Nutrition and Health
Series Editor: Adrianne Bendich

Ronald Ross Watson
George Grimble
Victor R. Preedy
Sherma Zibadi *Editors*

Nutrition in Infancy

Volume 1

Humana Press

Nutrition and Health Series

Adrianne Bendich, PhD, FASN, FACN, Series Editor

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Editors

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Editors
Ronald Ross Watson, Ph.D.
Arizona Health Science Center
Mel and Enid Zuckerman College of Public Health
University of Arizona
Tuscon, AZ, USA

Victor R. Preedy, Ph.D.
Department of Nutrition and Dietetics
King's College
London, UK

George Grimble, Ph.D.
Centre for Gastroenterology and Nutrition
University College London
London, UK

Sherma Zibadi, M.D., Ph.D.
Division of Health Promotion Sciences
Mel and Enid Zuckerman College of Public Health
University of Arizona
Tuscon, AZ, USA

ISBN 978-1-62703-223-0 ISBN 978-1-62703-224-7 (eBook)
DOI 10.1007/978-1-62703-224-7
Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2012952097

Printed on acid-free paper

Humana Press is a brand of Springer
Springer is part of Springer Science+Business Media (www.springer.com)

Preface

For millennia the importance is known to mothers and critical for child growth and survival. With the expansion of biomedical research in the late twentieth century fine details and specific solutions to prevention and treatment of childhood growth, diseases, and health can be defined. The editors have decades of research and interest in nutrition and health including editing a previous version of Nutrition and Infancy a dozen years ago. With many advances in studies on the role of foods and nutrients in childhood necessitated an updated version with expanded authors and topics in seven major areas as part of a *two volume set*.

Volume 1

Overview: global perspectives. This section begins with discussions of infant nutrition and lifelong health including adverse effects on infants in the Middle East and aboriginals in Canada. Developing problems for infants are reviewed on the role of fatty acids on neurological development and obesity.

Premature infant feeding. This section has six sections focusing on nutrition and premature infant health. These range from protein supplementation, colostrums, and total parenteral nutrition. Importantly these therapies effects on growth as well as defining knowledge and research gaps are discussed.

Breast feeding: growth and health. This historical and traditional method of infant feeding makes up one of two major sections of the book with nine diverse reviews. Breast milk has major roles in growth, development, obesity, and body composition. The causes and solutions to early breast milk feeding cessation. Thus the need to store breast milk and maintain their functions is critical to many mothers. Breast feeding in special populations including the Indian subcontinent vary. A variety of factors affect breast milk including maternal dietary salt, diet, milk oligosaccharides, and tobacco smoking are discussed to thereby modifying infant health. The question of breast milk and risk of subsequent breast cancer is reviewed. Importantly methods to improve use of breast feeding and its duration on infant growth and health are defined.

Micronutrients and healthy infant nutritional status. Clearly maternal supplement has been used to have effects on infants and benefits/risks are reviewed along with food fortification. Importantly the role of nutritional support of children with inborn errors of metabolism will be very helpful to physicians. Finally major vitamins are reviewed including vitamin A status assessment and role in health, vitamin K deficiency, and micronutrient deficiencies in infant skin problems. Magnesium is developing as a new mineral to use in infant health as described in its chapter.

Volume 2

Nutrition and neonatal/infant disease. Nutrition in infant diets plays key role in treatment of various challenging diseases and form the second major section with eight reviews. For examples, the reviews of intractable epileptic, chronic diseases, liver disease, short bowel syndromes, and Crohn's disease show important roles of diet to manage and treat them. Nutrition and diet supplement are reviewed as modulators of undernutrition-induced hearing loss, diabetes, and HIV-induced malnutrition. Hormones as therapy affect beneficially infants with kidney disease. Glangliosides are modified by diet affecting neurological development. The role of dietary supplementation in developmental or genetic disease like celiac disease, acute gastroenteritis, and intestinal failure are reviewed. Surgery is sometimes needed to correct birth issues and an example is reviewed, percutaneous endoscopic gastrostomy designed for children. In support of surgeries in infants the role of nutrition for those undergoing it is defined. Many diseases of infants have a nutritional component or therapy.

GI tract considerations. Parental nutrition can play important roles in the growth and development of the gastrointestinal tract of infants that need supplementation. This can include home parenteral nutrition in developing countries or low-income families. Colonic flora respond to diets and supplements and affect the infants' growth and development. Thus pro and probiotics are reviewed as potential over-the-counter prevention and therapies to treat disease and promote growth.

Formulas in health and disease of infants. Historically formulas with food and nutrition components have been used as therapies by physicians. Home and hospital parenteral nutrition are reviewed in two chapters. Two other chapters review parenteral nutrition in premature infants and promotion of safety in disease prevention. Parenteral nutrition is the major focus of this section. Probiotics and probiotics are novel and developing for disease therapy and promotion of infant growth. Protein nutrition is key for helping undernourished preterm infants.

Hormones and lipids: growth and development of infants. Hormones and lipids are becoming applied in diets, therapies, and from mother's milk to affect infants. Diet's role in managing hypercholesterolemia is defined. The role of infant adipose tissues and its hormones in changing infant development are carefully and completely reviewed. Maternal behavior and diet affect the infant as defined by clinicians in a review. Finally hormone therapy is described as it improves growth in infants with chronic kidney disease.

Summary. A wide range of nutritional and food-related therapies to prevent or ameliorate disease, growth retardation, and promote health are outlined by 113 experts in 59 chapters. This book becomes a definitive source for much of the methods and approaches to use nutrition to promote well-being in infants.

Tucson, AZ, USA — Ronald Ross Watson, Ph.D.
London, UK — George Grimble, Ph.D.
London, UK — Victor R. Preedy, Ph.D.
Tucson, AZ, USA — Sherma Zibadi, M.D.

