugar above the 5% of the TE, but much less (about 40%) ate sugar above 10% of the TE (Lopes *et al.*, 2017).

Fat intake is crucial for the central nervous system and retina, through cell membranes' maturation (Uauy *et al.*, 2001); due to this, fat recommendations in the first three years of life are higher. Fat consumption varies between countries: while Greek (Manios *et al.*, 2008) and Lebanese (Jomaa *et al.*, 2022) children had a fat intake above the percentual interval of recommendations, Swiss and German (Hilbig *et al.*, 2015; Brunner *et al.*, 2018) toddlers' fat intake was within the recommendations. In Belgian toddlers, the median fat intake was slightly below the recommendations and increased with age (Huysentruyt *et al.*, 2016). Most Irish children (87.0%) also had an intake below the recommended upper threshold: children aged 3-4 years old below 35%, and children aged 1-2 years old below 40% (Walton *et al.*, 2017). Results from FITS 2016 (Bailey *et al.*, 2018) also showed that more than 30% of the children (12-48 months) consumed a low proportion of energy from fat; the same happening in Spain (Dalmau *et al.*, 2015).

Another critical issue is related to the types of fat consumed. In some European countries, children presented an imbalance intake of types of fat, consuming saturated fatty acids above the recommendations (Verduci *et al.*, 2019; Steenbergen *et al.*, 2021;

Jomaa *et al.*, 2022) and polyunsaturated fatty acids in small quantities, as is the case of Italy, where more than two-thirds exceed the recommendations of saturated fat fatty acids. Nevertheless, the intake of polyunsaturated fatty acids is low (Verduci *et al.*, 2019). Finnish children also consumed a higher proportion of saturated fat and too little polyunsaturated fatty acids. However, the intake of saturated fatty acids has decreased in Finland in recent decades (Kyttälä *et al.*, 2010). Irish children also revealed this imbalance in saturated and polyunsaturated fatty acids intake (Walton *et al.*, 2017). Swiss toddlers exceeded the recommendations for saturated fatty acids intake (less than 10% of TE); however, despite the intake of unsaturated fatty acids (mono and polyunsaturated) being at the lower limit of the interval, it was mostly met (Brunner *et al.*, 2018).

The same was observed in Portugal, where about 20% of the Generation XXI children had an intake of total fat above the recommendations, as well as more than 70% of the children (7-9 years old) studied by Valente *et al.* (Valente *et al.*, 2010; Lopes *et al.*, 2014). More recently, data from IAN-AF (2-9 years old) revealed that over one-third of the children had an intake lower than 20%, which is well below the recommended lower limit (35%). However, the principal justification for this huge change is the utilization of different guidelines. While the Generation XXI study used DRI of IOM as the guideline, which recommends an intake of 25-35% of TE from fat, Valente *et al.* used WHO recommendations, that proposed a lower recommendation (15-30% of fat intake) and, in turn, IAN-AF utilised EFSA recommendations, that suggest a higher fat intake, of 35-40% for one to three years old children. Regardless of the different cut-offs used, the mean intake found in the three studies did not show large differences: Valente *et al.* found a mean fat intake of 35.0%, and 31.7% and 31.5% were observed in the Generation XXI study and IAN-AF, respectively (Valente *et al.*, 2010; Lopes *et al.*, 2014; Lopes *et al.*, 2017). Children included in the Valente study were older and had a higher median intake, contrary to the fat recommendations that are higher in the first years of age (Valente *et al.*, 2010).

Furthermore, data from the Generation XXI study found that more than 60% of the children had an intake of saturated fatty acids of 10% or more of the TE, and higher than the recommendations, and almost 80% did not comply with the recommendation of an intake of polyunsaturated fatty acids of at least 5% (Lopes *et al.*, 2014). Data from IAN-AF also showed that almost three-quarters of the children had an intake of saturated fatty acids above the recommendations (Lopes *et al.*, 2017). Valente *et al.* found that over than 80% of the children exceeded the recommendations (Valente *et al.*, 2010).

As the name suggests, micronutrients are nutrients needed in smaller quantities but with important and defined biological functions. There are micronutrients which inadequacy is generally shared by different European countries, notably vitamin D, iron and copper (Rippin *et al.*, 2019). However, there are also some asymmetries, since we can find very different eating habits between European countries. In addition, the recommendations themselves and the cut-offs used to determine nutritional inadequacy also vary greatly. Another factor contributing to the asymmetries found is related to the fortification of specific nutrients, which is mandatory for some foods in certain countries.

One of these critical micronutrients is vitamin D. Vitamin D is synthesised in the body, requiring sunshine to activate it. The supply of vitamin D is independent of food sources alone to cover its requirements. Several European countries have reported low vitamin D levels, based on biochemical data and by assessing food intake (Dalmau *et al.*, 2015; Hilbig *et al.*, 2015; Walton *et al.*, 2017; Brunner *et al.*, 2018; Verduci *et al.*, 2019). Swiss and Italian toddlers had a mean intake significantly lower than the reference value (Brunner *et al.*, 2018); likewise, German and Spanish toddlers (Dalmau *et al.*, 2015; Hilbig *et al.*, 2015) had a mean intake that did not supply the recommendations and less than 1% of Greek children exceeded the UL (Manios *et al.*, 2008). Finnish, English and Irish children also had a mean intake below the recommendations, even accounting for the supplementation (Kyttälä *et al.*, 2010; Syrad *et al.*, 2016; Walton *et al.*, 2017). In Portugal, data from IAN-AF were not available. However, children from Generation XXI (aged 4) revealed a total inadequacy for vitamin D, since 100% of the children did not comply with the recommendations, considering only dietary intake (Lopes *et al.*, 2014).

The recommendation to supplement with vitamin D is universal during the first year of life (ESPGHAN, 2013). However, vitamin D supplementation should be considered as a universal recommendation until the age of 2 and furthermore at any age, especially during the fall and winter months, when the lack of sun exposure prevents its synthesis (Saggese *et al.*, 2018). Corsello *et al.* summarised the current evidence and recommendations and concluded that after the first year of life, the need for vitamin D supplementation must be considered by health professionals and scientific societies, according to the geographical conditions (Corsello *et al.*, 2023).

Finland has had fortified liquid dairy products and fat spreads with vitamin D for almost 20 years. In addition, vitamin D supplementation in Finland is recommended during the winter up to the age of 17 in children and adolescents who do not consume such products (Finish Food Authority, 2020).

In Germany, there was a significant decrease in the prevalence of children supplemented with vitamin D after infancy (Drossard *et al.*, 2011). Data from German toddlers aged 2-3 years from the GRETA study (German Representative Study of Toddler Alimentation) found that more than 62% supplemented with vitamin D (Hilbig *et al.*, 2015). Additionally, SACN recommends vitamin D supplementation of children aged under 5 years in the UK, and beyond 5 years when sun exposure is not properly assured (UK Gov, 2022).

As already highlighted, another critical nutrient is iron. Iron has a significant prevalence of inadequacy in several European countries, where dietary intake is lower than the recommended level. This happens in Switzerland (Brunner *et al.*, 2018), Finland (Brunner *et al.*, 2018), Germany (Hilbig *et al.*, 2015), Ireland (Walton *et al.*, 2017) and the UK, where only about one-third of toddlers met the iron recommendations, and 6.3% are below the lower limit (Syrad *et al.*, 2016). Iron is essential in cognitive and physical development; insufficient intake can bring negative consequences. In Portugal, Generation XXI data showed that children were not inadequate in iron (Lopes *et al.*, 2014). At the same time, Valente *et al.* (7-9 aged children) found a low inadequacy prevalence (Valente *et al.*, 2010) and, more recently, data from IAN-AF (2-9 aged children) revealed an inadequacy prevalence of 20.8% in girls and 16.2% in boys (Lopes *et al.*, 2017).

Folate is also important in central nervous system development and cognitive function. The intake of folate in children varies across European countries. While in Finland and Ireland (Kyttälä *et al.*, 2010; Walton *et al.*, 2017), folate intake was within the recommendations, in Germany, folate is considered a critical micronutrient at toddler age (Hilbig *et al.*, 2015); in Greece and Spain, about 20% and 15% of toddlers, respectively, had nutritional inadequacy of folate (Manios *et al.*, 2008; Dalmau *et al.*, 2015).

i) Food Sources

Before 12 months, children can and should participate in the family meals and share some common foods, but in terms of the quantitative distribution of the suppliers of energy and nutrients, this still happens very gradually in the second year of life. Although the recommended consumption of milk and dairy products in this age group should be significantly lower compared to the first year of life (where milk is the preponderant food), its consumption is usually still very high in the second year of life (12-24 months), still occupying the role of the leading supplier of energy and protein for a high proportion of toddlers (Grimes *et al.*, 2015; Huysentruyt *et al.*, 2016; Jomaa *et al.*, 2022; Nasreddine *et al.*, 2022).

From the third year of life onwards, milk loses more and more preponderance, giving place to other foods that are important for growth and development. In other cases, this gradual reduction in energy from milk is replaced by increased consumption of sweets and sweetened beverages, which previously should not exist. An example is what happens in the UAE (Nasreddine *et al.*, 2022) and Lebanon (Jomaa *et al.*, 2022). In these two countries, milk and milk products were the highest energy sources during the second year of life, contributing to more than 35% of the TE. From 24 to 47 months, this percentage decreases to about half or less (Jomaa *et al.*, 2022; Nasreddine *et al.*, 2022), while the energy contribution of other groups is increasing, such as grain and grain products (Nasreddine *et al.*, 2022), and sweets, sweets beverages and desserts (Jomaa *et al.*, 2022; Nasreddine *et al.*, 2022). Data from the US also show that milk is the most significant contributor to energy intake in children aged 12 to 24 months, with a lower prevalence corresponding to 22.4% of TE (Grimes *et al.*, 2015). Belgian data revealed that milk is also the leading energy provider, contributing 25.4% to TE in the second year of life (12-23 months) and, with about 17% in the third year of life (24-36 months) (Huysentruyt *et al.*, 2016), similarly to what was observed in Lebanon and the UAE. This decrease in the contribution of milk to TE between the second and third years of life is also accompanied by an increase in the contribution of cakes and sweets, which rises from 14.1% to 21.3% (Huysentruyt *et al.*, 2016).

In France, milk and dairy products were the primary protein sources up to the age of 2 years and, after this, animal sources occupied the first place, followed by dairy products and cow's milk, showing a gradual decrease in the preponderance of milk, which is being occupied by other foods (Chouraqui *et al.*, 2022). Between the second and third years of life, it is also possible to observe a reduction in the intake of formula and an increase in the intake of cow's milk, which from the age of 12 months is no longer forbidden. In Spain, milk and dairy products contributed more than 30% to the total protein in children aged 1 to 3 years (Madrigal *et al.*, 2021). Grimes *et al.* also found that milk was the primary source of protein in toddlers (12-24 months), corresponding to 32.7% of the total consumption (Grimes *et al.*, 2015). A contribution of less than 25% (24.3% in children with 12-24 months and 21.7% with 25-36 months) was verified in Belgian toddlers (Huysentruyt *et al.*, 2016). In line with Belgian toddlers, dairy products contributed with 21.3% of TE intake in Portuguese children at 4 years old (Lopes *et al.*, 2014).

Milk and dairy products, oils and fats, and meat and meat products were the three primary group sources of fat and different fatty acids in the Nutritional Study in Spanish Paediatric Population (*Estudio Nutricional en Población Infantil Española,* EsNuPI) study, including children from 1 to 9 years old (Madrigal *et al.*, 2020). Grimes *et al.* also showed that milk was the most critical fat source in toddlers (12-24 months), contributing to more than 30% of the TE intake (Grimes *et al.*, 2015). Similarly, in Portugal, meat (20.4%) and dairy products (18.5%) were the main fat food sources in children aged 4 years, and the primary main saturated sources were dairy products (33.4%) and meat (20.7%) (Lopes *et al.*, 2014).

Regarding carbohydrates, the three leading suppliers in Spanish children of the EsNuPI study were cereals (32.2%-27.6%), milk and milk products (14.1%-18.8%), fruits (10.4%-12.5%) and bakery and pastry (9.3%-8.9%) (Samaniego-Vaesken *et al.*, 2020). In Portugal, the Generation XXI results are similar: the primary source of carbohydrates was cereals (34.1%), followed by milk and dairy (18.9%), with the worrying difference in the order of sweets and pastries (14.8%) that come in third place, with fruit (12.5%) coming only after (Lopes *et al.*, 2014).

As noted earlier, the adequacy of fibre intake in toddler years is generally low. The main foods that contribute to fibre intake vary somewhat. US data indicate that fruit was the main contributor, with more than 20%, followed by grain-based mixed dishes, with 8.4% (Grimes *et al.*, 2015). In the UAE, the most important source of fibre were vegetables (16.8% between 12-23.9 months and 13.5% between 24-47.9 months) (Kassis *et al.*, 2022). In Spain, the top sources of fibre in children (1-9 years old) were also fruits, cereals, vegetables, and bakery and pastries (Samaniego-Vaesken *et al.*, 2020). In Portugal, fruit was the main supplier of fibre (29.3%), followed by cereals (27.3%) and vegetables' soup (15.4%), in Portuguese children from Generation XXI (Lopes *et al.*, 2014).

It is well known that consuming too much sugar, especially added sugar, carries several health risks, such as dental caries, diabetes, dyslipidemia, HTA, CVD, OW and other non-communicable diseases (Malik *et al.*, 2013). Furthermore, sugar intake increases the overall energy intake and many times replaces other nutritional foods (Malik *et al.*, 2013, 2019).

As stated by the Panel on Nutrition, Novel Foods and Food Allergens (NDA) of EFSA, the main sources of added and free sugars in European countries are sugar and confectionary (including table sugar, honey, syrups, confectionery and water-based sweet desserts), beverages (sugar-sweetened soft and fruit drinks, fruit juices) and bakery, and also milk and dairy products (EFSA, 2022). Marinho *et al.* showed that in Portuguese children below 5 years, the main food sources of added sugar were yoghurts (16.8%), infant cereals (14.5%) and infant formula (14.0%). On the other hand, the total sugar main sources were milk (15.9%), fruits (15.7%), infant formula (11.9%) and yoghurts (11.1%) (Marinho *et al.*, 2019). In line with these results, in the Portuguese Generation XXI study, dairy (41.2%) and fruits (21.1%) were the total sugar main sources (Lopes *et al.*, 2014). Also, US data (Grimes *et al.*, 2015) revealed that the main sugar source in toddlers (12-24 months) was milk (26.3%), 100% juice (16.6%) and fruits (11.8%). In Spain, intrinsic sugars' main sources were milk and dairy products, fruits, vegetables and cereals (Redruello-Requejo *et al.*, 2022).

Concerning sweets, besides being composed of added sugar, they are also foods that are separate from the dietary recommendations and should not be part of the daily diet. In the case of dairy products, it is not easy to distinguish which ones have only natural sugars present in milk and which have added sugar. This insight is important since this group of foods should be part of children's diets.

That is why distinguishing between intrinsic sugars, which include naturally occurring sugars, and extrinsic or added sugars is essential. Regulation on Food Labelling 1169/2011 adopted in European countries does not require quantifying and declaring added sugars on labels, where information is given on the total sugars present only. The specific information about added sugars would be great and helpful to parents and educators when making food choices, allowing more awareness about this critical difference.

Regarding iron, in the UAE, the main food sources in the first years of life were infant/young child formula and baby cereals (Kassis *et al.*, 2022), in line with results from the US, where ready-to-eat cereals and baby food occupied the first places (Grimes *et al.*, 2015). Meat is also an iron-rich food that must be present in the daily diet, but still needs to play a more preponderant role at this age.

Vitamin D is synthesised in the skin in response to sun exposure, which is the main source of vitamin D (Saggese *et al.*, 2018). Foods have a reduced contribution in meeting the recommendations of vitamin D. In Portugal, the main food sources of vitamin D are dairy products, with almost 50% of the contribution (Lopes *et al.*, 2014). Most milk in European countries (with few exceptions, such as Finland) is not fortified with vitamin D, as in the US. This emphasises the crucial role of supplementation, especially for risk groups at any age when sun exposure is reduced and during the fall and winter months. Furthermore, sun exposure until 2 years of age is not recommended and, after that, the recommended use of sunscreens blocks the synthesis of vitamin D. ESPGHAN guidelines in Europe recommend the supplementation with 400 UI daily in infants, and beyond 1 year for children at risk (ESPGHAN, 2013).

Around the world, many infants and young children have sodium intakes at or above the recommended limit (Pereira-da-Silva *et al.*, 2016; Jun *et al.*, 2018; Verduci *et al.*, 2019; Weker *et al.*, 2019). One-third of Australian toddlers (12-24 months) exceeded the upper limit for sodium (Moumin *et al.*, 2022). One third (36.0%) of Lebanon's toddlers (12-23.9 months) and 68.0% of Lebanon's young children (24-47.9 months) exceeded the Chronic Disease Risk Reduction Intake (CDRR) (Jomaa *et al.*, 2022). The committee established CDRR in the last review of the DRI for sodium and potassium (DRI, 2019), but there was insufficient evidence to establish a UL. Although the CDRR value is more permissive (higher) than the already established AI value, there was still a high prevalence of children exceeding that limit, thus putting them at greater risk of chronic disease. Excessive sodium intake is associated with hypertension and cardiovascular diseases in the future (Rust and Ekmekcioglu, 2017). The main food source of salt in Portuguese children aged 4 years old (Lopes *et al.*, 2014) was vegetable soup (33%), followed by dairy products (15.0%), cereals and tubers (14.0%), and food-added salt (9.5%).

iii) Objectives of the Thesis

This work was based on data from EPACI Portugal 2012 study and aims to assess the growth pattern, nutritional status and feeding patterns of children aged 12-36 months living in mainland Portugal.

The specific objectives of this thesis are:

a) to estimate the prevalence of total and exclusive breastfeeding in Portugal, considering the geographical asymmetries;

b) to characterise complementary feeding and feeding practices in the first years of life in Portuguese infants and toddlers, associating them with their nutritional status;

c) to identify the main food sources of the principal nutrients, as well as nutritional deficits or excesses and vitamins and minerals' supplementation in Portuguese toddlers;

d) to characterise the nutritional status and growth pattern in the first 36 months of life in Portuguese children and its association with parental BMI;

e) to propose dietary recommendations adapted to the Portuguese population's reality.

For purposes of achieving the abovementioned objectives, the following scientific papers were elaborated:

1. *Recomendações Nutricionais em Idade Pedriátrica: O Estado da Arte* [Nutritional Recommendations for Paediatric Ages: State of the Art] (paper in Portuguese). *Acta Portuguesa de Nutrição*. 2016. DOI: 10.21011/apn.2016.0705 (published);
2. Prevalence of Nutritional Inadequacy in Children Aged 12-36 months: EPACI Portugal 2012. *Nutrition Bulletin*. 2023. DOI: 10.1111/nbu.12603 (published);
3. *Suplementação Vitamínica e Mineral em Portugal Durante o Primeiro Ano de Vida: Resultados do EPACI Portugal 2012* [Vitamin and Mineral Supplementation in Portugal During the First Year of Life: Results from EPACI Portugal 2012]. *Acta Pediátrica Portuguesa. 2016. DOI:* 10.25754/pjp.2016.6778 (paper in Portuguese) (published);
4. Early Feeding and Nutritional Status of Portuguese Children in the First 36 Months of Life: EPACI Portugal 2012 (submitted);
5. Association Between Parental and Offspring's BMI: Results from EPACI Portugal 2012. *Public Health Nutrition*. 2021. DOI: 10.1017/S1368980021001543 (published).

iv) Thesis Outline

a) **To estimate the prevalence of total and exclusive breastfeeding in Portugal, considering the geographical asymmetries** (paper 4);

b) **to characterise complementary feeding and feeding practices in the first years of life in Portuguese infants and toddlers, associating them with their nutritional status** (paper 4).

The prevalence of total and exclusive breastfeeding at the national level and by region and the determinants of exclusive breastfeeding were assessed. The timing of complementary feeding introduction, the first food introduced (vegetables' soup, cereal-based foods, or fruit puree) for total and by region, and information related to the person who advised about complementary feeding were collected. Other pieces of information about feeding practices in the early years, notably the different types and timings of infant formulas and other kinds of milk consumption (such as cow milk), as well as the median age for introduction of different foods in the first months of life, and the proportion of children who already consumed these foods, were collected. The association between the duration of breastfeeding or the timing of complementary feeding and zBMI in children was tested. The results were submitted to a national peer-reviewed journal, *Acta Médica Portuguesa*, in a paper entitled: "Early Feeding and Nutritional Status of Portuguese Children in the First 36 Months of Life: EPACI Portugal 2012" (paper 4) and is awaiting approval for publication.

c) **To identify the main food sources of the principal nutrients, as well as nutritional deficits or excesses and vitamins and minerals' supplementation in Portuguese toddlers** (papers 1, 2 and 3).

To meet this objective, it was first necessary to carry out a literature review on the nutritional intake of children and adolescents, to select the most used nutritional recommendations. Recommendations from three international organisations were selected: the FNB/IOM recommendations, FAO/WHO recommendations and EFSA/EC recommendations. Subsequently, these recommendations were systematised, compared and assessed. This systematisation and comparison allowed to determine which recommendations best fit the Portuguese reality. They thus also aimed to contribute to propose nutritional recommendations for the Portuguese paediatric population, since Portugal does not have recommendations exclusively developed for its population.

The results of this review were published in a national peer-reviewed journal, *Acta Portuguesa de Nutrição*, the paper being entitled "*Recomendações Nutricionais em Idade Pedriátrica: O Estado da Arte*" [Nutritional Recommendations for Paediatric Ages: State of the Art] (paper 1), available at: http://actaportuguesadenutricao.pt/wp-content/uploads/2017/02/n7a05.pdf.

To describe the current food pattern, the median intake and the main food sources of energy, macronutrients (protein, carbohydrates, fibre and fat) and sugar, and some micronutrients (vitamins A, B_1, B_2, B_6, B_{12}, C, D, folate, calcium, iron, magnesium, phosphorus, potassium and sodium) in Portuguese toddlers were determined. The prevalence of nutritional inadequacy was also evaluated, by comparing the assessed intake with the EFSA nutritional recommendation values for these ages. The results of this work were published in an international peer-reviewed journal, Nutrition Bulletin, the paper being entitled "Prevalence of nutritional inadequacy in children aged 12-36 months: EPACI Portugal 2012" (paper 2), available at: https://pubmed.ncbi.nlm.nih.gov/36722373/.

Finally, using the information collected on vitamin and mineral supplementation, the Portuguese scenario was characterised and the association with socio-demographic and health factors was quantified. The results were published as a paper in a national and peer-reviewed journal, *Acta Pediátrica Portuguesa*, the paper being intitled "*Suplementação Vitamínica e Mineral em Portugal Durante o Primeiro Ano de Vida: Resultados do EPACI Portugal 2012*" [Vitamin and Mineral Supplementation in Portugal During the First Year of Life: Results from EPACI Portugal 2012] (paper 3), available at https://repositorio.ucp.pt/bitstream/10400.14/22976/1/Suplementa%C3%A7%C3%A3o%20Vitam%C3%ADnica.pdf.

d) **To characterise the nutritional status and growth pattern in the first 36 months of life in Portuguese children and its association with parental BMI** (papers 4 and 5).

Anthropometrics data of children were obtained from the Child and Youth Health Bulletins (from birth to the interview). The zBMI was calculated and the nutritional characterisation, in five categories (underweight, normal weight, OW risk, OW and obese), was made. Parents' nutritional status (BMI) at the evaluation time was also calculated based on reported data. The longitudinal association between weight gain during pregnancy and the nutritional status of children in the first two years of life, and between parents' BMI and children's nutritional status (zBMI) since birth, were also assessed. These results were published in an international peer-reviewed journal, Public Health Nutrition, in a paper entitled: "Association Between Parental and Offspring's BMI: Results from EPACI Portugal 2012" (paper 5), available at: https://pubmed.ncbi.nlm.nih.gov/33843556/.

The characterisation of the nutritional status of toddlers at the evaluation was also made. These findings were submitted to a national peer-reviewed journal, *Acta Médica Portuguesa*, in the above referred paper "Early Feeding and Nutritional Status of Portuguese Children in the First 36 Months of Life: EPACI Portugal 2012" (paper 4).

e) To propose dietary recommendations adapted to the Portuguese population's reality.

To meet this objective, I have contributed to drafting a handbook entitled: "*Alimentação Saudável dos 0 aos 6 anos – Linhas de Orientação para Profissionais e Educadores*" ["Healthy Eating from 0 to 6 years – Guidelines for Professionals and Educators"], available at https://alimentacaosaudavel.dgs.pt/alimentacao-saudavel-dos-0-aos-6-anos/. This manual was based on the literature review, the knowledge acquired from this project and expert opinions. It aimed to promote healthy eating behaviours and habits for infants and children up to 6 years of age in order to promote a healthy growth and development. This manual was published and edited by the DGS under the National Programme for the Promotion of Healthy Eating and prepared by a group of professionals from health and education, led by paediatrician Prof. Doutora Carla Rêgo.

II. METHODOLOGY

EPACI Portugal 2012 is a cross-sectional and retrospective, nationally representative study, for which a sample of toddlers aged between 12 and 36 months was recruited. The study took place between May 2012 and July 2013.

The objectives of the EPACI Portugal 2012 study were to characterise the growth pattern, the nutritional status and the feeding patterns of the Portuguese infants and toddlers in mainland Portugal, setting a basis to propose scientific support for the development of national dietary recommendations, in a sensitive and determinant age for their future health and of the subsequent generations.

EPACI Portugal 2012 was a project designed by a team of researchers of the Faculty of Medicine of Porto University – Health Technologies and Services Research Centre (*Centro de Investigação em Tecnologias e Serviços de Saúde*, CINTESIS), the Faculty of Nutrition and Food Sciences of Porto University and the Faculty of Biotechnology of the Catholic University of Portugal, where it had its setting. The implementation of the project occurred with the collaboration of the Regional Health Administration (*Administração Regional de Saúde*, ARS), the 128 Health Units involved, the children and the respective caregivers. It was carried out by a coordination team and 28 autonomous and trained interviewers. The project included a training and information component in the form of a leaflet, aimed at health professionals and caregivers (Appendix 1).

Milupa/Danone® financed the project EPACI Portugal 2012, but had no influence on the design of the study, its application in the field, the analysis of results or the conclusions. The study was scientifically sponsored by these two Faculties (the Faculty of Medicine of Porto University – CINTESIS and the Faculty of Biotechnology of the Catholic University of Portugal) and was considered of relevant national interest by the DGS, the Portuguese Paediatric Society (*Sociedade Portuguesa de Pediatria*, SPP), the Portuguese Society for the Study of Obesity (*Sociedade Portugesa para o Estudo da Obesidade*, SPEO), and by the Portuguese Nutrition Association (*Associação Portuguesa de Nutrição*, APN).

The EPACI Portugal 2012 study was approved by the Ethic Committee of the Catholic University of Portugal (Ethics Screening Report 02/12), the Ethic Committee of the five ARS, and the National Committee of Data Protection.

i) Sample Selection

According to data from the National Institute of Statistics, about 200.000 children were born in Portugal in 2009 and 2010 (considering around 100,000 children per year). Thus, a representative sample of about 2,500 was defined as a target, corresponding to 1% of the children aged 12-36 months, plus estimating a possible non-response of around 25%. Afterwards, the sample was stratified by regions – NUTS II, a Nomenclature of Statistical Territorial Units, which divides Portugal's mainland into five areas –, to maintain the proportions of births in each of them. At an early stage, a list of all the health units (including all types: health centres, extensions, and family health units) was elaborated by consulting the health portal data. Following this, the list was divided into five sub-lists, according to the correspondence of health units with the respective NUTS II region. After acquiring the number of births per region, according to data from the National Institute of Statistics, (http://www.ine.pt), the number of children to be selected was proportionally calculated. It also added the extra corresponding to the probability of refusals to obtain the correspondent health units to be assessed in each NUTS II.

Finally, 128 health units were randomly selected at http://www.random.org/integer-sets/, according to the regions and the number of toddlers defined. Since the national vaccination plan in Portugal is applied only on public health care, the sample was based on primary health care registries.

In the meantime, and since the project had the scientific sponsorship of the DGS, the five ARS's administrations were contacted by the DGS, recommending the participation in this project of national interest. Subsequently, the Presidents of each ARS were also contacted and approached by the coordination team of EPACI Portugal 2012, informing the respective selected health units under their jurisdiction, asking them to inform their units of the importance of collaboration in this study and to elect a person to serve as interlocutor in the implementation of the field project. In parallel, all the selected health units were contacted via e-mail with the presentation of the project and were asked to initiate the process of obtaining the children's contacts.

Afterwards, the ARS indicated the person we should contact in each health unit (the director, or doctor, nurse or administrative). In some cases, when no linking element was indicated, the contact was made directly with the health unit director by call. In all cases, the responsible person in each health unit was contacted and invited to participate in the study.

Once the invitation had been accepted, the list of children inscribed in the health unit aged between 12 and 36 months was requested. A day was also scheduled to convene the children and their caregivers for the interview and evaluation. In addition, we asked for a suitable space to be made available for the interviews, a place to set down the scales, and a marquee to measure the children's length. All the logistics, including the contacts with all caregivers, the interviewers and the supply of all the material to assess the anthropometric measurements and collect the necessary information for the study were arranged by the EPACI Portugal 2012 coordination team.

In each health unit, 25 toddlers were randomly selected. Subsequently, their parents or caregivers were contacted by telephone and invited to participate on the day scheduled in the respective health unit. When the invitation was accepted, an interview was scheduled, according to the parents' availability. Whenever it was not possible to schedule with the first 25 selected children (due to the impossibility of attending on the stipulated date, or not fulfilling the inclusion criteria, or even not wishing to participate in the study, or for the impossibility of contact, due to incorrect numbers or missed calls – at least four attempts on different days and different day times), other children were selected, considering only those children who had not been selected the first time, until a total of 25 children was reached. However, less than 25 eligible children of that age group were registered in some health units. Sixty-four percent of the children's caregivers agreed to schedule the assessment and, of these, 72% of the children were effectively assessed.

All caregivers of the selected children were first contacted by telephone; the project and required procedures were brief and carefully presented and, once the invitation had been accepted, they received a formal written invitation by e-mail (requested during the telephone call) with the date and time of the evaluation in the respective health unit. The invitation by email also contained the research objectives, and the description of its voluntary nature was clearly stated. Caregivers were also informed on the first contact that the child's assessment would last approximately 20 minutes. In each health unit, all selected children were evaluated on the same day and during the whole day.

Moreover, parents were asked to bring on the assessment day their child's health bulletin, as well as the mother's pregnancy health bulletin (if possible), corresponding to the selected child, and it was requested that the child's caregivers should be someone who knew his living habits well and could answer the questions asked in the protocol. Before starting the assessment, each child's participation was formalised through the signature in duplicate of informed consent by the attendant of each child and the interviewers.

Informed consents respect the rules of conduct expressed in the “Helsinki Declaration” of the World Medical Association (Helsinki 1964; Tokyo 1975; Venice 1983, Hong Kong 1989, Somerset West 1996, Edinburgh 2000) and the national law in force at the time of the study implementation.

The confidentiality of all data obtained from the participants has been ensured with the utmost security, under Law no. 67/98, of 26 October (Law on the Protection of Personal Data). The National Data Protection Commission has approved all consent statements and questionnaires. Each child in the study was assigned an ID number, and only a very restrict group of researchers had access to the link between the personal data and their ID. This link was never made during the data analysis.

The exclusion criteria for participation in the study was any pathology that affected the children’s growth and development, such as the existence of congenital malformation syndromes (including severe cardiac malformation, osteoarticular disease, and syndromic disease, among others), as well as some chronic diseases. In cases where this condition was not known during the telephone appointment, the child was assessed on the day of the interview for non-discrimination, but the child’s data were not included in the study.

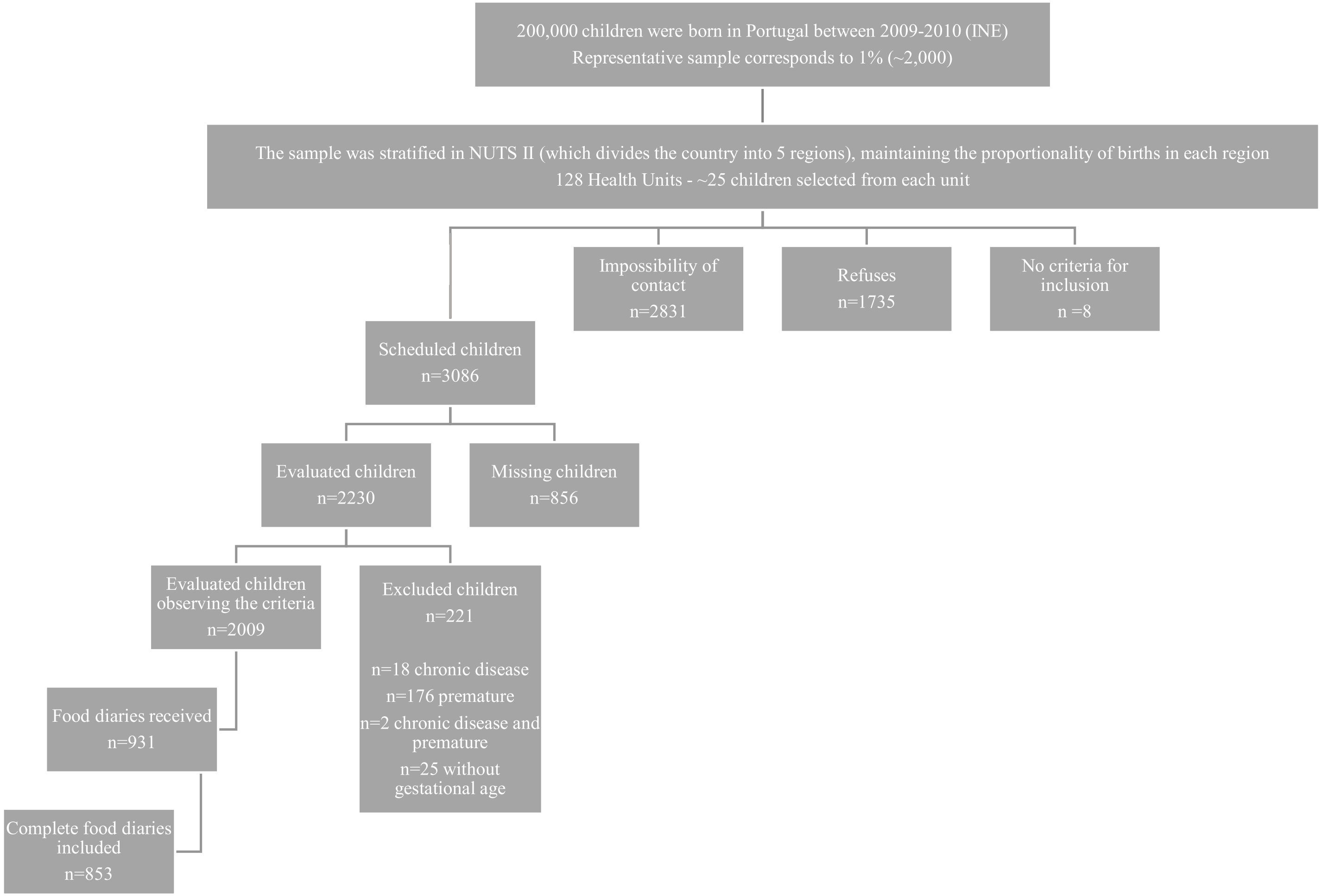

Fig. 3. Flowchart of participants in the EPACI Portugal 2012.

ii) Data collection

The data were collected in a face-to-face interview through a computer assisted structured protocol applied to the children's caregivers by trained interviewers, all of which nutritionists (Appendix 2). A procedures manual was created and presented to all interviewers to standardise practices and minimise errors in the data collection. Each interviewer had an identification code. This manual was tested, corrected, and constantly updated, whenever necessary. In addition, the contact telephone numbers of the coordination team were available to the interviewers for any clarification.

The questionnaire included firstly the collection of personal data (including who was the person accompanying the child and answering the questionnaire), data on the socio-economic characteristics of the parents, including parental age, marital status, number of schooling years, academic degree and occupational situation, monthly family income, number of children (<18 years old) in the household, and about child care, as well as the nutritional status of the parents (height and weight) at the evaluation time, the maternal weight gain during pregnancy and the weight before pregnancy. The height and weight of the mother (also before pregnancy) and the father were self-reported. The BMI of the mother (in the pre-pregnancy period) and of the mother and father at the evaluation time was calculated by dividing the weight (g) by the squared height (cm). Then, the respective nutritional status was classified using the WHO standard (de Onis M, Garza C, 2006).

