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University of Karachi

THE NGDS PILOT PROJECT

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Growth-and-Obesity Monitoring of Primary-School Children

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We all strive to provide the very best of education and living conditions for our children. However, the children can enjoy their life most and be useful to their society if they are physically, mentally and emotionally healthy. Often, the children are doing good in academics, but poor in social behavior, teamwork and decision making because they are not able to maintain proper weight-for-height. A severely underweight child does not have the energy to concentrate in studies. Such a child often misbehaves with parents and quarrels with siblings. Similarly, there are a number of complications associated with 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

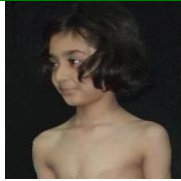
Adapted from D. S. Ludwig: Childhood Obesity — The Shape of Things to Come, *New England Journal of Medicine* 2007; **357 (23):** 2325-2327 (this paper refers to various phases of *Obesity Epidemic* — obesity has been declared epidemic in USA). Rafia Imtiaz (BS, Mathematics, KU, Class of 2011), critically, reviewed this paper as part of biomathematics course taught by Project Director. Prof. David 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."

Since 1998, the NGDS Pilot Project [URL: <http://ngds.uok.edu.pk>], an indigenous, goodwill, public service endeavor, has been conducted for the care and the development of young persons to prepare them mentally, physically, emotionally and morally for rewarding careers in the civil and the military services. In the capacity of Project Director, the author has measured over 2500 children in the schools run by the Armed Forces of Pakistan, developed training manuals for measurement of height, weight and mid-upper-arm circumference, devised methods to generate growth-and-obesity profiles of children and trained doctors (at the Aga Khan Hospi-



Fig. 1a, b. Measurement of (a) height and (a) mass of a boy SF Growth-and-Imaging Laboratory

Table 1. Sample Growth-and-Obesity Profile

Check up	1 st	Remarks
Photograph*		<i>Height Profile of E. M.</i> (mid-parental percentile = 13.00, taken as reference): At the age of 9.17 years, (average) height of E. M. comes out to 128.15 cm (4 ft 2.45 in), which lies at 19 th (18.45 to be exact) percentile [1.00% (+)]. F. N. has 1.27 cm (0.50 in) EXCESS height with respect to current-age-mid-parental (reference) height, but is not considered tall [†] . Based on this percentile, her estimated-adult height comes out to be 157.14 cm (5 ft 1.87 in).
Scanned Signatures*	<i>EM</i>	
Date of Check up	2009-02-05	
Age (years)	9.17	
Dress Code (Undressing)	1.5/2 (0/0.5)	
Height (cm)	128.15	
Height (ft-in)	4 ft 2.45 in	
Percentile for Height	18.45	
Estimated-Adult Height (cm)	157.14	
Estimated-Adult Height (ft-in)	5 ft 1.87 in	
Cutoff height for induction in Armed Forces: 5 ft 2 in		
Mid-Parental-Height Percentile**	13.00	
Current-Age-MP Height (cm)**	126.88	
Δ Height-for-Age (cm)**	+1.27	
Δ Height-for-Age (in)**	+0.50	
Status (pertaining to height)**	1.00% (+)[†]	*Photograph and scanned signatures on the day, check up was conducted. In order to protect the privacy of M. Family, the photograph, inserted in this Growth-and-Obesity Profile, does not show the actual child. Also, family-surname and child initials do not correspond to actual names.
Gross Mass (kg)	18.9	
Net Mass (kg)	18.9	
Net Weight (lb-oz)	41 lb 10.79 oz	
Percentile for Net Mass	< 3	
Estimated-Adult Mass (kg)	< 45.25	
Estimated-Adult Weight (lb-oz)	< 99 lb 12.42 oz	
BMI: Body-Mass Index (kg/m ²)	11.51	
Estimated-Adult BMI (kg/m ²)	< 18.32	
Optimal Mass (kg)	25.11	
Optimal Weight (lb-oz)	55 lb 5.85 oz	
Δ Mass-for-Height (kg)	-6.21	
Δ Weight-for-Height (lb-oz)	-13 lb 11.06 oz	
Status (pertaining to weight)	24.73% WASTED	**Parents' heights must be available to generate these fields (MP stands for mid-parental). Taken from: Kamal SA, Jamil N and Khan SA (2011). Growth-and-Obesity Profiles of Children of Karachi using Box-Interpolation Method, <i>Int. J. Biol. Biotech.</i> 8(1) : 87-96; web address: http://www.ngds-ku.org/Papers/J29.pdf

tal), physical-education teachers and special-education teachers in measurement techniques.

In 2011, growth-and-obesity monitoring was introduced in a civilian school located in Karachi for KG Class. Trained project staff measured heights and weights of children as per international standards (Fig. 1). Reports were handed out to students, 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 students are being re-measured every year (3 checkups conducted so far) to monitor their rates of growth.