Series Editor

The great success of the Nutrition and Health Series is the result of the consistent overriding mission of providing health professionals with texts that are essential because each includes: 1) a synthesis of the state of the science, 2) timely, in-depth reviews by the leading researchers in their respective fields, 3) extensive, up-to-date fully annotated reference lists, 4) a detailed index, 5) relevant tables and figures, 6) identification of paradigm shifts and the consequences, 7) virtually no overlap of information between chapters, but targeted, inter-chapter referrals, 8) suggestions of areas for future research and 9) balanced, data-driven answers to patient as well as health professionals questions which are based upon the totality of evidence rather than the findings of any single study.

The Series volumes are not the outcome of a symposium. Rather, each editor has the potential to examine a chosen area with a broad perspective, both in subject matter as well as in the choice of chapter authors. The editor(s), whose training(s) is (are) both research and practice oriented, have the opportunity to develop a primary objective for their book, define the scope and focus, and then invite the leading authorities to be part of their initiative. The authors are encouraged to provide an overview of the field, discuss their own research and relate the research findings to potential human health consequences. Because each book is developed de novo, the chapters are coordinated so that the resulting volume imparts greater knowledge than the sum of the information contained in the individual chapters.

"Nutrition in Infancy", edited by Professor Ronald Ross Watson, PhD, Professor George Grimble, PhD, Professor Victor R. Preedy, PhD, DSc, FRIPH, FRSH, FIBiol, FRCPath and Dr. Sherma Zibadi, MD, PhD clearly exemplifies the goals of the Nutrition and Health Series. The major objective of this comprehensive two volume text is to review the growing evidence that nutrition provided in utero and during infancy directly affects the entire lifetime health of the individual. This volume includes 60 up-to-date informative reviews of the current major dietary issues. Practicing health professionals, researchers and academicians can rely on the chapters in this volume for objective data-driven sources about essential vitamins and minerals, proteins, fats, and carbohydrates. This new comprehensive review of the science behind the nutritional strategies to assure the health of the neonate is of great importance to the nutrition community as well as for health professionals who have to answer patient, client or graduate student questions about the newest clinical research in nutrition and infancy.

"Nutrition in Infancy" represents the most comprehensive compilation of the recent data on the actions of specific essential nutrients and bioactive dietary components on fetal development and growth of the preterm and term infant. It is to the credit of Drs. Watson, Grimble, Preedy and Zibadi that they have organized this volume so that it provides an in-depth overview of the critical issues involved in the determination of the best nutrition for infants including those born preterm, those with medical conditions that require specific dietary interventions, those born in developing nations or in developed nations, those with special GI tract requirements and those with genetic factors that affect the metabolism of certain foods and/or nutrients.

Each of the two volumes contains about 30 comprehensive chapters. The first volume contains four related sections. The first section, an overview of global perspectives on infant feeding practices, contains seven chapters that include reviews of the history of breast feeding from the beginning of time up until present times; there are several unique chapters that describe the discovery of the infant requirements for vitamins and government projects to assure the nutritional adequacy of infant feeding programs. This is especially important when populations may be far from medical resources such as described in the chapters discussing infant nutrition issues in Aboriginal children living in remote regions such as in Northern Canada; infants from India, Pakistan, and Bangladesh; Middle East and North Africa. Infants can triple their birth weight during the first year of life and the quantity as well as the nutritional quality of the diet can affect the growth rate dramatically. The introduction of complementary foods during infancy in developing countries is usually dependent upon cultural norms and these are outlined for a number of African and East Asian nations in the next chapter. The final chapter in this section includes a synthesis of studies examining the potential for development of food allergies in children from developed countries. The chapter provides valuable discussions and tabulates the data on the importance of timing of introduction of specific foods to infants and subsequent development of asthma and/or allergies.

The second section contains six chapters on premature infant feeding. The chapter authors remind us that fetuses increase their weight 10 fold in the second and third trimester with concomitant gains in height and head circumference. Preterm birth may therefore result in stunted growth due to a variety of medical conditions. There is an important discussion of accurately determining whether a preterm neonate is small for its gestational age or growth retarded. If the birth weight is less than the 10th percentile-for-gestational age, this is defined as small-for-gestational age (SGA). Growth restriction and constitutional slow growth represent two distinct processes independent of SGA and are associated with different potential adverse outcomes. Potential maternal factors linked to preterm birth are reviewed in several chapters. These include smoking, gestational diabetes, infections, malnutrition, preeclampsia and most recently, excessive maternal weight as well as excessive maternal weight gain during pregnancy.

Preterm infants usually lose more weight after birth than term infants. Preterm infants require greater protein and lipid administration following birth and increased vitamin, mineral and caloric supplementation throughout the first year of life. The absorption and bioavailability of nutrients by the premature gut differs from that of the fetus that obtains nutrients across the placenta. The significant medical morbidities seen in preterm infants especially lung disease that requires ventilation and/or serious infections that require targeted nutritional interventions, add to the nutritional stresses seen in the preterm infant. The development of the microbiome also differs in preterm infants compared to term infants due to gut immaturity and medical conditions as mentioned above. Even when preterm infants reach term equivalent, their pattern of growth continues to differ from infants born at term. Thus, these chapters provide detailed information on methods used to evaluate growth and nutritional status in preterm infants.

One of the major considerations of preterm morbidity is that preterm infants exhibit intestinal wall immaturity which is measured as increased intestinal permeability. The importance of human breast milk and other sources of nutrients for the premature infant are discussed in a single detailed chapter. The authors discuss the fact that the gastrointestinal (GI) system doubles in length from 25 to 40 weeks' gestation. Preterm birth significantly increases the risk of necrotizing enterocolitis, an inflammatory cascade that leads to ischemia/necrosis of the intestines. This disease is found in 7-10% of very low birth weight infants who are usually born before the 25th week of gestation and is associated with 33% mortality and 33% long-term GI and/or neurodevelopmental morbidity. Several chapters review the data concerning the importance of glutamine and arginine in reducing gut permeability. Related to GI tract maturation is the availability of maternal colostrum. The chapter on colostrum reviews the immunological as well as nutritional importance of this first milk especially to very low birth weight preterm infants. Another important nutrient for the preterm infant is protein. Unlike term

infants who have a recommended daily protein intake of 1.5 g/kg/day for the first 6 months of life, the smallest preterm infant can have an increased protein need of about 4 g/kg/day and preterm infants >750-1500 grams require at least 3-3.5 g/kg/ day depending upon their medical conditions.