The second part of the survey included questions about the child's health history (including health problems that implied chronic treatment, emergencies, hospital admissions and routine childcare).

The third part of the questionnaire included questions about the child's diet and supplementation (which contained questions about the duration of exclusive and partial breastfeeding, the types of infant formulas consumed (formula 1, 2, 3, growth and soy), and/or milk (whole and semi-skimmed cow milk), or other, taken at different ages, the person who advised the child about complementary feeding, the beginning age of complementary feeding and first food introduced, the current consumption of different types of foods, through a food frequency questionnaire (FFQ), number of daily meals, vitamin and mineral supplements taken, and number of hours of sleep at night and during the day).

The FFQ comprised 15 food items (infant cereals, breakfast cereals, yoghurts, meat, fish, vegetables on the plate, vegetables on soup, fresh fruit, puree fruit, sweets and desserts, natural fruit juices, nectars, and soft drinks, with and without gas) and seven categories of intake frequency (from ≥ 3/day to never). The onset age of consumption for each item was also collected. The questionnaire about vitamin and mineral supplementation included questions specifically about the use and number of iron drops, vitamin D, vitamin C, fluoride, multivitamins, and others that might have been utilised.

The last section, called Anthropometry, included information regarding the child's gender, anthropometric data from birth and the parents' perception regarding the weight for height of the child and gestational age, if possible, with confirmation through the pregnant health bulletin.

The anthropometric data, weight (g), length/height (cm) and head circumference (cm) at birth, 2, 4, 6, 9, 12, 18 and 24 months (according to the child's current age and the available measures) was collected from the Child and Youth Health Bulletins, where anthropometrics and health vigilance of the Portuguese children must be registered at each health appointment. These were the time points considered, since they correspond to those recommended by the National Health System regarding child health monitoring. Only in some cases the registries overlapped exactly with these ages. In order to define the time frame considered for each time point and subsequent characterisation of the nutritional status, intervals of 15 days for the measurement at 2 months, 30 days for the 4 and 6 months, 45 days for the 9 and 12 months, and 60 days for the 18- and 24-months measurement were considered.

Moreover, the child's assessment at the evaluation time occurred on the same day as the questionnaire's application by the trained interviewers with standardised techniques. The assessment on the evaluation day implied the measurement of weight (g), length/height (cm), head circumference (cm) and waist circumference (cm) of each toddler.

After evaluation of the anthropometric parameters referred to above, the BMI of each child was calculated, expressed in z-score, zBMI and WHO criteria (WHO, 2000) were used to classify the nutritional status. The WHO classification divides toddlers into five nutritional status classes: underweight (UW) (zBMI < -2); normal weight (zBMI ≥ -2 and ≤ 1); OW risk (zBMI > 1 and ≤ 2); OW (zBMI > 2 and ≤ 3) and OB (zBMI > 3).

The 3-day food diary, which included data collection of two weekdays and one weekend day, was given at the end of the interview, to be filled in by the responsible for each child (Appendix 3). When the child was not with the same person all day, the other people who supervised the child's meal (educator, grandparents, relatives, or other people present) also obtained the information for filling. Each child's respondent was instructed to read the written instructions and to register the intake of all foods and beverages on these three days, including detailed information about each food item, the consumed quantity and the place and time of consumption, the ingredients, cooking methods and recipes' details in prepared dishes. The interviewers clarified this procedure of filling the 3-day food diaries and its subsequent return by a postage-paid envelope (provided at the assessment).

After the face-to-face data collection, some telephone calls were made by trained nutritionists to complete any information that had not been possible to obtain in some interviews (when the respondent was not the child's closest person, and so did not know some answers, and/or when respondents did not have the child's health bulletin and/or pregnant bulletin, among others).

Each child's information was stored in Microsoft Office Access databases, each database created corresponding to each health unit. After the conclusion of the assessments in all health units, all the information was gathered in a single database, and database correction and uniformization was performed in SPSS (Statistical Package for the Social Science). This single database was thoroughly cleaned, checked, and reviewed to minimise possible inconsistencies and errors in the data collection.

After reception by post of the 3-day food dairies, its codification was also carried out by a team of trained nutritionists. The food was converted into nutrients through the software Food Processor® SQL (ESHA Research, Salem, Oregon), based on the Food Composition Table of the US Department of Agriculture. The database has been adapted and the choice of food items was carefully compared with the Portuguese databases by researchers from the Institute of Public Health and Faculty of Medicine of the University of Porto and with the inclusion of nutritional information of typical Portuguese foods and recipes, where required.

iii) Statistical analysis

The statistical analysis was made through SPSS ® for Windows®, Statistical Program to Assess Dietary Exposure (SPADE) and the R package nlme. The details regarding the analysis that gave rise to each paper are detailed in the respective section thereof.

III. Scientific Papers

Paper 1

***Recomendações Nutricionais em Idade Pedriátrica: O Estado da Arte* [Nutritional Recommendations for Paediatric Ages: State of the Art] (paper in Portuguese).**

In this work, I was responsible for the literature review, systematisation, and comparison of nutritional recommendations, as well as the interpretation of results and writing the first draft of the manuscript.

ACTA
PORTUGUESA
DE NUTRIÇÃO

Associação Portuguesa dos Nutricionistas

RECOMENDAÇÕES NUTRICIONAIS EM IDADE PEDIÁTRICA: O ESTADO DA ARTE

NUTRITIONAL RECOMMENDATIONS FOR PAEDIATRIC AGES: STATE OF THE ART

A.R.
ARTIGO DE REVISÃO

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RESUMO

INTRODUÇÃO: A alimentação diária deve suprir as necessidades nutricionais e a sua adequação é fundamental para um crescimento e desenvolvimento saudáveis ao longo da infância e da adolescência. Não existem recomendações nutricionais portuguesas e na ausência destas, não há um consenso relativamente às recomendações que deverão ser utilizadas em Portugal.

OBJETIVOS: Sistematizar e comparar as recomendações nutricionais na infância e na adolescência (0-18 anos) e contribuir para a adoção de recomendações a utilizar para a população pediátrica portuguesa.

METODOLOGIA: Selecionaram-se as recomendações mais utilizadas para crianças e adolescentes, tendo por base uma revisão das publicações na base PubMed® nos últimos 10 anos: as do Food and Nutrition Board / Institute of Medicine, National Academies (EUA/Canadá), as da Organização das Nações Unidas para a Alimentação e a Agricultura / Organização Mundial da Saúde (Mundiais) e as da Autoridade Europeia para a Segurança Alimentar / Comissão Europeia (Europeias). Posteriormente, analisaram-se todos os documentos existentes relativos a estas recomendações nutricionais.

RESULTADOS: Os três Comités considerados apresentam critérios diferentes, nomeadamente na estratificação por idade que fazem, para apresentar as recomendações e na terminologia utilizada. As recomendações da Autoridade Europeia para a Segurança Alimentar / Comissão Europeia destinam-se à população europeia e têm por base uma metodologia sólida, incluindo recomendações dos outros dois Comités analisados, sendo também as mais recentes, no entanto as recomendações da Food and Nutrition Board / Institute of Medicine, National Academies são as mais utilizadas. Os valores recomendados para energia, proteína e lípidos não apresentam grandes variações entre Comités. Relativamente aos hidratos de carbono, as recomendações da Organização das Nações Unidas para a Alimentação e a Agricultura / Organização Mundial da Saúde são as mais elevadas. No que diz respeito às vitaminas e minerais, de uma forma geral, as recomendações para a vitamina B1, ácido pantoténico, cálcio, selénio, zinco e iodo são semelhantes para os três Comités, apresentando algumas variações para as restantes vitaminas e minerais.

CONCLUSÕES: A adoção oficial de recomendações nutricionais para a população portuguesa é importante e urgente, para permitir a uniformização de critérios e comparar resultados. A solidez metodológica e a atualidade das recomendações da Autoridade Europeia para a Segurança Alimentar / Comissão Europeia levam os autores a considerá-las uma opção a recomendar.

PALAVRAS-CHAVE
Adolescentes, Crianças, Recomendações nutricionais

ABSTRACT

INTRODUCTION: Dietary intake must supply nutritional requirements and its adequacy is crucial for a healthy growth and development during infancy and adolescence. There are no Portuguese nutritional guidelines and, consequently, there is no consensus about what should be used in Portugal.

OBJECTIVES: To systematize and to compare the nutritional guidelines for childhood and adolescence (0-18 years) and to contribute for the adoption of guidelines to be used among Portuguese paediatric population.

METHODOLOGY: The most used in children and adolescence, based on a PubMed® search of studies published in the last 10 years, were selected: those from the Food and Nutrition Board / Institute of Medicine, National Academies (USA/Canada), from the Food and Agriculture Organization of the United Nations / World Health Organization (Worldwide) and from the European Food Safety Authority / European Commission (European). Subsequently, all documents concerning these nutritional guidelines were assessed.

RESULTS: The three considered committees provide different criteria, namely in the age stratification that they use for presenting the respective guidelines and in the used terminology. The European Food Safety Authority / European Commission guidelines are targeted for European population and are based on a solid methodology, comprising guidelines of the other two committees, being also the most recent, whereas the Food and Nutrition Board / Institute of Medicine, National Academies guidelines are the most used. The recommendations for energy, protein and lipids do not evidence significant variations between committees. Concerning carbohydrates, the Food and Agriculture Organization of the United Nations / World Health Organization recommendations are the highest. With regard to vitamins and minerals, in general the recommendations for vitamin B1, pantothenic acid, calcium, selenium, zinc and iodine are similar between the three committees, but they showed some variations for the remaining vitamins and minerals.

CONCLUSIONS: The official adoption of nutritional recommendations for the Portuguese population is important and urgent, and would allow to uniform criteria and to compare results. The methodological consistency and the up-to-date of the European Food Safety Authority / European Commissionrecommendations lead the authors to consider them as an option to recommend.

KEYWORDS
Adolescents, Children, Nutritional recommendations

INTRODUÇÃO

A alimentação e a nutrição na infância e adolescência são fundamentais para um crescimento e desenvolvimento saudáveis e determinam o estado de saúde atual e futuro (1-3).

As necessidades nutricionais, por definição, representam a quantidade de energia e de nutrientes necessários para assegurar as funções orgânicas, a saúde e a correta nutrição, garantindo um adequado crescimento e desenvolvimento, bem como a prevenção de doenças crónicas (4-6). As necessidades nutricionais variam de indivíduo para indivíduo e ao longo da vida. Assim, as recomendações nutricionais correspondem à quantidade de nutrientes e energia estimados para cobrir as necessidades da maior parte dos indivíduos saudáveis da população (7-8).

Uma criança/adolescente deve praticar uma alimentação saudável, equilibrada, variada e completa (9), capaz de suprir as suas necessidades nutricionais. Neste período particular do ciclo de vida, estas variam em função da idade e, em algumas idades, também do sexo, na dependência dos seus padrões de crescimento (10). A adequação nutricional é avaliada tendo por base a comparação da ingestão nutricional de um indivíduo com as respetivas recomendações (11).

Existem recomendações nutricionais para as diferentes faixas etárias emanadas por organismos internacionais, tais como a Organização das Nações Unidas para a Alimentação e a Agricultura, a Organização Mundial da Saúde (FAO/OMS) e a Autoridade Europeia para a Segurança Alimentar (EFSA). Alguns países [Estados Unidos da América (EUA) e Canadá, Alemanha-Áustria-Suíça (D-A-CH), Países Nórdicos, entre outros] têm recomendações pretensamente mais adaptadas à sua população, elaboradas por Comités independentes. No que respeita a Portugal, não existem recomendações específicas para o país. As *Dietary Reference Intake* (DRI) (12), adotadas pelos EUA e Canadá, são as mais frequentemente utilizadas (13-17), muito embora as da FAO/OMS tenham servido de base, por exemplo, para a avaliação da adequação alimentar na população portuguesa (17), bem como para suportar o desenvolvimento de alimentos infantis, por parte da indústria alimentar (18).

A preocupação relativamente à necessidade da existência de recomendações que permitam avaliar a adequação nutricional de um indivíduo ou de uma população, data da primeira metade do século XX. Efetivamente, desde a década de 50, a FAO/OMS realiza reuniões de peritos, com uma regularidade variável e com o objetivo de fornecer orientações atualizadas sobre a ingestão recomendada e as necessidades dos diferentes nutrientes, a países desenvolvidos e em desenvolvimento. A informação reporta às recomendações em energia, macro e micronutrientes (19).

Também a Comissão Europeia (CE) disponibiliza recomendações para a Europa, sendo o último documento datado de 1993 (20). Num exercício de atualização das recomendações existentes, e visando a uniformização de critérios (10, 21), a EFSA, a pedido da CE, solicitou ao seu Painel dos produtos dietéticos, nutrição e alergias (DNA) que estabelecesse recomendações nutricionais (*Dietary Reference Values*) (DRV) (22-44) para macro e micronutrientes, energia e água para a população Europeia. No momento da presente revisão estavam disponíveis recomendações relativas a todos os macronutrientes, a 18 micronutrientes, à energia e à água, prevendo-se para breve as recomendações para os restantes (45). No que diz respeito aos micronutrientes, a EFSA, no sentido de otimizar os recursos, teve por base o trabalho desenvolvido pela *EURopean micronutrient RECommendations Aligned* (EURRECA) (46), que foi financiada pela União Europeia e cujo objetivo foi sistematizar as diferentes recomendações de micronutrientes disponíveis (47).

Finalmente, as DRI adotadas pelos EUA e Canadá foram desenvolvidas pelo *Food and Nutrition Board* (FNB) do *Institute of Medicine*, *National Academies* (IOM) e são atualizadas pelo *United States Department of Agriculture* (USDA) e pelo *Department of Health and Human Services* (HHS) a cada cinco anos, sendo que no momento da presente revisão as de 2015 aguardavam ainda publicação.

As recomendações das três entidades supracitadas (FNB/IOM, FAO/OMS e EFSA/CE) não são completamente sobreponíveis e, muito embora nos últimos anos tenha havido um esforço por parte da EFSA/CE, de uniformização de terminologias (10), de conceitos e de valores, a comunidade científica ainda não é unânime em relação às recomendações a adotar, nomeadamente no nosso país.

Posto isto, torna-se fácil entender que a diversidade de recomendações disponíveis para a idade pediátrica leva à dificuldade na escolha da referência a utilizar quando se pretende caracterizar a ingestão alimentar de crianças/adolescentes, bem como impossibilita comparações entre diferentes estudos.

OBJETIVOS

Foram objetivos deste estudo, sistematizar e comparar as recomendações nutricionais na infância e na adolescência (0-18 anos), propostas por três entidades internacionais e contribuir para a adoção de recomendações a utilizar para a população pediátrica portuguesa.

METODOLOGIA

O trabalho iniciou-se com uma revisão bibliográfica acerca da ingestão nutricional de crianças e adolescentes, com base em trabalhos indexados na Pubmed®, publicados em língua inglesa e portuguesa. Esta revisão teve como objetivo averiguar quais as recomendações nutricionais mais frequentemente utilizadas. Para esta revisão foram utilizadas as seguintes palavras-chave: [(nutritional adequacy) AND (infant OR children OR adolescent)], restringindo a pesquisa aos trabalhos publicados nos últimos 10 anos.

Desta forma, selecionaram-se as recomendações mais utilizadas para crianças e adolescentes, com potencial interesse para a população portuguesa e que se apresentam de seguida: as do FNB/IOM (EUA/Canadá), as da FAO/OMS (Mundiais) e as da EFSA/CE (Europeias). Posteriormente, acedeu-se às páginas eletrónicas oficiais de cada um dos Comités supracitados onde se pesquisaram todos os documentos existentes relativos a recomendações nutricionais, disponíveis até 1 de setembro de 2015. Nos casos em que a informação era omissa ou ambígua, as respetivas entidades foram contactadas para se obterem esclarecimentos.

Os três Comités considerados apresentam recomendações diferentes, sendo logo à partida diferentes na estratificação por idade. Efetivamente o FNB/IOM, que apresenta documentos (publicados entre 1997 e 2011) (48-54), utiliza como pontos de corte para a idade: 0-6 meses; 6-12 meses; 1-3 anos; 4-8 anos; 9-13 anos e 14 - 18 anos, estes dois últimos intervalos divididos ainda por sexo.

Já a FAO/OMS, para cada documento independente publicado em diferentes anos, (2003 – hidratos de carbono (55); 2004 – energia (5); 2004 – micronutrientes (56); 2007 – proteínas (57) e 2010 – lípidos (58)), apresenta diferentes pontos de corte. Atendendo à disparidade observada entre eles, no presente artigo assumiu-se os pontos de corte para a idade utilizados para os micronutrientes, a saber: 0-6 meses; 7-12 meses; 1-3 anos; 4-6 anos; 7-9 anos; 10-18 anos, este último intervalo de idades dividido ainda por sexo. Importa referir que, relativamente à proteína, se registam algumas especificidades, nomeadamente diferentes pontos de corte em função do sexo, na adolescência (11-14 anos; 15-18 anos). Como exceção aos pontos de corte referidos, temos o caso do ferro, do iodo e do zinco, onde são apresentados intervalos de idades diferentes.

Na última reunião do Comité (2004), relativamente aos micronutrientes, não foram abordados os seguintes minerais: fluor, molibdénio, cobre e crómio. Finalmente, as recomendações da EFSA/CE apresentadas no presente trabalho basearam-se nas mais recentemente emitidas pelo Painel DNA da EFSA, publicadas entre 2010 e 2015 (22-44). Como referido anteriormente, ainda não foram publicados por este painel os documentos relativos a todos os micronutrientes, pelo que em casos omissos foi utilizado o documento da CE de 1993 (20). Os valores que tiveram por base este último documento estão apresentados em itálico nas diferentes tabelas. Os pontos de corte utilizados para a idade são: 0-6 meses; 7-11 meses; 1-3 anos; 4-6 anos; 7-10 anos; 11-14 anos e 15-17 anos, com exceção para a vitamina E (39) e magnésio (42). Estas recomendações consideram que para lactentes até aos seis meses de idade, se considera que as necessidades são totalmente supridas pela ingestão de leite materno (59), à exceção das vitaminas D e K (10, 56), esta última considerando apenas as primeiras semanas de vida. Por convenção, os autores decidiram adotar os pontos de corte para a idade propostos pela EFSA, para análise e comparação das recomendações propostas pelos vários Comités (Tabelas 1, 2, 3 e 4). Assim, e no que diz respeito às recomendações para energia (5, 43, 52) cada Comité apresenta-as por ano de idade, sendo que para cada intervalo de idade considerado foi feita a média, com base nos pontos de corte utilizados como referência para os nutrientes, para cada Comité (Tabela 1). Neste âmbito em particular, importa ter em consideração o dispêndio energético inerente ao nível de atividade física (PAL).

Tabela 1

Recomendações para a energia para o *Food and Nutrition Board* (FNB) / *Institute of Medicine*, *National Academies* (IOM), Organização das Nações Unidas para a Alimentação e a Agricultura (FAO) / Organização Mundial da Saúde (OMS) e Autoridade Europeia para a Segurança Alimentar (EFSA) / Comissão Europeia (CE)

	97,5%			50%		
	RDA	RNI	PRI	EAR	EAR	AR
Energia				(Kcal/d)	(Kcal/d)	(Kcal/d)
0-6 M	n.d	n.d	n.d	♂ - 1M: 472; 2M: 567;3M: 572; 4M: 548; 5M: 596; 6M: 645; x̄**567** ♀ - 1M: 438; 2M: 500; 3M: 521; 4M: 508; 5M: 553; 6M: 593; x̄**519**	♂ - 0M: 518; 1M: 570; 2M: 596; 3M: 569; 4M: 608; 5M: 639; 6M: 653; x̄**593** ♀ - 0M: 464; 1M: 517; 2M: 550; 3M: 537; 4M: 571; 5M: 599; 6M: 604; x̄**549**	LM
6-12 M	n.d	n.d	n.d	♂ - 7M: 668; 8M: 710; 9M: 746; 10M: 793; 11M: 817; 12M: 844; x̄**763** ♀ - 7M: 608; 8M: 643; 9M: 678; 10M: 717; 11M: 742; 12M: 768; x̄**693**	♂ - 7M: 680; 8M: 702; 9M: 731; 10M: 752; 11M: 775; x̄**728** ♀ - 7M: 629; 8M: 652; 9M: 676; 10M: 694; 11M: 712; x̄**673**	♂ - 7M: 645; 8M: 669; 9M: 693; 10M: 717; 11M: 740; x̄**693** ♀ - 7M: 573; 8M: 597; 9M: 621; 10M: 645; 11M: 669; x̄**621**
1-3 A	n.d	n.d	n.d	♂ - 12M: 844; 24M: 1050; 35M: 1184; x̄**1026** ♀ - 12M: 768; 24M: 997; 35M: 1139; x̄**968**	♂ - 1A: 950; 2A: 1125; 3A: 1250; x̄**1108** ♀ - 1A: 850; 2A: 1050; 3A: 1150; x̄**1017**	♂ - 1A: 788; 2A: 1027; 3A: 1170; x̄**995** ♀ - 1A: 717; 2A: 955; 3A: 1099; x̄**924**
4-6 A	n.d	n.d	n.d	♂ - 4A: 1390; 5A: 1466; 6A: 1535; 7A: 1617; 8A: 1692; x̄**1540** ♀ - 4A: 1310; 5A: 1379; 6A: 1451; 7A: 1515;8A: 1593; x̄**1450**	♂ - 4A: 1350 ; 5A: 1475; 6A: 1575; x̄**1467** ♀ - 4A: 1250 ; 5A: 1325; 6A: 1425; x̄**1333**	♂ - 4A: 1433; 5A: 1529; 6A: 1600; x̄**1521** ♀ - 4A: 1338 ; 5A: 1409; 6A: 1505; x̄**1417**
7-10 A	n.d	n.d	n.d	♂ - 4A: 1390; 5A: 1466; 6A: 1535; 7A: 1617; 8A: 1692; x̄**1540** ♀ - 4A: 1310; 5A: 1379; 6A: 1451; 7A: 1515; 8A: 1593; x̄**1450**	♂ - 7A: 1700 ; 8A: 1825; 9A: 1975; x̄**1833** ♀ - 7A: 1550; 8A: 1700; 9A: 1850; x̄**1700**	♂ - 7A: 1720 ; 8A: 1815; 9A: 1935; 10A: 1935; x̄**1851** ♀ - 7A: 1600; 8A: 1696; 9A: 1791; 10A: 1815; x̄**1726**
11-14 A	n.d	n.d	n.d	♂ - 9A: 1787; 10A: 1875; 11A: 1985; 12A: 2113; 13A: 2276; x̄**2007** ♀ - 9A: 1660; 10A: 1729; 11A: 1813; 12A: 1909; 13A: 1992; x̄**1821**	♂ - 10A: 2150; 11A: 2350; 12A: 2550; 13A: 2775; 14A: 3000 ; 15A: 3175; 16A: 3325; 17A: 3400; x̄**2841**	♂ - 11A: 2030; 12A: 2173; 13A: 2341; 14A: 2508; x̄**2263** ♀ - 11A: 1911; 12A: 2006; 13A: 2102; 14A: 2173; x̄**2048**
15-17 A	n.d	n.d	n.d	♂ - 14A: 2459; 15A: 2618; 16A: 2736; 17A: 2796; 18A: 2823; x̄**2686** ♀ - 14A: 2036; 15A: 2057; 16A: 2059; 17A: 2042; 18A: 2024; x̄**2044**	♀ - 10A: 2000; 11A: 2150; 12A: 2275; 13A: 2375; 14A: 2450; 15A: 2500; 16A: 2500; 17A: 2500; x̄**2344**	♂ - 15A: 2508; 16A: 2699; 17A: 2842; x̄**2683** ♀ - 15A: 2221 ; 16A: 2269; 17A: 2269; x̄**2253**

x̄: Média
A: Anos
AI: *Adequate Intake*
AR: *Average Requirement*
EAR: *Estimated Average Requirement*
LM: Leite Materno
M: Meses
n.d: Não disponível
PRI: *Population Reference Intake*
RDA: *Recommended Dietary Allowance*
RNI: *Recommended Nutrient Intake*

A escolha efetuada pelos autores para o valor de PAL apresentado para cada um dos Comités, teve como suporte os valores de PAL mais semelhantes entre os três, havendo a preocupação de não apresentar valores que representassem uma sobrestimativa relativamente à maioria das crianças e adolescentes. Importa, por isso, referir que quando estes valores forem usados para efetuar recomendações a nível individual, o nível de atividade da criança deve ser considerado (Tabela 1). Concretamente, no que diz respeito ao FNB/IOM até aos três anos (52) os valores propostos

Tabela 2

Recomendações em macronutrientes para o *Food and Nutrition Board* (FNB) / *Institute of Medicine*, *National Academies* (IOM), Organização das Nações Unidas para a Alimentação e a Agricultura (FAO) / Organização Mundial da Saúde (OMS) e Autoridade Europeia para a Segurança Alimentar (EFSA) / Comissão Europeia (CE)

		97,5%			50%		
		RDA/AI*/ AMDR	RNI /AI*/AMDR	PRI/AI*/RI	EAR	EAR	AR
NUTRIENTE							
Proteína (g/kg/d)	0–6 M	1,52*	1,14–1,77	LM	n.d	0,98–1,41	LM
	6–12 M	1,2	1,14–1,31	1,14–1,31	1	0,95–1,12	0,95–1,12
	1–3 A	1,05	0,90–1,14	0,90–1,14	0,87	0,73–0,95	0,73–0,95
	4–6 A	0,95	0,85– 0,89	0,85– 0,89	0,76	0,69–0,72	0,69–0,72
	7–10 A	0,95	0,91–0,92	0,91–0,92	0,76	0,75–0,75	0,75–0,75
	11–14 A	0,85	♂ 0,89–0,91 ♀ 0,87–0,90	♂ 0,89–0,91 ♀ 0,87–0,90	0,76	♂ 0,72–0,75 ♀ 0,70–0,73	♂ 0,72–0,75 ♀ 0,70–0,73
	15–17 A	0,80	♂ 0,86–0,88 ♀ 0,83–0,85	♂ 0,85–0,88 ♀ 0,82–0,85	♂ 0,73 / ♀ 0,71	♂ 0,70–0,72 ♀ 0,67–0,69	♂ 0,69–0,72 ♀ 0,66–0,69
Hidratos de carbono (g/d) (%)	0–6 M	n.d	55–75%[†]	LM	n.d	n.d	n.d
	6–12 M	n.d	55–75%[†]	n.d	n.d	n.d	n.d
	1–3 A	45–65%	55–75%[†]	45–60%	100	n.d	n.d
	4–6 A	45–65%	55–75%[†]	45–60%	100	n.d	n.d
	7–10 A	45–65%	55–75%[†]	45–60%	100	n.d	n.d
	11–14 A	45–65%	55–75%[†]	45–60%	100	n.d	n.d
	15–17 A	45–65%	55–75%[†]	45–60%	100	n.d	n.d
Fibra (g/d)	0–6 M	n.d	> 25	n.d	n.d	n.d	n.d
	6–12 M	n.d	> 25	n.d	n.d	n.d	n.d
	1–3 A	19*	> 25	10*	n.d	n.d	n.d
	4–6 A	25*	> 25	14*	n.d	n.d	n.d
	7–10 A	25*	> 25	16*	n.d	n.d	n.d
	11–14 A	♂ 31*/♀ 26*	> 25	19*	n.d	n.d	n.d
	15–17 A	♂ 38*/♀ 26*	> 25	21*	n.d	n.d	n.d
Lípidos (%)	0–6 M	n.d	40–60%	LM	n.d	n.d	n.d
	6–12 M	n.d	↓ gradual (dependente de AF) até 35% (até 24M)	40%*	n.d	n.d	n.d
	1–3 A	30–40%	depois dos 2A: 25–35%	35–40%	n.d	n.d	n.d
	4–6 A	25–35%	25–35%	20–35%	n.d	n.d	n.d
	7–10 A	25–35%	25–35%	20–35%	n.d	n.d	n.d
	11–14 A	25–35%	25–35%	20–35%	n.d	n.d	n.d
	15–17 A	25–35%	25–35%	20–35%	n.d	n.d	n.d
Ácido Linoleico (g/d) (%)	0–6 M	4,4*	AI Baseado no LM como % da gordura total	4%*	n.d	n.d	n.d
	6–12 M	4,6*	3,0–4,5% *	4%*	n.d	n.d	n.d
	1–3 A	7*	12–24 M: 3,0–4,5%* depois n.d	4%*	n.d	n.d	n.d
	4–6 A	10*	n.d	4%*	n.d	n.d	n.d
	7–10 A	10*	n.d	4%*	n.d	n.d	n.d
	11–14 A	♂ 12*/♀ 10*	n.d	4%*	n.d	n.d	n.d
	15–17 A	♂ 16*/ ♀ 11*	n.d	4%*	n.d	n.d	n.d
Ácido alfa-Linolénico (g/d) (%)	0–6 M	0,5*	0,2–0,3% *	0,5%*	n.d	n.d	n.d
	6–12 M	0,5*	0,4–0,6% *	0,5%*	n.d	n.d	n.d
	1–3 A	0,7*	até 24 M: 0,4–0,6%* depois n.d	0,5%*	n.d	n.d	n.d
	4–6 A	0,9*	n.d	0,5%*	n.d	n.d	n.d
	7–10 A	0,9*	n.d	0,5%*	n.d	n.d	n.d
	11–14 A	♂ 1,2/♀ 1,0*	n.d	0,5%*	n.d	n.d	n.d
	15–17 A	♂ 1,6/♀ 1,1*	n.d	0,5%*	n.d	n.d	n.d

*AI: *Adequate Intake*
[†]: Percentagem de energia disponível tendo em conta o consumo de proteína e de lípidos
A: Anos
AR: *Average Requirement*
AF: Atividade Física
AMDR: *Acceptable Macronutrient Distribution Range*
EAR: *Estimated Average Requirement*
LM: Leite Materno
M: Meses
n.d: Não disponível
PRI: *Population Reference Intake*
RDA: *Recommended Dietary Allowance*
RI: *Reference Intake ranges for macronutrients*
RNI: *Recommended Nutrient Intake*

não têm em conta o nível de atividade física (PAL), dizendo apenas respeito ao metabolismo basal. A partir desta faixa etária, estão disponíveis valores para quatro níveis de atividade física, tendo-se optado por apresentar os valores que correspondem a um nível moderado e que equivalem a um PAL compreendido entre 1,4 e 1,6 (Tabela 1).

As recomendações da FAO/OMS até aos 12 meses (5) têm apenas em consideração a energia inerente ao metabolismo basal e à deposição de novos tecidos. A partir dos 12 meses de idade são apresentados valores para três níveis de PAL, tendo os autores optado por apresentar os valores de um nível de PAL moderado que varia entre 1,4 e 1,7, consoante a faixa etária a que diz respeito (Tabela 1). Finalmente, no caso da EFSA (43) e à semelhança da FAO/OMS, apenas os valores propostos até aos 12 meses não têm em consideração o PAL. A partir desta idade estão disponíveis recomendações que têm por base seis níveis de atividade física, tendo-se optado por apresentar valores que correspondem a um PAL de 1,6. No intervalo compreendido entre os 1 e 3 anos, o PAL apresentado é de 1,4, por não estarem disponíveis valores para um PAL de 1,6 para esta faixa etária (Tabela 1).

No que diz respeito aos valores propostos pela FAO/OMS para o zinco (56), estão disponíveis valores atendendo à biodisponibilidade (alta, moderada e baixa), tendo os autores optado por disponibilizar os valores intermédios. No caso do ferro, e ainda de acordo com a mesma entidade, estão disponíveis valores de biodisponibilidade de 5, 10, 12 e 15%, tendo os autores optado por apresentar os valores correspondentes a 12% (56).

Para além da disparidade de pontos de corte referentes à idade, outro aspeto que não é consensual entre Comités é a terminologia utilizada para as definições de um mesmo conceito (Tabela 5).

