Importance of Growth for Health and Development
Importance of Growth for Health and Development

Editors
Alan Lucas, London, UK
Maria Makrides, Adelaide, Australia
Ekhard E. Ziegler, Iowa City, IA, USA
## Contents

VII  Preface  
IX   Foreword  
XI   Contributors  

### Introduction

1  **Growth and Later Health: A General Perspective**  
Lucas, A. (UK)  

Growth, Obesity and CV Outcomes

13  **Early Infancy as a Critical Period for Development of Obesity and Related Conditions**  
Gillman, M.W. (USA)  

25  **Leptin, Nutrition, and the Programming of Hypothalamic Feeding Circuits**  
Bouret, S.G. (USA/France)  

41  **Early Growth and Ageing**  
Chen, J.-H.; Cottrell, E.C.; Ozanne, S.E. (UK)  

55  **Does Early Growth Affect Long-Term Risk Factors for Cardiovascular Disease?**  
Singhal, A. (UK)  

71  **Developing World Perspective: The Importance of Growth for Short-Term Health**  
Adair, L.S. (USA)
Contents

Growth and Neurological Development

85 Postnatal Growth and Development in the Preterm and Small for Gestational Age Infant
Cooke, R.J. (USA)

99 Interrelationship between Growth and Development in Low and Middle Income Countries
Martorell, R.; Nguyen, P. (USA)

123 Role of Long-Chain Polyunsaturated Fatty Acids in Neurodevelopment and Growth
Makrides, M.; Smithers, L.G.; Gibson, R.A. (Australia)

137 Growth and Development of the Brain and Impact on Cognitive Outcomes
Hüppi, P.S. (Switzerland)

153 Benefits and Harms of Iron Supplementation in Iron-Deficient and Iron-Sufficient Children
Domellöf, M. (Sweden)

Physical Growth and Body Composition

167 Effects of Selective Dropout on Infant Growth Standards
van Buuren, S. (The Netherlands)

181 The 2000 Centers for Disease Control and Prevention Growth Charts: Several Insights after 8 Years
Ogden, C.L.; Wei, R.; Curtin, L.R.; Flegal, K.M. (USA)

197 Growth Charts Compared
Ziegler, E.E.; Nelson, S.E. (USA)

213 Body Composition in Infancy: Impact on Health Later in Life
Ellis, K.J. (USA)

225 Endocrinology of Growth
Rosenfeld, R.G. (USA)

239 Concluding Remarks

247 Subject Index
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.
Preface

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.

Prof. Ferdinand Haschke, MD, PhD  
Chairman  
Nestlé Nutrition Institute  
Vevey, Switzerland

Dr. Petra Klassen, PhD  
Scientific Advisor  
Nestlé Nutrition Institute  
Vevey, Switzerland
Contributors

Chairpersons & Speakers

Prof. Linda S. Adair
Department of Nutrition
University North Carolina
School of Public Health
Chapel Hill, NC 27514
USA
E-Mail Linda_adair@unc.edu

Prof. Sébastien Bouret
Neuroscience Program
Saban Research Institute
Children's Hospital Los Angeles
University of Southern California
4650 Sunset Boulevard, MS No. 135
Los Angeles, CA 90027
USA
E-Mail sbouret@chla.usc.edu

Prof. Richard J. Cooke
Department of Pediatrics
University of California Davis
4100 Folsom Blvd No. 3C
Sacramento, CA 95819
USA
E-Mail richardjcooke@mac.com

Assoc. Prof. Magnus Domellöf
Department of Clinical Sciences, Pediatrics
Umeå University Hospital
SE-90185 Umeå
Sweden
E-Mail
magnus.domellof@pediatri.umu.se

Dr. Kenneth Ellis
Children’s Nutrition Research Center
Department of Pediatrics
Baylor College of Medicine
1100 Bates Street
Houston, TX 77030
USA
E-Mail kellis@bcm.edu

Prof. Matthew W. Gillman
DACP, HMS/HPHC
133 Brookline Avenue, 6th floor
Boston, MA 02115
USA
E-Mail
matthew_gillman@hms.harvard.edu

Prof. Petra S. Hüppi
Service du Développement et de la Croissance
Département de l’Enfant et de l’Adolescent
Hôpital des Enfants
6, rue Willy Donzé
CH–1211 Geneva
Switzerland
E-Mail Petra.Huppi@hcuge.ch

Prof. Alan Lucas
Institute of Child Health
30 Guildford Street
London WC1N 1EH
UK
E-Mail a.lucas@ich.ucl.ac.uk
Contributors

**Prof. Maria Makrides**
Child Nutrition Research Centre
Women’s and Children’s Health Research Institute
72 King William Road
North Adelaide, SA 5006
Australia
E-Mail
maria.makrides@health.sa.gov.au

**Prof. Reynaldo Martorell**
Hubert Department of Global Health
Rollins School of Public Health
Emory University
1518 Clifton Road NE
Atlanta, GA 30322
USA
E-Mail rmart77@sph.emory.edu

**Dr. Cynthia Ogden**
CDC/NCHS
3311 Toledo Road, Room 4414
Hyattsville, MD 20782
USA
E-Mail cao9@CDC.GOV

**Dr. Susan Ozanne**
Metabolic Research Laboratories
Level 4, Institute of Metabolic Science
Box 289, Addenbrooke’s Hospital
Cambridge, CB2 0QQ
UK
E-Mail seo10@cam.ac.uk

**Prof. Ron G. Rosenfeld**
Department of Cell and Developmental Biology
Oregon Health and Science University
Portland, OR
258 Valley Street
Los Altos, CA 94022
USA
E-Mail ron.rosenfeld@lpfch.org

