

Princeton University
Woodrow Wilson School of Public and International Affairs

WWS 594j
Health and Nutrition in Developing Countries

Spring 2009
Half-term course (Session II)

Tuesday 1.00 – 4.00
Venue: Robertson 005

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Course description:

Human growth has been described as “a mirror of society” in that the process of growth and development is exquisitely sensitive to environmental factors. The rate at which we grow and our tempo of development are directly related to the attainment of genetic potential and environmental factors that modify that potential. The environmental factors that are prevalent in developing and transitional societies impose chronic constraints on the process of human growth and development. The response of the organism to these constraints have both short term and long term sequelae in terms of economic productivity, morbidity, and mortality. Thus the health and nutrition of those living in developing countries is intimately related to their experience of childhood and adolescence.

This course examines the process of human growth in developing countries. Aimed at the non-biologist it will initially cover the biology of growth and the examination of critical periods of susceptibility to environmental insult. Other topics will include the impact of social and economic factors, the nutritional and epidemiological transition, and child growth in relation to health and disease in developing countries.

Required and Recommended reading:

I have included readings covering each of the discussions. This list is not exhaustive and will be updated prior to and during the course as relevant and pertinent material becomes available. Required reading i.e. reading that should be done prior to the weekly discussion is marked in the lists below by an asterisk (*). Recommended reading includes texts that will supplement and widen the topic under discussion. A significant amount of the reading for this course is from journals and books that are essentially medical or scientific and may not be present in the Princeton Library catalogue but are available on E-reserves in Blackboard.

Assessment:

- (1) Students will be expected to have read the relevant required readings and to participate fully in class discussions.
- (2) The final paper that requires a report on a developing country experiencing socio-economic transition that identifies critical issues in health and disease and discusses the factors guiding intervention strategies.

Details of format will be provided during the course.

Grading will be based on class participation and the final paper.

1. The Biology of Human Growth

Human growth and development – changes in physical size and functional ability with increasing chronological age – occurs in well recognised tissue-specific patterns with regard to time. These changes are influenced by both genetic and environmental factors that create significant variability within and between the sexes in both their timing and duration. For a radical change in, say, weight to occur there must also be changes in the anatomical components that make up total body weight and these changes are themselves variable. Acceleration, for instance, in weight gain or loss may be the result of different changes in fat or lean tissue and the latter may include muscle, bone, and viscera each of which may contribute differently to the total process. In addition, not only may the process be variable within a single child it may also be variable between different children of the same or opposite sexes. The mathematical and statistical problems arising from attempts to analyse the seemingly simple process of a weight change are thus complex.

In order to review the biology of human growth we will discuss the scientific principles of growth that are

fundamental to our ability to interpret the response of the child to factors that might modify the genetically programmed pattern of growth from conception to maturity. In this way the biology of human growth will be described by a set of phenomena that reflect the actions of biological control mechanisms. These mechanisms are subject to genetic and environmental influences and their expression is characterised by variation in timing, magnitude, and duration.

Required* and Recommended reading

*Bogin B Patterns of Human Growth. 2nd edition. Cambridge: Cambridge University Press. 1994 Chapters 1 & 2

Bogin B Patterns of Human Growth. 2nd edition. Cambridge: Cambridge University Press. 1994 Chapter 4

*Cameron N. Human Growth and Development. New York: Academic Press. 2002. Chapters 1 - 4, 16-18.

*Cameron N. The Biology of Human Growth. 61st Nestlé Nutrition Workshop, Bali, Indonesia 2007.

*Lamp M, Veldhuis J.D., Johnson M.L. Saltation and stasis: a model of human growth. Science 1992 158: 801-03.

*Marshall WA, Tanner JM. 1969. Variations in the pattern of pubertal changes in girls. Arch Dis Child 44:291-303.

*Marshall WA, Tanner JM. 1970. Variations in the pattern of pubertal changes in boys. Arch Dis Child 45:13-23.

Prader A, Tanner JM, Von Harnack GA. 1963 Catch-up growth following illness or starvation, J Ped, 62, 646-659.

Tanner JM. Growth at Adolescence. Oxford; Blackwell Sscientific Press. 1962

2. Developmental Origins of Health and Disease: Critical Periods

It has long been recognized that there are "critical periods" during mammalian development when exposure to specific environmental stimuli are required in order to elicit the normal development of particular anatomical structures or their normal functioning. The responses of the organism to these stimuli depend on there being a specific level of anatomical maturation and a state of rapid anatomical and/or functional change.