Tabela 3

Recomendações em vitaminas para o *Food and Nutrition Board* (FNB) / *Institute of Medicine*, *National Academies* (IOM), Organização das Nações Unidas para a Alimentação e a Agricultura (FAO) / Organização Mundial da Saúde (OMS) e Autoridade Europeia para a Segurança Alimentar (EFSA) / Comissão Europeia (CE)

		97,5%			50%		
		RDA/AI*	RNI /AI*	PRI/AI*	EAR	EAR	AR
Vitamina A (µg/d)	0-6 M	400*	375 †	LM	n.d	180	n.d
	6-12 M	500*	400 †	250	n.d	190	190
	1-3 A	300	400 †	250	210	200	205
	4-6 A	400	450 †	300	275	200	245
	7-10 A	400	500 †	400	275	250	320
	11-14 A	600	600 †	600	♂445 /♀ 420	330-400	480
	15-17 A	♂ 900/♀ 700	600 †	♂ 750/♀ 650	♂630/♀ 485	330-400	♂ 580/♀ 490
Vitamina D (µg/d)	0-6 M	10	5	LM	n.d	n.d	n.d
	6-12 M	10	5	*10 a 25*	n.d	n.d	n.d
	1-3 A	15	5	*10*	10	n.d	n.d
	4-6 A	15	5	*0-10*	10	n.d	n.d
	7-10 A	15	5	*0-10*	10	n.d	n.d
	11-14 A	15	5	*0-15*	10	n.d	n.d
	15-17 A	15	5	*0-15*	10	n.d	n.d
Vitamina E (mg/d)	0-6 M	4*	2,7	LM	n.d	n.d	n.d
	6-12 M	5*	2,7	5*	n.d	n.d	n.d
	1-3 A	6	5	6*	5	n.d	n.d
	4-6 A	7	5	9*	6	n.d	n.d
	7-10 A	7	7	9*	6	n.d	n.d
	11-14 A	11	♂ 10/♀ 7,5	♂ 13*/♀ 11*	9	n.d	n.d
	15-17 A	15	♂ 10/♀ 7,5	♂ 13*/♀ 11*	12	n.d	n.d
Vitamina K (µg/d)	0-6 M	2,0*	5 ‡	LM	n.d	n.d	n.d
	6-12 M	2,5*	10	*1 µg/kg/dia*	n.d	n.d	n.d
	1-3 A	30*	15	*1 µg/kg/dia*	n.d	n.d	n.d
	4-6 A	55*	20	*1 µg/kg/dia*	n.d	n.d	n.d
	7-10 A	55*	25	*1 µg/kg/dia*	n.d	n.d	n.d
	11-14 A	60*	35-55	*1 µg/kg/dia*	n.d	n.d	n.d
	15-17 A	75*	35-55	*1 µg/kg/dia*	n.d	n.d	n.d
Vitamina B1 (mg/d)	0-6 M	0,2*	0,2	LM	n.d	n.d	n.d
	6-12 M	0,3*	0,3	*0,3*	n.d	n.d	n.d
	1-3 A	0,5	0,5	*0,5*	0,4	n.d	n.d
	4-6 A	0,6	0,6	*0,7*	0,5	n.d	n.d
	7-10 A	0,6	0,9	*0,8*	0,5	n.d	n.d
	11-14 A	0,9	♂ 1,2/♀ 1,1	*♂ 1/♀ 0,9*	0,7	n.d	n.d
	15-17 A	♂ 1,2/♀ 1	♂ 1,2/♀ 1,1	*♂ 1,2/♀ 0,9*	♂ 1 /♀ 0,9	n.d	n.d
Vitamina B2 (mg/d)	0-6 M	0,3*	0,3	LM	n.d	n.d	n.d
	6-12 M	0,4*	0,4	*0,4*	n.d	n.d	n.d
	1-3 A	0,5	0,5	*0,8*	0,4	n.d	n.d
	4-6 A	0,6	0,6	*1,0*	0,5	n.d	n.d
	7-10 A	0,6	0,9	*1,2*	0,5	n.d	n.d

cont. >

		97,5%			50%		
		RDA/AI*	RNI /AI*	PRI/AI*	EAR	EAR	AR
Vitamina B2 (mg/d)	11-14 A	0,9	♂ 1,3/♀ 1,0	♂ *1,4*/♀ *1,2*	0,8	n.d	n.d
	15-17 A	♂ 1,3/♀ 1	♂ 1,3/♀ 1,0	♂ *1,6*/♀ *1,3*	♂ 1,1 /♀ 0,9	n.d	n.d
Vitamina B6 (mg/d)	0-6 M	0,1*	0,1	LM	n.d	n.d	n.d
	6-12 M	0,3*	0,3	*0,4*	n.d	n.d	n.d
	1-3 A	0,5	0,5	*0,7*	0,4	n.d	n.d
	4-6 A	0,6	0,6	*0,9*	0,5	n.d	n.d
	7-10 A	0,6	1	*1,1*	0,5	n.d	n.d
	11-14 A	1	♂ 1,3/♀ 1,2	♂ *1,3*/♀ *1,1*	0,8	n.d	n.d
	15-17 A	♂ 1,3/♀ 1,2	♂ 1,3/♀ 1,2	♂ *1,5*/ ♀ *1,1*	♂ 1,1/♀ 1	n.d	n.d
Vitamina B12 (µg/d)	0-6 M	0,4*	0,4	LM	n.d	0,3	n.d
	6-12 M	0,5*	0,7	1,5*	n.d	0,6	n.d
	1-3 A	0,9	0,9	1,5*	0,7	0,7	n.d
	4-6 A	1,2	1,2	1,5*	1	1,0	n.d
	7-10 A	1,2	1,8	2,5*	1	1,5	n.d
	11-14 A	1,8	2,4	3,5*	1,5	2,0	n.d
	15-17 A	2,4	2,4	4*	2	2,0	n.d
Niacina (mg NE/d)	0-6 M	2* mg/d	2	LM	n.d	n.d	n.d
	6-12 M	4*	4	1,6 mg NE/MJ	n.d	n.d	1,3mg NE/MJ
	1-3 A	6	6	1,6 mg NE/MJ	5	n.d	1,3mg NE/MJ
	4-6 A	8	8	1,6 mg NE/MJ	6	n.d	1,3mg NE/MJ
	7-10 A	8	12	1,6 mg NE/MJ	6	n.d	1,3mg NE/MJ
	11-14 A	12	16	1,6 mg NE/MJ	9	n.d	1,3mg NE/MJ
	15-17 A	♂ 16/♀ 14	16	1,6 mg NE/MJ	♂ 12 /♀ 11	n.d	1,3mg NE/MJ
Colina (mg/d)	0-6 M	125*	n.d	n.d	n.d	n.d	n.d
	6-12 M	150*	n.d	n.d	n.d	n.d	n.d
	1-3 A	200*	n.d	n.d	n.d	n.d	n.d
	4-6 A	250*	n.d	n.d	n.d	n.d	n.d
	7-10 A	250*	n.d	n.d	n.d	n.d	n.d
	11-14 A	375*	n.d	n.d	n.d	n.d	n.d
	15-17 A	♂ 550*/♀ 400*	n.d	n.d	n.d	n.d	n.d
Ácido Fólico (µg/d)	0-6 M	65*	80	LM	n.d	65	n.d
	6-12 M	80*	80	80*	n.d	65	n.d
	1-3 A	150	150	120	120	120	90
	4-6 A	200	200	140	160	160	110
	7-10 A	200	300	200	160	250	160
	11-14 A	300	400	270	250	330	210
	15-17 A	400	400	330	330	330	250
Vitamina C (mg/d)	0-6 M	40*	25	LM	n.d	n.d	n.d
	6-12 M	50*	30	20	n.d	n.d	n.d
	1-3 A	15	30	20	13	n.d	15
	4-6 A	25	30	30	22	n.d	25
	7-10 A	25	35	45	22	n.d	40
	11-14 A	45	40	70	39	n.d	60
	15-17 A	♂75 /♀ 65	40	♂100 /♀ 90	♂63 /♀56	n.d	♂85 /♀ 75
Ácido pantoténico (mg/d)	0-6 M	1,7*	1,7	LM	n.d	n.d	n.d
	6-12 M	1,8*	1,8	3*	n.d	n.d	n.d
	1-3 A	2*	2	4*	n.d	n.d	n.d
	4-6 A	3*	3	4*	n.d	n.d	n.d
	7-10 A	3*	4	4*	n.d	n.d	n.d
	11-14 A	4*	5	5*	n.d	n.d	n.d
	15-17 A	5*	5	5*	n.d	n.d	n.d
Biotina (µg/d)	0-6 M	5*	5	LM	n.d	n.d	n.d
	6-12 M	6*	6	6*	n.d	n.d	n.d
	1-3 A	8*	8	20*	n.d	n.d	n.d
	4-6 A	12*	12	25*	n.d	n.d	n.d
	7-10 A	12*	20	25*	n.d	n.d	n.d
	11-14 A	20*	25	35*	n.d	n.d	n.d
	15-17 A	25*	25	35*	n.d	n.d	n.d

*AI: *Adequate Intake*
†: Recommended Safe Intakes, em µg equivalente de retinol (RE)/dia e
‡: Não pode ser suprido em crianças em aleitamento materno exclusivo
A: Anos
AR: *Average Requirement*
EAR: *Estimated Average Requirement*
LM: Leite Materno
M: Meses
MJ: Megajoules
n.d: Não disponível
NE: Equivalente de niacina
PRI: *Population Reference Intake*
RDA: *Recommended Dietary Allowance*
RNI: *Recommended Nutrient Intake*

Tabela 4

Recomendações em minerais para o *Food and Nutrition Board* (FNB) / *Institute of Medicine*, *National Academies* (IOM), Organização das Nações Unidas para a Alimentação e a Agricultura (FAO) / Organização Mundial da Saúde (OMS) e Autoridade Europeia para a Segurança Alimentar (EFSA) / Comissão Europeia (CE)

		97,5%			50%		
		RDA/AI*	RNI /AI*	PRI/AI*	EAR	EAR	AR
Cálcio (mg/d)	0-6 M	200*	300; 400	LM	n.d	n.d	n.d
	6-12 M	260*	400	280*	n.d	n.d	n.d
	1-3 A	700	500	450	500	n.d	390
	4-6 A	1000	600	800	800	n.d	680
	7-10 A	1000	700	800	800	n.d	680
	11-14 A	1300	1300	1150	1100	n.d	960
	15-17 A	1300	1300	1150	1100	n.d	960
Ferro (mg/d)	0-6 M	0,27*	†	LM	n.d	n.d	n.d
	6-12 M	11	7,7 ‡	*6*	6,9	n.d	n.d
	1-3 A	7	4,8	*4*	3	n.d	n.d
	4-6 A	10	5,3	*4*	4,1	n.d	n.d
	7-10 A	10	7,4 (7-10 A)	*6*	4,1	n.d	n.d
	11-14 A	8	♂ 12,2/♀ 27,7 (11-14 A)	*♂ 10/♀ 22*	♂ 5,9/♀ 5,7	n.d	n.d
	15-17 A	♂ 11/♀ 15	♂15,7/♀ 25,8 (15-17 A)	*♂ 13/♀ 21*	♂ 7,7/♀ 7,9	n.d	n.d
Selénio (µg/d)	0-6 M	15*	6	LM	n.d	5,1	n.d
	6-12 M	20*	10	15*	n.d	8,2	n.d
	1-3 A	20	17	15*	17	13,6	n.d
	4-6 A	30	22	20*	23	17,5	n.d
	7-10 A	30	21	35*	23	17,0	n.d
	11-14 A	40	♂ 32/♀ 26	55*	35	♂ 22,5/♀ 20,6	n.d
	15-17 A	55	♂ 32/♀ 26	70*	45	♂ 22,5/♀ 20,6	n.d
Zinco (mg/d)	0-6 M	2*	2,8 §	LM	n.d	♂ 0,514/♀ 0,457 mg/Kg/d; / (0-3M) 0,204 (3-6M)	n.d
	6-12 M	3	4,1	2,9	2,5	0,311 mg/kg/d	2,4
	1-3 A	3	4,1	4,3	2,5	0,230 mg/kg/d	3,6
	4-6 A	5	4,8	5,5	4,0	0,190 mg/kg/d (3-6A)	4,6
	7-10 A	5	5,6	7,4	4,0	0,149 mg/kg/d (6-10A)	6,2
	11-14 A	8	♂ 8,6/♀ 7,2	10,7	7	♂ 0,133/♀ 0,113 mg/kg/d (10-12A) ♂ 0,126/♀ 0,107 mg/kg/d (12-15A)	8,9
	15-17 A	♂ 11/♀ 9	♂ 8,6/♀ 7,2	♂ 14,2/♀ 11,9	8,5♂/♀ 7,3	♂ 0,102/ ♀ 0,093/ mg/kg/d (15-18A)	♂11,8/9,9♀
Magnésio (mg/d)	0-6 M	30*	26 AM/36 FI	LM	n.d	n.d	n.d
	6-12 M	75*	54	80*	n.d	n.d	n.d
	1-3 A	80	60	170*	65	n.d	n.d
	4-6 A	130	76	230*	110	n.d	n.d
	7-10 A	130	100	230*	110	n.d	n.d
	11-14 A	240	♂ 220/♀ 230	♂ 300*/ ♀ 250 *	200	n.d	n.d
	15-17 A	♂ 410/♀ 360	♂ 220; ♀230	♂300*/ ♀ 250 *	♂ 340;♀ 300	n.d	n.d
Fósforo (mg/d)	0-6 M	100*	n.d	LM	n.d	n.d	n.d
	6-12 M	275*	n.d	160*	n.d	n.d	n.d
	1-3 A	460	n.d	250*	380	n.d	n.d
	4-6 A	500	n.d	440*	405	n.d	n.d
	7-10 A	500	n.d	440*	405	n.d	n.d
	11-14 A	1250	n.d	640*	1055	n.d	n.d
	15-17 A	1250	n.d	640*	1055	n.d	n.d
Iodo (µg/d)	0-6 M	110*	90	LM	n.d	n.d	n.d
	6-12 M	130*	90	70*	n.d	n.d	n.d
	1-3 A	90	90	90*	65	n.d	n.d
	4-6 A	90	90	90*	65	n.d	n.d
	7-10 A	90	120 (6-12A)	90*	65	n.d	n.d
	11-14 A	120	120 (6-12 A)	120*	73	n.d	n.d
	15-17 A	150	150 (13-18 A)	130*	95	n.d	n.d
Cobre (µg/d)	0-6 M	200*	n.d	LM	n.d	n.d	n.d
	6-12 M	220*	n.d	*300*	n.d	n.d	n.d
	1-3 A	340	n.d	*400*	260	n.d	n.d

cont. >

		97,5%			50%		
		RDA/AI*	RNI /AI*	PRI/AI*	EAR	EAR	AR
Cobre (µg/d)	4-6 A	440	n.d	*600*	340	n.d	n.d
	7-10 A	440	n.d	*700*	340	n.d	n.d
	11-14 A	700	n.d	*800*	540	n.d	n.d
	15-17 A	890	n.d	*1000*	685	n.d	n.d
Molibdénio (µg/d)	0-6 M	2*	n.d	LM	n.d	n.d	n.d
	6-12 M	3*	n.d	10*	n.d	n.d	n.d
	1-3 A	17	n.d	15*	13	n.d	n.d
	4-6 A	22	n.d	20*	17	n.d	n.d
	7-10 A	22	n.d	30*	17	n.d	n.d
	11-14 A	34	n.d	45*	26	n.d	n.d
	15-17 A	43	n.d	65*	33	n.d	n.d
Manganês (mg/d)	0-6 M	0,003*	n.d	LM	n.d	n.d	n.d
	6-12 M	0,6*	n.d	0,02-0,5*	n.d	n.d	n.d
	1-3 A	1,2*	n.d	0,5*	n.d	n.d	n.d
	4-6 A	1,5*	n.d	1,0*	n.d	n.d	n.d
	7-10 A	1,5*	n.d	1,5*	n.d	n.d	n.d
	11-14 A	♂ 1,9*/♀ 1,6*	n.d	2,0*	n.d	n.d	n.d
	15-17 A	♂ 2,2*/ ♀ 1,6*	n.d	3,0*	n.d	n.d	n.d
Sódio (g/d)	0-6 M	0,12*	n.d	n.d	n.d	n.d	n.d
	6-12 M	0,37*	n.d	n.d	n.d	n.d	n.d
	1-3 A	1,0*	n.d	n.d	n.d	n.d	n.d
	4-6 A	1,2*	n.d	n.d	n.d	n.d	n.d
	7-10 A	1,2*	n.d	n.d	n.d	n.d	n.d
	11-14 A	1,5*	n.d	n.d	n.d	n.d	n.d
	15-17 A	1,5*	n.d	n.d	n.d	n.d	n.d
Flúor (mg/d)	0-6 M	0,01*	n.d	LM	n.d	n.d	n.d
	6-12 M	0,5*	n.d	0,4*	n.d	n.d	n.d
	1-3 A	0,7*	n.d	0,6*	n.d	n.d	n.d
	4-6 A	1*	n.d	♂ 1*/♀ 0,9*	n.d	n.d	n.d
	7-10 A	1*	n.d	♂ 1,5*/♀ 1,4*	n.d	n.d	n.d
	11-14 A	2*	n.d	♂ 2,2*/♀ 2,3*	n.d	n.d	n.d
	15-17 A	3*	n.d	♂ 3,2*/♀ 2,8*	n.d	n.d	n.d
Crómio (µg/d)	0-6 M	0,2*	n.d	n.a	n.d	n.d	n.a
	6-12 M	5,5*	n.d	n.a	n.d	n.d	n.a
	1-3 A	11*	n.d	n.a	n.d	n.d	n.a
	4-6 A	15*	n.d	n.a	n.d	n.d	n.a
	7-10 A	15*	n.d	n.a	n.d	n.d	n.a
	11-14 A	♂ 25*/♀ 21*	n.d	n.a	n.d	n.d	n.a
	15-17 A	♂ 35*/♀ 24 *	n.d	n.a	n.d	n.d	n.a
Potássio (g/d)	0-6 M	0,4*	n.d	LM	n.d	n.d	n.d
	6-12 M	0,7*	n.d	*0,8*	n.d	n.d	n.d
	1-3 A	3,0*	n.d	*0,8*	n.d	n.d	n.d
	4-6 A	3,8*	n.d	*1,1*	n.d	n.d	n.d
	7-10 A	3,8*	n.d	*2*	n.d	n.d	n.d
	11-14 A	4,5*	n.d	*3,1*	n.d	n.d	n.d
	15-17 A	4,7*	n.d	*3,1*	n.d	n.d	n.d

*AI: *Adequate Intake*
†: Reservas de ferro neonatais suficientes para suprir as necessidades de lactentes de termo nos 1ºs 6 meses de vida
‡: Biodisponibilidade de ferro na dieta durante este período varia bastante
§: Crianças alimentadas fórmula infantil
A: Anos
AM: Aleitamento Materno
AR: *Average Requirement*
EAR: *Estimated Average Requirement*
FI: Fórmula Infantil
LM: Leite Materno
M: Meses
n.a: Não apropriado estabelecer
n.d: Não disponível
PRI: *Population Reference Intake*
RDA: *Recommended Dietary Allowance*
RNI: *Recommended Nutrient Intake*

Tabela 5

Equivalência de conceitos tendo em conta o *Food and Nutrition Board* (FNB) / *Institute of Medicine*, *National Academies* (IOM), Organização das Nações Unidas para a Alimentação e a Agricultura (FAO) / Organização Mundial da Saúde (OMS) e Autoridade Europeia para a Segurança Alimentar (EFSA) / Comissão Europeia (CE)

FNB/IOM	RDA	EAR	AI	AMDR
FAO/OMS	RNI*	EAR**	AI	AMDR
EFSA/CE	PRI	AR	AI	RI

*RNI: *Recommended Nutrient Intake ou Safe Level* (no caso das proteínas)
**EAR: *Estimated Average Requirement ou Average Protein Requirement* (APR)
%E: *Percent of energy*
AI: *Adequate Intake*
AMDR: *Acceptable Macronutrient Distribution Range*
AR: *Average Requirement*
PRI: *Population Reference Intake*
RDA: *Recommended Dietary Allowance*
RI: *Reference Intake ranges for macronutrients*

O conceito de *Estimated Average Requirement* (EAR) ou *Average Requirement* (AR) ou *Average Protein Requirement* (APR), esta última no caso específico da proteína, traduz a quantidade média diária de um nutriente capaz de suprir as necessidades de 50% dos indivíduos saudáveis. Deve ser considerada quando se pretende efetuar recomendações para grupos populacionais e para estabelecer prevalências de inadequação. Quando se utiliza a terminologia *Recommended Dietary Allowance* (RDA), *Recommended Nutrient Intake* (RNI) e [no caso específico da proteína, *Safe Level* (SL)] ou *Population Reference Intake* (PRI) faz-se referência à quantidade média diária de um nutriente capaz de suprir as necessidades de 97,5% dos indivíduos saudáveis da população, devendo apenas utilizar-se para recomendações individuais. Sempre que não existe evidência científica suficiente para estabelecer uma RDA ou EAR, são utilizadas as *Adequate Intake* (AI) (60), que traduzem a ingestão adequada de um nutriente em indivíduos saudáveis. Finalmente, os *Acceptable Macronutrient Distribution Ranges* (AMDR) ou *Reference Intake ranges for macronutrients* (RI) traduzem o intervalo da distribuição percentual adequada dos macronutrientes em relação ao valor energético total, ao qual não estão associados riscos de doença crónica.

RESULTADOS

As recomendações nutricionais propostas pelos três comités considerados (FNB/IOM, FAO/OMS e EFSA/CE), apresentam-se de acordo com a estratificação por idade descrita previamente na metodologia e encontram-se explanadas nas Tabelas 6, 7 e 8, respetivamente.

Tabela 6

Recomendações Nutricionais do Food and Nutrition Board (FNB) do Institute of Medicine, National Academies (IOM)

		RNI/AI*/AMDR						EAR					
		0-6 MESES	6-12 MESES	1-3 ANOS	4-8 ANOS	9-13 ANOS	14-18 ANOS	0-6 MESES	6-12 MESES	1-3 ANOS	4-8 ANOS	9-13 ANOS	14-18 ANOS
Proteína	(g/d)	9,1 *	11	13	19	34	♂ 52/ ♀ 46	n.d	n.d	n.d	n.d	n.d	n.d
	(g/Kg/d)	1,52*	1,2	1,05	0,95	0,85	0,8	n.d	1	0,87	0,76	0,76	♂0,73/♀0,71
	(%)	n.d	n.d	5-20	10-30	10-30	10-30						
Hidratos de carbono	(g/d)	60*	95*	130	130	130	130	n.d	n.d	100	100	100	100
	(%)	n.d	n.d	45-65	45-65	45-65	45-65						
Fibra	(g/d)	n.d	n.d	19*	25*	♂ 31*;♀ 26*	♂ 38*/♀ 26*	n.d	n.d	n.d	n.d	n.d	n.d
Lípidos	(g/d)	31*	30*	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
	(%)	n.d	n.d	30-40	25-35	25-35	25-35						
Ácido Linoleico	(g/d)	4,4*	4,6*	7*	10*	♂ 12*/♀ 10*	♂ 16*/♀ 11*	n.d	n.d	n.d	n.d	n.d	n.d
	(%)	5-10	5-10	5-10	5-10	5-10	5-10						
Ácido alfa-Linolénico	(g/d)	0,5*	0,5*	0,7*	0,9*	♂ 1,2*/♀ 1,0*	♂ 1,6*/♀ 1,1*	n.d	n.d	n.d	n.d	n.d	n.d
	(%)	0,6-1,2	0,6-1,2	0,6-1,2	0,6-1,2	0,6-1,2	0,6-1,2						
Vitamina A	(µg/d)	400*	500*	300	400	600	♂900/ ♀700	n.d	n.d	210	275	♂445/♀420	♂630/ ♀485
Vitamina D	(µg/d)	10	10	15	15	15	15	n.d	n.d	10	10	10	10
Vitamina E	(mg/d)	4*	5*	6	7	11	15	n.d	n.d	5	6	9	12
Vitamina K	(µg/d)	2,0*	2,5*	30*	55*	60*	75*	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina B1	(mg/d)	0,2*	0,3*	0,5	0,6	0,9	♂ 1,2/ ♀ 1,0	n.d	n.d	0,4	0,5	0,7	♂ 1/ ♀ 0,9
Vitamina B2	(mg/d)	0,3*	0,4*	0,5	0,6	0,9	♂ 1,3/♀ 1,0	n.d	n.d	0,4	0,5	0,8	♂ 1/ ♀ 0,9
Vitamina B6	(mg/d)	0,1*	0,3*	0,5	0,6	1	♂ 1,3/ ♀ 1,2	n.d	n.d	0,4	0,5	0,8	♂ 1/♀ 1
Vitamina B12	(µg/d)	0,4*	0,5*	0,9	1,2	1,8	2,4	n.d	n.d	0,7	1	1,5	2
Niacina	(mg/d)	2*	4*	6	8	12	♂ 16/ ♀ 14	n.d	n.d	5	6	9	♂ 12/ ♀ 11
Colina	(mg/d)	125*	150*	200*	250*	375*	♂ 550*/ ♀ 400*	n.d	n.d	n.d	n.d	n.d	n.d
Ácido Fólico	(µg/d)	65*	80*	150	200	300	400	n.d	n.d	120	160	250	330
Vitamina C	(mg/d)	40*	50*	15	25	45	♂ 75/♀ 65	n.d	n.d	13	22	39	♂ 63/♀ 56
Ácido pantoténico	(mg/d)	1,7*	1,8*	2*	3*	4*	5*	n.d	n.d	n.d	n.d	n.d	n.d
Biotina	(µg/d)	5*	6*	8*	12*	20*	25*	n.d	n.d	n.d	n.d	n.d	n.d
Cálcio	(mg/d)	200*	600*	700	1000	1300	1300	n.d	n.d	500	800	1100	1100
Ferro	(mg/d)	0,27*	11	7	10	8	♂ 11/♀ 15	n.d	6,9	3	4,1	♂ 5,9/♀ 5,7	♂ 7,7/♀ 7,9
Selénio	(µg/d)	15*	20*	20	30	40	55	n.d	n.d	17	23	35	45
Zinco	(mg/d)	2*	3	3	5	8	♂ 11/ ♀ 9	n.d	2,5	2,5	4	7	♂ 8,5/♀ 7,3
Magnésio	(mg/d)	30*	75*	80	130	240	♂ 410/ ♀ 360	n.d	n.d	65	110	200	♂340/♀300
Fósforo	(mg/d)	100*	275*	460	500	1250	1250	n.d	n.d	380	405	1055	1055
Iodo	(µg/d)	110*	130*	90	90	120	150	n.d	n.d	65	65	73	95
Cobre	(µg/d)	200*	220*	340	440	700	890	n.d	n.d	260	340	540	685
Molibdénio	(µg/d)	2*	3*	17	22	34	43	n.d	n.d	13	17	26	33
Manganês	(mg/d)	0,003*	0,6*	1,2*	1,5*	♂ 1,9* /♀ 1,6*	♂ 2,2*/♀ 1,6*	n.d	n.d	n.d	n.d	n.d	n.d
Sódio	(g/d)	0,12*	0,37*	1,0*	1,2*	1,5*	1,5*	n.d	n.d	n.d	n.d	n.d	n.d
Flúor	(mg/d)	0,01*	0,5*	0,7*	1*	2*	3*	n.d	n.d	n.d	n.d	n.d	n.d
Crómio	(µg/d)	0,2*	5,5*	11*	15*	♂ 25*/♀ 21*	♂ 35*/ ♀ 24*	n.d	n.d	n.d	n.d	n.d	n.d
Potássio	(g/d)	0,4*	0,7*	3,0*	3,8*	4,5*	4,7*	n.d	n.d	n.d	n.d	n.d	n.d

*AI: *Adequate Intake*
AMDR: *Acceptable Macronutrient Distribution Range*
EAR: *Estimated Average Requirement*
n.d: Não disponível
RNI: *Recommended Nutrient Intake ou Safe Level* (no caso das proteínas)

Tabela 7

Recomendações Nutricionais da Organização das Nações Unidas para a Alimentação e a Agricultura e da Organização Mundial da Saúde (FAO/OMS)

	RNI/AI*/AMDR						EAR					
	0-6 MESES	7-12 MESES	1-3 ANOS	4-6 ANOS	7-9 ANOS	10-18 ANOS	0-6 MESES	7-12 MESES	1-3 ANOS	4-6 ANOS	7-9 ANOS	10-18 ANOS
(g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Proteína (g/Kg/d)	1M: 1,77; 2M: 1,50; 3M: 1,36; 4M: 1,24; 5M: 1,14; x̄1,4	6M: 1,31; 1A: 1,14; x̄1,23	1A:1,14; 2A:0,97; 3A:0,90; x̄1,0	4A: 0,86; 5A:0,85; 6A:0,89; x̄0,87	7A:0,91; 8A:0,92; 9A:0,92; 10A:0,91; x̄0,92	♂ 11A: 0,91; 12A: 0,90; 13A: 0,90; 14A: 0,89 x̄♂: 0,90 ♀ 11A: 0,90; 12A: 0,89; 13A: 0,88; 14A :0,87 x̄♀: 0,89 ♂ 15A: 0,88; 16A: 0,87; 17A: 0,86; 18A: 0,85; x̄ ♂: 0,87 ♀ 15A: 0,85; 16A: 0,84; 17A: 0,83; 18A: 0,82; x̄ ♀: 0,84	1M: 1,41; 2M: 1,23; 3M: 1,13; 4M: 1,07; 5M: 0,98; x̄1,16	6M: 1,12; 1A: 0,95; x̄1,04	1A: 0,95; 2A: 0,79; 3A: 0,73; x̄0,82	4A: 0,69; 5A: 0,69; 6A: 0,72; x̄0,7	7A: 0,74; 8A: 0,75; 9A: 0,75; 10A: 0,75; x̄0,75	♂ 11A: 0,75; 12A: 0,74; 13A: 0,73;14A: 0,72; x̄ ♂: 0,74 ♀ 11A: 0,73; 12A: 0,72; 13A: 0,71; 14A: 0,70; x̄ ♀: 0,72 ♂ 15A: 0,72; 16A 0,71; 17A: 0,70; 18A: 0,69 x̄♂: 0,71 ♀ 15A: 0,69; 16 A: 0,68; 17A: 0,67; 18A: 0,66; x̄♀: 0,68
(%)	10-15	10-15	10-15	10-15	10-15	10-15						
Hidratos de carbono (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
(%)	55-75 †	55-75 †	55-75 †	55-75 †	55-75 †	55-75 †						
Fibra (g/d)	>25	>25	>25	>25	>25	>25	n.d	n.d	n.d	n.d	n.d	n.d
Lípidos (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
(%)	40-60* LM	↓ gradual (dependente de AF) até 35 (até 24M)	depois dos 2A: 25-35	25-35	25-35	25-35						
Ácido Linoleico (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
(%)	LM como % da gordura total*	3,0-4,5*	12-24 M: 3,0-4,5* depois n.d	n.d	n.d	n.d						
Ácido alfa-Linolénico (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
(%)	0,2-0,3*	0,4-0,6*	até 24 M: 0,4-0,6* depois n.d	n.d	n.d	n.d						
Vitamina A (μg RE/d)	375‡	400‡	400‡	450‡	500‡	600‡	180	190	200	200	250	330-400
Vitamina D (μg/d)	5	5	5	5	5	5	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina E (mg/d)	2,7	2,7	5	5	7	♂ 10 /♀ 7,5	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina K (μg/d)	5§	10	15	20	25	35-55	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina B1 (mg/d)	0,2	0,3	0,5	0,6	0,9	♂ 1,2/ ♀ 1,1	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina B2 (mg/d)	0,3	0,4	0,5	0,6	0,9	♂ 1,3/ ♀ 1	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina B6 (mg/d)	0,1	0,3	0,5	0,6	1	♂ 1,3/ ♀ 1,2	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina B12 (μg/d)	0,4	0,7	0,9	1,2	1,8	2,4	0,3	0,6	0,7	1,0	1,5	2
Niacina (mg NE/d)	2	4	6	8	12	16	n.d	n.d	n.d	n.d	n.d	n.d
Colina (mg/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ácido Fólico (μg/d)	80	80	150	200	300	400	65	65	120	160	250	330
Vitamina C (mg/d)	25	30	30	30	35	40	n.d	n.d	n.d	n.d	n.d	n.d
Ácido pantoténico (mg/d)	1,7	1,8	2	3	4	5	n.d	n.d	n.d	n.d	n.d	n.d
Biotina (μg/d)	5	6	8	12	20	25	n.d	n.d	n.d	n.d	n.d	n.d
Cálcio (mg/d)	300 AM 400 LV	400	500	600	700	1300	n.d	n.d	n.d	n.d	n.d	n.d
Ferro (mg/d)	‖	7,7 ¶	4,8	5,3	7,4 (7-10 A)	♂ 12,2/♀ 27,7 (11-14A) ♂ 15,7/♀ 25,8 (15-17A)	n.d	n.d	n.d	n.d	n.d	n.d

cont. >

	RNI/AI*/AMDR						EAR					
	0-6 MESES	7-12 MESES	1-3 ANOS	4-6 ANOS	7-9 ANOS	10-18 ANOS	0-6 MESES	7-12 MESES	1-3 ANOS	4-6 ANOS	7-9 ANOS	10-18 ANOS
Selénio (µg/d)	6	10	17	22	21	♂ 32 ♀ 26	5,1	8,2	13,6	17,5	17	♂ 22,5 ♀ 20,6
Zinco (mg/d) **(mg/kg/d)**	2,8**	4,1	4,1	4,8	5,6	♂ 8,6/ ♀ 7,2	**♂ 0,514/ ♀ 0,457 (0-3M) 0,204 (3-6M)**	**0,311**	**0,23**	**0,190 (3-6A)**	**0,149 (6-10A)**	**♂0,133/♀ 0,113 (10-12A) ♂0,126/ ♀ 0,107 (12-15A) ♂ 0,102/ ♀ 0,093 (15-18A)**
Magnésio (mg/d)	26 AM, 36 FI	54	60	76	100	♂ 230/ ♀ 220	n.d	n.d	n.d	n.d	n.d	n.d
Fósforo (mg/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Iodo (µg/d)	90	90	90	90	120 (6-12A)	150 (13-18A)	n.d	n.d	n.d	n.d	n.d	n.d
Cobre (µg/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Molibdénio (µg/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Manganês (mg/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Sódio (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Flúor (mg/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Crómio (µg/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Potássio (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d

*AI: *Adequate Intake*
** Crianças alimentadas fórmula infantil
x̄: Média
†: Percentagem de energia disponível tendo em conta o consumo de proteína e de lípidos
‡: *Recommended Safe Intakes*

§: Não pode ser suprido em crianças em AM exclusivo
||: Reservas de ferro neonatais suficientes para suprir necessidades de lactentes de termo nos 1.ºs 6 meses de vida
¶: Biodisponibilidade de ferro na dieta durante este período varia bastante

A: Anos
AF: Atividade Física
AM: Aleitamento Materno
EAR: *Estimated Average Requirement*
FI: Fórmula Infantil
LM: Leite Materno

LV: Leite de Vaca
M: Meses
n.d: Não disponível
RE: Equivalentes de retinol
RNI: *Recommended Nutrient Intake ou Safe Level* (no caso das proteínas)

Tabela 8

Recomendações Nutricionais Autoridade Europeia para a Segurança Alimentar (EFSA) / Comissão Europeia (CE)

	PRI/AI*/RI							AR						
	0-6 MESES	6-12 MESES	1-3 ANOS	4-6 ANOS	7-10 ANOS	11-14 ANOS	15-17 ANOS	0-6 MESES	6-12 MESES	1-3 ANOS	4-8 ANOS	9-13 ANOS	14-18 ANOS	15-17 ANOS
(g/d)	0,5M: ♂10 ♀9	0,5M: ♂10 ♀9	1A: ♂12 ♀11 2A: ♂12 ♀12 3A: ♂13 ♀13 x̄: ♂12,3 ♀12	4A: ♂15 ♀14 5A: ♂16 ♀16 6A: ♂19 ♀19 x̄: ♂16,7 ♀16,3	7A: 22 8A: 25 9A: 28 10A: 31 x̄: 26,5	11A: ♂34 ♀34 12A: ♂37 ♀38 13A: ♂42 ♀42 14A: ♂47 ♀45 x̄: ♂40 ♀39,8	15A: ♂52 ♀46 16A: ♂56 ♀47 17A: ♂ 58 ♀48 x̄: ♂55 ♀47	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Proteína (g/Kg/d)	LM	6M: 1,31; 1A: 1,14; x̄1,23	1A:1,14; 2A:0,97; 3A:0,90; x̄1,0	4A: 0,86; 5A:0,85; 6A:0,89; x̄0,87	7A:0,91; 8A:0,92; 9A:0,92; 10A:0,91; x̄0,92	♂ 11A: 0,91; 12A: 0,90; 13A: 0,90; 14A:0,89 x̄♂: 0,90; ♀ 11A: 0,90; 12A: 0,89; 13A 0,88; 14A: 0,87 x̄♀:0,89	♂ 15A: 0,88; 16A: 0,87; 17A: 0,86; x̄♂: 0,87; ♀ 15A: 0,85; 16A: 0,84; 17A: 0,83; x̄ ♀: 0,84	LM	6M: 1,12; 1A: 0,95; x̄1,04	1A: 0,95; 2A: 0,79; 3A: 0,73; x̄0,82	4A: 0,69; 5A: 0,69; 6A: 0,72; x̄0,7	7A: 0,74; 8A: 0,75; 9A: 0,75; 10A: 0,75; x̄0,75	♂ 11A: 0,75;12A: 0,74; 13A: 0,73;14A: 0,72; x̄ ♂: 0,74 ♀ 11A: 0,73; 12A:0,72; 13A :0,71; 14A 0,70; x̄ ♀:0,72	♂ 15A: 0,72; 16A 0,71; 17A: 0,70; 18A: 0,69 x̄ ♂:0,71 ♀ 15A: 0,69; 16 A: 0,68, 17A 0,67; 18A: 0,66; x̄ ♀ :0,68
(%)	n.d	n.d	n.d	n.d	n.d	n.d	n.d							
Hidratos de carbono (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Hidratos de carbono (%)	LM	n.d	45-60	45-60	45-60	45-60	45-60							
Fibra (g/d)	n.d	n.d	10*	14*	16*	19*	21*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Lípidos (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Lípidos (%)	LM	40*	35-40	20-35	20-35	20-35	20-35							
Ácido Linoleico (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ácido Linoleico (%)	4* †	4* †	4* †	4* †	4* †	4* †	4* †							
Ácido alfa-Linolénico (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ácido alfa-Linolénico (%)	0,5* †	0,5* †	0,5* †	0,5* †	0,5* †	0,5* †	0,5* †							

cont. >

	PRI/AI*/RI							AR						
	0-6 MESES	6-12 MESES	1-3 ANOS	4-6 ANOS	7-10 ANOS	11-14 ANOS	15-17 ANOS	0-6 MESES	6-12 MESES	1-3 ANOS	4-8 ANOS	9-13 ANOS	14-18 ANOS	15-17 ANOS
Vitamina A (µg/d)	LM	250	250	300	400	600	♂750/ ♀ 650	n.d	190	205	245	320	480	♂580/ ♀ 490
Vitamina D (µg/d)	LM	*10-25*	*10*	*0-10*	*0-10*	*0-15*	*0-15*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina E (mg/d)	LM	5*	6*	9*	9*	♂13*/ ♀ 11*	♂13*/ ♀ 11*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina K (µg/kg/d)	LM	*1*	*1*	*1*	*1*	*1*	*1*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina B1 (mg/d)	LM	*0,3*	*0,5*	*0,7*	*0,8*	*♂1/♀ 0,9*	*♂1,2/ ♀ 0,9*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina B2 (mg/d)	LM	*0,4*	*0,8*	*1*	*1,2*	*♂1,4/♀ 1,2*	*♂1,6/ ♀ 1,3*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina B6 (mg/d)	LM	*0,4*	*0,7*	*0,9*	*1,1*	*♂1,3/♀ 1,1*	*♂1,5/ ♀ 1,1*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Vitamina B12 (µg/d)	LM	1,5*	1,5*	1,5*	2,5*	3,5*	4*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Niacina (mg NE/MJ)	LM	1,6	1,6	1,6	1,6	1,6	1,6	n.d	1,3	1,3	1,3	1,3	1,3	1,3
Colina (mg/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Ácido Fólico (µg/d)	LM	80*	120	140	200	270	330	n.d	n.d	90	110	160	210	250
Vitamina C (mg/d)	LM	20	20	30	45	70	♂100/♀ 90	n.d	n.d	15	25	40	60	♂85/♀ 75
Ácido pantoténico (mg/d)	LM	3*	4*	4*	4*	5*	5*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Biotina (µg/d)	LM	6*	20*	25*	25*	35*	35*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Cálcio (mg/d)	LM	280*	450	800	800	1150	1150	n.d	n.d	390	680	680	960	960
Ferro (mg/d)	LM	*6*	*4*	*4*	*6*	*♂10/ ♀ 22‡*	*♂13/ ♀ 21‡*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Selénio (µg/d)	LM	15*	15*	20*	35*	55*	70*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Zinco (mg/d)	LM	2,9	4,3	5,5	7,4	10,7	♂14,2/ ♀ 11,9	n.d	2,4	3,6	4,6	6,2	8,9	♂11,8/♀ 9,9
Magnésio (mg/d)	LM	80*	170*	230*	230*	♂300*/ ♀ 250*	♂300*/♀ 250*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Fósforo (mg/d)	LM	160*	250*	440*	440*	640*	640*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Iodo (µg/d)	LM	70*	90*	90*	90*	120*	130*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Cobre (µg/d)	LM	*300*	*400*	*600*	*700*	*800*	*1000*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Molibdénio (µg/d)	LM	10*	15*	20*	30*	45*	65*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Manganês (mg/d)	LM	0,02-0,05*	0,5*	1,0*	1,5*	2,0*	3,0*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Sódio (g/d)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Flúor (mg/d)	LM	0,4*	0,6*	♂1*/ ♀ 0,9*	♂1,5*/ ♀ 1,4*	♂2,2*/ ♀ 2,3*	♂3,2*/ ♀ 2,8*	n.d	n.d	n.d	n.d	n.d	n.d	n.d
Crómio (µg/d)	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Potássio (g/d)	LM	*0,8*	*0,8*	*1,1*	*2*	*3,1*	*3,1*	n.d	n.d	n.d	n.d	n.d	n.d	n.d

*AI: *Adequate Intake*
x̄: Média
†: Com base em valores médios estimados de ingestão em que os sintomas de deficiência não são apresentados
‡: Para cobrir 95% da população
A: Anos
AR: *Average Requirement*
EAR: *Estimated Average Requirement*
LM: Leite Materno
M: Meses
n.d: Não disponível
n.a: Não apropriado estabelecer
PRI: *Population Reference Intake*
RI: *Reference Intake ranges for macronutrients*

Da análise da Tabela 1, podemos verificar que as recomendações para a energia não apresentam grandes variações entre Comités, sendo as recomendações da FAO/OMS um pouco mais altas a partir dos oito anos. No que à proteína diz respeito, os valores são muito semelhantes entre os diferentes Comités.