**Dr. Atul Singhal**
MRC Childhood Nutrition Research Centre
Institute of Child Health
30 Guildford Street
London WC1N 1EH
UK
E-Mail a.singhal@ich.ucl.ac.uk

**Prof. Stef van Buuren**
Department of Statistics
TNO Quality of Life
PO Box 2215
NL–2301 CE Leiden
The Netherlands
E-Mail stef.vanbuuren@tno.nl

**Prof. Ekhard E. Ziegler**
Department of Pediatrics
University of Iowa
A136 MTF
2501 Crosspark Road
Iowa City, IA 52242
USA
E-Mail ekhard-ziegler@uiowa.edu

**Prof. Nem Yun Boo**
Department of Pediatrics, Clinical School
International Medical University
Jalan Rasah
70300 Seremban
Negeri Sembilan
Malaysia
E-Mail nemyun_boo@imu.edu.my

**Moderators**

**Dr. Irene Cheah**
Neonatal Unit, Paediatric Institute
Kuala Lumpur General Hospital
50586 Jalan Pahang
Kuala Lumpur
E-Mail igscheah@hkl.gov.my
Contributors

Dr. Hussain Imam HJ
Muhammad Ismail
Paediatric Institute
Kuala Lumpur General Hospital
50586 Jalan Pahang
Kuala Lumpur
E-Mail drhussain@hkl.gov.my

Datuk Dr. Zulkifli Ismail
Selangor Medical Centre
Lot 4, Jalan Singa 20/140300
Shah Alam
Selangor Darul Ehsan
Malaysia
E-Mail dr.zul.ismail@gmail.com

Invited Attendees

Peter S.W. Davies/Australia
Manzoor Hussain/Bangladesh
Mohammad Sirajul Islam/Bangladesh
Reaz Mobarak/Bangladesh
Qumruzzaman/Bangladesh
Christiane Araujo Chaves Leite/Brazil
Elza Mello/Brazil
Pe Thet Khin/Burma
Hui Li/China
Zhixu Wang/China
Celestin Nsibu/Congo
Alexandre Lappillonne/France
Carl Peter Bauer/Germany
Elizabeth Ke/India
Bharat Mehta/India
Jayshree Bharat Mehta/India
Jose Batubara/Indonesia
Bernie Endyarni/Indonesia
Agung Mudapati/Indonesia
Retno Sutomo/Indonesia
Marcello Giovannini/Italy
Lucy Wainaina/Kenya
Khoresavanh Luangxay/Laos
Khampe Phongsavath/Laos
Nor Azmi Abdullah/Malaysia
Yow Ming Ang/Malaysia
Christopher Chiong Meng Boey/Malaysia
Lee Gaik Chan/Malaysia
Hon Kit Cheang/Malaysia
Hon Kin Cheong/Malaysia
Noorizan Ha Majid/Malaysia
Ismail Haron/Malaysia
Hasmawati Hassan/Malaysia
Phaik Choo Khoo/Malaysia

Prof. Way Seah Lee
Department of Pediatrics
University of Malaya Medical Centre
59100 Kuala Lumpur
Malaysia
E-Mail LEEWS@ummc.edu.my

Gunasaegaram Krishnan/Malaysia
Jimmy Kok Foo Lee/Malaysia
Yun Haw Liew/Malaysia
Kok Ewe Lim/Malaysia
Mohd Hanifah Mohd Jamil/Malaysia
Kock Chai Ng/Malaysia
Umathewi Paramasivam/Malaysia
Thian Lian Soo/Malaysia
Fauzia Zainal Abidin/Malaysia
See Chang Wong/Malaysia
Barbara Cormack/New Zealand
Pilar Angela Mendiola/Philippines
Edwin Rodriguez/Philippines
Josephine Sunga/Philippines
Elena Lukushkina/Russia
Talal Algoufi/Saudi Arabia
Mohammed Al-Jassir/Saudi Arabia
Mohammad Elmouzan/Saudi Arabia
Lourdes Mary Daniel/Singapore
Poh Choo Khoo/Singapore
Kah Yin Loke/Singapore
Cheo Lian Yeo/Singapore
Pujitha Wickramasinghe/Sri Lanka
Christian Moelgaard/Sweden
Johannes Spalinger/Switzerland
Ahmad Al-Aboud/Syria
Umaporn Suthuvoravut/Thailand
Supapan Tantracheewathorn/Thailand
Ayteg Atici/Turkey
Yousef Bastaki/United Arab Emirates
Sarah Lowe/UK
Thi Tin Hoang/Vietnam
Van Tran Ta/Vietnam
Contributors

Nestlé Participants

Mr. Lawrence Li/China
Ms. Natalia Wagemans/India
Mr. Mark Bong/Malaysia
Ms. Sonia Kumari Raj Kumar/Malaysia
Ms. Soon Yean Tan/Malaysia
Ms. Mei Ching Wong/Malaysia
Ms. Po Poh Yap/Malaysia
Ms. Dorothy Jane De Guzman/Philippines
Ms. Leilani Utama Lestarina/Singapore
Ms. Angel Lin/Singapore

Ms. Anette J. Rvi/Sweden
Mrs. Jelena Buncic/Switzerland
Prof. Ferdinand Haschke/Switzerland
Dr. Petra Klassen-Wigger/Switzerland
Dr. Nelly Jeanne Marmy Conus/Switzerland
Ms. Karin Rexeisen Robin/Switzerland
Ms. Somprattana Ekkathin/Thailand
Ms. Do Thi Lan Huong/Vietnam