The detailed growth-and-obesity profile includes information whether your child is *tall* or *stunted* (short height-for-age), *obese* or *wasted* (lesser weight-for-height), *estimated-adult height*, based on current height (whether your son or daughter can qualify for armed-forces career) and *estimated-adult weight*, based on current weight

(cf. Table 1). Those children needing special attention are invited to visit SF-Growth-and-Imaging Laboratory at University of Karachi accompanied by their parents. Measurements of height and weight, also, offer teaching and learning opportunities. The first one, for example, can be used to generate, illustrate and link concepts from various disciplines:

Biology: Food metabolism and the processes behind it

Chemistry: Tissue synthesis, the process behind height gain, as a result of food conversion

Engineering: Level surface needed, vertical mounting of engineering tape

Health and Safety: Information about nutritional status, failure-to-grow (unable to gain height and weight) may be a signal to some physical problem, failure-to-thrive (unable to gain height, weight and achieve developmental milestones) may indicate a much deeper problem

Physics: Physics of measurement, reproducibility of observations, equal weight on both feet

Quranic Studies: Tālōt was appointed as king

over Israelites (Holy Quran — Sura 2: 247). Israelites were made aware that their king would be as tall as the length of rod possessed by David (peace be upon him) — height comparison with agreed-upon standard

The mathematical concepts, which can be learnt from this activity, are serial measurements, graph plotting, slope computation, height function as time series, estimation of adult height and comparison with cut-off height for armed-forces career [expanded from my article: From Mathematics to Technology — A Bridge Through Physics and Engineering, *Proceedings of the International Conference on Physics and the World of Today*, edited by Jafri MA, Naqvi SM, Department of Physics, University of Karachi, Karachi, Pakistan, December 18-20, 2008, pp 32-39, address <http://www.ngds-ku.org/Papers/C70.pdf>]. A situation in which engineering tape is mounted in a tilted position by mistake (the correct mounted tape should be vertical, as determined by plumb line) may be used to teach the following concepts: (a) Computation of hypotenuse from perpendicular (trigonometry); (b) A line parallel to base intersects the sides of triangle such that

the line segments are proportional (geometry).

Similarly, measurement of weight could be used to teach concepts in biology (food digestion), chemistry (the process of food conversion resulting in gaining energy, sweating), health and safety (rapid loss of weight signals physical problems, unutilized food results in fat deposit, contributing to obesity), mathematics (prediction of estimated-adult weight, unclothed-weight computation from clothed weight, optimal weight-for-height) and physics (exertion of equal weight on both feet)

In the competitive world of today, children would be successful in the practical life if they have a healthy body to go with an educated mind. An obese and an awkwardly walking individual shall have a lower probability of getting a high-profile job as compared to a slim, a smart and a sharp candidate. Doctors have recommended that risks of diabetes and heart diseases could be minimized if height and weight monitoring is started around the age of five. By participating in this program, parents shall lay the foundation of a healthy and a happy childhood and adolescence leading to a healthier adulthood and old age.

Growth-and-obesity monitoring of primary-school children has been implemented in the schools run by the Armed Forces of Pakistan since 1998. The parents of students, interested in enrolling their children in the main NGDS Pilot Project, measurements to be performed in schools, as well as SGPP (Sibling Growth Pilot Project), parents can bring their children in the SF-Growth-and-Imaging Laboratory, Department of Mathematics, University of Karachi, may download *Participation Forms* from the internet:

http://www.ngds-ku.org/ngds_folder/Protocols/NGDS_form.pdf

http://www.ngds-ku.org/SGPP/SGPP_form.pdf

A detailed version of Growth-and-Obesity Profile, given in Table 1 may be downloaded from:

http://www.ngds-ku.org/Papers/J29/Additional_File_1.pdf

Please note that: (a) Calculations involved in generating the growth-and-obesity profiles are uploaded at:

http://www.ngds-ku.org/Papers/J29/Additional_File_2.pdf

(b) Measurement protocols (Manual for Obtaining Anthropometric Measurements) can be downloaded from:

http://www.ngds-ku.org/ngds_folder/M02.pdf

(c) Cumulative-Scoliosis-Risk Weightage (CSRW), appearing in reports generated starting September 2012, is computed on the basis of the table available at: http://www.ngds-ku.org/BLA/Scoliosis_Risk.pdf

The NGDS Pilot Project is conducted according to the human-right protocols applicable in this region. Project Director has close liaison with the Human Rights Commission of Pakistan and Transparency International Pakistan (TIP). He is Convener of Sub-Committee (Schools) of the Education Committee, TIP. No potential conflict of interest is identified for this work.

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Web address of this document: http://www.ngds-ku.org/ngds_folder/Growth_Monitoring.pdf

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