The preterm infant's protein requirements from parenteral and enteral sources are discussed in detail in the next two chapters. The chapters review the importance of parenteral nutrition (PN) for preterm infants. The provision of nutrients intravenously is complicated in adults, and it is extremely complicated in the smallest, least developed preterm infants. Not only are the procedures complex, but the administration of the correct balance of nutrients, fluids and maintenance of non-infective complications is of paramount importance. The determination of standards of growth for the preterm infant given parenteral nutrition is ongoing and several important studies are reviewed and extensively tabulated for the reader. These detailed chapters provide practice-based suggestions concerning the most critical aspects of assuring the health of the preterm receiving PN during the first days of life.

Nine chapters examine the role of breastfeeding in the growth and health of the term infant. The third section includes reviews of the nutritional value of human breast milk and the consequences of maternal smoking on these nutrients. There are also unique chapters on methods to improve the initiation and success of breastfeeding, another on potential reasons why infants stop breastfeeding and potential ways to restart breastfeeding; a chapter that reviews the totality of the evidence concerning the association of breastfeeding and cancer risks in the breastfed child, and a chapter on storage of breast milk with protocols tabulated for the reader. The section begins with a chapter on human milk oligosaccharides (HMO), complex carbohydrates abundant in human milk. Recent data show that HMO might protect very-low-birth-weight preterm infants from necrotizing enterocolitis. HMO help establish and maintain a healthy colonic microbiome. The authors remind us that currently there are no human clinical research studies with HMO.

The next chapter updates information concerning the role of breastfeeding duration and lowered risk of childhood and adult obesity. The authors objectively review the recent meta-analyses and also examine the data from studies with formula-fed infants. Maternal dietary factors that can affect breastfeeding duration are discussed in the chapter that describes the role of maternal dietary salt intake. Factors including maternal diabetes, obesity and undernutrition are examined in detail. Maternal smoking and/or fetal exposure to environmental tobacco smoke and its effects on the neonatal immune and respiratory systems is reviewed in the next chapter. There is a strong association between smoking exposure and increased risk of asthma and allergies in the neonate and the child of smoking parents. Moreover, maternal smoking is associated with reductions in oxytocin that is required for release of milk from the breast.

The fourth section, entitled "Micronutrients and Healthy Infant Nutritional Status", contains nine chapters that include examination of foods as well as individual nutrients. The prevalence of micronutrient deficiencies in infancy and in the second and third years of life are reviewed in the first chapter. Reference values from the World Health Organization are tabulated. Provision of supplements to expectant mothers is one strategy proposed to reduce infant nutritional deficiencies especially in developing countries. Supplemental iron, folic acid, calcium, zinc, vitamin D, vitamin A and other essential nutrients are discussed. Another strategy is food fortification that has the benefit of not having to change dietary habits. Successful fortification programs including iodization of salt, addition of iron and folic acid to staple foods and addition of vitamin A to rice are reviewed in detail.

The importance of examining the amino acid and protein sources and content of infant formulas is reviewed in the next chapter that reminds the reader that cow's milk and human milk differ significantly in their major proteins as well as the protein's amino acid concentrations. The potential consequences of these differences are discussed in light of the differences in compositions between currently available formulas. Taurine is considered a non-essential amino acid in adults, but may be essential to the developing embryo, fetus and neonate. The value of taurine for optimal development of the cardiovascular system is discussed in a separate, well-illustrated chapter. There is an additional chapter that reviews the importance of gangliosides in neuronal development and the value of

placental transfer and human breast milk as sources of gangliosides for the developing fetal and infant brain and nervous systems.

Determination of micronutrient deficiencies in infants, especially in developing countries where medical facilities may not be nearby, is of great importance as these are often multi-micronutrient deficiencies that can result in serious adverse effects. The chapter describing the cutaneous and mucous membrane manifestations of nutritional deficiencies reviews the symptoms that can be seen during the early stages as well as later deficiency diseases. In addition, treatment modalities for the most commonly seen vitamin and mineral deficiencies are described. One of the micronutrient deficiencies that may be overlooked is magnesium deficiency. The chapter on magnesium tabulates the requirements for this mineral in infants and young children, manifestations of low as well as high magnesium status and the consequences of these conditions in infants. Vitamin K is another essential micronutrient that may be low in the term infant and is often in very low concentrations in the blood of preterm infants. Vitamin K is essential for the synthesis of certain coagulation factors. If the neonate's plasma concentration of vitamin K is low, they may suffer from vitamin K deficiency bleeding, previously called hemorrhagic disease of the newborn. In the developed nations, neonates are supplemented with vitamin K immediately after birth. As described in the next chapter, neonates, and particularly those who are breastfed, benefit from prophylactic vitamin K but cost implications may be prohibitive in some regions of the world. The final chapter in this section reviews the importance of optimal vitamin A status in the mother and infant as a key determinant in maintaining the infant's natural immunity. Also included in the chapter is a discussion of the weaning transition time and diet as weaning is a risk factor for vitamin A deficiency. One strategy may be to improve maternal vitamin A status and her breast milk vitamin A levels so that the infant can build sufficient body reserves of vitamin A prior to the transition. Improving vitamin A content in weaning foods is also important.