This discussion of critical periods in growth is not confined to the classic definition of a narrow time frame of development during which a particular environmental threshold or limit must exist for normal growth and function to ensue. Using both auxological and epidemiological approaches we will discuss suggest a lifespan perspective which encompasses accumulating and interacting risks that are manifest from prenatal life onward. By understanding the process of growth and development, and by scrutinizing the growth process early variations that lead to later morbidity and mortality can be identified.

Required* and Recommended reading:

*Barker DJP. 1994. Mothers, babies and disease in later life. London: British Medical Journal.

*Cameron N, Demerath EW. Critical periods in human growth: relationships to chronic disease. Yearbook of Physical Anthropology 45 159-184 2002

*Eckel RH, Grundy SM, Zimmet PZ. 2005. Metabolic syndrome. Lancet. 365(9468):1415-28.

Hales CN, Barker DJP. 1992. Type II (non-insulin dependent) diabetes mellitus: the thrifty phenotype hypothesis. Diabetologia 35: 595-601.

Hales CN, Barker DJP, Clark PMS. 1991. Fetal and infant growth and impaired glucose tolerance at age 64. BMJ 303: 1019-1022.

Huxley RR, Shiell AW, Law CM. 2000. The role of size at birth and postnatal catch-up growth in determining systolic blood pressure: a systematic review of the literature. J Hypertension, 18(7): 815-3.

Katz LC, Cowley JC. 2002. Development of cortical circuits: lessons from ocular dominance columns. *Nature Reviews Neuroscience* 3: 34 -42

Law CM, Shiell AW, Newsome CA, Syddall HE, Shinebourne EA, Fayers PM, Martyn CN, de Swiet M. 2002. Fetal, infant, and childhood growth and adult blood pressure: a longitudinal study from birth to 22 years of age. *Circulation* 105(9):1088-1092.

Ong KKL, Ahmed ML, Emmett PM, Preece MA, Dunger DB, The ALSPAC Study Team. 2000. Association between postnatal catch-up growth and obesity in childhood: prospective cohort study. *BMJ* 320: 967-971.

*Parsons T, Power C, Logan S, Summerbell C. 1999. Childhood predictors of adult obesity: a systematic review. *Int J Obes* 23 (Suppl. 8): S1-S107.

*Stern M, Bartley M, Duggirala R, Bradshaw B. 2000. Birth weight and the Metabolic Syndrome: thrifty phenotype or thrifty genotype? *Diabetes/Met Res Rev* 16:88-93.

Stettler N, Zemel BS, Kumanyika S, Stallings V. 2002. Infant weight gain and childhood overweight status in a multicenter, cohort study. *Pediatrics* 109: 194-9.

3. Epidemiological transition

The pattern of disease in developing countries and particularly in those experiencing socio-economic transition has changed dramatically in the last four decades. Death rates from communicable infectious diseases have reduced as the incidence of non-communicable diseases of lifestyle have increased. This "epidemiological transition" was first described by Omran in 1971 and has since been expanded to include two transitions. The first from hunter-gathering to primary food production and the second from communicable to non-communicable diseases (infectious diseases to diseases of lifestyle). It is now becoming well recognised that increased risk for non-communicable diseases is apparent not only in childhood but in early infancy, foetal life and even in the characteristics of the mother when she was a pre-avid adolescent.

This discussion will combine our knowledge of human growth and critical periods with current literature concerning the lifespan approach to adult morbidity .

Required and Recommended reading:

Barker DJP. 1994. Mothers, Babies and Disease in Later Life. London: British Medical Journal.

Barker D, Osmond C, Golding J, Kuh D, Wadsworth M. 1989a. Growth in utero, blood pressure in childhood and adult life, and mortality from cardiovascular disease. *BMJ* 298:564-567.

Barker D, Martyn C, Osmond C, Hales C, Fall C. 1993 Growth in utero and serum cholesterol concentrations in adult life. *BMJ* 307:1524-1527.

Barker D, Winter P, Fall C, Simmonds S. 1989b. Weight in infancy and death from ischaemic heart disease. *Lancet* 2 (8663):577-580.

*Caldwell JC. Population health in transition. *Bull World Health Organisation* 2001, 79; 159-170

Cappuccio FP. Commentary: epidemiological transition, migration, and cardiovascular disease. *I J Epi*, 2004, 33: 387-388

*Gluckman PD, Cutfield W, Harding JE, Milner D, Jensen E, Woodhall S (1996) Metabolic consequences of intrauterine growth retardation. *Acta Paediatr Suppl* 417:3-6.

*Gluckman PD, Hansen MA. 2004. Living with the past: evolution, development and patterns of disease. *Science*, 305. 1733-1736.

