Importance of Growth for Health and Development

Nestlé Nutrition Institute Workshop Series
Pediatric Program, Vol. 65

Importance of Growth for Health and Development

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Nestec Ltd., 55 Avenue Nestlé, CH–1800 Vevey (Switzerland)
S. Karger AG, P.O. Box, CH–4009 Basel (Switzerland) www.karger.com

Printed in Switzerland on acid-free and non-aging paper (ISO 9706) by Reinhardt Druck, Basel
ISBN 978–3–8055–9304–5
e-ISBN 978–3–8055–9305–2
ISSN 1661–6677

Library of Congress Cataloging-in-Publication Data

Nestlé Nutrition Workshop (65th : 2009 : Kuala Lumpur, Malaysia)
Importance of growth for health and development / editors, Alan Lucas, Maria Makrides, Ekhard E. Ziegler.
p. ; cm. -- (Nestlé Nutrition Institute workshop series. Paediatric programme, ISSN 1661-6677 ; v.65)
Includes bibliographical references and index.
ISBN 978-3-8055-9304-5 (hard cover : alk. paper)
1. Children--Growth--Congresses. 2. Children--Nutrition--Congresses. 3. Child development--Congresses. I. Lucas, Alan, MD. II. Makrides, Maria. III. Ziegler, Ekhard E. IV. Title. V. Series: Nestlé Nutrition workshop series. Paediatric programme, v.65. 1661-6677 ;
[DNLM: 1. Child Development--physiology--Congresses. 2. Growth--Congresses. 3. Body Composition--Congresses. 4. Child Nutritional Physiology Phenomena--Congresses. W1 NE228D / WS 103 N468i 2010]
RJ131.N375 2010
618.92--dc22

2009042309

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Growth and Neurological Development

Physical Growth and Body Composition

Preface

Growth is universally used by health care professionals and caregivers to judge the well-being of babies and children, and this is based on an extensive scientific literature linking aberrant growth of either extreme, failure to thrive or rapid excessive growth, with adverse health and developmental outcomes. On one hand, poor growth in early life is most commonly associated with poor neurodevelopmental outcomes, while on the other hand rapid and excessive growth has been associated with obesity and detrimental cardiovascular outcomes. While such statements do provide a simple summary, they assume knowledge of optimal growth patterns and how these can be achieved. With clear gaps in these areas, the challenge of this workshop was to explore in some detail the associations of early growth patterns with later neurodevelopment, obesity, cardiovascular outcomes and longevity in both industrialized and semi-industrialized societies.

The workshop covered three sessions and involved a number of outstanding clinicians and scientists, who participated in an often vibrant discussion. The first session started with an overview and focused on the association of early growth with obesity and cardiovascular outcomes. Presentations drew on evidence from epidemiological as well as experimental studies, animal models and mechanistic studies. The second session concentrated on the interrelationship between growth and neurodevelopment. Some emphasis was placed on vulnerable groups such as preterm infants and children born in developing and emerging economies. The role and balance of specific nutrients, including iron and long-chain polyunsaturated fatty acids, were also highlighted. The final session of the workshop considered the control and assessment of physical growth in some detail. The hormonal control of growth was highlighted. Growth charts were compared and their relative strengths and limitations discussed.

This publication includes all the presentations together with the related discussions. The concluding remarks provide a comprehensive summary and conclusions drawn from the deliberations of the workshop.

Alan Lucas
Maria Makrides
Ekhard E. Ziegler

Foreword

The 65th Nestlé Nutrition Institute Workshop entitled 'Importance of Growth for Health and Development' was held in Kuala Lumpur, Malaysia, on 29 March to 2 April 2009. This workshop intended to follow up on the discussions from the 47th workshop entitled 'Nutrition and Growth' in 2000.

At the 65th Nestlé Nutrition Institute Workshop the definition of 'healthy growth' was discussed with respect to the risk of deviations from the standard in both directions: the risk of accelerated growth in early childhood is associated with a higher prevalence of obesity and cardiovascular disease. On the other hand, decelerated growth has a negative impact on cognitive development and morbidity. Gestation and the first 2 years of life were identified as the most vulnerable period for long-term negative outcomes. The role of nutritional factors, such as iron and LC-PUFAs were reviewed regarding their importance in different pediatric populations.

