



کراچی یونیورسٹی University of Karachi

THE NGDS PILOT PROJECT
Army Public School • Bahria College
Beacon Light Academy • Fazaia Degree College



Growth-and-Nutritional-Status Monitoring of Primary-School Students Enrolled in Armed Forces and Civilian Institutions Located in Karachi

Professor Dr. Syed Arif Kamal, PhD, MS, MA, Johns Hopkins, Baltimore, MD, USA

Director, SF Growth-and-Imaging Laboratory • Founding Project Director, the NGDS Pilot Project

Professor of Mathematics and Dean, Faculty of Science, University of Karachi, Karachi, Pakistan

Member, Subject Committee for Physical Education, Health and Sport Sciences, NTS

Sessional Faculty, AKU Medical College • Guest Lecturer, Harvard Medical School

Homepage: <https://www.ngds-ku.org/kamal> • e-mail: profdrakamal@gmail.com • Released: May 21, 2016

Every parent strives to provide excellent education and quality of life for one's child. However, the children can live the very best of their life and contribute to their societies if they are emotionally, mentally and physically healthy. Often, the children are doing well in academics. However, they are poor in social behavior, teamwork and decision making because they do not maintain proper weight-for-height. A severely underweight child lacks the energy to concentrate in studies. Such a child, frequently, misbehaves with parents and quarrels with brothers and sisters. On the other hand, there are a number of complications related to childhood obesity:

Cardiovascular: Chronic inflammation, coagulopathy, dyslipidemia, endothelial dysfunction, hypertension

Gastrointestinal: Constipation, gallstones, gastrointestinal reflux, steatohepatitis

Musculoskeletal: Back pain, Blount's disease, flat feet, forearm fracture, slipped capital femoral epiphysis

Neurologic: Pseudotumor cerebri

Psychosocial: Anxiety, depression, eating disorders, lower educational attainment, poor self-esteem, social isolation

Pulmonary: Asthma, exercise intolerance, sleep apnea

Renal: Glomerulosclerosis

Adapted from David S. Ludwig: Childhood Obesity — The Shape of Things to Come, *New England Journal of Medicine* 2007; **357 (23):** 2325-2327

This paper refers to various phases of *Obesity Epidemic* (obesity has been declared epidemic in United States). Rafia Imtiaz (BS, Mathematics, University of Karachi, Class of 2011), critically, reviewed Ludwig's paper as part of her course on biomathematics. Prof. Ludwig of Harvard Medical School replied to her queries: "Phase IV of the epidemic would develop slowing over time, as obese children grow up and give birth to the next generation of children. Good luck with your important work."

The NGDS (National Growth and Developmental Standards for the Pakistani Children) Pilot Project <https://ngds-ku.org> was initiated in 1998 — an indigenous, goodwill, public service endeavor for the care and the development of young persons to prepare them emotionally, morally and physically for rewarding careers in the civil and the military services. In the capacity of Project Director, the author has measured (Fig. 1) over 1500 children in institutions managed by the Armed Forces of Pakistan (Army Public School, 'O' Levels, Bahria College, NORE I, Fazaia Degree College, 'Faisal', all of them located in Karachi), developed training manual for measurement of mass (weight), height and mid-upper-arm

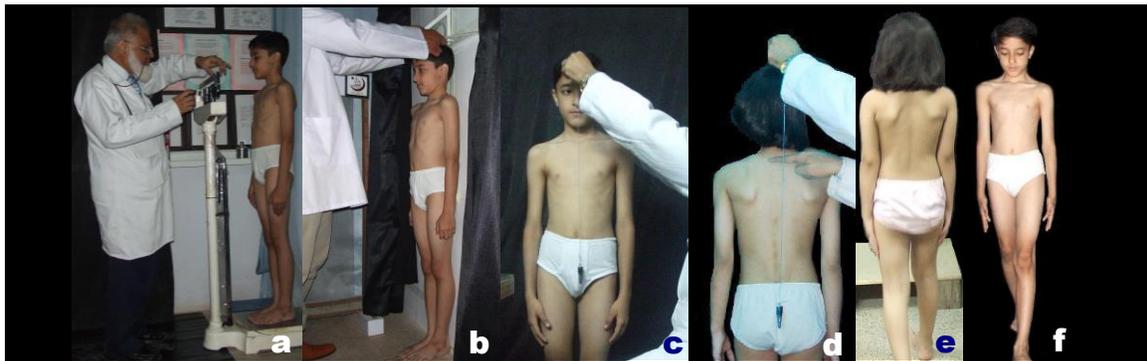
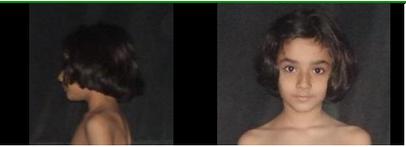