The second volume of "Nutrition in Infancy" emphasizes clinical conditions found in infancy. Half of the second volume is devoted to reviews of the clinical significance of nutritional factors in infants with diseases and/or conditions that are either inherited or develop postnatally. Section E contains 17 chapters devoted to these critical practice- related topics. The first chapter in this section describes two examples of altered body composition in children; those with cerebral palsy and Down syndrome, both prevalent disorders with differing etiologies, but significant and opposite impacts on growth, body composition and nutritional status. These differences require separate approaches for accurate nutrition-related clinical assessment and management that are described in detail. The second chapter provides an extensive overview of the major nutritional consequences and treatments of inborn errors of metabolism. Conditions reviewed include amino acid genetic errors such as phenylketonuria, errors in carbohydrate metabolism resulting in glycogen storage diseases and errors in fat metabolism. The third chapter on epilepsy in infancy reviews the importance of the ketogenic diet which is a high fat, low carbohydrate diet with an adequate amount of protein that mimics the metabolic state of fasting during an anabolic situation. This special dietary regime is used in conjunction with anti-epileptic drugs and also when the drugs do not provide benefit to the infant or young child. The chapter includes detailed appendices and tables.

Seven of the 17 chapters examine serious acute as well as chronic gastrointestinal (GI) diseases. There is a unique chapter that describes the effects of inherited malformations in the cranium and/or oral cavity on the nutritional status of the infant and growing child. Also included in this chapter are discussions of maintenance of the early teeth and avoidance of caries. Even when cranio-facial development is normal, feeding difficulties can arise in the neonatal period due to biological, developmental or behavioral issues. Reduced efficiency in feeding often occurs when there is oral motor dysfunction, which is common in children with developmental disabilities. With regard to acute gastroenteritis, this is the commonest indication seen in children in emergency rooms in the US. Diarrhea, usually caused by viral infection, is reviewed in detail and provides current treatment methods depending upon laboratory findings, diagnosis and current nutritional status of the child. The detailed description of the physiology of the gastrointestinal tract provides excellent background information for

understanding the effects of pathological conditions discussed in subsequent chapters. Over 20 pathogenic conditions are described in detail including viral, bacterial and parasitic infections.

As described in the chapter on short bowel syndrome, intestinal failure is defined as the critical reduction of functional gut mass below the amount that is minimally necessary for adequate digestion and absorption to satisfy nutrient and fluid requirements for growth in children. Therefore the use of parenteral nutrition (PN) is required. Intestinal failure may result from intestinal obstruction, dysmotility, surgical resection, congenital defects, or disease-associated loss of absorption. Intestinal failure may be caused by short bowel syndrome (SBS), mucosal enteropathy, or dysmotility syndromes. SBS is a subcategory of intestinal failure, which may result from surgical resection, congenital defect or disease-associated loss of absorption. This condition is characterized by the inability to maintain protein-energy, fluid, electrolyte or micronutrient balances when on a conventionally accepted, normal diet. One of the mechanisms used to provide nutrition to the infant with serious gastrointestinal issues is the use of a gastric feeding tube (gastrostomy). The next chapter describes this procedure, its benefits and risks. The commonest reason for gastrostomy placement in children is neurological disability, either congenital or acquired brain injury; other causes include congenital heart disease, chronic lung disease, cystic fibrosis, congenital malformations that prevent swallowing and malignancy.

The chapters that review Crohn's disease, celiac disease, intestinal failure, acute and chronic gastroenteritis and liver diseases also contain clinically relevant discussions of signs and symptoms and current therapies including considerations of use of enteral as well as PN where warranted. The chapters include excellent tables and figures as well as guidelines for patient evaluations of macro and micronutrient levels that are often affected by these chronic disease states that often develop in infancy, during the transition to semi-solid foods from breast feeding, and/or in early childhood. Relevant data on occurrences in developed and developing nations are included. As there are many commonalities between the symptoms seen in these chronic conditions, including failure to thrive, diarrhea and stunting, each chapter author provides specific mechanisms available to determine the exact causes of the gastric distress.

The final five chapters in this section examine the nutritional effects of kidney disease, HIV infection and diabetes. The chapters on the effects of undernutrition on hearing capacity, and the ability to fight infections that may be associated with surgery in infancy complete this section. The common thread of potentially severe malnutrition associated with these conditions is reviewed with emphasis on clinically validated methods to overcome growth retardation and improve GI functions. Specifically, in the chapter on HIV infection, the WHO guidelines are included as well as tabulation of the clinical studies in HIV-infected mothers and multifactorial effects of breastfeeding. Another unique chapter describes the fetal development of hearing and reviews the anatomy and physiology of the auditory processes. The chapter examines the micronutrients most commonly associated directly or indirectly with hearing impairment including iodine, iron, zinc and vitamins A, B12 and D. The chapter on Type I and Type II diabetes reminds us that this is the most common metabolic disease in infants and children. Nutritional management during early childhood is described in detail. The final chapter in this clinically-focused section examines the effects of severe stresses on the infant that include events such as cardiac surgery and burns. Young children, due to their low protein reserves, are particularly vulnerable to the adverse nutritional effects of stress. The chapter reviews the role of nutrition support in helping to preserve skeletal muscle and support organ and immune function. The optimal levels of macronutrients, micronutrients, energy and nutrition support in critically ill children are unknown. Predictive equations may not adequately predict energy needs during critical illness. As all of the authors acknowledge, more research in the area of nutrition support for the acute and/or chronically ill child is urgently needed.

The sixth section contains five chapters that examine PN in detail as well as the importance of the microbiome in the infant, toddler and growing child. The two comprehensive chapters that describe PN in the hospital and home settings provide important clinical data. PN is the technique of artificial nutrition that provides the patient with fluids, energy and nutrients that are delivered directly to the

circulatory system through the venous network. This non-physiological path of nutrient provision results in a dramatically different gastrointestinal response than that with enteral nutrition as PN provides no trophic effect on intestinal mucosa. Descriptions of protocols for determining constituents of PN for infants in hospitals and home settings are included.

