



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 Children Enrolled in Armed Forces and Civilian Institutions Located in Karachi

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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 USA). 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."

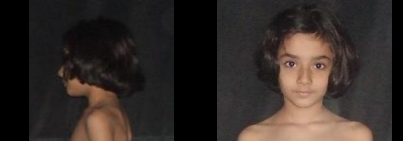
The NGDS (National Growth and Developmental Standards for the Pakistani Children) Pilot Project (<http://ngds.uok.edu.pk>) was initiated in 1998 — an indigenous, goodwill, public service endeavor for the care and the development of young persons to prepare them emotionally, morally and physically for rewarding careers in the civil and the military services. In the capacity of Project Director, the author has measured (Fig. 1) over 2500 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. 1. Anthropometry, body-alignment check and gait analysis 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<sup>†</sup>: 153.96 cm

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

[http://www.ngds-ku.org/ngds\\_folder/M02.pdf](http://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:

<http://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:

<http://www.ngds-ku.org/Articles/A28/Report.pdf>  
The students needing special attention come to SF-Growth-and-Imaging Laboratory at University of Karachi 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

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

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, Quadratullah, 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: (a) Hypotenuse computation from perpendicular (trigonometry); (b) 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<sup>rd</sup> to 97<sup>th</sup>) to include 0.01<sup>th</sup>, 0.1<sup>th</sup>, 1<sup>st</sup>, 99<sup>th</sup>, 99.9<sup>th</sup>, 99.99<sup>th</sup> percentiles:

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

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

<http://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.