Relativamente aos hidratos de carbono, podemos verificar que as recomendações propostas pela FAO/OMS são mais elevadas, propondo que a ingestão em hidratos de carbono se situe nos 55-75% do valor energético (Tabela 2).

No que se refere aos açúcares há uma grande disparidade entre o que é mencionado pela FNB/IOM e pela FAO/OMS. A primeira refere que o consumo de açúcar deve estar limitado a não mais que 25% do total da energia e a FAO/OMS sugere que o seu consumo seja inferior a 10% do total da energia consumida. Contudo, a FNB/IOM especifica que o valor mencionado não é uma recomendação de ingestão e que não está estabelecido nenhum valor de ingestão diária de açúcares adicionados numa dieta saudável. A EFSA/CE não estabelece nenhum valor, por considerar que não tem dados disponíveis que permitam propor um valor de AI ou RI.

Em relação aos lípidos, as recomendações são sobreponíveis entre os vários Comités, sendo superiores nos primeiros anos de vida e decrescendo após os três anos. Até aos três anos, a FNB/IOM e a EFSA/CE recomendam que a proporção de energia consumida sob a forma de gordura possa atingir os 40% e a partir desta idade os três Comités advogam que esta fração não ultrapasse os 35% (Tabela 2).

No que diz respeito às recomendações para as vitaminas lipossolúveis, a FAO/OMS apresenta para a vitamina A valores de uma forma geral mais altos do que os restantes Comités, sendo os valores da EFSA/CE os mais baixos. Relativamente à vitamina D, os valores propostos pelo FNB/IOM são os mais altos (10 ou 15 µg/dia), sendo estes o dobro ou o triplo dos valores propostos pela FAO/OMS. Para a vitamina E são propostos pelo FNB/IOM valores superiores aos propostos pela FAO/OMS e valores sobreponíveis aos da EFSA/CE que correspondem a AIs. Os valores propostos para a vitamina K pelo FNB/IOM correspondem a AIs e são superiores aos RNIs propostos pela FAO/OMS (Tabela 3). Já para as vitaminas hidrossolúveis, nomeadamente do complexo B, relativamente à vitamina B1, as recomendações propostas pelos três Comités são sobreponíveis, mas para as vitaminas B2, B6, B12 e niacina os valores disponibilizados pela EFSA/CE são ligeiramente superiores aos valores propostos pelo FNB/IOM e pela FAO/OMS, sendo as recomendações destes dois últimos Comités sobreponíveis. Os valores propostos pela EFSA/CE para a vitamina B12 correspondem a AI, sendo mais elevados do que os emanados pelos outros dois Comités. No que respeita ao ácido fólico, os valores propostos pelo FNB/IOM e pela FAO/OMS são sobreponíveis, sendo superiores aos da EFSA/CE. No caso da vitamina C, os valores recomendados pelo FNB/IOM no intervalo compreendido entre o 1.º e o 3.º ano de vida são metade do valor proposto pela FAO/OMS e o valor publicado pela EFSA/CE é semelhante ao da FAO/OMS, ainda que ligeiramente inferior para a mesma faixa etária. A partir desta idade as recomendações são semelhantes, sendo que a partir dos 11 anos os valores publicados pela EFSA/CE (70 mg/dia) são superiores, chegando a ser aproximadamente o dobro dos valores propostos pela FAO/OMS (40 mg/dia). Relativamente ao ácido pantoténico as recomendações dos diferentes Comités são sobreponíveis. Finalmente, os valores propostos pelo FNB/IOM e pela EFSA/CE para a biotina correspondem a AIs, sendo os valores da EFSA/CE um pouco superiores. As recomendações da FAO/OMS não traduzem AIs, no entanto são bastante sobreponíveis às do FNB/IOM (Tabela 3).

No que se refere aos minerais, e mais concretamente ao cálcio, as recomendações propostas pelos três Comités são semelhantes, embora ligeiramente superiores no caso do FNB/IOM. Relativamente ao ferro, as quantidades sugeridas pelo FNB/IOM são quase o dobro das da FAO/OMS e da EFSA/CE para os primeiros anos de vida. A partir da adolescência, os valores propostos pelo FNB/IOM são inferiores aos preconizados pelos outros Comités (FAO/OMS e EFSA/CE), sendo estas diferenças ainda mais acentuadas no sexo feminino (15 mg/dia, 25,8 mg/dia e 21 mg/dia, respetivamente). No caso do selénio, as recomendações são semelhantes entre os três Comités, correspondendo as da EFSA/CE a AIs e sendo os valores superiores em crianças e adolescentes mais velhos. Os valores propostos para o zinco não apresentam grandes variações entre os Comités, à exceção dos valores propostos pela EFSA/CE para adolescentes com idades compreendidas entre os 15 e 17 anos (♂14,2 mg/dia;♀ 11,9 mg/dia), que são aproximadamente o dobro dos valores propostos pela FAO/OMS (♂ 8,6 mg/dia; ♀ 7,2 mg/dia). No que respeita ao magnésio, as recomendações do FNB/IOM são um pouco superiores às da FAO/OMS e cerca de metade das recomendações da EFSA/CE, com exceção dos valores do FNB/IOM para adolescentes entre os 14 e os 18 anos, que são superiores aos valores recomendados pelos outros dois Comités. Relativamente ao fósforo, não estão disponíveis recomendações da FAO/OMS, e os valores propostos pelo FNB/IOM são superiores aos das AI propostos pela EFSA/CE, sendo que na adolescência os valores do FNB/IOM (1250 mg/dia) chegam mesmo a ser o dobro dos apresentados pela EFSA/CE (640 mg/dia). No que concerne ao iodo os valores propostos pelos três Comités são semelhantes (Tabela 4).

A FAO/OMS não disponibiliza recomendações para os oligoelementos cobre, molibdénio, manganês, flúor e crómio, bem como também não disponibiliza recomendações para sódio e potássio. Os outros dois Comités apresentam recomendações, contudo apenas AI, denotando a escassez de evidência para formular outro tipo de recomendações (Tabela 4).

DISCUSSÃO DOS RESULTADOS

As necessidades nutricionais apresentam variações desde o nascimento até aos 18 anos, tendo em conta as particularidades do crescimento e maturação, características desta fase da vida. Assim se compreende que as recomendações para cada idade e sexo apresentem também variações (7), resultando num verdadeiro desafio para os profissionais de saúde que trabalham nutrição pediátrica. Mas, para além destas particularidades, a tarefa ainda se torna mais árdua por não existir consenso entre os diferentes Comités. Relativamente a Portugal, não existe a adoção oficial de um conjunto de recomendações, tornando-se difícil a interpretação e comparação dos resultados dos diferentes grupos de investigação, tendo em conta a disparidade dos critérios utilizados.

A criação de recomendações nutricionais pressupõe a existência de um conjunto de evidências que nem sempre é possível obter. Por essa razão, para alguns nutrientes, não estão disponíveis, por exemplo, RDAs. De entre as evidências podemos citar a realidade socioeconómica e o estado nutricional e de saúde da população, mas também o alcance pretendido ou a população-alvo a que a recomendação se destina. Ora, a realidade em África ou na América do Sul é notoriamente diferente da Europa e dos EUA/Canadá e as recomendações da FAO/OMS terão necessariamente uma abrangência diferente das do FNB/IOM e das da EFSA/CE. Por outro lado, quando se tenta perceber exatamente o que suporta cada recomendação, nem sempre é fácil obter essa informação. Importa referir que neste aspeto, a EFSA/CE tem tido a preocupação de justificar as suas recomendações, que, em alguns casos, são as recomendadas por outros Comités. Por exemplo, no caso da proteína, a EFSA adotou em 2013 (24) os valores propostos em 2007 pela FAO/OMS (57) para as EAR (APR)/AR e RNI (SL)/PRI. A adoção destes valores teve por base o reconhecimento da abordagem que foi utilizada por este último Comité, que utilizou um modelo fatorial para estimar as necessidades proteicas a partir dos seis meses de idade (57). Assim, e atendendo à grande variação das necessidades, são propostos pela FAO/OMS valores mensais até ao sexto mês de vida e anuais até aos 17 anos, valores por isso mais específicos. Os valores propostos pelo FNB/IOM incluem intervalos de idade maiores e são superiores aos da FAO/OMS e da EFSA/CE até à idade da adolescência (Tabela 2).

Relativamente ao valor percentual de energia para os hidratos de carbono, podemos verificar que as recomendações propostas pela FAO/OMS em 2003 são mais elevadas do que as recomendações propostas pela FNB/IOM e pela EFSA (Tabela 2). Tal facto poderá dever-se à maior abrangência das recomendações da FAO/OMS, uma vez que pretendem suprir as necessidades da população mundial. Estão disponíveis recomendações do FNB/IOM em gramas para toda a idade pediátrica tendo os outros Comités apenas disponíveis valores percentuais. Importa ainda referir que, estas últimas recomendações são as únicas que propõem valores de EAR/AR. No que diz respeito às recomendações da FAO/OMS, o AMDR proposto em 2003 para este macronutriente é transversal para adultos e a toda a idade pediátrica, sendo suportada esta recomendação no objetivo de prevenção das doenças crónicas

(55), tendo inclusive sido proposto na última revisão, feita em 2007, uma redução do seu limite inferior para 50% (61). No que à fibra diz respeito, não são propostas EAR/AR por nenhuma das três entidades, muito embora a OMS no seu documento de 2003, proponha um consumo de, pelo menos, 25 g por dia de fibra como recomendação transversal à vida, sendo no caso das RDA/RNI/PRI apenas propostas AIs pelo FNB/IOM e pela EFSA a partir do 1.º ano de vida.

Em suma, numa análise global das recomendações emanadas pelas três entidades analisadas, de um modo geral, existe uma concordância relativa às recomendações em energia, proteína, lípidos e hidratos de carbono. Mesmo relativamente a este último macronutriente a FAO/OMS propôs, em 2007, uma revisão em baixa do contributo na distribuição energética total (55-75% versus 50%) (61).

No que respeita às recomendações para as vitaminas observam-se diferenças substanciais entre os diferentes Comités, traduzindo provavelmente as necessidades dos diferentes públicos-alvo. Assim, a FAO/OMS apresenta recomendações mais elevadas para a vitamina A, C (até aos 3 anos). A FNB/IOM apresenta recomendações mais elevadas para as vitaminas D, E, K fósforo e para o ferro primeiros anos) e a EFSA/CE para a vitamina B12, biotina, ácido pantoténico vitamina C (após os 11 anos), e de zinco e magnésio na adolescência.

As recomendações propostas pelos três Comités para os primeiros seis meses de vida têm por base o leite materno, uma vez que este é o alimento ideal a ser fornecido ao lactente, em exclusivo, no primeiro semestre de vida (59). Assim, enquanto a FNB/IOM propõe AIs para esta faixa etária, a FAO/OMS propõe valores com base no alimento ideal para os primeiros meses de vida, à exceção da vitamina K (56), e a EFSA decidiu não apresentar valores para esta faixa etária, reforçando que o consumo de leite materno é suficiente para cobrir as necessidades da maior parte dos nutrientes durante os primeiros seis meses de vida.

Muito embora tenham sido contempladas neste artigo recomendações para toda a idade pediátrica, importa referir que não estão incluídas nesta revisão recomendações para alguns casos particulares, tais como o caso das crianças e adolescentes que pratiquem desporto de alta competição, crianças que apresentem patologias que exijam necessidades especiais e ainda casos de gravidez na adolescência (62).

As EAR/AR são base de cálculo importante na caracterização da inadequação nutricional de uma população, contudo não estão disponíveis valores para as três entidades relativamente aos seguintes nutrientes: fibra, lípidos, ácido linoleico e alfa-linolénico, vitamina K, colina, ácido pantoténico, biotina, manganês, sódio, flúor, crómio e potássio. Nestes casos supracitados, e em outros casos (ex: recomendações da EFSA para a vitamina E) em que não estão disponíveis EAR/AR é utilizado o valor de AI para a caracterização da inadequação nutricional. Admite-se que uma ingestão habitual igual ou superior ao valor da AI seja indicador de uma baixa probabilidade de inadequação ao nível individual ou populacional. Contudo, se a média de ingestão for inferior ao valor da AI, não é possível determinar se a ingestão é adequada ou inadequada.

Apenas estão disponíveis valores de EAR/AR para os hidratos de carbono, vitamina D, B1, B2, B6, ferro e cobre e de AIs para a vitamina K, colina, sódio, crómio e potássio propostos pelo FNB/IOM. E tendo em conta os 28 micronutrientes apresentados, a FAO/OMS apenas disponibiliza valores de EAR/AI para cinco deles: vitamina A, vitamina B12, ácido fólico, selénio e zinco. Estes aspetos enunciados poderão justificar a utilização mais frequente das recomendações do FNB/IOM em estudos de inadequação nutricional em crianças portuguesas (Tabelas 2, 3 e 4).

A heterogeneidade de referências utilizadas na literatura científica, por exemplo, para determinar a prevalência de inadequação nutricional em diferentes populações, complexifica a comparação entre diferentes estudos, que podem apresentar diferentes resultados, meramente pela utilização de diferentes recomendações.

Um dos grandes desafios deste trabalho foi a utilização de diferentes pontos de corte e terminologia utilizados pelos três Comités. No que diz respeito ao FNB/IOM existe um grupo de tabelas com a informação sistematizada. Relativamente à EFSA/CE existe uma publicação independente para cada nutriente e que foram publicadas em anos diferentes. No caso da FAO/OMS, os documentos são mais difíceis de analisar, uma vez que não tem a informação tão sistematizada e no caso particular dos hidratos de carbono, é feita apenas uma proposta de alteração no último documento, sendo que desconhecemos se efetivamente já foi ou não adotada.

Outra das dificuldades encontradas prendeu-se com o facto de não estarem disponíveis valores para todos os macro e micronutrientes para os três Comités, direcionando nesses casos a opção de escolha.

As recomendações nutricionais não são um campo fechado, são pelo contrário um campo em constante atualização o que constitui também outro grande desafio nesta sistematização.

Apesar das dificuldades em sumariar um enorme manancial de informação e a obrigatoriedade de tomar opções metodológicas tendo em vista conseguir comparar as recomendações propostas pelos três Comités (por exemplo, escolha de um valor de PAL para comparar as recomendações para a energia), consideramos que esta súmula da informação existente será muito relevante para apoiar atividades e decisões em saúde.

CONCLUSÕES

Em conclusão, consideramos que a EFSA/CE é o Comité que descreve com maior clareza a metodologia utilizada para obter as suas recomendações, não significando que a FNB/IOM e a FAO/OMS não tenham efetuado todos esses procedimentos, contudo essa informação não está disponível.

Após esta análise comparativa das diferentes recomendações, e apesar das recomendações do FNB/IOM serem as mais utilizadas, considera-se que as da EFSA/CE por serem mais recentes, uma vez que têm vindo a ser atualizadas desde 2010, por terem como população-alvo, a população europeia, na qual se inclui o nosso país, por serem baseadas numa metodologia sólida que inclui, nomeadamente, as recomendações dos outros dois Comités, possam vir a ser adotadas para a população portuguesa.

A informação atualizada do consumo alimentar, bem como do estado nutricional em diferentes grupos etários da população portuguesa serão fundamentais como base para a discussão de quais as recomendações nutricionais mais adequadas à nossa população.

A adoção oficial de recomendações nutricionais para a população portuguesa, por parte das entidades responsáveis, seria uma mais-valia para todos os que, por um motivo ou por outro, necessitam da sua utilização.

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PAPER 2

Prevalence of Nutritional Inadequacy in Children Aged 12-36 months: EPACI Portugal 2012.

In this paper, I was responsible for coordinating and organising fieldwork and data collection, conducting the data treatment, performing the statistical analysis, contributing to the interpretation of data, and writing the first draft of the manuscript.

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ORIGINAL RESEARCH

Nutrition Bulletin

Prevalence of nutritional inadequacy in children aged 12–36 months: EPACI Portugal 2012

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Abstract

Adequate nutritional intake in the first years of life is crucial for future health. The purpose of this study is to assess the adequacy of nutritional intake in Portuguese toddlers. The *EPACI Portugal 2012* is a cross-sectional study of a representative sample of toddlers (n = 2230), aged between 12 and 36 months. Data on diets were collected by trained interviewers. The current analysis included 853 children with full data from 3-day food diaries completed by parents/caregivers. Intakes of energy, macro- and micronutrients were estimated through Statistical Program to Assess Dietary Exposure (SPADE). Nutritional adequacy was evaluated using Dietary Reference Values established by the European Food Safety Authority. A large proportion of children exceeded the recommended energy intake. The median daily protein intake was 4.7 g/kg/day, five times more than that recommended. About 9% and 90% of the children consumed a lower proportion of energy than the lower limit of the Reference Intake range for carbohydrates and fat, respectively. Around a third consumed less fibre and magnesium and 100% less vitamin D than the recommended Adequate Intake (AI). Almost a third consumed less vitamin A than the recommended Average Requirement (AR) and 86% of the children showed excessive sodium consumption. Portuguese toddlers consumed a low proportion of energy from fat, had energy and protein intakes above the recommendations and excessive intakes of sodium, and inadequate intakes of vitamin A. Every child consumed less than the recommended AI for vitamin D.

KEYWORDS
dietary recommendations, food sources, nutrients, nutritional inadequacy, Portuguese toddlers

INTRODUCTION

Childhood obesity is currently a major public health problem (Karnik & Kanekar, 2012) and its prevalence in Portugal is high from the first years of life (Nazareth et al., 2021; Spinelli et al., 2019; Vilela et al., 2019). Childhood nutrition determines children's growth and development, and also plays an important role in the origin of obesity and some non-communicable diseases (Mello et al., 2016). Evidence supports that early feeding patterns are determinants of children's future health and in the prevention of obesity and associated co-morbidities (Brands et al., 2014; Koletzko et al., 2012). Moreover, rapid weight gain in the first months of life increases the risk of being overweight and obesity throughout life (Druet et al., 2012; Monteiro & Victora, 2005; Ong & Loos, 2006; Stettler et al., 2002, 2003).

The period between the end of the first year of life and pre-school age (12–36 months) is called toddlerhood. During this period, there is a transition to the family diet, making it an opportunity to review the family's diet and establish adequate eating habits. It is known that interventions at early ages are more effective in the long term, allowing easier maintenance of the learned behaviours throughout life (Araújo et al., 2011).

The first years of life are a period of rapid growth and development, requiring the satisfaction of high energy and nutritional quality needs, which emphasises the concern about the quality of children's diets (EFSA, 2017; Nazareth et al., 2016). Nutritional adequacy is defined as being the intake of essential nutrients sufficient to meet the nutritional recommendations and promote optimal health (Castro-Quezada et al., 2014).

There are some studies on the nutritional intake, including toddlers, carried out in European countries, such as Spain (Dalmau et al., 2015), England (Syrad et al., 2016), Ireland (Walton et al., 2017), Belgium (Huysentruyt et al., 2016), Germany (Alexy et al., 1999), Switzerland (Brunner et al., 2018), Italy (Zuccotti et al., 2020), Greece (Manios et al., 2008; Roma-Giannikou et al., 1997) or Finland (Kyttälä et al., 2010). In Portugal, data from the Generation 21 birth cohort (G21) (Lopes et al., 2014), at 4 years of age are available on the prevalence of nutritional inadequacy and main food sources for different nutrients. Likewise, data from the Portuguese National Food and Physical Activity Survey (IAN-AF) (Lopes et al., 2015) are available, but these do not allow nutritional inadequacy to be characterised and the main food sources in these ages identified. In Portugal, there are no representative studies measuring the nutritional inadequacy of diets specifically concerning toddlerhood.

Knowledge of nutritional status at early ages, particularly regarding nutritional inadequacy and the foods that contribute most to each nutrient intake, may help to establish food policies and guide the setting out of dietary recommendations for parents, caregivers and educators (Fox et al., 2004).

The purpose of this study is to assess the nutritional intake and respective adequacy of diets of a representative group of Portuguese toddlers and to identify the main food sources for specific nutrients in this group.

METHODS AND MATERIALS

Study design

This study was based on *EPACI Portugal 2012* (*Study of the Childhood Feeding Patterns and Growth*), which was a cross-sectional study to characterise dietary intake and nutritional status of Portuguese toddlers (ages between 12 and 36 months).

Sample selection

The study aimed to recruit a representative sample of about 1% of Portuguese children aged 12–36 months living in mainland Portugal. The number of children to be evaluated in each NUTS II region was calculated (NUTS II is the Nomenclature of Statistical Territorial Units, which divides mainland Portugal in five regions). At that time, considering that about 100 000 births per year occur in Portugal, a sample of 2500 (2000 plus 25% for refusals) was defined. The sample was stratified by NUTS II, maintaining the proportions of births in each region, and children were recruited from 128 health units, also randomly selected.

After the identification of the selected health units, a contact with the director of each health unit was made, to invite participation in the study, to request the list of children aged 12–36 months and to schedule the evaluation day. Twenty-five children were randomly selected in each health care unit, their caregivers were contacted and interviews were scheduled. The evaluations took place between May 2012 and July 2013.

All the proceedings of the study were carefully explained by phone, and once again to the caregiver who accompanied each child in the beginning of the face-to-face interview. The participation was formalised through the signature of informed consent. This study was approved by the Portuguese Data Protection Authority and by the Ethic Committee of the Catholic University of Portugal (Ethics Screening Report 02/12) and by all the Ethics Committees of the five Portuguese Health Regional Administrations.

Data collection

Data were collected by trained interviewers. A structured study protocol was applied in face-to-face, computer-assisted interviews, which included data on socio-economic characteristics of the household, parental nutritional status, children's health, dietary intake and supplementation during the first years of life. Furthermore, data on nutritional status were collected from the individual child health bulletin (a document in which the children's health data, including anthropometrics evaluation over time, is recorded and which is given to all children's caregivers in Portugal), and children's anthropometric measurements were taken during the appointment. At the end of the interview, a 3-day food diary was delivered to be filled out by the parents or another main caregiver. The procedure for completing of the diary and subsequently returning by postage-paid envelope (delivered at the time) was explained by the interviewers at the interview.

A Procedures Manual was created, tested and exhaustively presented to all interviewers to minimise errors in the collection of data.

Dietary intake assessment

The 3-day food diary, including information on 2 weekdays and 1 weekend day, was filled in by the caregivers, who were instructed to read the written instructions and to record the intake of all foods and beverages during these days, including detailed information about each item, the quantity consumed and the place and time of consumption, as well as all ingredients, cooking methods, recipes details (like type of fat used) in prepared dishes. Parents were encouraged to share the booklet with other caregivers of the children (for example, schools or nannies), to complete the information.

The codification of the food diaries was performed by a team of trained nutritionists and the food conversion into nutrients was carried out subsequently using the software Food Processor® SQL (ESHA Research). This software is based on Food Composition Table of the United States of America Department of Agriculture. Furthermore, the database has been adapted by researchers from the Institute of Public Health and Faculty of Medicine of the University of Porto with the inclusion of nutritional information of typical Portuguese foods and recipes.

The prevalence of nutritional inadequacy was obtained by the comparison of the children's estimated intake of energy, macro- and micronutrients, obtained from food diaries, and the Dietary Reference Values established by the European Food Safety Authority (EFSA) for children in this age interval (12–36 months) (EFSA, 2017). For clarification, the different terminologies and respective definitions used were summarised in Table 1. The Reference Intake ranges for macronutrients (RI) and Average Requirements (AR) were used as the cut-offs or, alternatively, the Adequate Intake (AI) when the AR was not established (EFSA, 2010b). The AR was adjusted for intra-individual variability. The RI range was used for carbohydrates and total fat, and all children, whose intakes were outside the range (above the upper limit or below the lower limit), were considered to have inadequate or excessive intakes (EFSA, 2010b). For micronutrients, the percentage of intakes below the AR or AI cut-offs were used to estimate the prevalence of inadequate intakes with intakes below the cut-off revealing a likely inadequacy (EFSA, 2010b). However, intakes below the AI are not necessarily inadequate. For sodium, the tolerable upper intake level (UL) issued by Institute of Medicine was used as cut-off (EFSA, 2019; IOM, 2011) and intakes above this cut-off are considered to be excessive.

The 10 main food sources for energy, macronutrients (protein, total fat, total carbohydrates, sugar and fibre) and micronutrients (calcium, vitamin C, vitamin B1, folate, potassium, sodium and iron) were obtained. To evaluate the main food sources, 13 groups were established. The name of each food group and the food items included in it are described in detail in the Table S1.

TABLE 1 Terminologies and definitions of Dietary Reference Values (DRVs)[a] and Dietary Reference Intakes (DRIs)[b] used

Terminology	Definitions
Reference Intake ranges for macronutrients (RI)[a]	Corresponds to the intake range for macronutrients, expressed as % of the energy intake
Average Requirement (AR)[a]	Corresponds to the level of (nutrient) intake that is adequate for half of the people in a population group, given a normal distribution of requirement
Population Reference Intake (PRI)[a]	Corresponds to the level of (nutrient) intake that is adequate for virtually all people in a population group
Adequate Intake (AI)[a]	Corresponds to the value estimated when a Population Reference Intake cannot be established because an average requirement cannot be determined
Tolerable Upper Intake Level (UL)[b]	Corresponds to the highest average daily nutrient intake level likely to pose no risk of adverse health effects to almost all individuals in a particular life stage and gender group

[a]DRVs from EFSA (EFSA, 2010b).
[b]The Tolerable Upper Intake Level (UL) used in the case of sodium was based on DRIs issued by Institute of Medicine (Food and Nutrition Board, 2003).

Statistical analysis

Median intake and percentiles 25 and 75 (P25; P75) of energy (in kcal per day), macronutrients (in %, grams or grams per kg, per day), and micronutrients (in mg or mcg per day) and nutritional inadequacy prevalence of macro- and micronutrients were estimated by gender and age. Prevalence estimates were weighted according to the complex sampling design, considering stratification by Portuguese geographical regions (NUTS II) and cluster effect for the selected Primary Health Care Unit. The Statistical Program to Assess Dietary Exposure (SPADE) software (Dekkers et al., 2014) was used to estimate usual intakes of energy, macro- and micronutrients, adjusting for intra-individual day-to-day variability, to estimate the prevalence of nutrients' inadequacy, and using survey weights, to assure nationally representative estimates. Statistical analysis was performed using the R package nlme and the Statistical Package for the Social Sciences SPSS® version 27 for Windows®.

RESULTS

A total of 2230 children (n = 1049; 47% female) aged between 12 and 36 months were evaluated in *EPACI Portugal 2012*, 1107 (49.6%) aged between 12 and 23 months and 1123 (50.4%) aged between 24 and 36 months.

Only 931 mothers/caregivers filled in and returned food diaries and, from these, 853 presented 3-day complete dietary information (participation proportion - 38%). Only these were included in the present analysis, corresponding to 475 (55.7%) males. Approximately half (n = 427; 51.1%) were aged between 12 and 23 months and (n = 426; 49.9%) between 24 and 36 months.

These children (n = 853) were compared with the rest of the sample (n = 1377) from the analysis regarding characteristics such as parental age, education, body mass index (BMI) and child's gender, age, exclusive breastfeeding at 4 months and BMI. Significant differences were found concerning gender (p = 0.042), maternal age (p < 0.001), paternal age (p = 0.004), maternal education (p < 0.001) and paternal education (p < 0.001) (Table 2). The sub-sample included in the analysis, therefore, has a higher proportion of boys and the parents were older and better-educated than the rest of the sample.

The median daily energy intake was 1221 kcal (percentile 25: 1078; percentile 75: 1381), being 1149 kcal (P25; P75: 1021–1291) in the second year of life (12–23 months) and 1297 kcal (P 25; P 75: 1155–1455) in the third year of life (24–36 months) (Table 3). These median intakes and even the 25th percentiles were higher than the mean recommendations at 12 and 24 months of age, which means that a large proportion of the children had a consumption above the energy recommendations for their age. The food groups that most contributed to energy intake were dairy products (25.4%) and cereal and cereal products, potatoes and other tubers group (23.5%) (Table S2). When analysing individual foods, the main energy sources were milk (10.7%), vegetable soup (8.8%) and fresh fruit (7%) (Table 4).

TABLE 2 Demographic characteristics of the sample with the three-day complete diaries compared to the rest of the sample

	Sample (n = 1377)	Sample with 3-day complete diaries (n = 853)	p
Child's gender *n* (%)	Girls: 671 (48.7) Boys: 706 (51.3)	Girls: 378 (44.3) Boys: 475 (55.7)	**0.042**
Maternal education *n* (%)	9 schooling years: 581 (43.0) 12 schooling years: 399 (29.5) Higher education: 371 (27.5)	9 schooling years: 291 (34.3) 12 schooling years: 246 (29.0) Higher education: 311 (36.7)	**<0.001**
Paternal education *n* (%)	9 schooling years: 713 (54.6) 12 schooling years: 365 (27.9) Higher education: 229 (17.5)	9 schooling years: 394 (47.5) 12 schooling years: 241 (29.0) Higher education: 195 (23.5)	**<0.001**
Maternal age [P50; (P25; P75)]	*n* = 1368 32.3 (13; 53)	*n* = 848 33.2 (14; 48)	**<0.001**
Paternal age [P50; (P25; P75)]	*n* = 1298 34.9 (19; 62)	*n* = 832 35.7 (13: 68)	**0.004**
Pre-pregnancy BMI [P50; (P25; P75)]	*n* = 1298 24.0 (15.1; 53.4)	*n* = 836 24.0 (14.7; 42.1)	0.753
Child BMI [P50; (P25; P75)]	*n* = 1291 0.52 (– 4.37;3.82)	*n* = 812 0.45 (–4,15; 4.15)	0.335
Exclusive Breastfeeding at 4 months *n* (%)	Yes: 786 (62.7) No: 468 (37.3)	Yes: 499 (64.2) No: 278 (35.2)	0.484

Note: The values in bold correspond to statistically significant values.

Abbreviation: BMI, body mass index.

TABLE 3 Median intakes of energy and macronutrients and respective prevalence of inadequacy, by age (months)

	DRV [(1)]	Total median (P25-P75)	PI %	Age 12–23 months median (P25-P75)	PI %	Age 24–36 months median (P25-P75)	PI %
Energy (Kcal/day)	Mean 870[a] [(2)]	1221 (1078; 1381)	—	1149 (1021; 1291)	—	1297 (1155; 1455)	—
Boys	Mean 903[a] [(3)]	1246 (1100; 1412)	—	1177 (1045; 1326)	—	1318 (1171; 1484)	—
Girls	Mean 829[a] [(4)]	1190 (1055; 1336)	—	1115 (995; 1244)	—	1270 (1140; 1411)	—
Protein (g/kg/d)	Mean 0.87[a] [(5)]	4.7 (4.1; 5.4)	—	4.8 (4.2; 5.5)	—	4.5 (3.9; 5.2)	—
Carbohydrates (% of energy)	45–60[b]	50.3 (47.7; 52.9)	9.2	50.4 (47.8; 53.0)	8.8	50.2 (47.6; 52.8)	9.5
Fibre (g)	10[c]	10.9 (9.2; 12.8)	36[d]	10.7 (9.0; 12.5)	39.3[d]	11.2 (9.4; 13.0)	32.8[d]
Total sugar (% of energy)		22.7 (20.3; 25.2)	—	23.7 (21.3; 26.1)	—	21.7 (19.4; 24.0)	—
Total fat (% of energy)	35–40[b]	30.8 (28.8; 32.9)	90.9	30.9 (28.9; 33.0)	90.9	30.8 (28.8; 32.9)	91

Note: (1) Recommendations from European Food Safety Authority.
Note: (2) Mean of average requirement at 1 and 2 years old (745; 987).
Note: (3) Mean of average requirement at 1 and 2 years old (777; 1028).
Note: (4) Mean of average requirement at 1 and 2 years old (712; 946).
Note: (5) Mean of average requirement at 1 and 2 years old (0.95 and 0.79).
Abbreviations: DRV, dietary reference value; PI, prevalence of inadequacy.
[a]Average requirement.
[b]Reference intake.
[c]Adequate intake.
[d]In the case of AI's, these % correspond to % of children who are below the AI value.

The median daily protein intake was 4.7 g/kg/day (Table 3), more than five times the mean average requirement, which is 0.87 g/kg/day for this age group (EFSA, 2012). The dairy products group contributed 35.4% of protein intake, with the main food source being milk (15.1%) (Table S2). About 9% of the children consumed a lower proportion of energy as carbohydrates than recommended lower limit (45–60% of total energy [TE]) and about 90% consumed a lower proportion of energy as fat than the recommended lower limit (35%–40% of TE) (Table 3). The major contributors to carbohydrate intake were fresh fruit (14.6%) and vegetable soup (8.3%) and the main contributors for fat intake were also vegetable soup (13.4%) and milk (8.9%) (Table 4). Concerning fibre intake, the median intake was slightly higher than the recommended value (10.9 g vs. 10 g) and 36% of the toddlers had an intake below the AI (10 g), with this proportion, being higher in the second year than in the third year of life (39.3% vs. 32.8%) (Table 3). About 50% of fibre intake was supplied by fresh fruit (31.4%) and vegetable soup (14.6%) (Table 4). An analysis by gender was also carried out and differences were found in the prevalence of children that consumed less fibre than the recommended AI (30.9% in male vs. 42.9% in female). The median total sugar intake, considering all mono- and disaccharides, was 22.7% of TE. (Table 3). The main food sources for this nutrient were fresh fruit (20.1%), milk (15.4%) and yogurt (13.9%) (Table 4).