Three chapters examine the role of the microbiome in the health of healthy as well as infants with serious GI-related diseases. As described by the authors, at birth, the intestine is sterile and colonic function of the human infant is immature. The development of the infant's microbiome is described in detail. The development of the colonic functions, including water absorption and carbohydrate fermentation, is related in part to the intestinal microbiota. These bacteria have well-established metabolic functions and perform important inmunoregulatory roles. Data from the human microbiome project has begun to identify and characterize the microorganisms found in both healthy and diseased individuals. The chapters objectively describe the functions of beneficial microorganisms that are consumed, and are referred to as probiotics, and nutritional sources for the probiotics, that are referred to as prebiotics. The microbiome contributes to the nutritional welfare of the infant through its metabolism of complex carbohydrates, generation of short-chain fatty-acids as an energy substrate for colonic epithelia, and production of folate and other B vitamins. Prebiotics have been found to selectively stimulate favorable growth and/or activity of selected probiotic bacteria in the colon. Probiotics have been shown to be beneficial in the treatment of acute infectious diarrhea as these reduce duration and stool frequency. We are reminded that optimal prebiotic usage as well as probiotic strains and dosages for preterm as well as full term infant patients still remain to be determined.

The final section of the second volume examines the newest research on the importance of long chain lipids in the growth of infants and also reviews the data linking early nutritional exposure to the risk of developing hypercholesterolemia, premature cardiovascular disease and obesity. The first chapter reviews in detail the value of lipid emulsions for the preterm and very preterm infant provided as either PN or enteral nutrition. The chapter includes a valuable discussion of the sources of oils used in available emulsions and provides recommendations based upon efficacy and safety data. Another chapter extensively reviews the roles of long chain omega-3 and omega-6 fatty acids in the neurological development and growth of the fetus and neonate with emphasis on the increased requirements in the preterm infant. The development of the brain and retina, visual and cognitive functions are reviewed and relevant epidemiological and intervention studies are tabulated. Recommendations for maternal intakes of long chain polyunsaturated fatty acids during pregnancy are included.

The balance between infant energy and growth requirements and increased risk of higher than normal serum lipids is compounded by genetic factors that predispose certain infants to premature cardiovascular disease. Relevant treatments, patient evaluation and review of the literature are provided in the next chapter. The mechanisms of action of adipose tissue cells, adipocytes, in regulating hunger, satiety and weight in utero as well as in infancy are examined in a separate chapter. Details concerning the effects of preterm birth followed by rapid weight gain and significantly increased risk of cardiovascular disease in adulthood are described. The receptors on adipocytes, hormones synthesized by adipocytes and their actions are reviewed.

The reader is reminded that currently there is no national or international agreed upon diagnostic cut off or definition of obesity in infants and young children. Strategies, from individual recommendations to public health measures are discussed and provide options for health providers. An overriding issue remains that there is no agreed-upon recommendation concerning when to begin screening for potential weight problems in infants, toddlers and young children. The two main hypotheses to explain the observed inverse association between small size at birth and adult disease are fetal programming i.e. the thrifty phenotype hypothesis and genetic susceptibility hypothesis. These, as well as future research areas and implications, are reviewed in detail in the following chapter. The book's final chapter examines the interactions between maternal behaviors and infant's weight gains. This unique chapter reviews the data that suggest that a mother can overfeed by virtue of failing to heed her infant's satiety signals, with a resultant heavier infant. The historic overview of studies on infant

feeding practices in this chapter suggests that clinicians can help guide mothers to better read their infants' hunger and satiety cues to avoid overfeeding.

The logical sequence of the Sections as well as the chapters within each Section enhance the understanding of the latest information on the current standards of practice in infant feeding for clinicians, related health professionals including the dietician, nurse, pharmacist, physical therapist, behaviorist, psychologist and others involved in the team effort required for successful treatment of infants with relevant diseases and conditions that adversely affect normal metabolic processes. This comprehensive two volume resource also has great value for academicians involved in the education of graduate students and post-doctoral fellows, medical students and allied health professionals who plan to interact with parents of infants with disorders that may be beneficially affected by nutritional supports including enteral and parenteral nutritional modalities.

Cutting edge discussions of the roles of signaling molecules, growth factors, hormones, cellular and nuclear receptors and all of the cells and tissues directly involved or affected by the nutrients provided to infants, both term and preterm are included in well-organized chapters that put the molecular aspects into clinical perspective. Of great importance, the editors have provided chapters that balance the most technical information with discussions of its importance for clients and parents of patients as well as graduate and medical students, health professionals and academicians.

The volume contains over 200 detailed tables and figures that assist the reader in comprehending the complexities of breast milk, breastfeeding, other sources of infant nutrition as well as the biological significance of critical nutrients and the microbiome in maintaining infant growth and health. The over-riding goal of this volume is to provide the health professional with balanced documentation and awareness of the newest research and therapeutic approaches including an appreciation of the complexity of the interactions between genetics, intrauterine growth, maternal health, and term compared to preterm birth issues in this relatively new field of investigation. Hallmarks of the 60 chapters include key words and bulleted key points at the beginning of each chapter, complete definitions of terms with the abbreviations fully defined for the reader and consistent use of terms between chapters. There are over 4000 up-to-date references; all chapters include a conclusion to highlight major findings. The volume also contains a highly annotated index.

This unique text provides practical, data-driven resources based upon the totality of the evidence to help the reader understand the basics, treatments and preventive strategies that are involved in the understanding the role dietary components may play in the early development of healthy infants as well as those with gastrointestinal diseases, genetic defects, metabolic or other complications and/or neurological impairments. Of equal importance, critical issues that involve parental concerns, such as food preferences in children, potential effects on weight gain or growth, breastfeeding versus formula feeding and differences in critical issues such as HIV infections in developing and developed nations are included in well-referenced, informative chapters. The overarching goal of the editors is to provide fully referenced information to health professionals so they may have a balanced perspective on the value of various preventive and treatment options that are available today as well as in the foreseeable future.

