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ACUTE MALNUTRITION IN A CHILD SUFFERING FROM CARDIAC PROBLEMS

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ABSTRACT

This paper reports the case of a girl, whose growth-and-obesity pattern was followed up during the age range 6.47-8.53 *years*, who was suffering from Pulmonary Atresia with Ventricular Septal Defect. She underwent 3 cardiac surgeries, when she was 5-*day*, 5-*year* and 7-*year* old. She showed signs of 'Failure-to-Grow', with both height and mass percentiles lying below 3rd throughout the period of observation. She presented with a case of acute malnutrition with a small build. There were pseudo gains of height (physical gain with drop in percentile) from 2nd to 4th checkup, physical loss of mass between 2nd and 3rd checkup. A new index, *Severity of Acute Malnutrition*, is introduced, which is computed by multiplying the difference of unity and one-sixth of sum of percentiles of height and mass with 100 to give a percentage. This index increased from 47.67% to 58.00% (1st to 4th checkup), with a drop at 2nd checkup. Month-wise targets to attain specific heights and masses (on specific dates of a given month) as well as guidelines for lifestyle adjustment accompanied with diet and guarded-graduated exercise plans are provided for the child. Similar month-wise targets to shed off mass for father and put on mass for mother are given with associated lifestyle-adjustment guidelines as well as diet and exercise plans. This work, also, gives a short review of heart-function modeling, nutritional-status classification, classification of build and methods of generating 'Growth-and-Obesity Roadmaps' of a family prior to describing the clinical problem.

Keywords: Growth-and-Obesity Roadmap, heart-function modeling, nutritional-status classification, classification of build, extended growth tables

LIST OF ABBREVIATIONS

cm: centimeter(s) • *m*: meter(s) • *ft*: foot(feet) • *in*: inch(es) • *lb*: pound(s) • *oz*: ounce(s) • *kg*: kilogram(s)

AM: **A**cute **M**alnutrition
BMI: **B**ody-**M**ass **I**ndex
CDC: **C**enters for **D**isease **C**ontrol and Prevention Atlanta, Georgia, United States http://www.cdc.gov
Deg: **Deg**ree (of wasting/obesity; stunting/tallness)
EC I: **E**nergy-**C**hannelization I
EC II: **E**nergy-**C**hannelization II
EC III: **E**nergy-**C**hannelization III
MP: **M**id-**P**arental
NGDS: **N**ational **G**rowth and **D**evelopmental **S**tandards for the Pakistani Children http://ngds.uok.edu.pk
ON: **O**ver-**N**utrition
SF: **S**yed **F**irdous
SGPP: **S**ibling **G**rowth **P**ilot **P**roject
UN: **U**nder-**N**utrition
VSD: **V**entricular **S**eptal **D**efect

INTRODUCTION

Acute malnutrition is one of the leading problems in third-world countries, which may be addressed with drugs, medical devices, lifestyle adjustment, medical nutrition and immune-system-targeted nutracauticals to lower costs of care, fewer complications, shorter stays in hospitals and reduction of mortality (Allison *et al.*, 2015). Teivaanmäki *et al.* (2015) mentioned that over 162 million under-5 children suffer from stunting as a result of chronic malnutrition. Tathiah *et al.* (2013) define malnutrition as either under-nutrition (underweight, wasting and stunting) or over-nutrition (overweight and obesity). However, in the context of this paper, acute malnutrition is defined as the limiting case of under-nutrition (Kamal and Jamil, 2014).

Acute malnutrition resulting in growth faltering may contribute to physical and cognitive disadvantage, mortality and morbidity. There is a need for anthropometric assessment of growing children employing standard protocols, which could facilitate early identification and subsequent timely intervention for emerging health problems (Maleta *et al.*, 2003).

In this paper, case of a girl is reported, who underwent multiple cardiac surgeries. It was only through anthropometric assessment that it was discovered that she was not picking up height and putting on weight as expected and needed further medical evaluation and subsequent surgery. Detailed Growth-and-Obesity Roadmaps of the child and her parents are given, which include date-wise recommendations to manage mass (weight) for the next 6 *months*. In addition, these roadmaps contain date-wise recommendations to achieve certain height milestones by the child for the next 6 *months*. Suggestions are prepared for lifestyle adjustment, diet and exercise plans to accomplish these

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targets. Modeling of heart function, nutritional-status classification, classification of build and methods of generating Growth-and-Obesity Roadmaps are, briefly, described before presenting the clinical case.