*Omran, AR (2005) The Epidemiologic Transition: A Theory of the Epidemiology of Population Change *The Milbank Quarterly* 83 (4), 731–757.

doi:10.1111/j.1468-0009.2005.00398.x

(reprinted from the original article in *The Milbank Quarterly*, 1971 49 (4), 509–38).

*Popkin BM. The nutrition transition and obesity in the developing world. *J Nutr.* 2001 Mar;131(3):871S-873S

4. Human Growth as an indicator of social and economic change.

In the last decade of the 20th Century James Tanner wrote "If you want to measure the classlessness of society and you are not interested in rhetoric but in actual conditions and facts, then looking at the growth of children...is perhaps the best way". Many of the studies of child growth that have been undertaken in both developed and developing countries during the last 50 years were historically embedded in times of social and political transition. As such they form a barometer of change. The biological responses of the growing organism to this environmental change are at times subtle and at other times dramatic yet they all reflect the organism's potential for plasticity with the aim of successful reproduction and survival. Socio-political changes invariably affect the society in terms of economics, nutrition, health, and lifestyle. Aspect of human growth that reflect these changes include linear dimensions, proportionality, and body composition in terms of the absolute size of components and their distribution.

This cocktail of changes that are synchronised with societal change have been documented throughout the 20th century through times of peace, war, famine, and plenty. The growth and development of children demonstrates the ability of the pattern of human growth to accurately mirror the effectiveness of social and health policy. This discussion will explore the growth of children within this context of social change.

Required and Recommended reading

*Bogin B Patterns of Human Growth. 2nd edition. Cambridge: Cambridge University Press. 1994 Chapter 5

Bogin B, Keep R. Eight thousand years of human growth in Latin America: economic and political history revealed by anthropometry. In *The Biological Standard of Living and Economic Development: Nutrition Health and Well being in Historical Perspective*, ed J. Komlos & J 'Baten, pp 277-308. Munich: Fritz Steiner.

*Cameron N. 1991. Human growth, nutrition and health status in Sub-Saharan Africa. *Yearbook of Physical Anthropology*, 34;211-250.

*Hauspie RC, Vercauteren M, Susanne C. Secular changes in growth. *Hormone Research* 1996 45, Suppl. 2, 8-17.

Komlos J, Baten J. *The Biological Standard of Living and Economic Development: Nutrition Health and Well being in Historical Perspective*. 1998 Munich: Fritz Steiner.

*Martorell R, Rivera J, Kaplowitz H, Pollitt E. Long-term consequences of growth retardation during early childhood. In: Hernandez M, Argente J, eds. *Human Growth: Basic and Clinical Aspects*. Amsterdam : Elsevier Science Publishers. 1992 pp 143-149.

Ravelli G-P, Stein Z, Susser M. 1976. Obesity in young men after famine exposure in utero and early infancy. *N Engl J Med* 295: 349-53.

*Seckler D. Malnutrition: an intellectual odyssey. *Western journal of Agricultural Economics* 1980, 5, 219-227.

Seckler D. 'Small but Healthy': a basic hypothesis in the theory, measurement, and policy of malnutrition. In *Newer Concepts of Nutrition and their Implications for Policy*, ed. P.V. Sukhatme, pp 127-137, Pune, India: Maharashtra Association for the Cultivation of Science Research Institute.

*Tobias PV. The negative secular trend. *J Hum Evolution* 1985 14, 347-356

5. Growth and health in transitional economies

The economic transition to be found in developing countries is not always the result of the change from a centrally-planned to a free-market economy but may be found within a pre-existing free-market economy as a result of profound political change. The unique set of political changes during the last decade in South Africa has resulted in both economic and social transition. The release of Nelson Mandela in

February 1990 heralded an end to apartheid and the social, political, and economic enfranchisement of 30 million non-white people in South Africa. The first freely elected non-white government came to power in 1994 and initiated a number of social and economic reforms aimed at alleviating the worst consequences of apartheid. This discussion uses the effect of post-apartheid economic and social transition on the growth and development of children in urban environments to examine the relationship between growth and health in transitional societies.

Required and Recommended readings

*Cameron N. Physical growth in a transitional economy: the aftermath of South African apartheid. *Economics and Human Biology* 2003 1(1):29-42.

*Cameron N. Human growth as an indicator of social change. *Humanbiologia Budapestensis* 2006 29: 39-54

*Gortmaker SL, Must A, Perrin JM, Sobol AM, Dietz WH. 1993. Social and economic consequences of overweight in adolescence and young adulthood. *New Engl J Med* 329: 1008-12.