In conclusion, "Nutrition in Infancy", edited by Professor Ronald Ross Watson, PhD, Professor George Grimble, PhD, Professor Victor R. Preedy, PhD, DSc, FRIPH, FRSH, FIBiol, FRCPath and Dr. Sherma Zibadi, MD, PhD provides health professionals in many areas of research and practice with the most up-to-date, well referenced and comprehensive volume on the current state of the science and medical practice guidelines with regard to maintaining the optimal nutritional status of the infant. This volume will serve the reader as the most authoritative resource in the field to date and is a very welcome addition to the Nutrition and Health Series.

Adrianne Bendich, Ph.D., F.A.C.N., F.A.S.N.

Series Editor Bios

Dr. Adrianne Bendich has recently retired as Director of Medical Affairs at GlaxoSmithKline (GSK) Consumer Healthcare where she was responsible for leading the innovation and medical programs in support of many well-known brands including TUMS and Os-Cal. Dr. Bendich had primary responsibility for GSK's support for the Women's Health Initiative (WHI) intervention study. Prior to joining GSK, Dr. Bendich was at Roche Vitamins Inc. and was involved with the groundbreaking clinical studies showing that folic acid containing multivitamins significantly reduced major classes of birth defects. Dr. Bendich has coauthored over 100 major clinical research studies in the area of preventive nutrition. Dr. Bendich is recognized as a leading authority on antioxidants, nutrition and immunity and pregnancy outcomes, vitamin safety, and the cost-effectiveness of vitamin/mineral supplementation.

Dr. Bendich, who is now President of Consultants in Consumer Healthcare LLC, is the editor of ten books including "Preventive Nutrition: The Comprehensive Guide For Health Professionals," fourth edition coedited with Dr. Richard Deckelbaum, and is the Series Editor of "Nutrition and Health" for Springer/Humana Press (www.springer.com/series/7659). The Series contains 50 published volumes—major new editions in 2010–2011 include "Vitamin D," second edition edited by Dr. Michael Holick; "Dietary Components and Immune Function" edited by Dr. Ronald Ross Watson, Dr. Sherma Zibadi, and Dr. Victor R. Preedy; "Bioactive Compounds and Cancer" edited by Dr. John

A. Milner and Dr. Donato F. Romagnolo; "Modern Dietary Fat Intakes in Disease Promotion" edited by Dr. Fabien DeMeester, Dr. Sherma Zibadi, and Dr. Ronald Ross Watson; "Iron Deficiency and Overload" edited by Dr. Shlomo Yehuda and Dr. David Mostofsky; "Nutrition Guide for Physicians" edited by Dr. Edward Wilson, Dr. George A. Bray, Dr. Norman Temple, and Dr. Mary Struble; "Nutrition and Metabolism" edited by Dr. Christos Mantzoros, and "Fluid and Electrolytes in Pediatrics" edited by Leonard Feld and Dr. Frederick Kaskel. Recent volumes include "Handbook of Drug-Nutrient Interactions" edited by Dr. Joseph Boullata and Dr. Vincent Armenti; "Probiotics in Pediatric Medicine" edited by Dr. Sonia Michail and Dr. Philip Sherman; "Handbook of Nutrition and Pregnancy" edited by Dr. Carol Lammi-Keefe, Dr. Sarah Couch, and Dr. Elliot Philipson; "Nutrition and Rheumatic Disease" edited by Dr. Laura Coleman; "Nutrition and Kidney Disease" edited by Dr. Laura Byham-Grey, Dr. Jerrilynn Burrowes, and Dr. Glenn Chertow; "Nutrition and Health in Developing Countries" edited by Dr. Richard Semba and Dr. Martin Bloem; "Calcium in Human Health" edited by Dr. Robert Heaney and Dr. Connie Weaver, and "Nutrition and Bone Health" edited by Dr. Michael Holick and Dr. Bess Dawson-Hughes.

Dr. Bendich serves on the Editorial Boards of the Journal of Nutrition in Gerontology and Geriatrics, and the e-journal, Antioxidants and has served as Associate Editor for "Nutrition" the International Journal; served on the Editorial Board of the *Journal of Women's Health and Gender-Based Medicine*, and was a member of the Board of Directors of the American College of Nutrition.

Dr. Bendich was the recipient of the Roche Research Award, is a *Tribute to Women and Industry* Awardee, and was a recipient of the Burroughs Wellcome Visiting Professorship in Basic Medical Sciences, 2000–2001. In 2008, Dr. Bendich was given the Council for Responsible Nutrition (CRN) Apple Award in recognition of her many contributions to the scientific understanding of dietary supplements. Dr. Bendich holds academic appointments as Adjunct Professor in the Department of Preventive Medicine and Community Health at UMDNJ and has an adjunct appointment at the Institute of Nutrition, Columbia University P&S, and is an Adjunct Research Professor, Rutgers University, Newark Campus. She is listed in Who's Who in American Women. In 2012, Dr. Bendich was elected as a Fellow of the American Society for Nutrition.

Volume Editors Bios

Ronald R. Watson, Ph.D., attended the University of Idaho but graduated from Brigham Young University in Provo, Utah, with a degree in chemistry in 1966. He earned his Ph.D. in biochemistry from Michigan State University in 1971. His postdoctoral schooling in nutrition and microbiology was completed at the Harvard School of Public Health, where he gained 2 years of postdoctoral research experience in immunology and nutrition.

From 1973 to 1974 Dr. Watson was assistant professor of immunology and performed research at the University of Mississippi Medical Center in Jackson. He was assistant professor of microbiology and immunology at the Indiana University Medical School from 1974 to 1978 and associate professor at Purdue University in the Department of Food and Nutrition from 1978 to 1982. In 1982 Dr. Watson joined the faculty at the University of Arizona Health Sciences Center in the Department of Family and Community Medicine of the School of Medicine. He is currently professor of health promotion sciences in the Mel and Enid Zuckerman Arizona College of Public Health.