Fig. 1a-f. Anthropometry (a, b), body-alignment check (c, d) and gait analysis (e, f) in SF Growth-and-Imaging Laboratory

Table 1. Sample Growth-and-Obesity Roadmap of LG (SGPP-KHI-20131021-02/01)

Gender: † Female • Date of Birth (year-month-day): 2004-11-02 • Army-Cutoff Height: 157.48 cm*
 Father's Height: † 167.90 cm • Mother's Height: † 153.02 cm • Target Height[†]: 153.96 cm

Checkup	1 st	2 nd	Remarks
Photograph			Date-wise Targets March 28, 2015 Height: 140.47 cm (4 ft 7.30 in) Mass: 28.47 kg Wt: 62 lb 12.54 oz
Scanned Signatures	LG	LG	
Class	II	II	Wt: 62 lb 12.54 oz
Date of Checkup (year-month-day)	2014-11-22	2015-02-28	April 28, 2015
Age (year-month-day)	07-03-07	07-05-23	Height: 141.03 cm (4 ft 7.52 in)
Age (decimal year)	7.27	7.54	Mass: 31.26 kg Wt: 68 lb 14.75 oz
Dress Code	0/0.5	0/0.5	
Cumulative-Scoliosis-Risk Weightage	8.50	11.50	Wt: 68 lb 14.75 oz
Height, h (cm)	126.96	139.92	May 28, 2015
Height (ft-in)	4 ft 1.98 in	4 ft 7.09 in	Height: 141.58 cm (4 ft 7.74 in)
Percentile-for-Height, P(h)	74.37 ^P	99.01 ^P	Mass: 34.04 kg Wt: 75 lb 0.95 oz
Estimated-Adult Height (cm) [∇]	167.59	180.03	
Estimated-Adult Height (ft-in)	5 ft 5.98 in	5 ft 10.88 in	June 28, 2015
Current-Age-MP Height (cm)	118.00	119.59	Height: 142.13 cm (4 ft 7.96 in)
Δ Height w. r. t. Current-Age-MP Height (cm)	+8.96	+20.33	Mass: 36.82 kg Wt: 81 lb 3.15 oz
Algeb. Status (pertaining-to-height), STATUS _± (h)	+7.59%	+17.00%	
Qualitative Status (pertaining-to-height)	1st-Degree Tall	2nd-Degree Tall	
Current-Age-Army-Cutoff Height (cm)	118.26	119.86	July 28, 2015
Δ Height w. r. t. Army-Cutoff Height (cm)	+8.70	+20.06	Height: 142.69 cm (4 ft 8.18 in)
Reference Height (cm)	126.96	139.92	Mass: 39.61 kg Wt: 87 lb 5.35 oz
Percentile-for-Reference-Height	74.37 ^P	99.01 ^P	
Age of Prediction, A+ (years)	7.77	8.04	August 28, 2015
Reference Height, at A+ (cm)	130.09	143.24	Height: 143.24 cm (4 ft 8.39 in)
6-Month-Height Management (cm)	+3.13	+3.32	Mass: 42.39 kg Wt: 93 lb 7.55 oz
Month-Wise-Height Management (cm/month)	+0.52	+0.55	
Month-Wise-Height Management (in/month)	+0.21	+0.09	
Gross Mass (kg)	23.66	25.99	
Clothing Correction (kg)	0	0.30	
Net Mass, μ (kg)	23.66	25.69	Lifestyle Adjustment
Net Weight (lb-oz)	52 lb 2.72 oz	56 lb 10.34 oz	Adequate daily dose of vitamin D
Percentile-for-Net-Mass P(μ)	51.31 ^P	61.58 ^P	
Estimated-Adult Mass (kg)	58.62	61.76	Diet Plan
Estimated-Adult Weight (lb-oz)	129 lb 4.04 oz	136 lb 2.73 oz	10-12 glasses of water; calcium-, protein- and fiber-rich diet (milk, fruit, potato items and chicken)
BMI: Body-Mass Index (kg/m ²)	14.68	13.12	
Estimated-Adult BMI (kg/m ²)	20.87	19.05	
Optimal Mass (kg)	26.37	39.28	
Δ Mass-for-Height (kg)	-2.71	-13.59	
Algeb. Status (pertaining-to-mass), STATUS _± (μ)	-10.28%	-34.60%	
Qualitative Status (pertaining-to-mass)	2nd-Degree Wasted	4th-Degree Wasted	
Optimal Mass for Reference Height, at A+ (kg)	28.09	42.21	Exercise Plan
6-Month-Mass Management (kg)	+4.43	+16.52	Guarded-graduated light-stretching and heavy exercises for shorter duration [‡]
Month-Wise-Mass Management (kg/month)	+0.74	+2.75	
Month-Wise-Weight Management (lb-oz/month)	+1 lb 10.05 oz	+6 lb 10.05 oz	
Nutritional Status	Energy-Channel.	Energy-Channel.	
Build	Medium	Big	