*Pollitt E, Gorman KS, Engle PL, Rivera JA, Martorell R. 1995. Nutrition in early life and the fulfilment of intellectual potential. *J Nutr* 125 Suppl 4:1111S-1118S.

*Popkin BM, Richards MK, Monteiro CA. 1996. Stunting is associated with overweight in children of four nations that are going through the nutrition transition. *J Nutr* 126: 3009-3016.

*Richter L, Norris SA, Pettifor JM, Yach D, Cameron N. Mandela's Children: The 1990 Birth to Twenty Study in South Africa. *International Journal of Epidemiology* 2007; 1-8 doi:10.1093/ije/dym016

Yach D, Padayachee GN, Cameron N, Wagstaff LA, Richter L. 1990. Editorial : "Birth To Ten" - a study of children of the 1990s living in the Johannesburg-Soweto area, *S Afr Med J*, 77, 435-326.

6. Case histories and critical research questions

This final discussion will focus on case histories provided by student assignment presentations. Critical research questions that have evolved from the previous discussion of human growth and development as a reflection of social and economic change will be highlighted in relation to how infant growth and health relates to later outcomes, what intervention strategies can be effective given environmental constraints, the relationship between national economic development and child health and growth and the increased susceptibility to non-communicable diseases in specific nationalities.

Required and Recommended readings

Cameron N, Preece MA, Cole TJ. 2005. Catch-up growth or regression to the mean? Recovery from stunting revisited. *Am J Hum Biol.* 17(4):412-417.

Cole TJ. 2004. Children grow and horses race: is the adiposity rebound a critical period for later obesity? *BMC Pediatrics* 4:6

Cole TJ, Freeman JV, and Preece MA. 1998. British 1990 growth reference centiles for weight, height, body mass index and head circumference fitted by maximum penalized likelihood, *Stat Med*, 17, 407-429

De Onis M, Garza C, Victora CG. The WHO Multicentre Growth Reference Study: strategy for developing a new international growth reference. *Forum Nutr.* 2003;56:238-40. Review.

*Gortmaker SL, Must A, Perrin JM, Sobol AM, Dietz WH. 1993. Social and economic consequences of overweight in adolescence and young adulthood. *New Engl J Med* 329: 1008-12.

*Haas JD, Murdoch S, Rivera J, Martorell R. Early nutrition and later physical work capacity. *Nutr Rev.* 1996 Feb;54(2 Pt 2):S41-8.

*Habicht JP, Victora CG, Vaughan JP. Evaluation designs for adequacy, plausibility and probability of

public health programme performance and impact. *Int J Epidemiol.* 1999 Feb;28(1):10-8.

*Martorell R, Behrman JR, Flores R, Stein AD. Rationale for a follow-up study focusing on economic productivity. *Food Nutr Bull.* 2005 Jun;26(2 Suppl 1):S5-14.

Martorell R, Stein AD, Schroeder DG. Early nutrition and later adiposity. *J Nutr.* 2001 Mar;131(3):874S-880S.

*Martorell R, Ramakrishnan U, Schroeder DG, Melgar P, Neufeld L. Intrauterine growth retardation, body size, body composition and physical performance in adolescence. *Eur J Clin Nutr.* 1998 Jan;52 Suppl 1:S43-52; discussion S52-3.

*Martorell R. The role of nutrition in economic development. *Nutr Rev.* 1996 Apr;54(4 Pt 2):S66-71.

Martorell R, Ramakrishnan U, Schroeder DG, Ruel M. Reproductive performance and nutrition during childhood. *Nutr Rev.* 1996 Apr;54(4 Pt 2):S15-21.

*Martorell R, Khan LK, Schroeder DG. Reversibility of stunting: epidemiological findings in children from developing countries. *Eur J Clin Nutr.* 1994 Feb;48 Suppl 1:S45-57.

*Monteiro PO, Victora CG. Rapid growth in infancy and childhood and obesity in later life--a systematic review. *Obes Rev.* 2005 May;6(2):143-54. Review. Erratum in: *Obes Rev.* 2005 Aug;6(3):267.

*Ramakrishnan U, Martorell R, Schroeder DG, Flores R. Role of intergenerational effects on linear growth. *J Nutr.* 1999 Feb;129(2S Suppl):544S-549S.

UNICEF Progress for Children. UNICEF report number 4 May 2006

Victora CG, Barros FC. Infant mortality due to perinatal causes in Brazil: trends, regional patterns and possible interventions. *Sao Paulo Med J.* 2001 Jan 4;119(1):33-42.

WHO 2006 Obesity and Overweight on:
<http://www.who.int/dietphysicalactivity/publications/facts/obesity/en/>.