Dr. Watson is a member of several national and international nutrition, immunology, cancer, and alcoholism research societies. Among his patents he has one on a dietary supplement; passion fruit peel extract with more pending. He had done DHEA research on its effects on mouse AIDS and immune function for 20 years. He edited a previous book on melatonin (Watson RR. *Health Promotion and Aging: The Role of Dehydroepiandrosterone* (DHEA). Harwood Academic Publishers, 1999, 164

pages). For 30 years he was funded by Wallace Research Foundation to study dietary supplements in health promotion. Dr. Watson has edited more than 100 books on nutrition, dietary supplements and over-the-counter agents, and drugs of abuse as scientific reference books. He has published more than 500 research and review articles.

Dr. George Grimble has been working in the area of Clinical Nutrition since 1980 with a special emphasis on clinical gastroenterology research, intensive care medicine and nutrition in older people. He is currently Principal Teaching Fellow at UCL in the Centre for Gastroenterology & Nutrition in the Division of Medicine.

The path which led him here started with a B.Sc. in Biochemistry at UCL, followed by a Ph.D. from the Department of Human Nutrition at the London School of Hygiene and Tropical Medicine. From 1980 to 1994, he worked as Director, Biochemical Research in the Department of Gastroenterology & Nutrition at Central Middlesex Hospital before moving to the University of Roehampton (until 2004), London Metropolitan University (until 2006) and University of Reading (until 2011).

From 2007, he ran RECOMMEND (*Re*ading *Co*mmunity *Me*dical *N*utrition *D*ata) which investigated the attitudes of Family doctors towards nutrition and weight management. From 2008, he held concurrent appointments at Reading and UCL, running M.Sc. programs in both universities.

Dr. Grimble is a very active teacher in graduate programs and has published extensively. He is currently preparing his seventh book, has more than 250 scientific publications which include 74 reviews and book chapters and two patents. He has acted as consultant for many companies active in clinical nutrition support.

Professor Victor R. Preedy B.Sc. D.Sc. FSB FRCPath FRSPH is currently Professor of Nutritional Biochemistry in the Department of Nutrition and Dietetics, King's College London and Honorary Professor of Clinical Biochemistry in the Department of Clinical Biochemistry, King's College Hospital. He is also Director of the Genomics Centre, Kings College London and a member of the School of Medicine, King's College London. King's College London is one of the world's leading universities. Professor Preedy gained his Ph.D. in 1981 and in 1992 he received his Membership of the Royal College of Pathologists (MRCPath), based on his published works. He was elected a Fellow of the Royal College of Pathologists (FRCPath) in 2000. In 1993 he gained his second doctorial degree (DSc) for his outstanding contribution to protein metabolism. In 2004 Professor Preedy was elected as a Fellow to both the Royal Society for the Promotion of Health (FRSH) and The Royal Institute of Public Health (FRIPHH). In 2009 he was elected as a Fellow of the Royal Society for Public Health (RSPH). He is also a Fellow of The Society of Biology (FSB). Professor Preedy has written or edited over 550 articles, which includes over 160 peer-reviewed manuscripts based on original research and 85 reviews and 30 books. His interests pertain to matters concerning nutrition and health at the individual and societal levels.

Dr. Sherma Zibadi received her Ph.D. in nutrition from the University of Arizona and is a graduate of the Mashhad University of Medical Sciences, where she earned her M.D. She has recently completed her post-doctoral research fellowship awarded by the American Heart Association. Dr. Zibadi engages in the research field of cardiology and complementary medicine. Her main research interests include maladaptive cardiac remodeling and heart failure, studying the underlying mechanisms and potential mediators of remodeling process, which helps to identify new targets for treatment of heart failure. Dr. Zibadi's research interest also extends into alternative medicine, exploring the preventive and therapeutic effects of natural dietary supplements on heart failure and its major risk factors in both basic animal and clinical studies, translating lab research finding into clinical practice. Dr. Zibadi is an author of multiple research papers published in peer-reviewed journals and books, as well as coeditor of several books.

Acknowledgments

The work of editorial assistant, Bethany L. Stevens, and Daniel Dominguez of Humana Press in communicating with authors, working with the manuscripts and the publisher was critical to the successful completion of the book and is much appreciated. Their daily responses to queries and collection of manuscripts and documents were extremely helpful. Support for Ms Stevens' work was graciously provided by the National Health Research Institute as part of its mission to communicate to scientists about bioactive foods and dietary supplements was vital (http://www.naturalhealthresearch.org). This was part of their efforts to educate scientists and the lay public on the health and economic benefits of nutrients in the diet as well as supplements. Mari Stoddard of the Arizona Health Sciences library was instrumental in finding the authors and their addresses in the early stages of the book's preparation. The support of Humana Press staff as well as the input by the series editor, Adrianne Bendich is greatly appreciated for the improved organization of this book.

Contents

Contributors

Milana Abramovich Department of Human Nutritional Sciences, University of Manitoba, Winnipeg, MB, Canada

Nisreen A. Alwan Nutritional Epidemiology Group, School of Food Science & Nutrition, University of Leeds, Leeds, UK

Gema Ariceta Pediatric Nephrology, Hospital Universitario Materno Infantil, Vall d'Hebron, Barcelona, Spain

Laura Hjeij Awada Nutrition Program, University of Ottawa, Ottawa, ON, Canada

Malek Batal Nutrition Program, University of Ottawa, Ottawa, ON, Canada

Jacques Berger UMR-204 Prevention of Malnutrition, IRD Centre Montpellier, IRD-UM2-UM1, Montpellier, France

Department of Human Nutrition, Copenhagen University, Copenhagen, Denmark

Pita Birch Department of Paediatrics, Gold Coast Hospital, Southport, QLD, Australia

