

Human growth patterns

-with focus on pubertal growth and secular changes

Akademisk avhandling

Som för avläggande av medicine doktorexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentligen försvaras i föreläsningssal Tallen, Drottning Silvias Barn- och ungdomssjukhus, den 23 november, klockan 13:00

av **Anton Holmgren**

Fakultetsopponent:

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Juliane Marie Centret/Københavns Universitet, Danmark

Avhandlingen baseras på följande delarbeten

- I. **Anton Holmgren**, Aimon Niklasson, Lars Gelander, A. Stefan Aronson, Andreas F.M. Nierop and Kerstin Albertsson-Wikland. **Insight into human pubertal growth by applying the QEPS growth model** *BMC Pediatrics* (2017) 17:107
- II. **Anton Holmgren**, Aimon Niklasson, Andreas F.M. Nierop, Lars Gelander, A. Stefan Aronson, Agneta Sjöberg, Lauren Lissner and Kerstin Albertsson-Wikland. **Pubertal height gain is inversely related to peak BMI in childhood** *Pediatric Research* 2017;81, 448–454
- III. **Anton Holmgren**, Aimon Niklasson, A. Stefan Aronson, Agneta Sjöberg, Lauren Lissner and Kerstin Albertsson-Wikland. **Nordic populations are still getting taller - secular changes in height from the 20th to 21st century** *Acta Paediatrica*, Manuscript under revision
- IV. **Anton Holmgren**, Aimon Niklasson, Andreas F.M. Nierop, Lars Gelander, A. Stefan Aronson, Agneta Sjöberg, Lauren Lissner and Kerstin Albertsson-Wikland. **Estimating secular changes in longitudinal growth patterns underlying adult height with the QEPS model: the Grow Up Gothenburg cohorts** *Pediatric Research* 2018;84, 41–49

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Abstract

Introduction: Human growth is a dynamic process, an indicator of health and disease. Previous used growth models have been limited in describing the pubertal growth spurt.

Aim: The overall aim of this thesis is to increase knowledge regarding human growth. The specific aims were to; explore pubertal growth in detail with new estimates from the QEPS model (paper I), investigate associations between peak BMI_{SDS} in childhood and subsequent growth (II), evaluate secular changes in adult height (AH) for Nordic countries (in Sweden including parental heights of study populations) and analyse during which growth phases (fetal/infancy/childhood/puberty) changes occur (III), study changes in growth patterns from birth to AH in two Swedish population based cohorts born in 1974 and 1990 (IV).

Methods: The main study material was based on longitudinal growth data (height/weight) from two population based Swedish growth cohorts (~4000) born around 1974 and 1990. The novel QEPS growth model was used for analysing height/growth patterns. By applying four mathematical functions, QEPS describes the individual height gain; Quadratic (ongoing from before birth to AH), Exponential (rapid gain during fetal life/infancy), Puberty (adding the specific pubertal growth), Stop (ending gain in height to AH). The Nordic study analysed height data from present and past growth references (Denmark/Finland/Norway) and Swedish growth studies, comparing height at different ages up to AH (in Sweden including parental height).

Results and conclusions: New estimates from QEPS model including markers of quality (CI) and SDS for onset, middle and end of puberty showed: the later onset of puberty, the greater the AH. Pubertal gain due to the specific pubertal P-function was independent of age at onset of puberty; boys had higher total gain during puberty due to P-function growth than to QES-function, reversed for girls. The novel pubertal growth estimates enable a more detailed analyse of pubertal growth than previously possible (I). Higher childhood BMI_{SDS} was associated with more growth before onset of puberty, earlier pubertal growth and less pubertal height gain for both sexes, over the entire BMI-spectrum (II). The Nordic countries have similar positive secular changes in AH (females +4-7/males +5-15mm/decade), mainly due to increased height in childhood, the change was more pronounced in parental heights, i.e. earlier decades and for males. Earlier pubertal growth was seen in the most recent growth study in all four countries (III). When studying changes in height between the 1974 and 1990 cohorts, a positive change in AH was found (1990), due to more growth during childhood in both sexes and during puberty in girls. QEPS is effective detecting small changes of growth patterns, in cohorts born only 16 years apart (IV).

KEYWORDS: Growth, height, QEPS model, puberty, growth pattern, BMI, secular change, growth phases (infancy/childhood/puberty)