The median intake of vitamin C (58.3 mg) was almost four times higher than the recommendation (15 mg). The median intake of folate was almost double the recommendation (Table 5). The main food groups contributing to folate intake are cereal and cereal products and potatoes and other tubers (36.1%) (Table S3) and the main food sources were breakfast cereals (12.7%) and vegetables (11.4%) (Table 6). Regarding vitamin A, the prevalence of inadequacy between 12 and 23 months was almost twice as high as between 24 and 36 months (35.7% vs. 19.3%) (Table 5). For calcium, the median intake was much higher than the AR for calcium, as was the median intake of phosphorus above the AI for phosphorus (Table 5). The median intake of vitamin B_{12} was almost double the AI but 30% of the children consumed less magnesium than the recommended AI (Table 5). Concerning iron, the prevalence of nutritional inadequacy in the second year of life was higher than in the third year (15.3% vs. 9.3%) and the main food sources were infant cereals (25%) and breakfast cereals (14.7%) (Table 6). Regarding sodium, most children were above the UL, and the prevalence of excessive intakes in the third year of life was higher than in the second year (95.6% vs. 79.5%) (Table 5). The main contributor to sodium intake was vegetable soup, providing more than 40% (Table 6). When analysing

TABLE 4 The 10 main food sources of energy and macronutrients (%) in Portuguese toddlers (12–36 months)

Food source	% Energy	Food Source	% Protein	Food source	% Total fat	Food source	% Carbohydrates	Food source	% Sugar	Food source	% Fibre
Milk	10.7	Milk	15.1	Vegetable soup	13.4	Fresh Fruit	14.6	Fresh Fruit	20.1	Fresh Fruit	31.4
Vegetable soup	8.8	Poultry	12.3	Milk	8.9	Vegetable soup	8.3	Milk	15.4	Vegetable soup	14.6
Fresh Fruit	7	Yogurt	12.3	Beef and veal	6.9	Infant Cereals	7.8	Yogurt	13.9	Vegetables	10.1
Yogurt	6.8	Fish	11.4	Poultry	6.8	Bread, crispbread, rusks	7.3	Infant Cereals	7.8	Potatoes and other tubers	6.6
Infant Cereals	6.1	Beef and veal	9	Growing-up Milk	6	Milk	7.3	Sweet biscuits	7.1	Bread, crispbread, rusks	6.3
Bread, crispbread, rusks	4.9	Infant Cereals	4.4	Rice	4.6	Yogurt	6.6	Growing-up Milk	4.7	Sweet biscuits	4.7
Poultry	4.7	Growing-up Milk	4.4	Yogurt	4.1	Sweet biscuits	5.5	Processed Fruits	4.3	Processed Fruits	4.5
Rice	4.3	Bread, crispbread, rusks	3.4	Infant Cereals	4	Potatoes and other tubers	5.4	Breakfast Cereals	3.3	Infant Cereals	4
Beef and veal	4.2	Pork meat	3.4	Fish	3.9	Rice	5.1	Vegetable soup	2.2	Cakes, pastries and croissants	2.6
Fish	3.8	Cheeses	1.8	Pork meat	3.3	Breakfast Cereals	4.3	Breast Milk	1.9	Pasta	1.7

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TABLE 5 Median intake of micronutrients and respective prevalence of inadequacy, by age (months)

	DRV [(1)]	Total median (P25-P75)	PI %	Age [12–23 months] median (P25-P75)	PI %	Age [24–36 months] median (P25-P75)	PI %
Vitamin A (mcg/d)	205[a]	271.2 (197.7; 360.9)	27.4	242.8 (176.7; 323.6)	35.7	301.2 (224.3; 393.8)	19.3
Vitamin B_1 (mg/d)	0.30[a] M; 0.28[a] F	0.7 (0.6; 0.9)	0.1	0.7 (0.6; 0.8)	0.2	0.8 (0.7; 1.0)	0
Vitamin B_2 (mg/d)	0.5	1.4 (1.1; 1.8)	0.4	1.3 (1.0; 1.6)	0.7	1.6 (1.3; 1.9)	0.1
Vitamin B_6 (mg/d)	0.5[a]	1.1 (0.9; 1.3)	0.4	1.0 (0.8; 1.2)	0.6	1.2 (1.0; 1.4)	0.1
Folate (mcg/d)	90[a]	158.2 (131.6; 190.0)	1.9	147.0 (123.2; 175.4)	3.1	169.9 (142.4; 202.7)	0.8
Vitamin B_{12} (mcg/d)	1.5[b]	2.9 (2.2; 3.7)	5.5[c]	2.6 (2.0; 3.3)	8[c]	3.1 (2.4; 4.0)	3[c]
Vitamin C (mg/d)	15[a]	58.3 (46.7; 72.0)	0	59.5 (47.7; 73.4)	0	57.1 (45.7; 70.6)	0
Vitamin D (mcg/d)	15[b]	2.1 (1.2; 3.3)	100[c]	2.3 (1.4; 3.6)	100[c]	1.9 (1.1; 3.0)	100[c]
Calcium (mg/d)	390[a]	970.3 (836.0; 1118.3)	0	942.9 (812.3; 1086.8)	0	997.6 (861.9; 1146.9)	0
Iron (mg/d)	5	7.8 (6.0; 10.1)	12.3	7.3 (5.7; 9.5)	15.3	8.2 (6.4; 10.6)	9.3
Magnesium (mg/d)	170[b]	187.1 (166.0; 209.2)	29.3[c]	179.0 (159.0; 200.0)	38.2[c]	195.1 (174.3; 216.9)	20.6[c]
Phosphorus (mg/d)	250[b]	961.1 (833.9; 194.5)	0[c]	906.9 (787.4; 1032.0)	0[c]	1015.4 (890.9; 1145.4)	0[c]
Potassium (mg/d)	800[b]	2246.5 (1993.1; 2513.7)	0[c]	2156.3 (1914.5; 2411.0)	0[c]	2336.8 (2085.8; 2600.8)	0[c]
Sodium (g/d)	1.5[d] [(4)]	1.9 (1.6; 2.1)	85.6	1.8 (1.6; 2.0)	79.5	2.0 (1.7; 2.2)	91.6

Note: (1) Recommendations from European Food Safety Authority.
Note: (2) Cut-off from Food and Nutrition Board of the Institute of Medicine.
Abbreviations: DRV, dietary reference value; F, female; M, male; PI, prevalence of inadequacy.
[a]Average requirement.
[b]Adequate intake.
[c]In the case of AI's, these % correspond to % of children who are below the AI value.
[d]Tolerable upper intake level.

nutritional intake by gender, girls presented a lower intake of vitamin B12 (lower than AI: 8.5% in girls and 3.6% in boys) and magnesium (lower than AI: 35.0% in girls and 25% in boys).

DISCUSSION

A large proportion of Portuguese toddlers had an excessive consumption of energy and sodium, high intakes of protein and a poor intake of vitamin A. They also consumed a low proportion of energy from fat due to the high proportion of energy from protein. About one-third of the sample consumed less than the recommended AI for fibre and magnesium and 100% had intakes less than the AI for vitamin D. For the other macro- and micronutrients, the intake was similar to the recommendations or presented negligible proportions of inadequacy.

These toddlers presented a high energy intake, as observed in other studies (Devaney et al., 2004; Huysentruyt et al., 2016; Manios et al., 2008). Besides resting energy expenditure, the recommendations for energy account for the energy needed for physical activity (at these ages, considered a low active lifestyle) and an additional 1% of energy expenditure for growth (EFSA, 2013). Excessive daily intakes of energy result in a positive energy balance that can predispose to obesity and ultimately, cardiovascular diseases (Weber et al., 2014) (FAO/WHO, 2003) (Smethers et al., 2019). Previous analyses of this sample, published by our group, found that at 24 months, 7.5% of toddlers were overweight or obese with a BMI z-score greater than 2 and 26.5% were at risk of overweight or obese with a

TABLE 6 The 10 main food sources of micronutrients (%) in Portuguese toddlers (12–36 months)

Food source	% Calcium	Food source	% Vitamin C	Food source	% Vitamin B1	Food source	% Folate	Food source	% Potassium	Food source	% Sodium	Food source	% Iron
Milk	32	Fresh Fruit	28.1	Breakfast Cereals	14	Breakfast Cereals	12.7	Milk	20.1	Vegetable Soup	42.1	Infant Cereals	25
Yogurt	24.2	Vegetables	18.5	Yogurt	8.8	Vegetables	11.4	Yogurt	13.2	Salt	8.6	Breakfast Cereals	14.7
Growing-up Milk	8.6	Vegetable Soup	11.8	Pork meat	7.1	Bread, crispbread, rusks	10.8	Fresh Fruit	11.7	Milk	6.1	Vegetable Soup	10.6
Infant Cereals	8.11	Infant Cereals	8.8	Fresh Fruit	7	Fresh Fruit	8.9	Vegetable Soup	10.7	Stocks	5.1	Bread, crispbread, rusks	5.5
Breakfast Cereals	3	Potatoes and other tubers	5.3	Infant Cereals	6.8	Yogurt	8.4	Potatoes and other tubers	7	Yogurt	4.7	Beef and veal	4.7
Cheeses	2.9	Breakfast Cereals	4.8	Potatoes and other tubers	6.2	Vegetable Soup	7.4	Fish	4.9	Bread, crispbread, rusks	4.6	Poultry	4.4
Vegetable Soup	2.6	Processed Fruits	4.6	Growing-up Milk	6	Pasta	4.3	Growing-up Milk	4.8	Fish	3.3	Milk	2.9
Vegetables	2.3	Natural Fruit and Vegetable juices	3.8	Bread, crispbread, rusks	5.7	Infant Cereals	3.8	Vegetables	4.8	Canned meat and meat products	2.9	Sweet biscuits	2.1
Milk beverages	1.7	Formula Milk	1.8	Vegetables	5.5	Fish	3.6	Beef and veal	3	Sweet biscuits	2.3	Rice	1.9
Fresh Fruit	1.4	Breast Milk	1.7	Pasta	4.9	Cakes, pastries and croissants	3.1	Poultry	2.6	Cheeses	2	Fish	1.9

BMI z-score greater than 1 and less than 2 (Nazareth et al., 2021).

The food group that most contributed to energy intake was dairy products, which contributed more than 25%, with milk being the major food contributor (10.7%). Other studies carried out in the United States also found that milk was the largest contributor to energy intakes from 12 to 24 months, with even higher contributions of more than 20% of energy intake (Fox et al., 2006; Grimes et al., 2015). Data from the G21 for Portuguese children at 4 years of age (Lopes et al., 2014), showed that dairy products contributed 21.3% of the energy intake, with milk also being the major contributor, representing 13.9%.

The average protein intake was 4.7 g/kg/day, corresponding to more than five times the average recommended intake (0.87 g/kg/day) by EFSA (EFSA, 2012). This result is in accordance with other studies, where the intake of protein was three or four times higher than the respective recommendations (Brunner et al., 2018; Michaelsen & Greer, 2014; Walton et al., 2017). These results are also in line with other two Portuguese studies, the G21 (4.2 g/kg/day) for children at age of 4 (Lopes et al., 2014) and the *IAN-AF*, where the authors found that 83.2% of the children below 10 years had an intake above 2 g/kg/day (Lopes et al., 2015). The *EPACI* results showed high protein intakes from a young age and corroborate, once again, the observations of protein intakes above recommendations that have been described in several European countries (Agostoni et al., 2005; Hörnell et al., 2013). The literature supports that an excessive intake of protein at earlier ages was associated with a greater risk of overweight and obesity in long term (Günther et al., 2007; Michaelsen & Greer, 2014; Weber et al., 2014), and it can be explained by the "Early Protein Hypothesis" (Koletzko et al., 2013; Michaelsen, 2000; Rolland-Cachera et al., 1995).

The main food source for protein intake was milk (15.1%). Milk was a central food in the Portuguese toddler's diet, although the European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) recommendations (ESPGHAN, 2017a) establish that from the age of complementary feeding (between 17 and 26 weeks), milk should no longer be the main food. Between the first and the third year of life, the daily consumption of dairy products should not exceed 400–500 ml (Benelam et al., 2015). In fact, milk continues to appear as a main food at this age, as parents always find it to be a complete food. It is a food that is familiar for children, who will therefore not reject it, providing an easy and convenient source of calories, and nutrients. The small decrease in average protein intake from the second year (4.8 g/kg/day) to the third year (4.5 g/kg/day) can be explained by the decrease in milk consumption with increasing age.

EPACI results described a high prevalence of inadequate fat intakes, where 90% of children consumed a lower proportion of energy as fat as that recommended (35%–40%). However, added fat is often underestimated, which can lead to an overestimation of inadequacy. It should also be noted that even though fat intakes as a proportion of energy are below the recommendations, the children had a high energy intake so that the absolute fat intake could meet or even exceed their needs. Nonetheless, we can find other references to the low intake of fat at these ages, in the literature. Walton et al. (Walton et al., 2017) found that 87% of children had a fat intake below recommendations, and the present results are also in line with previous results in the Portuguese population (Lopes et al., 2015; Vilela et al., 2019). The main food sources for fat were vegetable soup (13.4%), milk (8.9%), beef and veal (6.9%) and poultry (6.8%). As mentioned, milk continues to be a preponderant food in Portuguese toddlers' diets, and that at this age, the most consumed type of milk is semi-skimmed milk. This may explain why milk was not the main supplier of fat and contributes to the nutritional inadequacy of vitamin A since whole milk is also a good source of vitamin A, but semi-skimmed is not. Total fat was previously associated with cardiovascular disease (CVD), which probably led to changes in eating habits that included a reduction in its consumption (in all ages). This may explain the low intakes found in our study since there are no recommendations in Portugal, as there are in other countries such as the United Kingdom, not to give semi-skimmed milk as a main drink to children under 2 years. However, in the first years of life, fat plays a fundamental role in the maturing of cell membranes, especially in the central nervous system and in the retina (EFSA, 2010a). For this reason, it is not recommended to reduce fat intake until the age of 3 years, even in cases where the child presents dyslipidaemia or family risk for this disease. It is therefore important to also consider intakes of the different fatty acids (EFSA, 2010a).

Our results showed that 36% of the toddlers consumed less than the recommended AI for fibre, a pattern which has already been found in other studies. In fact, another Portuguese study concerning children aged between 7 and 9 years, found a prevalence of fibre inadequacy of about 90% (Valente et al., 2010), although a different recommendation was used. The main food sources for fibre were fresh fruit (31.4%), vegetable soup (14.6%) and vegetables (10.1%). The intake recommendations of five child-size portions of vegetables and fruit per day (Benelam et al., 2015; HSC Public Health Agency Belfast, 2018) must be achieved, so it is important to pay attention to this issue, always including vegetables in main meals (lunch and dinner) and including fruits in meals and snacks.

European children's sugar intake exceeds the recommendations (ESPGHAN, 2017b). The literature established that an excessive intake of sugar is related to dental caries (ESPGHAN, 2017b; Moynihan, 2016) and higher risk of overweight/obesity (ESPGHAN, 2017b). In the *EPACI* data, the median intake of total sugar was almost 25% of TE, and this percentage may be higher, since sugar consumption is often under-reported. However, the intake of free sugars was not possible to ascertain, and therefore it is not possible to determine the inadequacy prevalence. In fact, the three main food sources of sugar (fresh fruit, milk and yogurt) have naturally present sugars, which are not included in the definition of free sugars. As such, it can be postulated that the total sugar consumption was high, but an evaluation regarding only the free sugars would be more comprehensive. The EFSA recommendations were still not available in respect of sugar, but the World Health Organisation (WHO) Guidelines can be used (WHO, 2015). WHO guidelines for children and adults establish a cut-off of 10% of energy intake of free sugars, or even 5%. On the other hand, ESPGHAN (ESPGHAN, 2017b) advocate that the consumption of free sugars should be, at most, 5% of the TE intake for children of these ages.

A Portuguese study (Marinho et al., 2020) that analysed the different types of sugars found that almost 30% of children under 5 years consumed free sugars below 5% and almost 70% below 10%. The same study (Marinho et al., 2020) found that yogurts (16.1%) and infant cereals (14.2%) were the main food sources of free sugar in children under 5 years, and the main food sources of total sugars were milk (15.9%) and fruits (15.7%), which is in line with our results that are related to the total sugar.

In toddlerhood, rapid growth occurs, which is accompanied by an increase in nutritional requirements (Allen & Myers, 2006; Riley et al., 2018). At this stage, children acquire motor skills and become increasingly independent and able to feed themselves (Allen & Myers, 2006). Caregivers must provide a diversified diet, since a monotonous one could lead to nutritional deficits (Allen & Myers, 2006). Micronutrients play an important role in this life stage, characterised by rapid growth and development, with the needs per kg of weight being the highest in life and much higher than for adults (Weaver et al., 2008). This reinforces the importance of a varied and balanced diet (Benelam et al., 2015). A healthy diet during toddlerhood is also crucial to establish appropriate dietary habits in the future (Saavedra et al., 2013).

EPACI data revealed a low prevalence of nutritional inadequacy for many micronutrients, such as vitamins B_1, B_2, B_6, C, folate, calcium, but a prevalence of inadequacy for iron (12.3%), and vitamin A (27.4%). It also showed excessive intakes of sodium (85.6%). Similar results were found in previous national studies (Lopes et al., 2014; Valente et al., 2010) and in international studies in this age group (Brunner et al., 2018; Dalmau et al., 2015; Syrad et al., 2016).

Our results emphasise that food is a small contributor to vitamin D adequacy in this age group, as the total sample (100%) had an intake below the recommended AI. Since the main source of vitamin D is sun exposure, in cases where an adequate sun exposure is not guaranteed and/or recommended, supplementation should be considered. Apart from the recommendation for its universal supplementation during the first year of life, with a dosage of 400 IU/day (ESPGHAN, 2013; Wagner & Greer, 2008), supplementation should also be considered at any age, in at-risk groups, and especially during the fall and winter months (Holick et al., 2011; Saggese et al., 2018). Furthermore, unprotected sun exposure is not recommended until at least 2 years of age and this highlights the recommendation for universal supplementation in vitamin D up to that age, in line with the current recommendations from some nutrition committees (ESPGHAN, 2013).

More than a quarter of children were likely to have inadequate vitamin A intakes. Vitamin A can be found in the fat of dairy products, as well as in foods such as liver, eggs, yellow-orange vegetables and fruits and dark green vegetables (Mahan & Escott-Stump, 2000). An explanation for the high vitamin A inadequacy prevalence can be related to the low consumption of eggs and the reduced fat content of some dairy products, despite a heavy consumption of dairy products at these ages. As such, the use of reduced fat dairy products is probably not the best option at these ages.

About one-third of the toddlers (29.3%) consumed less than the recommended AI for magnesium. However, the median intake of magnesium was higher than the recommended AI and, therefore, the probability of inadequacy is low. These results are in line with the results found in other studies in different Portuguese populations (Dalmau et al., 2015; Lopes et al., 2014; Valente et al., 2010), some of which were conducted in older children (4 and 7–9 years old). The main food sources of magnesium are dried fruit, seeds, whole grains and dark green leafy vegetables, foods which are less frequently consumed by younger children, which may explain our results.

Our data also showed an excessive intake of sodium (especially considering the likely under-reporting of sodium) in children aged 12 months onwards. Sodium addition is proscribed during first year of life (ESPGHAN, 2017a) and sodium needs can be easily supplied by the salt naturally present in foods consumed by toddlers, so salt should not be added to food. The main food sources for sodium consumption were homemade vegetable soup (42.1%) and salt added to other dishes, mainly cooked at home (8.6%). Thus, since at this age children are supposed to be included in the family diet, it is important to reduce the amount of salt added (including in the vegetable soup) in the preparation of food for the whole family. There is an association between early consumption of excess sodium and the risk of hypertension, with the prevalence of hypertension in the Portuguese adult population being almost 40% (Rodrigues et al., 2019).

Many studies reveal a high prevalence of nutritional inadequacy for iron in young children (Brunner et al., 2018; Syrad et al., 2016), and a prevalence of nutritional iron inadequacy of 12.3% was found in this study. Inadequate iron intakes at this age could be explained by the high consumption of dairy products, which take the place of iron-rich foods, such as meat, and which also reduce the bioavailability of the iron (ESPGHAN, 2014). This is particularly relevant since the high growth velocity observed at this age results in a depletion of iron reserves around the sixth month of life, increasing the risk of iron deficiency and/or anaemia (EFSA, 2015). Iron plays an essential role in growth and health and its insufficiency in early ages may have implications on cognitive function and development (Walton et al., 2017). It is important that iron-rich and iron-fortified foods are always included in the diet, especially at these ages (Eussen et al., 2015), and particular attention must be paid to the amount of milk consumed.

In our study, the main contributors to the energy intakes were dairy products and vegetable soup, dairy products also being the main contributors to protein intakes. Although vegetable soup intake was relevant, we found that the total vegetable consumption was below the Portuguese dietary recommendations (Rodrigues et al., 2006). Intakes of cereals and tubers and fruits were also below the Portuguese dietary recommendations (Rodrigues et al., 2006). It would be helpful to promote the consumption of vegetables in main meals, as well as to increase the consumption of cereals, tubers and fruit throughout the day. We also found that, despite being foods that should not be part of toddlers' diets, sweets and sweet beverages are among the top nine food groups contributing to energy intake of toddlers.

The main strengths of this study are: (1) it is based on a national representative sample (Portugal mainland) - in fact, the *EPACI Portugal 2012* was the first study which provided dietary data about the intake of energy and nutrients, the prevalence of inadequate intakes and main food sources specifically in toddlers ages in Portugal; (2) the utilisation of food diaries as method for dietary intake assessment, which within the methods to record dietary intake is considered the gold standard.

However, some weaknesses must also be considered: only 38% of the sample filled in and returned the 3-day food diaries, although this participation rate is similar to other studies (Marinho et al., 2020; Moreira et al., 2015). Since this subsample (38%) consisted of older and better educated parents who, in general, tend to be better informed and more careful with their children's diet (Costarelli et al., 2022), the inadequacies could theoretically have been higher if the analysis had included all the assessed children.

It is important to consider that the data was reported by parents, which can lead to over or underreporting. Moreover, another weakness of our study was the analysis of sugars intake, which did not allow us to differentiate between added, free and total sugars, meaning a comparison with existing cut-offs that relate only to free sugars could not be made. Finally, since the data collection of the *EPACI* study was made 10 years ago, some food habits may have changed and the collection of updated data would be pertinent. Notwithstanding, these data are valuable as the baseline for further assessments.

CONCLUSIONS

Portuguese toddlers presented high intakes of energy and protein and a low proportion of energy from fat. Milk plays an important role in the diet at this age and was the main food responsible for this imbalance in the diet. An excessive intake of sodium begins at a young age, low intakes of vitamin A was observed in nearly a third of children and 100% of the children consumed less vitamin D than the recommended AI. The main contributor to sodium intake was vegetable soup and salt added to other dishes, reinforcing the importance of the recommendation to reduce salt when cooking at home. These data do not support a universal recommendation of multivitamin supplementation during toddlerhood, but supplementation must be considered for vitamin D.

AUTHOR CONTRIBUTIONS

M.N. was responsible for the coordination of fieldwork and data collection, conducted the treatment of data, performed statistical analysis, contributed to the interpretation of data and wrote the manuscript. E.P. contributed to the study design, was responsible for the fieldwork and data collection supervision, performed data and statistical analysis and revised the manuscript. M.S. performed statistical analysis and interpretation of data. P.G. contributed to the study design and interpretation of the results. C.L. contributed to the study design and revised the final version of the manuscript. C.R. was responsible for the coordination of the project, contributed to the study design, interpretation of data and revised the manuscript. All authors approved the final version of the manuscript.

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CONFLICTS OF INTEREST

The authors report no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

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Paper 3

***Suplementação Vitamínica e Mineral em Portugal Durante o Primeiro Ano de Vida: Resultados do EPACI Portugal 2012* [Vitamin and Mineral Supplementation in Portugal During the First Year of Life: Results from EPACI Portugal 2012] (paper in Portuguese).**

For this manuscript, I coordinated fieldwork, prepared and collected data and made final revisions of the manuscript.

Suplementação Vitamínica e Mineral em Portugal Durante o Primeiro Ano de Vida. Resultados do EPACI Portugal 2012

Vitamin and Mineral Supplementation in Portugal During the First Year of Life. Results From EPACI Portugal 2012

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Resumo

Introdução: A adequação nutricional e o *status* vitamínico e mineral são determinantes para a saúde, crescimento e desenvolvimento. São desconhecidas as práticas de suplementação nos lactentes portugueses. Pretendeu-se caracterizar a suplementação em vitaminas e minerais e quantificar a sua associação com fatores sociodemográficos e sanitários, numa amostra representativa nacional.

Métodos: Do questionário retrospetivo, presencial, aplicado aos acompanhantes de 2232 crianças (12-36 meses) e integrado no protocolo do Estudo do Padrão Alimentar e de Crescimento na Infância - Portugal 2012, foi retirada informação relativa à toma de suplementos durante o primeiro ano de vida.

Resultados: Verificou-se que 68,3% dos lactentes portugueses efetuam suplementação com vitamina D e 16,6%, 24,0 % e 4,5% efetuam, respetivamente, com ferro, vitamina C e flúor. Residir na zona Norte (exceto para o flúor) ou ser acompanhado em simultâneo por pediatra/médico de família, associa-se a maior frequência de suplementação. O acompanhamento apenas por médico de família aumenta o risco em 23,0% e 45,0% de não ser efetuada suplementação, respetivamente, com vitamina D e ferro. A prematuridade associa-se a suplementação com ferro e com multivitamínico. Maior escolaridade materna ou viver casada/em união de facto associa-se a maior frequência de suplementação em vitamina D.

Discussão: Apenas dois terços dos lactentes portugueses efetuam suplementação com vitamina D, um sexto efetua com ferro e um quarto com vitamina C. A suplementação com flúor é residual e a suplementação com multivitamínico associa-se à prematuridade. Fatores socioeconómicos, o prestador de cuidados de saúde de rotina e a localização geográfica associam-se, em Portugal, à prevalência da suplementação vitamínica e mineral durante o primeiro ano de vida.

Palavras-chave: Determinantes Sociais da Saúde; Lactente; Minerais/uso terapêutico; Suplementos Nutricionais; Vitaminas/uso terapêutico

Abstract

Introduction: Adequate nutritional status is essential for health, growth and development. Practices regarding vitamin and mineral supplementation in Portuguese infants are unknown. The objectives were to characterise vitamin and mineral supplementation practices and to quantify their association with social, demographic and health-related factors, in a representative national sample.

Methods: From the EPACI Portugal 2012 study protocol, a questionnaire that included, among others, retrospective information reporting supplementation during the first year of life was applied in the presence of the caregivers of 2232 children (aged 12-36 months).

Results: A total of 68.3% of Portuguese infants receive vitamin D supplements; 16.6%, 24.0% and 4.5% receive supplements of iron, vitamin C and fluoride, respectively. Living in the North region (except for fluoride) and followed simultaneously by a paediatrician and a general practitioner is associated with a significantly higher frequency of supplementation. Being followed only by a general practitioner increases the risk of non-supplementation with vitamin D and iron in 23% and 45%, respectively. Prematurity is associated with iron and multivitamin supplementation. Children whose mothers have higher education level or are married or live in a *de facto* union are more often supplemented with vitamin D.

Discussion: Only two-thirds of Portuguese infants receive vitamin D supplements, a sixth receive iron supplements and a quarter receive vitamin C supplements. Fluoride supplementation is uncommon, and multivitamin supplementation is strongly associated with prematurity. Socioeconomic factors, the usual health care provider and the geographical area of residence seem to be associated, in Portugal, with the prevalence of vitamin and mineral supplementation during the first year of life.

Keywords: Dietary Supplements; Infant; Mineral/ therapeutic use; Vitamins/therapeutic use; Social Determinants of Health

Introdução

O estado nutricional em geral e particularmente o *status* vitamínico e mineral têm um forte impacto no estado de saúde, numa perspetiva transversal à vida. Após o nascimento, o leite materno (LM) é um alimento completo para um lactente saudável até ao sexto mês de vida, exceto no que reporta à vitamina D (vitD) e ao ferro.[1] A partir do sexto mês, a sua composição em macronutrientes e a sua insuficiência em algumas vitaminas e minerais obriga à introdução de alimentos complementares, tornando esta fase da vida um verdadeiro desafio relativamente à adequação da oferta alimentar.[2,3-6]
As deficiências em vitD e ferro são as mais frequentes em todos os grupos etários à escala global, mas são particularmente frequentes durante a gravidez e o primeiro ano de vida, especialmente em grupos de risco.[2,7-12]
No que respeita à vitD, a mudança do estilo de vida e as particularidades da síntese desta vitamina (90% da sua síntese é cutânea, resultando da exposição à radiação solar ultravioleta), estão na origem do aumento mundial da prevalência de situações carenciais ao longo de toda a vida.[2,11,12] Para além do *status* de vitD da gestante ser determinante das reservas do recém-nascido,[13]o aleitamento materno exclusivo, a suplementação irregular no lactente, a prematuridade, a pele escura, a ausência de exposição solar, o excesso de peso e a residência numa elevada latitude e/ou altitude são alguns dos fatores de risco conhecidos para a diminuição das reservas.[2,12,14] A vitD tem um importante papel no metabolismo fosfocálcico e na formação de massa óssea,[15] sendo crescente a literatura que atribui à sua suplementação efeitos protetores da saúde cardiovascular e uma redução do risco de doença neoplásica, autoimune e mental, entre outras, particularmente na idade adulta.[16] A suplementação em vitD é universalmente recomendada durante o primeiro ano de vida na dose de 400 UI/dia,[2,11] não apenas tendo em conta a saúde óssea, mas atendendo ao possível envolvimento desta vitamina /pro-hormona em processos de *imprinting* metabólico.[17] Deve ser introduzida nos grupos de risco,em qualquer idade,durante os meses de outono e inverno.[2,9,11-14]
A deficiência em ferro (DF) é um problema de saúde pública à escala planetária e a carência nutricional mais prevalente a nível mundial.[8] Em lactentes amamentados, a prevalência da DF no primeiro e segundo semestres de vida oscila entre 6-15%[18,19] e 4-9%,[20] respetivamente. Já no que respeita à anemia por deficiência em ferro (ADF) e neste grupo particular de lactentes, as prevalências para o primeiro semestre rondam os 1%[19,21] e os 3-3,6%,[18,21,22] enquanto no segundo semestre oscilam entre os 1-2% (Suécia, Estados Unidos)[18,21] e os 18,8% (Honduras),[21] denotando uma forte influência das variáveis socioeconómicas. O LM é pobre em ferro (0,2-0,4 mg/L), que muito embora apresente uma elevada biodisponibilidade,[23,24] poderá não cobrir as necessidades para o crescimento e para a substituição das perdas, particularmente no segundo semestre de vida.[25-27]
Em lactentes alimentados com fórmula para lactentes, não existe evidência científica que permita concluir sobre a adequação da ingesta em micronutrientes,[28] nomeadamente em ferro. Em Portugal, é desconhecida a prevalência nacional de DF e ADF no primeiro ano de vida, apontando um estudo realizado em 2005 no Norte do país, para valores de ADF de 19% aos 9 meses de idade.[29] Alguns autores demonstram a existência de um risco de compromisso neurocognitivo e motor associado à DF numa fase precoce da vida (0-2 anos), nunca totalmente reversível,[7,22,26,30,31] e com uma gravidade tanto maior quanto, para além da DF, se registe ADF.[26,31,32] A DF está ainda associada a alterações da resposta imune à infeção, a alterações gastrointestinais, bem como a compromisso da velocidade de crescimento.[7,30,33] Muito embora situações de deficiência severa na gestante[32,34] ou certas complicações da gravidez[32,35] possam reduzir as reservas de ferro do recém-nascido, na maioria das circunstâncias o *status* de ferro materno não é um determinante *major* das reservas de ferro ao nascimento, sendo de momento desconhecidas as causas que determinam a sua variação.[32] Muito embora tendo em consideração a possibilidade de uma grande variabilidade individual,[32] o recém-nascido saudável, de termo e adequado à idade gestacional terá reservas de ferro adequadas às exigências de crescimento e maturação até cerca dos 4-5 meses de vida.[1,3,32] A dimensão das reservas de ferro individuais, a elevada velocidade de crescimento, o sexo masculino, a pobreza em ferro do LM e a dificuldade em, mesmo com a diversificação alimentar, se atingirem as recomendações diárias para este mineral, leva a ponderar a sua suplementação em alguns lactentes, pelo menos até ao final do primeiro ano de vida.[7,10,18,28,33] Tal facto torna-se tanto mais impor-

tante quanto se reconhece que a velocidade de declínio das reservas depende particularmente da precocidade do seu início,[17] mas também do aporte exógeno de ferro.[18,32,36] Uma revisão sistemática recente demonstra que os lactentes da maioria dos países europeus efetuam, durante o segundo semestre de vida, uma ingesta média de ferro de 7,8mg/dia,[27] para um aporte médio recomendado de 11 mg/dia,[10,25] variando a prevalência de adequação da ingesta entre 6% (Holanda) e 50% (Alemanha e Islândia),[27] com valores mais baixos nos grupos socioeconómicos mais desfavorecidos e naqueles que introduzem o leite de vaca em natureza como principal fonte láctea, durante o primeiro ano de vida.[27]
A inexistência de dados relativos a Portugal é um aspeto apontado pelos autores.[27]

No que respeita à vitamina C (vitC), o LM ou a fórmula para lactentes em exclusivo até ao sexto mês e a adequada introdução da diversificação alimentar, garantem o suprimento das necessidades, não existindo, pois, risco de carência que justifique a recomendação para a sua suplementação universal, durante o primeiro ano de vida.[1,25,28]

Relativamente ao flúor, a publicação, em 2005, das recomendações para a prevenção de cáries pela German Society of Oral and Maxillofacial Surgery (DGZMK) criou grandes divergências entre pediatras e dentistas.[37] Efetivamente, a DGZMK tal como a European Academy of Pediatric Dentistry (EAPD) e a American Academy of Pediatric Dentistry (AAPD), recomendam o uso precoce de pasta fluoretada na escovagem dos dentes como medida de prevenção de cáries definitivas,[38-40] enquanto a German Society of Pediatrics and Adolescent Medicine (DGKJ) e a German Academy for Pediatrics and Adolescent Medicine (DAKJ) rejeitam o uso de dentífrico fluoretado no lactente e criança pequena (menor de 4 anos) e recomendam o uso de suplementos de flúor (gotas ou comprimidos).[41] Em 2013 ainda não tinha sido encontrado um consenso entre estas sociedades científicas.[37]

É desconhecida a prevalência e o tipo de suplementação em vitaminas e minerais efetuado pelos lactentes portugueses. Pretendeu-se assim caracterizar a suplementação em vitaminas e minerais durante o primeiro ano de vida e quantificar a sua associação com fatores sociodemográficos e sanitários, numa amostra representativa nacional de crianças dos 0-36 meses.

Métodos

O presente trabalho teve por base o Estudo do Padrão Alimentar e de Crescimento na Infância (EPACI) Portugal 2012, um estudo representativo nacional, transversal, com recolha retrospetiva de informação desde o nascimento até à data da avaliaçãoe que decorreu entre maio de 2012 e julho de 2013. Foram avaliadas 2232 crianças entre os 12-36 meses (47% do sexo feminino e 49,5% entre os 12-24 meses), selecionadas aleatoriamente com base no registo do Sistema Nacional de Saúde. O tamanho amostral foi calculado para que fossem avaliadas aproximadamente 1% das crianças portuguesas com idades compreendidas no intervalo em estudo, tendo sido selecionadas e avaliadas em 128 unidades de saúde de cuidados primários, distribuídas em Portugal continental.
O estudo recebeu o parecer favorável da Comissão Nacional de Proteção de Dados e o aval da Comissão de Ética da Universidade Católica Portuguesa e das Comissões de Ética das várias Administrações Regionais de Saúde (ARS). Os objetivos e as características do estudo foram cuidadosamente explicados ao adulto que acompanhava a criança, sendo a participação formalizada através da assinatura de consentimento informado.
As avaliações decorreram nas unidades de saúde de referência das crianças, foram efetuadas por entrevistadores treinados e incluíam a caracterização do estado de nutrição, bem como a aplicação ao cuidador (preferencialmente os progenitores) de um questionário semiestruturado e a recolha de informação do Boletim de Saúde Infantil e Juvenil.

Do protocolo de avaliação foi retirada informação relativa a dados sociodemográficos e à toma de suplementos vitamínicos (vitD, vitC e multivitamínicos com minerais) e minerais (ferro e flúor) durante o primeiro ano de vida. De forma a aumentar a precisão da informação, foram utilizadas para demonstração embalagens dos suplementos prescritos na prática clínica em Portugal. Nos casos em que o cuidador inquirido não sabia ou não se recordava da suplementação realizada, procedeu-se ao contacto telefónico para recolha ou confirmação dessa informação.
A descrição das variáveis categóricas foi feita através de frequências absolutas e frequências relativas. A única variável contínua considerada na presente análise foi a idade materna, tendo sido descrita através de média e respetivo desvio-padrão, após verificação da normalidade da sua distribuição. Foram calculados os intervalos de confiança a 95% (IC95%) para a prevalência de suplementação vitamínica e mineral durante o primeiro ano de vida para as regiões sob jurisdição da Administração Regional de Saúde (ARS). O teste de qui-quadrado foi usado para comparação de proporções e, para quantificar a associação entre as várias características e a toma dos suplementos, foram construídos modelos de regressão logística múltipla. Foi considerado um nível de significância de 5%. A análise estatística foi elaborada com recurso ao *software* SPSS 21.0.

Resultados

Do total dos cuidadores entrevistados, 88,3% eram mães. As características do binómio mãe-filho podem ser analisadas na Tabela 1.