MODELING OF HEART FUNCTION

A good review of heart models was given by Noble (2002). One could start with the top-down approach or the bottom-up approach for biological simulation of this important organ of the human body. However, most researchers agree that it should be a middle-out approach. One should start modeling at the level(s), where rich biological data exist and then reach down or up to the next level. In the case of human heart, not only, data-rich-cellular-level modeling was done, but also, data-rich modeling of 3D geometry of the whole organ was attempted (Wasim, 1994; 2006; 2007; Kamal and Wasim, 2013).

Hunter *et al.* (2003) reviewed computational models of the electrical and the mechanical functions of heart, which explained heart function in terms of ventricular anatomy, structure and material properties of myocardial tissue, membrane ion channels, calcium handling and myofilament mechanics of cardiac myocytes. Ottesen and Danielsen (2003) modeled ventricular contraction with heart-rate changes.

The human heart may be visualized as an engine, which performs work. It may be modeled as a bullet, a sphere or as a vibrating system. Our group used the concept of standing waves to calculate frequencies of vibrations of the human heart (Kamal and Siddiqui, 1992; 2002). Acoustic properties of the human heart were modeled by applying ideas from physics and mathematics in order to link frequencies of phonocardiogram to shape of heart.

Mathematics of the Human Heart: In the spirit of the Strong Noether's Theorem — "if one sets up a problem closer to natural symmetries of the system, one is bound to discover additional constants of motion" (Kamal, 2004), the cardiac-coördinate mesh was devised as a generalization of the elliptic-cylindrical-coördinate mesh to set up heart equations. Human-heart shape was approximated as a deformed ellipsoid of revolution, generated by revolving about major axis a deformed ellipse, which is a union of 2 semi-ellipses, both of them having the same minor axes, but differing in the major axes — length of the semi-minor axes of both semi-ellipses was taken as b, whereas length of the semi-major axes of one of the semi-ellipses was a and the other was ka, where, the dimensionless parameter, $k < 1.$ Rotational invariance about the major axis existed in the deformed ellipsoid of revolution. Hence, the corresponding angular momentum (the canonical momentum) was conserved. Because of this symmetry one of the coördinates was dropped (the coördinate becoming cyclic), the three-dimensional problem thus reducing to a two-dimensional problem.

Physics of the Human Heart: To relate the phonocardiogram frequencies to the heart shape, one must know the geometrical properties of surface of the human heart. The human heart was visualized as a system of standing waves. Standing waves were set up in a closed string if the path length, was an integral multiple of wavelength. Heart surface being a bound system should admit discrete frequencies.

Ratio of Frequencies of Phonocardiogram: The above concepts were combined to link standing-wave frequencies of phonocardiogram to geometrical parameters of heart through the following equation — detailed calculations presented in Kamal and Siddiqui (2002)

$$\frac{\omega_{\text{higher}}}{\omega_{\text{lower}}} = 1 + \frac{A_1}{8} - \frac{3A_2}{128} + \frac{5A_3}{512} - \ldots \tag{1}$$

where $A_i = (a^2/b^2 - 1)^i + (k^2a^2/b^2 - 1)^i$; $i = 1, 2, 3, \ldots$

Heart Parameters from PMI: The values of a, b and k may be computed by locating *PMI* (Point of Maximum Intensity) positions — sounds generated by the pulmonary valve (P), the tricuspid valve (T) and the mitral valve (M). In the triangle PTM (Figure 1), $PM = \beta$, $PT = \alpha$, $TM = \gamma$, $\angle\, TPM = \theta$. From the cosine law

$$\cos\theta = \frac{\alpha^2 + \beta^2 - \gamma^2}{2\alpha\beta} \tag{2a}$$

$$a = \beta - \alpha\cos\theta = \frac{\beta^2 + \gamma^2 - \alpha^2}{2\beta} \tag{2b}$$

$$k = \frac{\alpha\cos\theta}{\beta - \alpha\cos\theta} = \frac{\alpha^2 + \beta^2 - \gamma^2}{\beta^2 + \gamma^2 - \alpha^2} \tag{2c}$$