Lars Bode Divisions of Neonatology and Gastroenterology and Nutrition, Department of Pediatrics, University of California, San Diego, CA, USA

Janet E. Cade Nutritional Epidemiology Group, School of Food Science & Nutrition, University of Leeds, Leeds, UK

Nilgun Demirli Çaylan Department of Social Pediatrics, Dr. Sami Ulus Children's and Maternity Hospital, Ankara, Turkey

Zaynah Tahmina Chowdhury Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, AZ, USA

Willemijn E. Corpeleijn The Erasmus MC–Sophia Children's Hospital, Rotterdam, The Netherlands

Marjoleine A. Dijkhuizen UMR-204 Prevention of Malnutrition, IRD Centre Montpellier, IRD-UM2-UM1, Montpellier, France

Department of Human Nutrition, Copenhagen University, Copenhagen, Denmark

Henrietta Nkechi Ene-Obong Department of Biochemistry (Nutrition Unit), University of Calabar, Calabar, Nilgeria

Caroline Fall MRC Lifecourse Epidemiology Unit, University of Southampton, Southampton, UK

Asefeh Faraz Yale School of Nursing, Yale University, New Haven, CT, USA

James Friel Department of Pediatrics, University of Manitoba, Winnipeg, MB, Canada

Masako Fujita Department of Anthropology, Michigan State University, East Lansing, MI, USA

Johannes B. van Goudoever Department of Pediatrics, Erasmus MC–Sophia Children's Hospital, Rotterdam, The Netherlands

Melissa A. Henderson Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, AZ, USA

Kenneth Herrmann Department of Pediatrics, IU School of Medicine, Deaconess-Riley NICU at the Women's Hospital, Newburgh, IN, USA

Evelyn Jantscher-Krenn Divisions of Neonatology and Gastroenterology and Nutrition, Department of Pediatrics, University of California, San Diego, San Diego, CA, USA

Candemir Karacan Department of Pediatrics, Dr. Sami Ulus Children's and Maternity Hospital, Ankara, Turkey

Liza Konnikova Division of Newborn Medicine—Enders 961, Harvard Medical School, Children's Hospital, Boston, Boston, MA, USA

Camilia R. Martin Harvard Medical School, Department of Neonatology Director for Cross-Disciplinary Research Partnerships, Division of Translational Research, Beth Israel Deaconess Medical Center, Boston, MA, USA

Margaret F. McHugh Telethon Institute for Child Health Research, Centre for Child Health Research, University of Western Australia, Perth, Australia

Sambasiviah Chidambara Murthy Department of Dermatology and Venereology, Vijayanagara Institute of Medical Sciences, Bellary, Karnataka, India

Christine A. Northrop-Clewes GAIN Health, Geneva, Switzerland

Bright Ibeabughichi Nwaru School of Health Sciences, University of Tampere, Tampere, Finland

Wendy Oddy Telethon Institute for Child Health Research, Centre for Child Health Research, University of Western Australia, Perth, Australia

Antonio Oliver-Roig Department of Nursing, University of Alicante, San Vicent del Raspeig, Alacant, Spain

Margaret G. Parker Boston Medical Center, Boston University School of Medicine, Boston, MA, USA

Juliana Pugmire Arizona Respiratory Center, Tucson, AZ, USA

Mariana Rendon Departments of Anthropology and Microbiology and Molecular Genetics, Michigan State University, East Lansing, MI, USA

Siân Robinson MRC Lifecourse Epidemiology Unit, University of Southampton, Southampton, UK

Nancy A. Rodriguez Evanston Hospital, NorthShore University Health System, Evanston, IL, USA

Julie Ross Department of Pediatrics, Medical University of South Carolina, Charleston, SC, USA

Sanya Roysommuti Department of Physiology, Khon Kaen University, Khon Kaen, Thailand

Sandra Castillo San-Juan Department of Pediatrics, University of Manitoba, Winnipeg, MB, Canada

Rakesh Sharma Center of Nanobiotechnology, Florida State University, Tallahassee, FL, USA

Eugen-Matthias Strehle Northumbria Healthcare NHS Foundation Trust, The Newcastle Hospitals NHS Foundation Trust and The Medical School, Newcastle University, Newcastle-Upon-Tyne, UK

Sarah N. Taylor Department of Pediatrics and Neonatology, MUSC Children's Hospital, Charleston, SC, USA

Linda J. Titus Dartmouth Medical School, Norris Cotton Cancer Center and Hood Center for Children and Families, Lebanon, NH, USA

Peter Orji Uvere Department of Food Science and Technology, University of Nigeria, Nsukka, Nigeria

Christina J. Valentine Division of Neonatology, Perinatal, and Pulmonary Biology, Center for Interdisciplinary Research in Human Milk and Lactation, The University of Cincinnati, Cincinnati Children's Hospital Medical Center, Cincinnati, OH, USA

Sergio Verd Hospital de la Santa Cruz y San Pablo, Barcelona, Spain

Marijn J. Vermeulen Department of Pediatrics, Erasmus MC–Sophia Children's Hospital, Rotterdam, The Netherlands

Carol L. Wagner Department of Pediatrics, Medical University of South Carolina, Charleston, SC, USA

Frank T. Wieringa UMR-204 Prevention of Malnutrition, IRD Centre Montpellier, IRD-UM2-UM1, Montpellier, France

Ronald Ross Watson Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, AZ, USA

Noreen Willows Department of Agricultural, Food and Nutritional Science (AFNS), University of Alberta, Edmonton, AB, Canada

Lauren A. Wise Slone Epidemiology Center, Boston University, Boston, MA, USA

Sean Woolen Department of Neonatology, Indiana University School of Medicine, Evansville, IN, USA

J. Michael Wyss Department of Cell Biology, University of Alabama at Birmingham, Birmingham, AL, USA

Gonca Yilmaz Department of Pediatrics, Dr. Sami Ulus Children's and Maternity Hospital, Ankara, Turkey