We thank the three chairpersons, Prof. *Alan Lucas* from the UK, Prof. *Maria Makrides* from Australia, and Prof. *Ekhard Ziegler* from the USA, who are well-known experts in this field for putting together this outstanding program and inviting as speakers the opinion leaders in the field of health and development.

We also want to thank Ms. *Mei Ching Wong* and her team for the excellent organization of the workshop and the warm hospitality.

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65th Nestlé Nutrition Institute Workshop
Pediatric Program
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Lucas A, Makrides M, Ziegler EE (eds): Importance of Growth for Health and Development.
Nestlé Nutr Inst Workshop Ser Pediatr Program, vol 65, pp 1–11,
Nestec Ltd., Vevey/S. Karger AG, Basel, © 2010.

Growth and Later Health: A General Perspective

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Abstract

Whilst growth and its derangement in disease have been a long-standing focus in pediatrics, increasing evidence points to a further, fundamental role of early growth in the programming of later health. In studies on animals and humans, rapid early growth is associated with higher risk of obesity and cardiovascular disease, and in animals, senescence and life span – a concept encapsulated in the postnatal growth acceleration hypothesis. This hypothesis explains the benefits of breastfeeding to infants for reduced cardiovascular disease risk in terms of their slower early growth and the fetal origins hypothesis in terms of the adverse postnatal catch-up growth in infants born small. Early growth, notably prior to full term, also influences brain development and cognition – and emerging evidence suggests diverse, broader effects, for instance cancer and the onset of puberty. Understanding the mechanisms, triggers and windows for such effects is important, given the major public health implications, including potential new opportunities for primary prevention of adult disease.

In humans, growth is a key feature that distinguishes the pediatric from adult population. Growth is the traditional measure of overall nutritional status. Much scientific attention has been paid to its measurement and derangement in a wide variety of diseases.

More recently, a new focus has been its association with long-term health outcomes, and in animal models, also senescence and lifespan [1, 2]. Emerging research on the importance of early growth is providing insights into developmental biology, the early influences on adult health, and potential strategies for primary prevention of disease.

Programming

Central to this field is programming [3] – the broader concept that a stimulus or insult at a critical period may have long-term or lifetime effects.

The first studies on critical periods related to imprinting in birds [4]. In the last 80 years, much work has shown programming effects of early nutrition or growth. The first experimental studies were in animals. McCay, in the 1930s [2], showed reduced energy intake in rats, resulting in growth stunting, increased lifespan and favorably affected several later health outcomes. Conversely McCance [5] showed faster early growth in the first 3 weeks in rats, achieved by reducing litter size, increased final size; using a similar model, Hahn [6] showed adverse long-term metabolic effects, notably cholesterol levels. Since then, manipulation of early nutrition and growth has been shown in numerous animal studies to influence long-term or lifetime blood pressure, lipid metabolism, body fatness, insulin resistance, atherosclerosis, bone health, learning and behavior [2, 6–9]. Such long-term effects have been found in humans in observational studies and, importantly, random intervention trials (RCTs) that can establish causation [3, 10–13].

Growth is fuelled by *nutrition*, making it difficult to extricate the influence of these two early factors on later health. Yet, a central programming influence of growth itself is suggested by the close association between growth and outcome across numerous species [14] including humans.

Programming of Obesity and Risk of Cardiovascular Disease

Animal studies provide extensive evidence on the programming of obesity and cardiovascular disease (CVD) risk factors, including atherosclerosis itself. Lewis [7] showed in infant baboons that an energy-enriched diet, which produced transient excessive weight gain during the intervention, programmed late emergence of obesity in adolescence and adult life. Ozanne and Hales showed in rats that postnatal catch-up growth after nutrient restriction in utero increased later fatness and reduced lifespan [1]. These examples illustrate potentially deleterious effects of rapid early growth now demonstrated across diverse species including invertebrates, fish, rodents and primates, reviewed by Metcalfe and Monaghan [14] who present the concept of ‘grow now, pay later’, referring to the long-term cost of any short-term advantage of rapid growth.

In 1982, Lucas [15] set up experimental studies (RCTs) in humans to test the programming concept, initially in preterm infants. Those assigned diets that promoted more rapid early growth had, 16 years later, higher blood pressure, cholesterol, insulin resistance, leptin resistance and greater endothelial dysfunction (as the earliest marker of the atherosclerotic process) [13, 16]. A subsequent RCT in healthy, full-term but small (SGA) infants showed