Cerca de dois terços das mães tinham mais de 12 anos de escolaridade. Observou-se uma prevalência de prematuridade de 8,1% e de desadequação do peso ao nascimento de 7,4%, com uma distribuição sobreponível entre a classificação de leve para a idade gestacional (LIG) (3,5%) e grande para a idade gestacional (3,9%).

A caracterização da suplementação vitamínica e mineral durante o primeiro ano de vida pode ser observada na Tabela 2.

Observa-se um incumprimento das recomendações para a suplementação universal com vitD durante o primeiro ano de vida em 31,7% dos lactentes portugueses e, apesar da ausência de evidência que justifique a suplementação, cerca de um quarto dos lactentes ainda efetuam suplementação com vitC. A suplementação em ferro e vitD durante o primeiro ano de vida é significativamente menos reportada pelos cuidadores das crianças que, à data da avaliação, tinham 24-36 meses, comparativamente ao que acontece com o grupo de crianças mais jovem.

Tabela 1. Características maternas e da criança

Característica	n =2232
Idade materna (anos) (média ± DP)	32,6 ±5,5
Estado civil da mãe [n(%)]	
Casada /união de facto	1972 (88,4)
Outra situação	260 (11,6)
Escolaridade materna [n(%)]	
≤ 12 anos	885 (40,0)
>12 anos	1325 (60,0)
Nascimentos pré-termo [n(%)]	178 (8,1)
Peso ao nascimento*	
<2500g	71 (3,5)
2500 - 3999 g	1871 (92,6)
>3999 g	79 (3,9)

DP - desvio padrão.
* Apenas considerados recém-nascidos de termo.

Muito embora o EPACI seja um estudo representativo nacional, não tendo a pretensão de ter representatividade regional, a distribuição da frequência da suplementação nas diferentes vitaminas e minerais avaliados, por região, pode ser observada na Tabela 3. A divisão regional tem em conta as zonas alocadas às ARS e não as regiões administrativas do país.

Observam-se diferenças significativas na frequência de suplementação entre as diferentes regiões, para todas as vitaminas e minerais estudados, sendo que a zona Norte regista as taxas de suplementação mais elevadas do país, excepto para o flúor.

A Tabela 4 mostra a influência do profissional de saúde que acompanha regularmente a criança no cumprimento da suplementação. As crianças que foram simultaneamente acompanhadas por pediatra e médico de família efetuaram, de uma forma significativamente mais frequente, suplementação com todas as vitaminas e minerais estudados, quando comparadas com as crianças acompanhadas apenas por um dos profissionais.

Na Tabela 5 pode observar-se a influência dos fatores sociodemográficos, distribuição geográfica, características e tipo de cuidados de saúde de rotina das crianças, na suplementação vitamínica e mineral. Apresentam-se somente os resultados dos modelos ajustados, sendo que cada variável foi ajustada para as restantes variáveis constantes na tabela. Verifica-se que viver em qualquer região do país diferente da região Norte aumenta o *odds* de não realizar suplementação em vitD e ferro, mas não em multivitamínico, à exceção para este último no que respeita à região Centro, quando comparada com a região Norte. A prematuridade cursa com um *odds* acrescido de quatro vezes relativamente à suplementação em ferro e multivitamínico, enquanto ser seguido apenas pelo médico de família aumenta em 27% e 45% o *odds* de não efetuar suplementação em vitD e ferro, respetivamente. O estado civil da mãe (casada ou a viver em união de facto) e a sua escolaridade (mais de 12 anos) tem um *odds* acrescido de ser regularmente efetuada suplementação com vitD no primeiro ano de vida.

Tabela 2.Caracterização da suplementação vitamínica e mineral durante o primeiro ano de vida tendo em conta a totalidade da amostra e o grupo etário à data da avaliação (12-24 ou 24-36 meses)

Suplemento	Total (n= 2232)	12-24meses (n= 1106)	24-36 meses (n= 1126)	p
Vitamina C[n(%)]	536 (24,0)	252(22,9)	284(25,4)	0,159
Vitamina D[n(%)]	1 524 (68,3)	802(72,7)	722(64,8)	< 0,001
Ferro[n(%)]	371(16,6)	202(18,3)	169(15,1)	0,045
Flúor[n(%)]	101(4,5)	44(4,0)	57(5,1)	0,208
Multivitamínico[n(%)]	204(9,1)	106(9,6)	98(8,8)	0,499

Tabela 3. Caracterização da suplementação vitamínica e mineral durante o primeiro ano de vida tendo em conta totalidade da amostra e a região sob jurisdição da Administração Regional de Saúde

Suplemento	Total (n= 2232)	ARS Norte (n=775;34,7%)	ARS Centro (n=334;15%)	ARS Lisboa e Vale do Tejo (n=921;41,3%)	ARS do Alentejo (n=107;4,8%)	ARS do Algarve (n=95;4,3%)	p
Vitamina C [% (IC95%)]	24,0 (22,3;25,8)	32,3 (29,0;35,7)	20,1 (16,0;24,8)	18,3 (15,8;21,0)	27,1 (19,0; 36,6)	25,3 (16,9;35,2)	<0,001
Vitamina D [% (IC95%)]	68,3 (66,3; 70,2)	84,5 (81,7;87,0)	54,1 (48,5;59,5)	64,9 (61,7;68,0)	46,7 (37,0;56,6)	53,7 (43,2;64,0)	<0,001
Ferro [% (IC95%)]	16,6 (15,1;18,2)	33,0 (29,7;36,5)	12,0 (8,7;16,0)	6,5 (5,0;8,3)	7,5 (3,3;14,2)	7,4 (3,0;14,6)	<0,001
Fluor [% (IC95%)]	4,5 (3,7;5,5)	6,1 (4,5;8,0)	2,4 (1,0;4,7)	3,3 (2,2;4,7)	5,6 2,1;11,8)	10,5 (5,2;18,5)	0,001
Multivitamínico [% (IC95%)]	9,1 (8,0;10,4)	11,7 (9,5;14,2)	5,1 (3,0;8,1)	9,1 (7,3;11,2)	7,5 (3,3;14,2)	6,3 (2,4;13,2)	0,008

ARS - Administração Regional de Saúde; IC95% -intervalo de confiança a 95%.

Tabela 4. Suplementação vitamínica e mineral de acordo com o profissional responsável pela vigilância da saúde da criança

Suplemento	Total (n=2214)	Pediatra (n= 633)	Médico de família (n= 882)	Pediatra e médico de família (n= 699)	p
Vitamina C[n(%)]	534 (24,5)	132 (21,1)	205 (23,9)	194 (28,5)	0,007
Vitamina D[n(%)]	1518 (68,8)	448 (71,1)	541 (62,3)	524 (75,2)	<0,001
Ferro[n(%)]	372 (17,0)	95 (15,2)	96 (11,2)	179 (25,9)	<0,001
Flúor[n(%)]	101 (4,7)	33 (5,3)	24 (2,8)	44 (6,5)	0,002
Multivitamínico[n(%)]	203 (9,4)	56 (9,0)	61 (7,2)	85 (12,5)	0,002

Tabela 5. Determinantes da suplementação vitamínica e mineral durante o primeiro ano de vida

	Vitamina D OR ajustado* (IC95%)	Ferro OR ajustado* (IC95%)	Multivitamínico OR ajustado* (IC95%)
ARS			
Norte	1	1	1
Centro	**0,21 (0,16; 0,29)**	**0,27 (0,19; 0,40)**	**0,43 (0,25; 0,74)**
Lisboa e Vale do Tejo	**0,33 (0,26; 0,43)**	**0,14 (0,10; 0,20)**	0,89 (0,63; 1,26)
Alentejo	**0,15 (0,10; 0,23)**	**0,13 (0,06; 0,29)**	0,66 (0,30; 1,42)
Algarve	**0,20 (0,13; 0,32)**	**0,17 (0,08; 0,37)**	0,58 (0,24; 1,39)
Idade gestacional da criança			
< 37 semanas	0,75 (0,53; 1,07)	**3,96 (2,75; 5,71)**	**4,23 (2,89; 6,18)**
≥ 37 semanas	1	1	1
Idade da criança na avaliação			
12-24 meses	1	1	1
24-36 meses	**0,69 (0,57; 0,84)**	**0,78 (0,61; 0,99)**	0,90 (0,67; 1,22)
Acompanhamento de saúde de rotina			
Pediatra	1	1	1
Médico de família	**0,73 (0,57; 0,94)**	**0,55 (0,39; 0,79)**	0,93 (0,62; 1,41)
Pediatra e médico de família	0,96 (0,73; 1,25)	1,00 (0,73; 1,38)	1,37 (0,92; 2,02)
Estado civil da mãe			
Casada/ união de facto	**1,46 (1,09; 1,96)**	1,00 (0,65; 1,55)	1,76 (0,95; 3,26)
Outro	1	1	1
Escolaridade materna			
< 12 anos	1	1	1
≥ 12 anos	**1,32 (1,07; 1,63)**	1,12 (0,85; 1,47)	1,13 (0,81; 1,58)

ARS - Administração Regional de Saúde; OR - *odds ratio*.
* Todas as variáveis foram ajustadas para as restantes variáveis constantes na tabela.
Os valores realçados a negrito são estatisticamente significativos (p< 0,05).Todas as classes assinaladas com OR=1 foram consideradas como classes de referência.

Discussão

É inquestionável a importância dos micronutrientes na saúde de uma forma geral e, particularmente, o seu papel no crescimento e desenvolvimento saudáveis, durante a idade pediátrica.

Em Portugal, é totalmente desconhecida a taxa de suplementação em vitaminas e minerais durante o primeiro ano de vida, sendo também escassa a informação acerca desta realidade em outros países da europa.[42-45]

Pode verificar-se que foram as mães que responderam em mais de dois terços dos casos, e que a esmagadora maioria das crianças portuguesas avaliadas (88,4%) vive em famílias nucleares. A mulher apresenta maior escolaridade (mais de 60% tem mais de 12 anos de escolaridade, comparativamente a 21% para o homem), mas também maior taxa de desemprego (22,7% vs 10,9%) (dados não apresentados). Muito embora culturalmente seja a mulher quem habitualmente acompanha a criança à consulta médica, esta maior prevalência de desemprego na mulher poderá ser um factor adicional a justificar a predominância da sua presença, sozinha, na entrevista.

A prevalência de incumprimento registada pelo EPACI, relativamente às recomendações para a suplementação universal com vitD durante o primeiro ano de vida, é preocupante (31,7% dos lactentes). É sabido que a deficiência em vitD *in utero* e durante os primeiros anos está associada a atraso de crescimento, a deformidades esqueléticas (raquitismo) e a maior risco de osteoporose e fraturas ósseas na idade adulta.[2,9,15] O aumento crescente de carência nesta vitamina na população em geral e na grávida em particular,[2,6,9,12,46-48] acrescido do facto de ser frequentemente desconhecido o *status* de vitD da grávida, resulta num risco não desprezível de compromisso do *status* de vitD do recém-nascido com consequências na saúde para a vida. Existem evidências que a deficiência em vitD aumenta drasticamente na díade mãe-filho durante o primeiro mês pós-parto, particularmente em mulheres que amamentam, atingindo valores superiores a 50% na mulher (insuficiência mais deficiência) e a 80% no recém-nascido (deficiência).[48] A prevalência de deficiência no lactente reduz-se consideravelmente aos 4 meses, na dependência da exposição solar e/ou da suplementação em vitD,[47] razões que reforçam a importância da suplementação universal, precoce e regular. Importa chamar a atenção para o facto de que a administração irregular (não diária) ou numa dose inferior à recomendada (< 400 UI/dia) se associa a um maior risco de deficiência em vitD,[49] bem como a ausência de suplementação durante a diversificação alimentar está associada à ingestão de quantidades inferiores a 400 UI/dia em mais de 50% dos lactentes.[50] Tendo em conta o conhecimento atual, vários países, nomeadamente da Europa Central, preconizam o rastreio e a suplementação universal para toda a população.[51] Suportados na literatura, os autores julgam ser recomendável a inclusão da avaliação do *status* da vitD na rotina da vigilância da gravidez, bem como um esforço imprescindível de sensibilização dos profissionais de saúde para a prescrição sistemática da suplementação e para a vigilância do seu cumprimento, até pelo menos ao final do primeiro ano. Existem poucos estudos acerca da adesão dos profissionais de saúde, particularmente dos pediatras, à prescrição da suplementação com vitD no primeiro ano de vida, variando os resultados encontrados entre 96% no Chile,[42] 36,4-48,0% nos Estados Unidos[43-45,52] e 40%na Arábia Saudita.[53] Um certo facilitismo por parte dos profissionais no que respeita à educação e informação dos pais[53] bem como o desconhecimento das recomendações,[42] são as causas mais frequentemente apontadas. Já os estudos que abordam a adesão dos pais relativamente ao cumprimento da prescrição são ainda mais escassos, encontrando-se valores que oscilam entre 15,1% nos Estados Unidos,[45] 60,2% na Polónia[54] e 79% na Turquia.[49] Como razões para o não cumprimento da recomendação médica está o esquecimento, a noção de que o leite materno é completo, de que a diversificação alimentar garante o suprimento de todas as vitaminas, o número de filhos (mais de dois) e a pouca importância atribuída à vitD.[42,45,50,53] Em Portugal, quando o seguimento da criança é apenas efetuado pelo médico de família, existe significativamente menor probabilidadede ser efetuada suplementação com vitD e ferro, enquanto as crianças acompanhadas simultaneamente por ambos os profissionais cumprem, mais frequentemente, a suplementação nesta vitamina e mineral, e realizam, mais frequentemente, suplementação com vitC, flúor e multivitamínico (Tabelas 4 e 5). Pode daqui inferir-se que o reforço da recomendação e uma maior vigilância, garantem um maior cumprimento. Torna-se interessante referir, muito embora salvaguardando a inexistência de representatividade regional do EPACI, a ocorrência de marcadas assimetrias regionais, com prevalências de suplementação significativamente mais elevadas para a região Norte, à excepção do flúor. Em Portugal, a vigilância da saúde infantil em algumas zonas do país é mais da responsabilidade dos cuidados de saúde primários (região Centro), sendo por isso essencialmente feita por médicos de medicina geral e familiar, enquanto noutras, o recurso ao pediatra em regime privado é culturalmente mais frequente (região Norte). Estas particularidades regionais do tipo de prestação de cuidados de saúde à criança poderão justificar, em parte, as assimetrias regionais encontradas, muito embora

também não se possa excluir a influência das "escolas" académicas na promoção de diferentes práticas clínicas.
Relativamente ao ferro, o EPACI documenta uma frequência de suplementação baixa (16% a nível nacional), com valores notoriamente mais elevados na região Norte (33% dos lactentes). Como causa provável pode apontar-se a ausência de consenso relativamente à recomendação de suplementação com este mineral. Efetivamente, alguns autores demonstram que a suplementação precoce (no primeiro semestre) está associada a uma melhoria do *status* do ferro mas não apresenta repercussões hematológicas[18] e a suplementação por rotina, no segundo semestre de vida, resulta numa melhoria dos parâmetros hematológicos mas não influencia os parâmetros neurocognitivos, comportamentais e de crescimento,[33] enquanto outros autores encontram uma associação entre a suplementação precoce (aos 1-6 meses de vida) e um aumento da concentração da hemoglobina e do volume corpuscular aos 6 meses, bem como uma melhoria da acuidade visual e dos índices de desenvolvimento psicomotor aos 13 meses.[55] A suplementação com ferro no primeiro semestre de vida (4-5 meses), particularmente em lactentes alimentados com LM, está ainda associada a uma menor velocidade de redução das reservas de ferro e menor risco de DF no segundo semestre de vida.[32] Nunca é demais recordar as consequências da DF/ADF no desenvolvimento neurocognitivo e não só, sendo o primeiro ano e particularmente o segundo semestre de vida (*brain gowth spurt*) e o sexo masculino, apontados como fatores de maior susceptibilidade.[7,29,56] Não havendo uma relação clara entre o *status* em ferro da mulher antes e durante a gravidez e o risco de DF/ADF no primeiro ano de vida, as reservas de ferro do recém-nascido, mas particularmente o adequado aporte exógeno (alimentar ou por suplementação), devem ser tidos em conta, num contexto de prevenção. Neste âmbito,importa relembrar o baixo teor de ferro do LM bem como a grande dificuldade em se atingir a recomendação diária na ingesta deste mineral, durante a fase de diversificação alimentar. Efetivamente, mesmo nos lactentes alimentados com fórmula, muito dificilmente se consegue ultrapassar uma ingestão de 7 mg/dia sem agravar ainda mais a já frequente inadequação, por excesso, em proteína (dados não apresentados).
Num lactente saudável, o LM ou a fórmula para lactente e a adequada diversificação alimentar suprem totalmente as necessidades em vitC necessárias ao crescimento e desenvolvimento durante o primeiro ano de vida.[1,28] No que respeita ao flúor, a divergência de recomendações no que reporta à prevenção primária da cárie nos primeiros anos de vida gera alguma confusão, não apenas nos progenitores mas particularmente nos profissionais de saúde, razão da frequente disparidade de atitudes encontrada, quer na literatura[37] quer nos resultados presentes. Para além deste aspeto, no primeiro ano de vida não existe carência comprovada neste mineral e a suplementação,muito embora se associe à redução futura do número de cáries, conduz por vezes a situações de fluoretação, ainda que pouco graves.[57] Assim, não existindo evidência científica que suporte a recomendação da suplementação universal com vitC e flúor durante o primeiro ano de vida, o EPACI vem mostrar que esta é ainda uma prática relativamente frequente, transversalmente ao país.
As recomendações relativamente à suplementação com multivitamínicos contendo minerais, durante o primeiro ano de vida, apontam os recém-nascidos pré-termo e os LIG como fortes candidatos, por ausência de reservas orgânicas capazes de garantir um adequado crescimento.[1,58] A suplementação ocorre em 9,1% dos lactentes portugueses durante o primeiro ano de vida, sendo de novo mais frequente nas situações em que a vigilância da saúde está simultaneamente a cargo do médico de família e do pediatra, e na região Norte do país. Se se tiver em conta a prevalência de prematuridade (8,1%) e de recém-nascidos LIG (3,5%) pode inferir-se que, provavelmente, a maioria dos lactentes que efetuou este tipo de suplementação pertence a um destes grupos. Efetivamente, o EPACI demonstra que a prematuridade está associada a um *odds* acrescido de 3,9 e 4,2 vezes relativamente à suplementação, respetivamente com ferro e multivitamínicos com minerais, durante o primeiro ano de vida.
Observou-se ainda que o grupo etário a que a criança pertencia à altura da realização do inquérito (12-24 meses ou 24-36 meses) se repercute nos valores de prevalência reportados para a suplementação com vitaminas e minerais, com diferenças estatísticas apenas para os mais frequentemente usados (vitD e ferro). Tal facto alerta para um provável viés da informação reportada, na dependência da memória, tão menos fiável quanto mais distante o acontecimento, mas denota alguma fiabilidade da informação, pois as diferenças na dependência do viés temporal não têm significado para os suplementos menos frequentemente usados.
Finalmente, para além do prestador de cuidados de saúde,também a escolaridade materna e o estado civil estão associados a melhor cumprimento das recomendações relativamente à suplementação com vitD. A maior perceção da importância desta vitamina para o crescimento e uma maior estabilidade familiar poderão ser a causa, dados concordantes com a literatura.[14,42,45,50,53]

Durante o primeiro ano de vida, apenas dois terços dos lactentes portugueses efetua suplementação com vitD, menos de um sexto efetua suplementação com ferro e cerca de um quarto efetua suplementação com vitC. A suplementação com flúor é residual, estando a suplementação com multivitamínico com minerais, e com ferro fortemente associada à prematuridade. Fatores socioeconómicos, o prestador de cuidados de saúde de rotina e a localização geográfica de residência parecem estar associados, em Portugal, à prevalência da suplementação vitamínica e mineral durante o primeiro ano de vida.

O QUE ESTE ESTUDO TRAZ DE NOVO

- A suplementação em vitamina D, muito embora seja uma recomendação de caráter universal durante o primeiro ano de vida, carece de cumprimento em cerca de um terço das crianças portuguesas.
- A suplementação em vitamina C e flúor, muito embora sem suporte de recomendação, ainda é frequente em Portugal.
- As consultas de saúde infantil durante o primeiro ano de vida deverão constituir sempre um momento de verificação do cumprimento da suplementação em vitamina D.
- Agregados familiares mais desfavorecidos sob o ponto de vista socioeconómico e/ou cultural deverão ser alvo de maior atenção por parte dos profissionais de saúde no que respeita a este cumprimento.

Conflitos de Interesse

Os autores declaram a inexistência de conflitos de interesse na realização do presente trabalho.

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Proteção de Pessoas e Animais

Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pelos responsáveis da Comissão de Investigação Clínica e Ética e de acordo com a Declaração de Helsínquia da Associação Médica Mundial..

Confidencialidade dos Dados

Os autores declaram ter seguido os protocolos do seu centro de trabalho acerca da publicação dos dados de doentes.

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Apresentações e Prémios

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PAPER 4

Early Feeding and Nutritional Status of Portuguese Children in the First 36 Months of Life: EPACI Portugal 2012.

For this work, I coordinated and organised the fieldwork and data collection, performed the treatment of data and the statistical analysis, contributed to the interpretation of data, and wrote the first draft of the manuscript.

Early feeding and nutritional status of Portuguese children in the first 36 months of life: EPACI Portugal 2012.

Alimentação e estado de nutrição precoce das crianças portuguesas nos primeiros 3 anos de vida: EPACI Portugal 2012.

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Ethical considerations: Informed consents were signed by the caregivers. The Portuguese Data Protection Authority, the Ethic Committee of the Catholic University of Portugal and the Ethics Committees of the five Portuguese Health Regional Administrations approved this study. The authors report no conflict of interest.

Abstract

Introduction

Early feeding practices have a critical role in the future, not only in health but also in modulating eating habits. This study aimed to assess breastfeeding and complementary feeding practices and the nutritional status of Portuguese toddlers aged 0-36 months.

Materials and Methods

EPACI Portugal 2012 is a cross-sectional study of a national representative sample. Trained interviewers collected data about early feeding practices and anthropometrics. Body mass index was classified according to World Health Organization criteria. Frequencies and survival analysis were used to characterise variables.

Results and Discussion

More than 90% of children initiated breastfeeding, around 20% were exclusively breastfed for six months and about 20% were breastfed at 12 months, while complementary feeding was taking place. Exclusive breastfeeding was determined by maternal pre-pregnancy body mass index (HR 1.01; 95% CI 1.00, 1.03) and low birth weight (HR 1.61; IC 95% 1.21, 2.15) of the infants. About 90% initiated complementary feeding between four and six months and almost 10% introduced cow's milk before 12 months. In the second year of life, 83.2% and 61.6% of toddlers have already consumed nectars and sweet desserts, respectively. About one-third of Portuguese toddlers showed a body mass index z-score >1 and 6.6% were overweight/obese (z-score >2). No association was found between the duration of breastfeeding or the timing of complementary feeding and body mass index z-score in children.

Conclusions

Despite the low prevalence of exclusive breastfeeding at six months, Portuguese infants effectively comply with dietary recommendations during the first year of life. The transition into the family diet must be carefully made. There is a high prevalence of Portuguese toddlers at least at overweight risk. The duration of breastfeeding or the timing of complementary feeding was not associated with the expression of overweight/obesity.

Keywords: early feeding patterns, breastfeeding, complementary feeding, nutritional status, Portuguese children

Resumo

Introdução

O padrão alimentar nos primeiros anos de vida assume um papel fundamental no futuro, não só na saúde, mas também na modulação dos hábitos alimentares. Este estudo teve como objetivo avaliar as práticas de aleitamento materno e de diversificação alimentar, e o estado nutricional das crianças portuguesas com idades entre os 0-36 meses.

Material e Métodos

O EPACI Portugal 2012 é um estudo transversal de uma amostra representativa nacional. Os dados sobre o padrão alimentar precoce e os dados antropométricos foram recolhidos por entrevistadores treinados. O índice de massa corporal foi classificado de acordo com os critérios da Organização Mundial de Saúde. Foram utilizadas frequências e análises de sobrevida para caracterizar as variáveis.

Resultados e Discussão

Mais de 90% das crianças iniciaram o aleitamento materno, aproximadamente 20% foram exclusivamente amamentadas durante seis meses e cerca de 20% foram amamentadas até aos 12 meses, enquanto ocorria a diversificação alimentar. O aleitamento materno exclusivo foi determinado pelo índice de massa corporal materno pré-gravidez (HR 1,01; IC 95% 1,00, 1,03) e pelo baixo peso à nascença (HR 1,61; IC 95% 1,21, 2,15) dos lactentes. Cerca de 90% iniciaram a diversificação alimentar entre os quatro e os seis meses e quase 10% introduziram o leite de vaca antes dos 12 meses. No segundo ano de vida, 83,2% e 61,6% das crianças consumiram néctares e sobremesas doces, respetivamente. Cerca de um terço das crianças portuguesas apresentaram um z-score de índice de massa corporal >1 e 6,6% apresentaram excesso de peso/obesidade (z-score >2). Não foi encontrada nenhuma associação entre a duração do aleitamento materno ou momento da diversificação alimentar e o z-score de índice de massa corporal da criança.

Conclusões

Apesar da baixa prevalência do aleitamento materno exclusivo aos seis meses, os lactentes portugueses cumprem as recomendações alimentares durante o primeiro ano de vida. A transição para a dieta familiar deve ser feita cuidadosamente. Há uma elevada prevalência de crianças portuguesas que apresentam pelo menos risco de excesso de peso. A duração do aleitamento materno ou o momento da introdução da diversificação alimentar não se associou com a expressão de excesso de peso/obesidade.

Palavras-chave: padrão alimentar precoce, aleitamento materno, diversificação alimentar, estado nutricional, crianças portuguesas.

Introduction

Overweight (OW) and obesity (OB) are major public health concerns of the 21st century [1]. World Health Organization (WHO) data suggest that 39 million children under five years old are OW or obese in 2020 [2]. Increasing evidence seems to support an early onset of OB and its tracking for later life[3]. Therefore, studying the early risk factors, particularly feeding practices, is essential.

One of the factors pointed out as protective against childhood OW is breast milk [4], even though not all studies demonstrated this [5]. One of the arguments supporting this role is related to the self-regulation of milk intake in directly breastfed infants [6]. Breast milk has leptin and adiponectin, which are related to self-regulation and appetite [7]. It is consensual that breast milk, when available, is the ideal way of exclusively feeding an infant in the first six months of life [8,9]. Despite this, most developed countries have a low breastfeeding (BF) prevalence [10], notwithstanding the plans for promoting and supporting BF [10].

After six months, BF alone is insufficient to meet the infants' nutritional requirements and it is therefore recommended to start complementary feeding (CF). CF is often started before six months, for most infants between four and six months, and, in this range, it does not seem to make a difference in terms of the risk of OB [11].

The first food to be introduced at the time CF is also variable [12], as cultural factors and access to food are of major importance.

This study aimed to assess the timing and characteristics of BF and CF and the nutritional status (NS) of Portuguese toddlers aged 0-36 months.

Methodology

This study was based on EPACI Portugal 2012 (Study of the Childhood Feeding Patterns and Growth), a cross-sectional study that characterised Portuguese infants' and toddlers' feeding patterns and NS.

A nationally representative sample of children aged between 12 and 36 months was recruited, and information about early feeding patterns and growth (since birth) was collected retrospectively. The NS of the children at the time of the interview was assessed.

Sample Selection

A sample of 2500 (2000 plus 25% for refusals) was set, to obtain a representative sample of about 1% of Portuguese toddlers aged 12-36 months living in mainland Portugal.

Children were divided according to the Nomenclature of the territorial unit for statistics (NUTS) II, a territorial classification that divides the country into five areas with the same proportions of births per region. Subsequently, 128 health units were randomly selected since an initial criterion was to assess 20 children per unit.

In each health unit, 25 children aged 12-36 months were randomly selected, and their caregivers were contacted and invited to participate. In cases where it was not possible to schedule the appointment with the 25 children of the first selection (due to incorrect numbers, missed calls, and even the impossibility of attending that day or severe disease), other children were selected until a total of 25 scheduled children was obtained. The evaluations took place between May 2012 and July 2013.

The study procedures were explained to the caregivers during the telephone call and the beginning of the interview, and an informed consent was signed. The Portuguese Data Protection Authority, the Ethic Committee of the Catholic University of Portugal and the Ethics Committees of the five Portuguese Health Regional Administrations approved this study.

Data collection

A protocol was created and previously validated for the collection of data on sociodemographic characteristics [parental age, marital status, number of schooling years and occupation, monthly family wage, number of children (<18 years old) in the household], parental NS (mother pre-pregnancy weight and gestational weigh gain, mother and father weight and height at the evaluation), children's gestational age, health history (including diseases, hospital admissions and health professional responsible for routine health monitoring), early feeding patterns and a food frequency questionnaire about current dietary intake, information about vitamin and mineral supplementation, sleep patterns and anthropometric data collected from the individual health bulletin. The protocol was applied by trained interviewers and addressed to the children's caregivers, in face-to-face computer-assisted interviews. The interviewers also measured children's anthropometrics on the interview day.

At the end of the interview, a 3-day food diary was delivered to be filled in by the caregivers. The fill-in and subsequent return by postage-paid envelope procedures were explained by the interviewers, which were nutritionists.

The pre-pregnancy weight and height of the mother were self-reported. When the respondents did not know some answers or did not have the pregnant bulletin in the interview, they were contacted afterwards by telephone to collect the missing information. The mother's BMI was obtained by dividing her weight (kg) by the squared height (cm).

Data about total and EBF were collected. We considered total BF as the time (in months) a child was fed breast milk, even if not exclusively. We considered EBF whenever only breast milk was given, not complemented with any other type of milk or food, excluding water or tea.

We also collected data on the consumption of formula: infant formula, follow-on formula, young-child formula and soya formula, as well as whole and semi-skimmed cow's milk.

Information related to who advised on the CF and its introduction age was collected. We also asked about the first food (vegetable soup, cereal-based foods or fruit puree) to be introduced at the time of the CF. If the infant had started two foods on the same day, more than one answer could be included. Data on the current food consumption was collected through a food frequency questionnaire which included 15 items. The questionnaire comprised seven categories of intake frequency (from ≥3/day to never). The onset age of each item consumption was also ascertained.

For the present study, we excluded children with any disease which affects the children's development and growth, such as malformation syndrome, severe cardiac, osteoarticular, or chronic disease and premature (gestational age <37 weeks) or postmature (≥42 weeks) children.

Information about birth weight was divided into three categories: low birth weight when the weight was less than 2500g; normal weight if the newborn's weight was between 2500g and 3999g; and macrosomia when the weight was higher than 3999g.

At the evaluation, the length/height (cm) and weight (kg) of each toddler was measured, and then the BMI was calculated, expressed in z-score (zBMI), and classified according to the WHO criteria. According to NS, toddlers were divided into five categories: underweight (zBMI <−2); normal weight (zBMI ≥ −2 and ≤1); OW risk (zBMI >1 and ≤2); OW (zBMI >2 and ≤3) and OB (zBMI >3) [13]. The zBMI above 1 combined the three last categories.

Statistical analysis

For the statistical analysis, some variables were recoded. The variable regarding the mother's marital status was recoded into two classes and compared mothers who were married or in a consensual union versus single, separated/divorced or widowed. Maternal education was recoded into a grade below 12 years of schooling and another including all mothers with 12 years of schooling or more. The number of household children variable was codified into two classes: one child and two or more children.

Prevalence estimates were weighted according to the complex sampling design, considering stratification by (NUTS) II, a territorial classification that divides the country into five areas, and cluster effect for the selected Primary Health Care Unit. To test independence between categorical variables in complex samples, a Crosstabs test was tested, and to test for independence between continuous variables, the General Linear Model was computed. A level of significance of 5% was considered. Statistical analysis was conducted in the *Statistical Package for the Social Sciences* SPSS® version 27 for Windows®.

Weighted data were estimated through survival analysis using the log-rank test. The Kaplan-Meier curve was designed to assess the probability of BF throughout time. Cox regression was used to determine the association between factors. This analysis was performed using the R package nlme.

Results

From an initial sample of 2230, 221 children were excluded: 20 by chronic disease, 178 by prematurity, and 25 because the respective gestational age was missing. From these, a total of 2009 (n= 1056; 52.6% male) were eligible to participate: 1002 (49.9%; 51.9 % male) were aged between 12-23 months and 1007 (50.1%; 53.5% male) were aged between 24 -36 months.

Almost all children (94.4%) started BF, and 76.1%, 61.5%, 46.6%, 19.8 %, and 4.3% were breastfed at 2, 4, 6, 12, and 24 months, respectively (Fig. 1).

The prevalence of BF initiation slightly differed between the different five regions, from 89.6% in the North to 91.1%, 93.2%, 93.8%, and 94.3% in Alentejo, Lisbon and Tejo Valley, Algarve and Centre Region, respectively (p=0.046).

Almost 60% of the infants were exclusively breastfed for at least four months and one-fifth for six months. Furthermore, 11.3% of the children were never exclusively breastfed. The prevalence of EBF until at least four months of age varied between 49.7%, in Alentejo, to 53.0%, 62.1%, 64.8%, and 68.9% in Lisbon and Tejo Valley, Centre Region, North and Algarve, respectively. The differences between the five NUTS II were statistically significant (p<0.001). The prevalence of EBF for six months of age ranged between 17.0%, in Alentejo, and 17.7%, 17.9%, 24.6%, and 24.8%, in Algarve, Lisbon, and Tejo Valley, Centre Region and North, respectively. The differences were statistically significant (p=0.003).

Those born from mothers with high BMI before pregnancy and those with low birth weight were more likely to stop being EBF (Table 1).

A total of 80.7% of the children initiated a formula: 54.3% an infant formula, 52.3% a follow-on formula and 25.4% a young child formula. Cow's milk was introduced before 12 months by 181 (9.0%) infants [24 infants (1.2%) whole and 157 (7.8%) semi-skimmed]. After 12 months, 16.0% of the children consumed whole cow's milk, 77.3% were fed semi-skimmed cow's milk, 30.9% with growing-up milk, and 2.2% with soya formula.

The paediatrician was responsible for advising on the CF in more than half of the cases (55.1%), and a large proportion of the children (43.2%) was advised by the general practitioner (Table 2). A total of 1810 (91.1%) of the infants initiated CF between four and six months of age (Table 2).

The first food used to start CF was vegetable soup for 51.6%, cereal-based food for 45.8% and fresh fruit for 9.0% of the children. The prevalence of vegetable soup as the first food ranged between 31.2%, in Algarve, and 44.6%, 52.8%, 55.8% and 71.1% in the North, Lisbon, and Tejo Valley, Alentejo and the Centre Region, respectively (p<0.001). Regarding the cereal-based food, it varied between 27.9%, in the Centre Region, and 48.1%, 48.2%, 52.7%, and 54.2%, in Lisbon and Tejo Valley, North, Algarve and Alentejo, respectively (p=0.003).

The median age for the introduction of vegetables in the soup was five months, six months for cereal-based food, fruit, meat and yoghurt, eight months for fish, 12 months for vegetables on the plate, 16 months for sweet desserts and 20 months for nectars (Fig. 2). In the interview, 83.2% of the toddlers had already consumed sweet desserts, more than 60% nectars and non-carbonated soft drinks. About one-third had already consumed carbonated soft drinks (Fig. 2).

Between 12-36 months, the prevalence of children at risk of OW (zBMI>1) was 32.0%, and 6.6% were OW/OB (zBMI>2). No significant differences were observed between 12-23 months and 24-36 months [risk of OW 12-23 months: 34.0%; 24-36 months: 30.0% (p = 0.136); OW/OB 12-23 months: 6.2%; 24-36 months: 6.9% (p=0.716); OB 12-23 months: 0.9%; 24-36 months: 0.7% (p=0.662). Considering all the population, the prevalence of zBMI above 1 ranged between 26.7%, in Algarve, and 37.6%, in the North Region (p=0.014). No association was found between children who started CF right after EBF and their BMI z-score at the time of assessment (p=0.139).

Discussion

The EPACI study contributed to the knowledge about Portuguese early feeding practices, i.e. in the first three years of life. Our data from a representative sample of Portuguese toddlers showed that 92.1% started BF, in line with a Portuguese registry which found a prevalence of 98.6% [14]. In a study about BF rates in European countries, the BF initiation prevalence rate oscillated between 56% in Ireland [10], 67% in France [15] and 97% in Germany [10]. Nevertheless, overall, BF rates are lower than what we observed.