*Depends neither on child's height nor on parents' heights (based only on country standards)

†Depends on parents' heights & not on child's height

∇ Depends on child's height & not on parents' heights

‡ Light-stretching exercises for height gain & heavy exercises for weight gain

circumference (MUAC):

https://www.ngds-ku.org/ngds_folder/M02.pdf
trained doctors (at the Aga Khan Hospital), physical-education instructors as well as special-education teachers in anthropometric techniques and devised methods to generate Growth-and-Obesity Roadmaps of children:

<https://www.ngds-ku.org/Papers/J35.pdf>

In 2011, growth-and-obesity monitoring was introduced in a civilian school located in Karachi for KG Class. Heights and weights of students were taken as per international standards. Reports were handed out, which contained detailed instructions to maintain optimal weight-for-height, gain height for students short-for-age, overcome vitamin-D deficiency and monitor clues leading to curvatures of spinal column. The parents came to school for detailed discussion with the Project Director.

The detailed Growth-and-Obesity Roadmap included information whether the student was *tall* or *stunted* (short height-for-age), *obese* or *wasted* (lesser weight-for-height), *estimated-adult height*, based on height at the time of checkup (whether the student can qualify for armed-forces career), *estimated-adult weight*, based on weight on checkup date, nutritional-status classification (*energy-channelization*, *under-nutrition*, *over-nutrition*, *acute malnutrition*), build (*small*, *medium*, *big*) — last one used to make sport teams (Table 1). Detailed Report:

<https://www.ngds-ku.org/Articles/A28/Report.pdf>
The students needing special attention come to SF Growth-and-Imaging Laboratory accompanied by their parents.

Measurements of mass (weight) and height, also, offer teaching and learning opportunities. The first one, for example, can be used to generate, illustrate and link concepts from various disciplines:

Biology: The metabolism of food

Chemistry: The process of food conversion resulting in gaining energy, sweating

Engineering: Need of level surface, checking if the weighing machine, itself, is level

Health and Safety: Rapid loss of weight signals physical problems, unutilized food results in fat deposit, contributing to obesity

Mathematics: Significance of serial measurements, plotting of graph, computation of slope, concept of time series, prediction of adult mass (weight), net-mass (mass with zero clothing on) computation from gross mass (mass in indoor clothes), optimal mass-for-height

Physics: Measurement techniques, reproducibility of measurers, equal weight on both feet

Similarly, measurement of height could be employed to teach concepts in biology (food metabolism and the processes behind it), chemistry (tissue synthesis — the process behind height gain as a result of food conversion), engineering (need of level surface, vertical mounting of engineering tape), health and safety (information about nutritional status, physical problem indicated by failure-to-grow — unable to gain height and weight, psychosomatic problem suspected by failure-to-thrive — unable to gain height, weight and achieve developmental milestones), mathematics (serial measurements, graph plotting, slope computation, height function as time series, estimation of adult height and comparison with cutoff height for armed-forces career), physics (measurement physics, reproducibility of measurements, equal weight on both feet) and Quranic studies (Tālōt was appointed Israelite king over Israelites — *Al-Quran* 2: 247. Samuel, peace be upon him, had a rod, which served as reference to determine height of their king; comparison of height with agreed-upon standard: *Kanz-ul-Imān*, p 51, Qudratullah, Lahore, 1999).

Students can learn from mistakes. An engineering tape mounted in a tilted position (the correct position is vertical, to be checked by plumb line) can be utilized to elaborate: (i) Hypotenuse computation from perpendicular (trigonometry); (ii) A line parallel to base intersects triangular sides such that the resulting line segments are proportional (geometry).

The major accomplishments of the NGDS Team may be summarized as:

a) Increasing accuracy of height- and mass-measurement systems to least counts of 0.01 *cm* and 0.01 *kg* (rest of world measures to least counts of 0.1 *cm* and 0.1 *kg*).

b) Enhancing CDC (Centers for Disease Control and Prevention, USA) Growth Tables (percentile range 3^P to 97^P) to include 0.01^P, 0.1^P, 1^P, 99^P, 99.9^P, 99.99^P percentiles:

<https://www.ngds-ku.org/Papers/J34.pdf>

c) Mathematical modeling of childhood-obesity problem, by accounting for height gain when recommending weight management:

<https://www.ngds-ku.org/Papers/J38.pdf>

In today's competitive world, children would achieve success in their practical life if they possess a healthy body along with an educated mind, accompanied by emotional balance. An obese and an awkwardly walking individual shall have a lesser probability of getting a high-profile job as compared to a slim, a smart and a sharp candidate.

Web address of this document: <https://www.ngds-ku.org/Articles/A28.pdf>