In Portugal, almost 60% of infants were exclusively breastfed until four months and only 21.1% until six months. Furthermore, 80.7% of the children consumed any IF at any time and 9.0% of the infants were introduced to cow's milk before 12 months. Despite the high prevalence rate of BF initiation in some countries, the prevalence of exclusive and full BF gradually decreases over time during the first months of life [10], as we also observed in EPACI data. According to WHO data, the European Region has the lowest prevalence of exclusively breastfed children during the first six months of life (25%) [16]. In Spain, 25.4% of infants were exclusively breastfed until six months [17] and a lower prevalence rate was found in Switzerland (10.0%), Denmark (13.0%), Sweden (14.0%) and Norway (17.0%) [10]. Data from the Portuguese National Food and Physical Activity Survey (IAN-AF) showed that about 22% of the infants were EBF for at least six months [18]. Our data can be explained by the duration of the maternity leave in Portugal, which is paid in full only for the first four months. Support policies vary between countries and, in addition to each country's socio-economic level, may partially explain the different prevalence of any BF and EBF in the world [19]. According to Victora et al. [20], high-income countries have low BF duration compared to low or middle-income countries, where 37.0% of the children younger than six months were exclusively breastfed. Data from the WHO South-East Asia Region describes a much higher prevalence rate of EBF, presenting a prevalence of 43.0% of infants exclusively breastfed during the first six months of life [16]. Several factors influence the duration of BF, including the mother's level of knowledge, which is positively associated with the BF rate. Gianni et al. [21] found that 70.3% of the mothers reported BF difficulties. The more informed pregnant women are, the better prepared they will be to overcome the challenges that arise during the establishment of BF. According to some authors [22], older mothers with higher education are more likely to initiate BF since, theoretically, they have more information. Moreover, fathers' support [23] and BF counselling [24] are also critical factors in the success and duration of BF. Being born in a hospital considered baby-friendly also increases BF rates. On the other hand, short maternity leave is often a limitation for maintaining EBF after the mother's return to work. It may also justify the low prevalence rate of EBF for six months found in the present study.

In EPACI data, the only determinants for EBF were maternal BMI before pregnancy and low birth weight. Children born with low birth weight were 61% more likely to stop being exclusively breastfed.

Evidence supports that adequate early feeding practices promote healthy growth and development and protect against disease throughout life[25]. The literature describes that breastfed infants have a lower risk of infection, notably gastroenteritis and respiratory tract infection, and sudden death [26]. For mothers, breastfeeding also has benefits, such as facilitating uterine involution [27], lowering the risk of breast cancer [28] and easier postpartum weight loss [29]. Several studies showed the protective effect of breast milk against OB [4,30]. A recent meta-analysis [31] also showed that breastfed children had a lower risk of OB than children who had never been breastfed. However, our results showed no protection from breastfeeding duration or the timing of CF on the expression of OW/OB.

When a child cannot be breastfed, IF can be given to meet the nutritional needs and ensure an adequate growth profile. Our results showed that 80.7% of the children took a formula, which is in line with another Portuguese study [32] that found a prevalence rate of almost 80%.

According to ESPGHAN recommendations [33], cow's milk should not be introduced before 12 months, yet, according to our data, cow's milk (semi-skimmed and whole milk) was introduced earlier in almost 10% of the children (n=181), a slightly higher prevalence than IAN-AF refer (6.5%) [18]. This is not the case in all countries, as a North Italy study found that 37.0% of the children were introduced to cow's milk before 12 months [34].

After six months of age, breast milk alone cannot ensure the infants' nutritional needs [35], especially concerning energy, protein, iron, zinc, and vitamins A, D, E, and K [36], so CF should be initiated. This period is an essential stage in the transition to family diet [36], being a window of opportunity for training new tastes and textures, during which the intake of a variety of healthy foods, including green vegetables [33], should be ensured. Literature shows that adequate timing of CF determines future health and food behaviour. Recommendations for CF vary greatly between countries, according to their cultural habits. Generally, CF starts earlier in high-income countries. Some studies have shown strong associations between BF duration and the introduction of CF [33,37], being longer BF duration positively associated with later CF [38].

EPACI data showed that 91.1% of the infants introduced CF between four and six months of age, following ESPGHAN recommendations [33]. In Spain [39], most infants also initiated CF in this interval, as well as in Italy [40]. In the French ELFE cohort study [41] and Poland and Austria [42], only about two-thirds of the infants initiated CF in this interval.

However, 4.6% of Portuguese infants introduced CF before four months. This prevalence is in line with other countries, such as Poland and Austria, which found a prevalence rate of 2.4% and 4.3%, respectively [42]. Results from the ELFE study showed a prevalence of 26.0%. Previous studies described that early CF could be associated with an increased risk of OB [43]. However, according to the results from an Australian cohort, the duration of BF has more impact [44].

The first food given to infants also varied between countries: in Sweden, the more common first foods are potatoes, vegetables, fruits/berries and porridges [45], fresh fruit in Italy [34] and cereals along with fruit in Spain [39]. A Polish study found that in 83.0% of infants, vegetables were the first solid food to be introduced at the time of CF [46]. In our study, the prevalence is not so high, but more than half of the children started their CF with vegetables (51.6%) through vegetable soup, an old cultural tradition in Portugal.

Around the first year of life, the child will gradually be able to eat the family diet, which should consist of a balanced, complete, varied and healthy diet. EPACI data showed that from the first year onwards, and when the family diet is integrated, some excesses are registered, notably the consumption of sugar, mainly from sweet beverages and desserts. Data from Generation XXI [32] also found daily regular consumption of nectars and soft drinks in 52.0% of the children (4 years old) and 65.0% consumed cakes and sweets daily. Our results are in line with other studies carried out in the United States, one of which with data from the National Health and Nutrition Examination Survey (NHANES) 2009-2012 [47], which found that more than 50% of young toddlers (12-23 months) had a daily consumption of sweetened beverages, and another posterior study with data from FITS 2016 [48], showing that about 75% of toddlers consumed sweet and sweet beverages. High consumption of sugar-sweetened beverages in early life has been associated with an increased probability of OB in childhood [49]. These results are alarming since, according to the recommendations of ESPGHAN [50], the consumption of free sugars present in these foods should not exceed 5% of the total energy requirements and EFSA has warned that high consumption of sugar increases the risk of caries [51], steatosis [52], diabetes and OB [53].

It is essential to take advantage of this transition to a family diet to review the family's nutrition choices in order to maintain them in accordance with healthy behaviour. The recommendations from the first year of life should be reinforced and detailed to parents by health professionals. At this stage, parents are still very permeable and receptive, and it will be easier to obtain a good collaboration. It is also important to establish specific recommendations because young children have a high appetence for energy-dense foods rather than healthy foods [54], so healthy foods should be made available daily.

Few studies assessed the prevalence of OW/OB in toddlers and it is difficult to compare prevalence, as different classification criteria, age cut-off points, and data collection methods were used. The use of BMI or weight-for-length to assess NS in such young children is one of the main factors. In a study by Biro et al. [55], a prevalence of 18.0% of OW risk and 6.7% of OW and OB in children from birth to 2 years was found, using weight for length z-score. A systematic review of European preschool children (2-7 years), including data from 27 countries, found a lower prevalence (17.9% of OW and 5.3% of OB). However, these data were based on IOTF criteria, and the study group was older than the EPACI population. In EPACI, we used BMI as criteria, and we found an OW-risk prevalence (BMI>1) of 25.4% and 6.6% of OW (BMI>2) and OB (BMI>3), totalising 32.0%.

Knowing that early OB increases the risk of being obese in adolescence and adulthood, it is essential to evaluate and identify children as early as possible.

Our study is based on a large nationally representative sample, which is one of the strengths of this work. Another strength is the structured protocol for data collection and the fact that data was gathered in face-to-face interviews, by trained interviewers, following standardised procedures. It was also possible to collect by telephone the information that, in some cases, was not available in the interview. The EPACI study was also the first one that characterised Portuguese toddlers' feeding habits, bringing new insights for health professionals in establishing guidelines for this age group and in the future implementation of training programmes for educators, parents and parents-to-be.

This work had, however, some limitations. The data about feeding practices during the first year of life were retrospectively collected, implying recall bias of the caregiver, as much of the information requested was not in the child's health bulletin.

Conclusions

Despite the high rate of BF initiation, the prevalence of BF diminishes over time. Less than a quarter of the Portuguese infants met the WHO recommendations of being exclusively breastfed for six months. Mother`s BMI and low birth weight were the only predictors of EBF unsuccess.

CF was initiated mostly between 4 and 6 months and, during the first year of life, the early feeding practices followed the ESPGHAN recommendations. However, the consumption of sugary foods and beverages starts very early, shortly after 12 months.

The prevalence of OW/OB in about one-third of Portuguese toddlers is alarming, considering the high tracking pattern of OB. The duration of breastfeeding or the timing of CF did not show protection on the expression of OW/OB.

Author Contributions

M.N. coordinated fieldwork and data collection, performed data treatment, statistical analysis and data interpretation and contributed to writing the manuscript. E.P. contributed to the study design, supervised fieldwork and data collection, conducted the study design and statistical analysis and contributed to writing the manuscript. M.S. performed the statistical analysis and data interpretation and contributed to writing the manuscript. P.G. contributed to the study design, data interpretation and manuscript writing. C.L. contributed to the study design, data interpretation and manuscript writing. C.R. coordinated the project and contributed to the study design, data interpretation and manuscript writing. All authors approved the final version of the manuscript.

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Conflicts of Interest statement

The authors report no conflict of interest.

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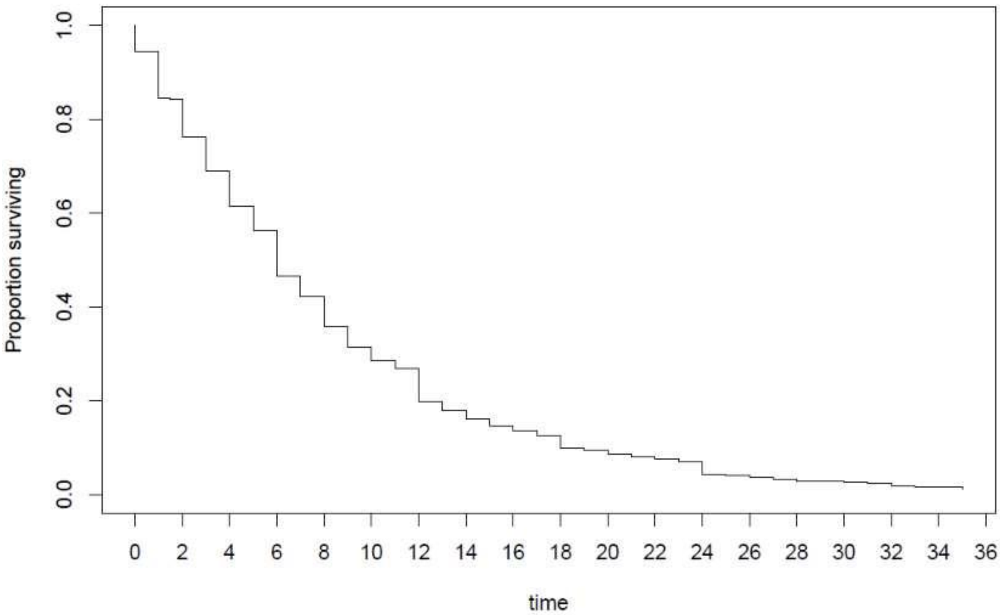


Figure 1. Probability of total breastfeeding in each moment of the time (months) (n = 1850)

Table 1. Determinants of exclusive breastfeeding HR (95%)

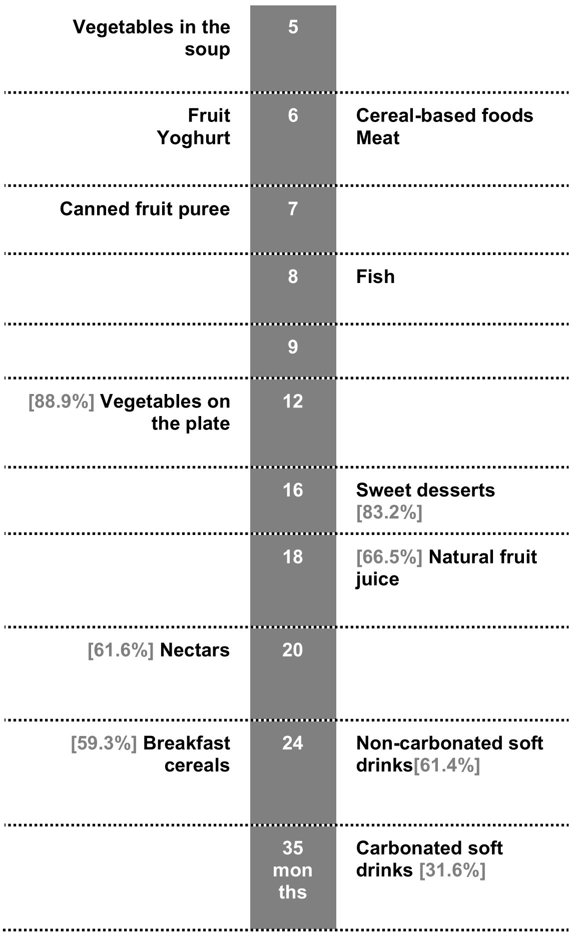
	HR (95%)	p	HR (95%)	p	HR (95%)	p
Maternal age	0.99 (0.98, 1.00)	0.05	1.00 (0.99, 1.01)	0.93	1.00 (0.98,1.01)	0.83
Maternal marital status	1.07 (0.92; 1.26)	0.38	1.08 (0.89, 1.32)	0.43	1.07 (0.88,1.31)	0.49
Maternal occupational situation	1.07 (0.96; 1.18)	0.24	1.11 (0.99; 1.23)	0.06	1.10 (0.99, 1.23)	0.08
Maternal education/ maternal schooling years	0.94 (0.84, 1.04)	0.22	0.92 (0.82, 1.04)	0.18	0.92 (0.82, 1.03)	0.14
BMI before pregnancy	1.01 (1.00; 1.02)	0.12	1.01 (1.00, 1.03)	0.03	**1.01 (1.00, 1.03)**	**0.03**
Paternal age	0.99 (0.98;1.00)	0.02	0.99 (0.98, 1.00)	0.06	0.99 (0.98; 1.00)	0.12
Number of children in the household	0.91 (0.84; 0.99)	0.03	0.93 (0.85, 1.02)	0.14	0.94 (0.85; 1.03)	0.20
Birth weight						
LBW	1.59 (1.22; 2.07)	<0.001			**1.61 (1.21, 2.15)**	**0.001**
Macrosomia	0.96 (0.73; 1.26)	0.75			1.03 (0.81, 1.31)	0.83

HR: Hazard Ratio; BMI: Body Mass Index; LBW: Low Birth Weight

Table 2. Complementary feeding counselling n (%) and children's age introduction (months) n (%)

Complementary feeding Counselling	n (%)
Paediatrician	1107 (55.1)
General practitioner	869 (43.2)
Personal Initiative	122 (6.1)
Familiar	38 (1.9)
Own experience	96 (4.8)
Other	237 (11.8)

Children's age (months)	n (%)
<4	92 (4.6)
4	1002 (50.4)
5	323 (16.3)
6	485 (24.4)
>6	86 (4.3)



The proportions of children who already tried different food groups until the interview are available in square brackets

Figure 2. Median age at the first consumption/ introduction of different foods/food groups. The proportion in light grey expresses the proportion of children you have already introduced these foods at the evaluation moment (12-36 months)

PAPER 5

Association Between Parental and Offspring's BMI: Results from EPACI Portugal 2012.

For this paper, I was responsible for coordinating and organising fieldwork and data collection, conducted data treatment, performed the statistical analysis, contributed to the interpretation of data and wrote the first draft of the manuscript.

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Association between parental and offspring's BMI: results from EPACI Portugal 2012

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Abstract

Objective: To assess the longitudinal association between parental BMI and offspring's BMI, in EPACI Portugal 2012.

Design: Longitudinal study with retrospective collection of children's anthropometry data since birth. Children's anthropometric data were gathered from individual child health bulletins, and parents' anthropometrics were self-reported. Children's and parents' BMI were classified according to WHO cut-offs. Linear mixed models with random intercept and slope for age were applied to quantify the association between parental BMI and children BMI *Z*-score (zBMI).

Setting: EPACI Portugal 2012.

Participants: Representative sample from the Portuguese population (*n* 2230) aged from 12 to 36 months.

Results: 58·9 % of the fathers and 35·6 % of the mothers were overweight (OW) or obese. Prevalence of infants who were, at least, at risk of OW increased from 17·0 % to 30·3 % since birth to 12 months. About half of the mothers with pre-pregnancy OW and obesity (OB) gained gestational weight above the recommendations. The children from mothers with gestational weight gain (GWG) below the recommendations showed a −0·15 SD lower zBMI (95 % CI −0·23, −0·06) in early life, comparing with mothers within GWG recommendations. Children of obese mothers were more likely to present a higher zBMI (0·24 SD, 95 % CI 0·13, 0·35) throughout the first months of life.

Conclusions: A high prevalence of OW and OB was observed in Portuguese young adults and toddlers. Mothers' pre-pregnancy BMI and insufficient GWG had a direct effect on offspring BMI. Early effective interventions are needed in order to prevent the transgenerational transmission of OB.

Keywords
Parents
Offspring
Body mass index
Obesity

Obesity (OB), especially childhood OB, has been growing in recent decades all over the world(1–3). According to the WHO, 1·9 billion of adults and 41 million of children under the age of 5 years are obese or overweight (OW)(4). Portugal is not an exception, as the prevalence of OW and OB in adults is 37·5 % and 24·9 %, respectively(5); moreover, 25 % of the children (<10 years old) and 32·3 % of the adolescents (10–17 years) are OW or obese(5). Other nationally representative study of 6- to 8-year-old children showed an OW/OB prevalence of 30·7 %(6). However, toddlerhood is much less studied in Portugal, and until now, no study about OW status in these ages has been conducted.

It is well known that nutrition before conception, as well as during pregnancy and in the first 2 years of life, can influence the long-term nutritional status of the children. Lucas defined this concept as 'programming' in 1998(7). In fact, different studies show that prenatal and postnatal factors play an important role in the programming of some diseases(8), including future OB(2). To this regard, the Early Nutrition Project (a multicentre

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and multidisciplinary collaborative research) brought new insights about the impact of early nutritional programming on later life, providing knowledge to invest in practical strategies for OB prevention[9–11].

Regarding prenatal factors, the high pre-pregnancy BMI of parents[12,13], particularly of the mother[14–16], the excessive gestational weight gain (GWG)[16–19] as well as caesarean delivery[20,21] have been described as significant childhood OB risk factors. The association between parental pre-pregnancy and offspring BMI at birth is stronger for mother's BMI than for father's BMI[22]. The most plausible explanation for this difference is fetal overnutrition, since, on the one hand, other influences (such as the major role of mothers in feeding and taking care of the children), which can also impact offspring BMI, are discarded[23] in this period and, on the other hand, father's role has its impact later on in life.

Concerning postnatal factors, high infant birth weight and high infant weight gain during the first years of life are strongly associated with OB risk[14,24]. Children's diet and physical activity[15] and the current parental BMI[25,26] are also associated with OB.

It is also clearly demonstrated that there is an association between parents' and children's OB prevalence, supported by the share of the genetic and of the obesogenic environment[25,27,28].

Currently, it is known that OB shows a tracking from infancy to adulthood[2,9]. Some authors suggest that being OW or obese at the age of 5 years increases the risk of being obese in the future[2]. However, there is a significant lack of knowledge regarding the onset age in which the OB's clinical expression occurs.

Much of the existing evidence was gathered by cross-sectional analysis, based in different studies and in different populations, and there is a lack of studies that explore the influence of parental weight status throughout the first years of life, particularly in European countries. In the particular cases of Southern European countries that present high prevalence of OW[5,6,29,30], it is especially relevant to study the determinants and tracking of OB since earlier ages[31]. Although studies have been conducted in other non-European countries[32,33], the OB prevalence found in adults in such studies was lower than that found in Portugal and therefore the parental influence can be different.

The purpose of this study is to assess the association between parental BMI and offspring's BMI at 0–24 months, in the EPACI Portugal 2012 (Study of the Childhood Feeding Patterns and Growth).

Methodology

Study design and sampling

EPACI Portugal 2012 was a cross-sectional study which purpose was to characterise dietary intake and nutritional status of Portuguese infants and toddlers. Children aged between 12 and 36 months were recruited, and the extraction of anthropometrics from the individual health bulletins, measured since birth, allowed a longitudinal approach of children's growth.

A representative sample of about 1 % of Portuguese toddlers aged 12–36 months (Portugal mainland only) was recruited. Since about 100·000 births per year occurred in Portugal, a sample size of 2000 plus 25 % for refusals was defined. Based on the National Institute of Statistics data, the sample was stratified by Portuguese geographical regions (NUTS II, a territorial classification that divides the country in five areas), in the same proportions of the births.

Considering that the national vaccination plan in Portugal is applied only in the primary health care, the sampling was based on primary health care registries. First, a list with all Portuguese primary health care units was obtained, and then the number of units in each region was randomly selected. This allowed to reach the target number of children for each region, considering that in each unit, twenty children would be assessed. However, some of the health units were very small and had less than twenty eligible children registered. In total, 128 health units were included.

After identifying the health units, respective directors were contacted, invited to participate and asked for the lists of children aged 12–36 months of age registered in their units. In each health unit, twenty-five children were randomly selected and their tutors contacted. If the appointments could not be successfully scheduled in this first selection (e.g. due to incorrect phone numbers, impossibility to participate on the scheduled day, children with chronic disease or severe malformations), more children were randomly selected until twenty-five children were scheduled. Sixty-four percentage of the tutors consented to the scheduling of the assessment and, from these, 72 % were evaluated.

Children's assessment by the research staff occurred on the same day in each health unit.

Data collection

Data on sociodemographic characteristics (including parental age and education level), health history (including diseases, emergencies and hospital admissions) and dietary history (including breast-feeding, artificial formulas, complementary feeding and a FFQ in respect of current dietary intake) were collected by trained interviewers, using a structured protocol in face-to-face, computer-assisted interviews. In Portugal, all children have an individual health bulletin where anthropometrics and health vigilance are registered. Anthropometric information (weight, length/height and head circumference) at birth, 2, 4, 6, 9, 12, 18 and 24 months (depending on each child's age and according to the available measures) was extracted, allowing a longitudinal analysis. These time points were considered since they correspond to those preconised by the National Health System regarding children health survey. However, the registries do not always overlap exactly with these ages. As such, for the nutritional status characterisation (zBMI) during the first 2 years of life, we considered an interval of 15 d for the measurement at 2 months, of 30 d for the 4 and 6 months, 45 d for the 9 and 12 months and 60 d for the 18 and 24 months measurement.

Low birth weight was defined as a birth weight lower than 2500 g[34] and macrosomia as a birth weight higher than 3999 g[35,36]. Nutritional status (BMI) of each child, at each age, was characterised and expressed as *Z*-score, using the WHO standard[37], and divided into five categories: underweight (UW) (*Z*-score < -2); normal weight (*Z*-score ≥ -2 and ≤ 1); OW risk (*Z*-score > 1 and ≤ 2); OW (*Z*-score > 2 and ≤ 3) and OB (*Z*-score > 3)[37]. The category designated 'OW + OB' combined the OW and OB categories, which correspond to *Z*-score above 2. The expression 'OW risk onwards' combined the three categories corresponding to a BMI *Z*-score (zBMI) above 1: OW risk, OW and OB.

For the present analysis, we excluded: (a) children with any disease which affects the children's development and growth, such as malformation syndrome, severe cardiac, osteoarticular and chronic disease; and (b) premature (gestational age <37 weeks) or postmature (≥42 weeks) children.

Information on parents' anthropometrics was also collected. Regarding mothers, the pre-pregnancy weight, the gestational age, the GWG and the current weight and height were obtained by self-report. From fathers, the self-reported current weight and height were collected. Posterior telephone contacts were scheduled when the respondents did not know or did not remember some of the information or when they did not have the pregnant bulletin or individual health bulletin at the appointment.

Based on parents' weight and height, BMI was calculated as the ratio between weight (in kg) and the squared height (in metres). BMI was classified according to WHO classification into four categories: UW (BMI $< 18{\cdot}5$ kg/m^2); normal weight (BMI $\geq 18{\cdot}5 \leq 24{\cdot}9$ kg/m^2); OW (BMI ≥ 25 and $\leq 29{\cdot}9$ kg/m^2) and OB (BMI ≥ 30 kg/m^2)[38]. The recommended intervals of GWG were defined for each BMI class according to the Institute of Medicine guidelines[39]. Adequate weight gain range (kg) was 12·5–18 kg in mothers with pre-pregnancy UW; 11·5–16 kg among those who were normal weight; 7–11·5 kg for OW category and 5–9 kg for OB[39]. Weight gain below recommendations was defined as weight gain lower than the minimum value of each interval, and weight gain above recommendations was defined as the weight gain higher than the maximum value of each of the intervals. The variable 'obese mother and father' comprises all children who have obese mother and father, simultaneously.

Only children with complete data (*n* 1671) concerning child gender, mother age, pre-pregnancy BMI, parental education, parental BMI, weight gain adequacy were considered and included in the linear mixed models. The mean number of measurements was four for each child, and only 6 % of the children had less than three measurements.

Statistical analysis

Prevalence estimates were weighted according to the complex sampling design, considering stratification by Portuguese geographical regions (NUTS III, a territorial classification that divides the country in twenty-eight areas) and cluster effect for the selected Primary Health Care Unit. A level of significance of 5 % was considered. For this analysis, *Statistical Package for the Social Sciences* SPSS® version 24 for Windows® was used.

Linear mixed models with random intercept and slope for age were applied, and the linear regression fixed coefficients were used to quantify the longitudinal association between GWG and children's zBMI and between parental BMI and children's zBMI. All the mixed models were adjusted to mother's age and mother's pre-pregnancy BMI. The mother and father education were also tested but were not included in the final models because they did not present any significant association. Although other potential confounders are referred in the literature, EPACI Portugal 2012 study did not gather these; therefore, this adjustment was not possible. The linear mixed effect models assume missing at random. In this specific analysis, data were not weighted. This analysis was performed using the R package nlme.

Results

A total of 2230 children aged between 12 and 36 months were evaluated in EPACI Portugal 2012. For this analysis, 221 children were excluded: twenty by chronic disease, 178 by prematurity (two had simultaneously a chronic disease and prematurity) and twenty-five because the respective gestational age was not possible to ascertain. A total of 2009 children (*n* 953; 47·4 % female) were included in this study. From these 2009, 1007 (50·1 %) were aged between 12 and 24 months and 1002 (49·9 %) were older than 24 months. However, the determinants of the children's BMI *Z*-score were analysed only in the 1671 children with complete data for the variables that were included in the analysis.

We compared children included in the analysis (*n* 1671) with children who did not participate (*n* 338) regarding gender, mother's age, mother's pre-pregnancy BMI, GWG adequacy, mother's OB, father's OB, and mother's and father's BMI. We only found significant differences, concerning GWG adequacy ($P = 0{\cdot}02$), mother and father BMI ($P < 0{\cdot}01$) and mother age ($P < 0{\cdot}01$).

A very high prevalence of OW/OB in Portuguese young adults ($\overline{X} = 33$ years old for mothers and $\overline{X} = 35$ years old for fathers) was found. At the recruitment, 23·9 % of the mothers and 45·1 % of the fathers were OW; 11·7 % of

Table 1 Pre-pregnancy nutritional status (BMI), weight gain during pregnancy and weight gain adequacy*

							Weight gain adequacy* (% weighted)			
							<	=	>	
BMI classes	*n*	Pre-pregnancy BMI *n*	% weighted	Weight gain mean (kg)	95 % CI	*P* value	29·4†	37·4†	33·2†	*P* value
Underweight	97	105	5·5	14·9	13·4, 16·3		48·4	26·8	24·8	
Normal weight	1216	1218	62·9	13·6	13·3, 14·0	0·270	34·9	40·7	24·4	<0·001
Overweight	438	431	22·3	12·7	12·0, 13·3		12·0	34·6	53·5	
Obesity	181	179	9·3	8·0	6·8, 9·3		23·1	28·0	49·0	

<, weight gain lower than recommended; =, weight gain as recommended; >, weight gain higher than recommended.
*According Institute of Medicine Recommendations, 2009[38].
†Prevalence in the total sample.
Weight gain range (kg): underweight (12.5–18); normal weight (11.5–16); overweight (7–11.5); obesity (5–9).
The sample was % weighted.

mothers and 13·8 % of fathers were obese. Prevalence of OW plus OB in mothers increased from 31·6 % to 35·6 % between pre-pregnancy and the recruitment for the study (12–36 months after birth). Considering the whole sample, mean BMI before pregnancy was 23·9 kg/m^2 and mean weight gain was 13 kg. Pre-pregnancy nutritional status, weight gain during pregnancy and weight gain adequacy are described in Table 1. In this sample, weight gain during pregnancy was similar among mothers who were UW and those with a normal pre-pregnancy BMI.

GWG means were within recommended intervals[39], except for mothers who were OW before pregnancy, for whom mean GWG was above the interval. The mean of GWG was closer to the inferior limit of the recommended interval in women who were UW or normal weight before pregnancy and was just slightly superior and closer to the superior limit for OW and obese women before pregnancy, respectively (Table 1).

A third (37·4 %) of women had adequate weight gain during pregnancy, while 29·4 % increased weight below and 33·2 % increased weight above the recommendations. When stratified by BMI class, almost 75 % of the mothers who were UW/obese before pregnancy had an inadequate weight gain during pregnancy, whereas in the other BMI classes, the prevalence of inadequate weight gain was lower. About half (53·5 % and 49·0 % of mothers with pre-pregnancy OW and OB, respectively) increased weight above the recommendations during pregnancy, while 48·4 % of mothers who were UW before pregnancy increased weight below the recommendations during pregnancy (Table 1).

Anthropometric characterisation at birth is described in Table 2. The prevalence of infant with low birth weight (*n* 73) and macrosomia (*n* 74) was the same (3·7 %).

Nutritional status from birth until 24 months can be observed in Table 3. The prevalence of infants who are at OW risk onwards almost doubled from birth to 12 months (17·0 % to 30·3 %), and the sum of OW and OB almost tripled in the same interval (2·2 % *v.* 5·8 %). From 12 to 24 months, the increase in the prevalence of the sum of OW and OB was 1·7 %.

The longitudinal association between GWG during pregnancy and zBMI of the children in the first 24 months of life can be observed in Table 4. No interaction between the growth trajectory and sex was observed. Mothers with GWG below the recommendations had a lower progression of the children's zBMI (−0·15 SD, 95 % CI −0·23, −0·06), comparing with mothers with GWG within recommendations. Higher mothers' BMI before pregnancy was associated with a higher progression of children's zBMI (0·03 SD, 95 % CI 0·02, 0·03). There was also an inverse association between maternal age and the progression of children's zBMI (−0·01 SD, 95 % CI −0·01, 0·00). All these associations were independent over time (0·03 SD, 95 % CI 0·03, 0·03). When considering length for age as outcome, a positive association was found regarding weight gain above recommendations, but not with weight gain below the recommendations.

The association between the parents' BMI at the recruitment and the zBMI of children since birth can be observed in Table 5. Children of obese mothers were more likely to have a higher increase in zBMI (0·24 SD, 95 % CI 0·13, 0·35), but fathers' OB had no effect on children's zBMI trajectory (0·08 SD, 95 % CI −0·02, 0·18). When both mother and father were obese, an interaction with time was verified and the children's zBMI grew faster (0·02 SD, 95 % CI 0·00, 0·03). When considering length for age as outcome, the association with mother's OB is not observed.

Discussion

The prevalence of OW/OB among Portuguese adult population is very high (62·4 %)[5], and EPACI shows an alarming increase of OW prevalence in the first 2 years of life. Comparing nutritional status of parents and children, we observed a positive association between mothers' OB and children's zBMI, whereas no association between fathers' OB and children's zBMI was found.

EPACI shows a high prevalence of OW/OB in Portuguese young adults (45·1 % of the fathers and 23·9 % of the mothers are OW and 13·8 % and 11·7 % are

Table 2 Anthropometry at birth (mean (95 % CI))

	Total	Mean	95 % CI	Female gender	Mean	95 % CI	Male gender	Mean	95 % CI
Weight (g)	*n* 2003*	3247	3227, 3268	*n* 948	3197	3173, 3221	*n* 1055	3292	3255, 3330
Height (cm)	*n* 1996*	48·8	48·7, 49·0	*n* 943	48·4	48·3, 48·5	*n* 1053	49·2	49·0, 49·4
Head circumference (cm)	*n* 1977*	34·4	34·3, 34·5	*n* 937	34·1	34·0, 34·2	*n* 1040	34·7	34·6, 34·8
zBMI (SD)	*n* 1993*	0·08	0·04, 0·13	*n* 941	0·15	0·09, 0·21	*n* 1052	0·02	−0·05, 0·10

*Total does not sum up 2009 due to missing data. The sample was % weighted.

obese, respectively). Nonetheless, these results are slightly lower than those found in the IAN-AF[5]. When comparing the results of both of these studies by gender, similar prevalence was found in men (OW: 41·8 % in IAN-AF *v.* 45·1 % in EPACI; OB: 19·7 % *v.* 13·8 %, respectively), but there were greater differences in women (OW: 31 % in IAN-AF *v.* 23·9 % in EPACI, OB: 23·7 % *v.* 11·7 %, respectively). Notwithstanding, in IAN-AF, anthropometrics were measured, whereas in the present study, these were self-reported. As observed in other studies, when nutritional data are self-reported, it is common to observe an underestimation of the weight[2,9] and this could be the reason for the differences found in women's OW/OB prevalence.

As described in previous studies[40,41], the prevalence of OW in men is always significantly higher than that of women (at least more than 12 %)[40,41], which is in accordance with what we found in our study. This may perhaps be justified with a higher social pressure of body image in women[39].

Mothers' BMI is a strong predictor of the newborn's nutritional status[18,42,43]. In the present study, 31·6 % of women were OW/OB before conception, which is consistent with another Portuguese study (30·1 %)[44]. Furthermore, in women who were UW or with a normal pre-pregnancy BMI, mean weight gain during pregnancy was closer to the inferior limit of Institute of Medicine-recommended guidelines[39], whereas in women who were OW and obese before pregnancy, this was just slightly superior/closer to the superior limit. These results are according to the existing research, which shows that pre-pregnancy nutritional status influences the mother's weight gain during pregnancy[45] and has an impact on future fetal growth and health[46,47]. For instance, if a mother is obese before pregnancy, this will increase the risk of some health complications in the mother/newborn dyad, including fetal macrosomia and later OB[48].

Weight gain during pregnancy also has an impact on the nutritional status of the fetus and on the future health of the child. In the present study, 37·4 % of women showed an adequate weight gain during pregnancy[39], a result similar to another Portuguese study (35·8 %)[49]. However, comparing with the same study, in EPACI, a higher proportion of women gained weight during pregnancy below the recommendations (29·4 % *v.* 22·6 %) and a lower proportion of women had a GWG above the recommendations (33·2 % *v.* 41·7 %).

When stratified by BMI class, EPACI data showed that three quarters of the mothers who were UW and obese before pregnancy had an inadequate weight gain during pregnancy (above or below), which is consistent with the results found by Henriques *et al.*[49]. In the EPACI study, almost half of the mothers who had pre-pregnancy OW and OB increased weight above the recommendations during pregnancy, while very few increased weight below the recommendations. In addition, almost half of UW mothers before pregnancy increased weight below the

Table 3 Nutritional status characterisation (zBMI)* during the first 2 years of life (*n* (%); CI 95 %)

	Birth *n* 1993	2 months *n* 1593	4 months *n* 1775	6 months *n* 1694	9 months *n* 1747	12 months *n* 1665	18 months *n* 1204	24 months *n* 679
UW								
n	47	51	46	36	15	8	5	3
weighted	2·4	3·2	2·6	2·1	0·8	0·5	0·4	0·4
95 % CI	1·7, 3·3	2·3, 4·4	1·8, 3·6	1·4, 3·2	0·5, 1·5	0·2, 1·0	0·2, 1·0	0·2, 0·9
NW								
n	1607	1356	1480	1398	1299	1152	754	446
weighted	80·6	85·1	83·4	82·5	74·4	69·2	62·6	65·7
95 % CI	78·4, 82·7	83·2, 86·8	81·4, 85·3	80·5, 84·4	71·8, 76·7	66·2, 72·1	59·6, 65·6	61·6, 69·5
OW risk								
n	295	167	217	220	357	408	334	179
weighted	14·8	10·5	12·2	13·0	20·5	24·5	27·7	26·5
95 % CI	13·2, 16·5	8·9, 12·4	10·5, 14·1	11·3, 14·9	18·4, 22·7	22·1, 27·0	25·0, 30·6	23·0, 30·2
OW + OB								
n	44	19	32	40	76	97	111	517
weighted	2·2	1·2	1·8	2·3	4·3	5·8	9·2	7·5
95 % CI	1·6, 3·1	0·7, 1·9	1·2, 2·6	1·7, 3·2	3·4, 5·6	4·5, 7·6	7·6, 11·2	5·1, 10·7

zBMI, BMI *Z*-score; UW, underweight; NW, normal weight; OW risk, overweight risk; OW, overweight; OB, obesity.
*According WHO, 2006[36].
The sample was % weighted.
UW: zBMI < −2; NW: zBMI ≥ −2 e ≤ 1 OW risk: zBMI > 1 e ≤ 2; − OW + OB: zBMI > 2 (WHO Classification).

Table 4 Linear mixed model on children zBMI (SD)* (*n* 1671)

	β Est.	95 % CI Lower	Upper
Intercept	−0·38	−0·65	−0·12
Weight gain according to the recommendations†	Ref		
Weight gain below recommendations†	−0·15	−0·23	−0·06
Weight gain above recommendations†	0·02	−0·06	0·10
Age (months)	0·03	0·03	0·03
Mother Pre-pregnancy BMI (kg/m^2)	0·03	0·02	0·03
Mother age (years)	−0·01	−0·01	0·00
	σ‡	Corr§	
Intercept	0·57		
Age slope	0·03	−0·02	
Residual	0·69		

zBMI, BMI *Z*-score.
*According to WHO, 2006[36].
†According to Institute of Medicine Recommendations, 2009:[38] Weight Gain Range (kg): underweight (12·5–18); normal weight (11·5–16); overweight (7–11·5); obesity (5–9).
‡Standard deviation of the random effects.
§Correlation between the random effects; with random intercept and slope for age; the model was adjusted to mother age and mother pre-pregnancy BMI.

Table 5 Linear mixed model on children zBMI (SD)* (*n* 1671)

	β	95 % CI Lower	Upper
Mother			
Non obese†	Reference		
Obese†	0·24	0·13	0·35
Age	0·03	0·03	0·03
Father			
Non obese†	Reference		
Obese†	0·08	−0·02	0·18
Age	0·03	0·03	0·03
Mother and father			
Non obese†	Reference		
Obese†	0·12	−0·11	0·34
Age	0·03	0·03	0·03
Non obese† × age	Reference		
Obese† × age	0·02	0·00	0·03

zBMI, BMI *Z*-score.
*According to WHO, 2006[36].
†According to WHO, 2000[37].
With random intercept and slope for age; the model was adjusted to mother age and mother pre-pregnancy BMI.

recommendations during pregnancy. These results are consistent with the study of Deputy *et al.*, in which the UW women had also the highest prevalence of weight gain below the recommendations (39·3 %) and the OW/OB women had the highest prevalence of weight gain above the recommendations (64·1 % and 63·5 %, respectively)[50].

Previous studies showed that excessive weight gain during pregnancy is associated with several adverse pregnancy outcomes, such as large-for-gestational-age births, childhood OW and OB and maternal postpartum weight retention[17,51,52]. In the EPACI study, there was not a significant different trajectory in the zBMI of children whose mothers gained excessive weight during pregnancy, when comparing with offspring of women with adequate GWG. However, it should be noted that, in this analysis, the included sample had nearly 10 % more mothers with adequate GWG, compared with the sample that was excluded. If a higher proportion of mothers with an excessive GWG during pregnancy had been included, it is possible that the association between mothers who gained gestational weight above the recommendations and children's BMI would be significant.

On the other hand, women who gain weight below the recommendations are more likely to have small-for-gestational age children[50,52,53], and EPACI results were in line with this. In fact, we found that mothers with GWG below recommendations showed a lower children's zBMI trajectory, comparing with mothers with GWG within recommendations, which can protect from later childhood OB. EPACI children had a mean birth weight very similar to the Generation XXI study[54], but an inferior prevalence of low birth weight when compared with another Portuguese study (3·7 % *v.* 6·8 %)[55]. Regarding macrosomia, EPACI found precisely the same prevalence observed by Moreira *et al.*[55]. Anthropometry at birth, in particular birth weight, reflects the intrauterine environment[56], more specifically the genetic background and nutritional and environmental experiences and is also a predictor of future health.

A high prevalence and an early expression of OW and OB in Portuguese children were found in EPACI. In fact, the OW risk onwards prevalence almost doubled from birth to 12 months (17 % to 30·3 %), the greatest increase occurring at 9 months, which corresponds to the first follow-up after the recommended beginning of complementary feeding (at 5–6 months). Similar data were observed in a Chinese cohort[33], where this increase was even more evident, almost tripling from birth to 12 months (10 % – 30 %). This very significant increase of the OW risk prevalence in a short period of time suggests that environment plays a more important role than genetic[57,58]. The developmental origins of health and diseases, also known as Barker Hypothesis, explain the association between environmental events in early life and the risks in future health through epigenetic modifications[59,60]. According to the current knowledge, the first years of life are a period of vulnerability for the OB persistency and future disease programming[61]. Literature shows an intergenerational transmission of OB[62], justified by the sharing of the genetic and obesogenic environment[25,27,28] and also by behavioural factors and intrauterine environment[19].

A significant association between parental weight status and offspring's BMI seems to exist. In fact, according to the EPACI data, an association between mothers' BMI and children's zBMI was visible and mothers' OB showed a significant effect on a higher zBMI in children. In line with Portuguese results, the referred study from a Chinese cohort[33] showed that pre-pregnancy maternal BMI had a significant effect on offspring's BMI. Similarly to EPACI results, a birth cohort study in Malaysia, following mothers throughout pregnancy, demonstrated that a high pre-pregnancy BMI may increase offspring's BMI in the first year of life[32].

Fathers' OB had no effect on offspring's BMI. In fact, according to the results presented above, there was an association between maternal BMI and offspring's zBMI trajectory, but the same does not happen when paternal BMI is analysed. These results can be justified by the influence of intrauterine mechanisms and experiences that occur during pregnancy, such as the overnutrition hypothesis, which predict OB in the future[63]. Curiously, when the presence of OB in both parents was considered, there was no effect on children's zBMI trajectory, but an interaction effect with time was observed.

Contrary to our results, a study in an Australian cohort observed an association between paternal and offspring's BMI. This study, conducted at the age of 14 years, also demonstrated a higher association between maternal and offspring's BMI than between paternal and offspring's BMI[64]. Despite we are comparing nutritional status in older ages of the children, it is known that parental OB shows a tracking until adult age. In addition, and relating to early ages, the Chinese cohort[33] also showed that maternal BMI had more impact in children's growth in the first 24 months and that father's BMI had less impact, even though it had influence in children's growth. A study from Malaysia[32], which focus was the first 12 months of life, corroborates EPACI data and also found an association between mothers' pre-pregnancy BMI and children's BMI.

Notwithstanding, our findings are not in consonance with the results found by Smith[57], based in the Avon Longitudinal Study of Parents and Children and by Fleten *et al.*[65], based in a Norwegian Mother and Child Cohort Study, which showed a similar association between BMI of both parents and offspring childhood BMI. These authors argue that these results probably indicate that the association between maternal and offspring's BMI is more related to the share of the genetic and environment factors rather than with the influence of intrauterine programming[57,65], since if the intrauterine environment had a relevant influence, this association between mothers and offspring would be superior and stronger than the paternal association[57].

In a pandemic OB context, where the influence of the first months of life seems unequivocal, it is crucial to revisit the cut-off points and to consider as OW zBMI above 1 in children from birth to the age of 5 years, since current recommendations only consider OW above *Z*-score 2 at this age range[37]. However, the OW cut-off point of zBMI above 1 for children under 5 years of age is already considered by some authors, such as Mei *et al.*[33], and is already used in clinical practice. Furthermore, in older children, above 5 years of age[66], this same cut-off point of zBMI above 1 classifies children as OW. Thus, for all reasons mentioned above, EPACI results considered as OW risk onwards children with zBMI above 1.

A direct comparison of our results with those of other studies is more difficult because of differences in the birth cohorts, the ages at which examinations were performed, the methods used for the measurement of adiposity, the definitions of OB and the reference populations used to adjust measurements for age and sex. Nevertheless, the influence of maternal BMI on offspring OW and OB since early ages seems unquestionable.

Moreover, we tested the association of parental BMI in the two first years of life, whereas in some of the referred studies, older ages were used. Nonetheless, it should be noted that in the above referred studies, the maternal pre-pregnancy BMI was used, while in our study, the current mother BMI was used.

Concerning the strengths of this study, one is the national representative sample ($n > 2000$) and the fact that this was the first longitudinal assessment in a national representative sample. Another strength of our study relates to the protocol for data collection, which was prepared by specialists (paediatricians and nutritionists) and the data being gathered in face-to-face interviews by trained interviewers following standardised procedures. In addition, our results brought more knowledge about OB prevention and the influence of pre-pregnancy BMI and GWG on offspring's OW and consequently in long-term health, which reinforced the need for early prevention (since preconception).

In contrast, some weaknesses must also be considered. The parental BMI data were self-reported and, as pointed out, when weight is self-reported, it is usual to have underestimation[2,9]. It is possible that stronger effects could appear if measured anthropometrics were considered. Furthermore, children's data were taken from individual health bulletins, and some inconsistencies were found in data. In order to minimise inconsistent data, an exhaustive and logical verification of the database was made, before the data treatment was performed.

Conclusions

A high prevalence of OW and OB was observed in Portuguese young adults. An early onset and a high prevalence of OW and OB were observed in Portuguese toddlers.

Older mothers and mothers with low GWG showed a lower offspring's zBMI trajectory throughout the first 2 years of life. High pre-pregnancy BMI and obese mothers showed a higher offspring's zBMI trajectory. Almost half of OW and obese women increased their gestational weight above the recommendations.

Urgent and early, ideally before conception, effective interventions are needed in order to prevent the transgenerational transmission of OB. It is imperative to implement surveillance plans and changes of attitude, especially in primary health care and particularly concerning women in fertile age and pregnant.

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IV. Conclusions

The work developed in this project allowed the formulation of the set of conclusions listed below.

EFSA's nutritional recommendations issued for European countries are supposedly more adapted to the Portuguese reality than the WHO recommendations, which are more comprehensive, and than the American recommendations from the FNB of IOM, whose population has several characteristics different from those of the Portuguese population. Furthermore, EFSA's recommendations were drawn up for European countries, where Portugal is included, were recently updated and were carried out with great methodological robustness. Therefore, we defend that, between the available recommendations, they are the more appropriate and must be officially adopted in Portugal. The DRI concept, which is related to the American recommendations, is still deeply rooted in the Portuguese population.

Portuguese toddlers had energy and protein intakes above the respective recommendations and low energy consumption from fat. In this age group (12 to 36 months), milk plays a predominant role, contributing to this imbalanced diet.

Portuguese children started excessive sodium intake early. The main contributors were vegetables' soup and salt added to other dishes, which means that Portuguese families must reduce the salt used in meal cooking. On the other hand, one-third of the toddlers had an inadequate intake of vitamin A, and all children consumed less vitamin D than the respective AI. Regular supplementation of vitamin D between the ages of 1 and 2 years must be globally considered, and during autumn and winter months after that age. In fact, even in the summer months, when children are usually most exposed to the sun, their synthesis is compromised by the recommended use of sunscreens.

Portuguese infants had a significant prevalence of breastfeeding initiation. However, its prevalence decreases over time. Only one-fifth of Portuguese infants met WHO's recommendations of six months of exclusive breastfeeding. The predictors of stopping exclusively breastfeeding, identified in this study, were mothers' nutritional status (BMI) and born with low weight.

Complementary feeding was initiated according to ESPGHAN recommendation for most of the infants. Other early feeding practices related to timings and types of food introduced are also according to those recommendations, except for sugary foods, that start especially early by a great prevalence of young children.

This study also showed that parents are very attracted to information during the first year of life and comply with the recommendations. It is therefore essential to focus on raising parents' awareness and sharing with them concrete information and specific recommendations to be complied with after the first year of life, replacing the standard recommendation that only says that the child can integrate the family diet, and that this is a time to rethink the family's eating habits, which should be healthy. Only in this way, will it be possible to empower parents, the majority of which remain permeable to information, and thus obtain better compliance with the recommendations after the first year of life.

Neither breastfeeding nor the timing of dietary diversification showed a protective effect on the expression of OW and/or OB in Portuguese children.

Portuguese children revealed an early onset of the expression of OW and OB, and 32.0% of young Portuguese toddlers were at least at OW risk (zBMI>1). A huge prevalence of OW/OB was also found in young Portuguese adults (35.6% of the mothers and 58.9% of the fathers). Older mothers and mothers with gestational weight gain below recommendations showed a downward zBMI trajectory in their offspring in the first two years of life. On the other hand, a high pre-pregnancy BMI and current OB mothers revealed a higher zBMI trajectory in their offspring. Approximately half of OW and OB mothers had weight gain above the recommendations during pregnancy.

Sustained interventions in primary health care for young adults and their offspring's age are urgently needed to prevent the transgenerational transmission of OB.

V. SUGGESTIONS FOR FUTURE WORK FOLLOWING THE CONCLUSIONS OF THE THESIS

The end of a study of this nature, besides providing numerous answers, gives rise to a lot of questions and suggestions for further research and action.

Regarding data collection, it was clear that some parents and/or other caregivers could not recall accurately the duration of breastfeeding some months later. Considering its relevance, it would be important that this information would be registered in the children's health bulletin. Health professionals should be elucidated about the importance of this issue.

On the other hand, notwithstanding the great job that Portuguese health professionals do regarding complementary feeding being evident, after 12 months the children food pattern has a lot of bad practices. Clearly, parents should be educated to maintain a healthy diet for their children (ideally extensive to all the family), and bad practices in kindergartens and other social contexts frequented by children should be corrected.

It would be interesting to repeat this analysis after a decade, to assess the nutritional status of these same children, now as adolescents, and after the effect of the COVID-19 pandemic.

In addition, it would also be helpful to re-assess the current toddlers and understand what has changed since our data was collected, so that we can continue to provide nutritional advice to ensure the best future for our children.

VI. APPENDICES

Appendix 1: EPACI leaflet for health professionals and caregivers

Appendix 2: EPACI protocol applied to the children's caregivers

Appendix 3: EPACI 3-day food diary

APPENDIX 1: EPACI leaflet for health professionals and caregivers

10 REGRAS A NÃO ESQUECER

1. Ser um bom exemplo;
2. Estabelecer horários e fazer as refeições em família;
3. Não fazer as refeições em frente à televisão;
4. Habituar a criança às regras básicas de higiene e a mastigar calmamente;
5. Respeitar as oscilações de apetite e, caso não coma à refeição, não substituir ou compensar mais tarde;
6. Promover a independência da criança às refeições e estabelecer regras;
7. Não utilizar os alimentos como recompensa ou castigo;
8. Ter um papel ativo e atento, relativamente às refeições da creche/infantário;
9. Promover o treino do paladar, introduzindo alimentos diferentes, um a um;
10. Envolver a criança num estilo de vida ativo e saudável.

Para saudável ser, bem tenho de comer!

Patrocínio Científico:
Sociedade Portuguesa de Pediatria
Sociedade Portuguesa para o Estudo da Obesidade
Associação Portuguesa de Nutricionistas

Apoio:

EPACI PORTUGAL 2012

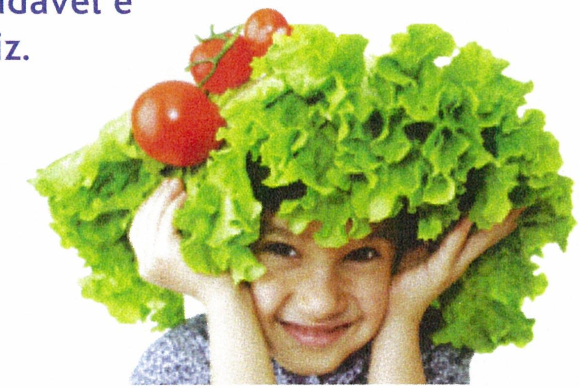
Agora que começou a comer...

O que fazer?

A alimentação é determinante no crescimento do seu filho, que dispara no primeiro ano de vida e desacelera até aos 3-5 anos.

Este facto conduz à diminuição das necessidades nutricionais, traduzindo-se em oscilações de apetite, perfeitamente naturais.

Diga não à preocupação e familiarize a criança com diferentes alimentos para que ela cresça saudável e feliz.



PRINCÍPIOS PARA UMA ALIMENTAÇÃO SAUDÁVEL

A roda dos alimentos é um guia fácil de usar e extremamente útil na prática de uma alimentação completa, variada e equilibrada:

- Tem representados todos os grupos essenciais para um crescimento e desenvolvimento apropriados;
- É adequada a toda a família;
- Durante a semana, devem evitar-se alimentos que não constem da roda;
- O tamanho das "fatias" da roda indica a proporção;
- Incluir água em todas as refeições e intervalos das mesmas.

Nas festas e aos fins-de-semana, pode ser "esquecida" a Roda dos Alimentos... e há espaço para a exceção!!

- Fazer 5 refeições, por dia;
- O leite e derivados (iogurte e queijo) não devem ultrapassar os 500 ml/dia;
- Optar por lanches saudáveis: pão, fruta, leite, iogurtes;
- Iniciar sempre as refeições principais com sopa de legumes ou salada;
- A carne (4x/semana) e o peixe (3x/semana) não devem exceder, por dose, a palma da mão;
- Introduzir legumes e leguminosas de forma atrativa;
- Reduzir a utilização de sal;
- Evitar fritos, refogados e assados com muita gordura.

Realizado por:
C Rêgo; C Lopes; C Barros; E Pinto; M Nazareth; S Ferreira; S Nascimer

APPENDIX 2: EPACI protocol applied to the children's caregivers

EPACI PORTUGAL 2012

ID __ __ __ __/12

Data entrevista: |___|___| / |___|___| / |___|___|___|___| Entrevistador: |____|____|

Pessoa que responde ao questionário:
Mãe ☐ Pai ☐ Avó ☐ Ama ☐ Outro ☐ Quem? ____________________

Centro de Saúde: ____ Código |__|__|__|

Nome do médico de família: ____

Data de nascimento da criança: |___|___| / |___|___| / |___|___|___|___|

Nome da criança: ____

Morada:____

Código Postal |___|___|___|___| - |___|___|___| ____________________________________

Tlm mãe: |___|___|___|___|___|___|___|___|___| Tlm pai: |___|___|___|___|___|___|___|___|___|

Outro contacto: |___|___|___|___|___|___|___|___|___| Qual? _____________________________

Email da mãe: ____ Não tem: ☐

Email do pai: ____ Não tem: ☐

OBSERVAÇÕES

ID __ __ __ __/12

I. Caracterização socioeconómica dos progenitores

A) MÃE

Dados disponíveis? Sim ☐ (passar à pergunta 1) Não ☐
Morte ☐ Mãe sem contacto com a criança ☐ Outro ☐ Qual?________________________

1) Data de nascimento: |___|___| / |___|___| / |___|___|___|___|

2) Situação marital:

Casada/ União de facto	☐	Viúva	☐
Solteira	☐	Separada/ Divorciada	☐

3) Escolaridade:|___|___| anos completos

4) Grau académico:

- 1º Ciclo do Ensino Básico (Primária) ☐
- 2º Ciclo do Ensino Básico (6º ano) ☐
- 3º Ciclo do Ensino Básico (9º ano) ☐
- Ensino Secundário (12º ano) ☐
- Bacharelato ☐
- Licenciatura ☐
- Outro ☐ Especifique ________________________

5) Profissão: ____ Nunca teve: ☐

6) Condição perante o trabalho:

- Exerce profissão ☐
- Estudante ☐
- Trabalhadora-estudante ☐
- Doméstica ☐
- Procura do 1º emprego ☐
- Desempregada ☐
- Inválida/ reformada ☐

7) Peso: |___|___|___| , |___| Kg NS ☐

8) Estatura: |___|, |___|___| m NS ☐

9) Peso antes da gravidez deste filho: |___|___|___| , |___| Kg NS ☐

10) Aumento de peso na gravidez deste filho: |___|___|___| , |___| Kg NS ☐

B) PAI

Dados disponíveis? Sim ☐ Não ☐
Morte ☐ Pai sem contacto com a criança ☐ Outro ☐ Qual?________________________

11) Data de nascimento: |___|___| / |___|___| / |___|___|___|___|

12) Situação marital:

Casado/ União de facto	☐	Viúvo	☐
Solteiro	☐	Separado/ Divorciado	☐

13) Escolaridade:|___|___| anos completos

14) Grau académico:

1º Ciclo do Ensino Básico (Primária)	☐
2º Ciclo do Ensino Básico (6º ano)	☐
3º Ciclo do Ensino Básico (9º ano)	☐
Ensino Secundário (12º ano)	☐
Bacharelato	☐
Licenciatura	☐
Outro	☐ Especifique ________________________

15) Profissão: ____ Nunca teve: ☐

16) Condição perante o trabalho:

Exerce profissão	☐
Estudante	☐
Trabalhadora-estudante	☐
Procura do 1º emprego	☐
Desempregado	☐
Inválido/ reformado	☐

17) Peso: |___|___|___| , |___| Kg NS ☐

18) Estatura: |___|, |___|___| m NS ☐

19) Nº de pessoas que constituem o agregado familiar da criança:
|___|___| crianças (<18 anos)
|___|___| adultos (≥18 anos)

20) Rendimento mensal do agregado familiar:

A) <500 euros	☐	F) 2500 – 3000 euros	☐
B) 501 – 1000 euros	☐	G) >3000 euros	☐
C) 1000 – 1500 euros	☐	H) Não sabe	☐
D) 1500 – 2000 euros	☐	I) Prefere não dizer	☐
E) 2000 – 2500 euros	☐		

21) Agregado familiar vive em:
Casa própria ☐
Casa alugada ☐
Casa de familiares ☐

22) Quem cuidou/ cuida da criança
Mãe e/ou pai ☐
Entre |___|___| meses e |___|___| meses; ☐ Entre |___|___| meses e |___|___| meses
Ama ☐
Entre |___|___| meses e |___|___| meses; ☐ Entre |___|___| meses e |___|___| meses
Avó(s) ☐
Entre |___|___| meses e |___|___| meses; ☐ Entre |___|___| meses e |___|___| meses
Infantário ☐
Entre |___|___| meses e |___|___| meses; ☐ Entre |___|___| meses e |___|___| meses
Outro. Quem _________________________
Entre |___|___| meses e |___|___| meses; ☐ Entre |___|___| meses e |___|___| meses

II. Saúde

23) Problema de saúde que implicasse tratamento crónico, em algum momento desde o nascimento:
Sim ☐ Não ☐

a. Se sim, qual? ____

24) Necessidade de internamento:
Sim ☐ Não ☐

a. Se sim, quanto tempo?
1º ano: |__|__|__| dias 2º ano: |__|__|__| dias 3º ano: |__|__|__| dias

25) Nº de vezes, no último ano, em que a criança recorreu ao médico devido aos problemas que afetam frequentemente as crianças, tais como, tosse, febre, otite, amigdalite, constipação,…:
Nunca ☐ |___|___| vezes Foi, mas não sabe dizer quantas vezes ☐

26) Acompanhamento de saúde de rotina da criança:
Pediatra ☐
Médico de família ☐
Pediatra e médico de família ☐
Outro ☐ Quem? ___________________________________

III. Alimentação e suplementação

27) Aconselhamento para a diversificação alimentar:

Pediatra	☐
Médico de família	☐
Iniciativa própria	☐
Familiar	☐
Experiência de filhos anteriores	☐
Outro	☐ ______________________________

28) Tipo de leite:

		Início (meses)	Fim (meses)	Continua
Leite materno	☐	__ __	__ __	☐
Fórmulas infantis	☐	__ __	__ __	☐
Fórmulas 1	☐	__ __	__ __	☐
Fórmulas 2	☐	__ __	__ __	☐
Fórmulas 3	☐	__ __	__ __	☐
Outras. Qual?				
______________	☐	__ __	__ __	☐
Leite de crescimento	☐	__ __	__ __	☐
Leite de vaca G	☐	__ __	__ __	☐
Leite de vaca MG	☐	__ __	__ __	☐
Bebidas de soja	☐	__ __	__ __	☐

29) Duração de aleitamento “exclusivo”: |___|___|, |___| meses

30) Início da diversificação alimentar: |___|___| meses

31) Primeiro alimento na diversificação alimentar

Sopa:	Sim	☐	Não	☐
Papa de cereais:	Sim	☐	Não	☐
Fruta:	Sim	☐	Não	☐

32) Frequência da ingestão de grupos de alimentos

	Idade de início (m)	Atualmente						
		≥3/ dia	2/ dia	1/ dia	4-6/ sem	1- 3/sem	<1/sem	Nunca
Cereais infantis	__ __	☐	☐	☐	☐	☐	☐	☐
Cereais peq.-almoço	__ __	☐	☐	☐	☐	☐	☐	☐
Leite		☐	☐	☐	☐	☐	☐	☐
Iogurtes	__ __	☐	☐	☐	☐	☐	☐	☐
Carne	__ __	☐	☐	☐	☐	☐	☐	☐
Peixe	__ __	☐	☐	☐	☐	☐	☐	☐
Vegetais no prato	__ __	☐	☐	☐	☐	☐	☐	☐
Vegetais na sopa	__ __	☐	☐	☐	☐	☐	☐	☐
Fruta fresca	__ __	☐	☐	☐	☐	☐	☐	☐
Fruta boião	__ __	☐	☐	☐	☐	☐	☐	☐
Sobremesas e doces	__ __	☐	☐	☐	☐	☐	☐	☐
Sumos fruta natural	__ __	☐	☐	☐	☐	☐	☐	☐
Néctares	__ __	☐	☐	☐	☐	☐	☐	☐
Refrigerantes c/ gás	__ __	☐	☐	☐	☐	☐	☐	☐
Refrigerantes s/ gás	__ __	☐	☐	☐	☐	☐	☐	☐

33) Número de refeições diárias: |___|___|

a. Quais? PA ☐ MM ☐ A ☐ MT ☐ J ☐ C ☐

34) Toma de suplementos vitamínicos e minerais:

	1º ano			2º ano			3º ano		
	Sim	*Não*	*Nº gotas*	*Sim*	*Não*	*Nº gotas*	*Sim*	*Não*	*Nº gotas*
Ferro	☐	☐	____	☐	☐	____	☐	☐	____
Vitamina D	☐	☐	____	☐	☐	____	☐	☐	____
Vitamina C	☐	☐	____	☐	☐	____	☐	☐	____
Flúor	☐	☐	____	☐	☐	____	☐	☐	____
Multivitamínicos	☐	☐	____	☐	☐	____	☐	☐	____
________________	☐	☐	____	☐	☐	____	☐	☐	____
________________	☐	☐	____	☐	☐	____	☐	☐	____

35) Em média, quantas horas por noite dorme a criança? |____|____|,|____| horas

36) A criança faz sesta…

a. Durante a manhã? Nunca ☐ <1h ☐ 1 – 2h ☐ >2h ☐

b. Durante a tarde? Nunca ☐ <1h ☐ 1 – 2h ☐ >2h ☐

37) Estaria disponível para ser contactado futuramente em etapas subsequentes desta investigação? Sim ☐ Não ☐ Não sabe ☐

IV.Antropometria (recolha do Boletim de Saúde Infantil e Juvenil; Avaliação)

38) Sexo da criança: Feminino ☐ Masculino ☐ Entrevistador: |____|____|

39) Idade gestacional: |___|___| semanas

40) Na opinião do(a) respondente, a criança:

Tem o peso adequado para o comprimento e idade ☐
Tem peso a mais para o comprimento e idade ☐
Tem peso a menos para o comprimento e idade ☐
Não sabe julgar ☐

41) Antropometria:

	Data	Peso (g)	Comprimento (cm)	PC (cm)	Pcintura (cm)
nascimento		__ __ __ __	__ __ __ , __	__ __ , __	
2 meses	_ _/_ _/_ _	__ __ __ __	__ __ __ , __	__ __ , __	
4 meses	_ _/_ _/_ _	__ __ __ __	__ __ __ , __	__ __ , __	
6 meses	_ _/_ _/_ _	__ __ __ __	__ __ __ , __	__ __ , __	
9 meses	_ _/_ _/_ _	__ __ __ __	__ __ __ , __	__ __ , __	
12 meses	_ _/_ _/_ _	__ __ __ __	__ __ __ , __	__ __ , __	
18 meses	_ _/_ _/_ _	__ __ __ __	__ __ __ , __	__ __ , __	
24 meses	_ _/_ _/_ _	__ __ __ __	__ __ __ , __	__ __ , __	
Na avaliação		__ __ __ __	__ __ __ , __	__ __ , __	__ __ , __

42) A criança foi adotada?

Sim ☐ Não ☐

Se sim, com quantos meses? |__|__|

APPENDIX 3: EPACI 3-day food diary

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INSTRUÇÕES PARA O PREENCHIMENTO DO DIÁRIO ALIMENTAR DE 3 DIAS

Por favor anote **tudo o que a criança comer ou beber durante 3 dias**, a começar no próximo domingo, inclusive.

Quando a criança comer fora de casa, por favor anote tudo o que for consumido. Não se esqueça também de registar tudo o que for comido ou bebido entre as refeições, como por exemplo, fruta, bolachas, rebuçados ou outros alimentos.

Caso a criança não esteja consigo todo o dia, deve ser solicitada ajuda no preenchimento deste diário a quem supervisiona a refeição (educador de infância, avós, familiares ou outras pessoas presentes).

Como fazer o registo:

Inicie o registo com a página correspondente a esse dia (existe 1 folha para cada dia); por favor assegure-se que preencheu as partes correspondentes a: HORA, LOCAL DE CONSUMO, ALIMENTOS E BEBIDAS CONSUMIDOS, QUANTIDADE.

Descrição do Alimento:

Faça **descrições pormenorizadas** de alimentos e bebidas como, por exemplo, tipos de pão (trigo, mistura, integral, etc.), bolachas (Maria, por exemplo) ou tipo de leite (meio-gordo, magro, achocolatado). Mencione também os ingredientes e o método de confecção culinária utilizado (cozido, frito, assado na brasa) e o tipo de gordura utilizada (ex. óleo, margarina, manteiga) como, por exemplo, carne de vaca guisada, gema de ovo cozido, costeleta de porco frita em margarina, etc.
Sempre que possível, anote a marca dos produtos consumidos (ex. iogurte natural Danone®).
Não se esqueça de registar o açúcar que adiciona ao leite, iogurtes, fruta, etc. e o azeite ou molhos que adiciona no prato.
Registe todos os alimentos consumidos, mesmo que tenham sido em quantidades muito pequenas.

Quantidades e tamanhos das porções:

Mencione o **tamanho dos alimentos** e a **quantidade das bebidas**. Para tal, use medidas caseiras como, por exemplo, 1 colher de chá de manteiga, 3 colheres de sopa cheias de arroz, 1 concha de massa, 1 tigela de sopa, 1/2 chávena almoçadeira de leite (ou 1/2 chávena de chá, se for mais pequena), etc.

Seguem-se alguns exemplos:

Bebidas
Use copos ou chávenas e refira o tipo como, por exemplo, chávena almoçadeira de leite.

Sopas
Use tigelas, número de conchas ou pratos (cheio, meio prato).

Carne, pescado, aves, ovo
Indique as quantidades consumidas especificando os alimentos e classificando as porções em tamanhos fatias, unidades (1/2 ovo ou ½ perna de frango, por exemplo), cubos de carne, latas (1/2 lata de atum, por exemplo), ou medidas caseiras (3 colheres de sopa de peixe, por exemplo).

Hortaliças e legumes
Use rodelas (por exemplo, tomate, cebola, pepino), parte do prato (meio prato, um quarto de prato) ou chávenas almoçadeiras (meia chávena de alface, por exemplo).

Arroz, massa, feijão, ervilhas ou grão
Indique o número de colheres de sopa.

Batatas
Se forem cozidas, indique o número de batatas do tamanho de um ovo; em puré, diga o número de colheres de sopa. Se forem fritas, indique a que parte do prato corresponde (meio prato, um quarto de prato); em pacote, diga se é pequeno, médio ou grande.

Óleos, manteiga e margarina
Use colheres de sopa ou de chá.

Açúcar, cacau, chocolate, mel
Use pacotes de açúcar ou colheres de chá.

Pão, pastelaria e doces
Use o número de pães ou fatias e mencione o tipo de pão se não for corrente (de trigo, centeio, broa de milho).
Bolos: 1 unidade ou 1 fatia

Fruta
Refira o nome da fruta e indique o número de porções médias; se forem uvas ou morangos, por exemplo, poderá dizer o número de unidades aproximado por porção.

NOTA: Se tiver balança ou conhecer o peso do alimento pode referi-lo.

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Exemplo do registo de um dia ID __ __ __ __ / 12

Dia da semana: **Domingo** Data: |_1_|_7_| / |_0_|_4_| / |_1_|_2_|

Hora	Local de consumo	Descrição detalhada dos Alimentos e Bebidas	Quantidade (gramas ou medidas caseiras)	Codificação (por favor não preencha)
8h	Casa	Leite Nestlé® crescimento 1+	200ml	
	"	Chocolate em pó	1 colher de sobremesa	
	"	Pão de mistura	1 pão (40g)	
	"	Manteiga Mimosa®	½ colher sobremesa	
10h	Infantário	Iogurte natural Danone®	125g	
12h	Infantário	Sopa (brócolos, batata, cenoura, azeite)	2 conchas (200g)	
12h30	Infantário	Carne de vaca estufada	50g	
	"	Cenoura estufada	3 rodelas (20g)	
	"	Ervilha estufada	1 colher de sopa (10g)	
	"	Ingredientes estufados em azeite		
	"	Arroz branco	3 colheres de sopa rasas	
14h	Infantário	Papa de fruta: maçã, pêra, banana	200g (1 maçã média, ½ pêra média, 1 banana pequena)	
16h	Rua	Chupa de morango	1 chupa	
17h	Casa avó	Leite Meio Gordo Agros®	200ml	
	"	Chocolate em pó	1 colher de sobremesa	
	"	Bolacha tipo Maria	3 bolachas	
20h00	Casa avó	Sopa (abóbora, cebola, batata, cenoura, repolho, azeite)	2 conchas (150g)	
20h00	Casa avó	Ovo cozido	1 ovo médio	
	"	Batata cozida	1 batata tamanho de 1 ovo	
23h	Casa	Leite Nestlé® crescimento 1+	200ml	

Em termos alimentares, o dia de hoje reflecte a alimentação do seu filho num dia habitual de fim-de-semana? ☒ Sim ☐ Não

EPACI PORTUGAL 2012

ID __ __ __ __ / 12

Dia da semana: **Domingo** Data: |___|___| / |___|___| / |___|___|

Hora	**Local de consumo**	**Descrição detalhada dos Alimentos e Bebidas**	**Quantidade** (gramas ou medidas caseiras)	**Codificação** (por favor não preencha)

EPACI PORTUGAL 2012

Hora	Local de consumo	Descrição detalhada dos Alimentos e Bebidas	Quantidade (gramas ou medidas caseiras)	Codificação (por favor não preencha)

Em termos alimentares, o dia de hoje reflecte a alimentação do seu filho num dia habitual de fim-de-semana? ☐ Sim ☐ Não

EPACI
PORTUGAL
2 0 1 2

ID __ __ __ __ / 12

Dia da semana: **Segunda-feira** Data: |___|___| / |___|___| / |___|___|

Hora	**Local de consumo**	**Descrição detalhada dos Alimentos e Bebidas**	**Quantidade** (gramas ou medidas caseiras)	**Codificação** (por favor não preencha)

Hora	Local de consumo	Descrição detalhada dos Alimentos e Bebidas	Quantidade (gramas ou medidas caseiras)	Codificação (por favor não preencha)

Em termos alimentares, o dia de hoje reflecte a alimentação do seu filho num dia habitual de semana? ☐ Sim ☐ Não

EPACI
PORTUGAL
2 0 1 2

ID __ __ __ __ / 12

Dia da semana: **Terça-feira** Data: |___|___| / |___|___| / |___|___|

Hora	Local de consumo	Descrição detalhada dos Alimentos e Bebidas	Quantidade (gramas ou medidas caseiras)	Codificação (por favor não preencha)

Hora	Local de consumo	Descrição detalhada dos Alimentos e Bebidas	Quantidade (gramas ou medidas caseiras)	Codificação (por favor não preencha)

Em termos alimentares, o dia de hoje reflecte a alimentação do seu filho num dia habitual de semana? ☐ Sim ☐ Não

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