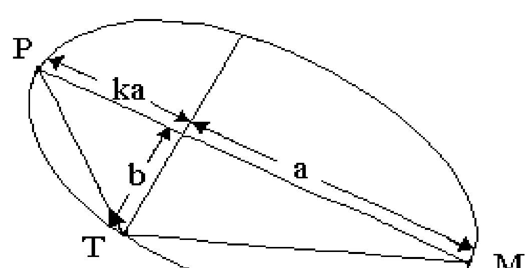


Fig. 1. Geometry of the heart-sound triangle — first appeared in Kamal and Siddiqui (2002)

(2*d*) $$b = \alpha \sin\theta = \alpha\sqrt{1-\cos^2\theta} = \frac{\sqrt{(\alpha^2+\beta^2+\gamma^2)^2-(\alpha^4+\beta^4)}}{\beta\sqrt{2}}$$

The preliminary data suggested that *PMI* locations might estimate shape of human heart (Wasim, 2006; Kamal and Wasim, 2013).

NUTRITIONAL-STATUS CLASSIFICATION

Stunting and tallness, wasting and obesity as well as pseudo gains of height and mass need to be explained before discussing nutritional-status classification

Stunting and Tallness

In the literature, stunting is defined as height falling below 50th percentile. However, in the absence of reliable local charts and tables for the Pakistani population, CDC (Centers for Disease Control and Prevention) Growth Charts and Tables were used, which represented height statistics of the American population. The Americans are, in general, taller as compared to the Pakistanis. Hence, the NGDS Team classified the Pakistani children as stunted, whose heights were lying below 40th percentile according to CDC charts. A child was classified as severely stunted, if the individual's height fell below 3rd percentile.

Estimated-Adult Height: One of the areas of interest to pediatricians is computation of estimated-adult (final) height (Karlberg, 1996), as it may indicate whether the youngster is meeting desired targets for induction into the armed forces (Karpinos, 1961). It is computed from the percentile of current height of child and does not depend on heights of parents.

Target (Adult-Mid-Parental) Height: Another way to determine status of height is by considering height of biological parents. Target (Adult-mid-parental) height of daughter (son) is computed by subtracting 6.5 *cm* from (adding 6.5 *cm* to) average of heights of father and mother (Tanner *et al.*, 1970). Target height depends, only, on heights of parents and is independent of child's own height. Our group defined algebraic status (pertaining-to-height), $STATUS_{\pm}(h)$, expressed as percentage, as 100 times the ratio of difference of measured height and current-age-mid-parental height to current-age-mid-parental height — negative (positive) value indicated stunting (tallness). Quantitative status (pertaining-to-height) was determined using Figure 2 (Kamal *et al.*, 2011; 2015*b*).

Army-Cutoff Height: For induction into the Armed Forces of Pakistan cutoff height for males has been fixed at 5 *ft* 4 *in* (162.56 *cm*), whereas for females the value is 5 *ft* 2 *in* (157.48 *cm*). This height neither depends on child's height nor on parents' heights. The army-cutoff height is based on country-wise standards.

4th-Degree Stunted	**4th-Deg Stunted**	$STATUS_{\pm}(h) < -30$
3rd-Degree Stunted	**3rd-Deg Stunted**	$-30\% \le STATUS_{\pm}(h) < -20\%$
2nd-Degree Stunted	**2nd-Deg Stunted**	$-20\% \le STATUS_{\pm}(h) < -10\%$
1st-Degree Stunted	**1st-Deg Stunted**	$-10\% \le STATUS_{\pm}(h) < -1\%$
Normal	**Normal**	$-1\% \le STATUS_{\pm}(h) < +1\%$
1st-Degree Tall	**1st-Deg Tall**	$+1\% \le STATUS_{\pm}(h) < +10\%$
2nd-Degree Tall	**2nd-Deg Tall**	$+10\% \le STATUS_{\pm}(h) < +20\%$
3rd-Degree Tall	**3rd-Deg Tall**	$+20\% \le STATUS_{\pm}(h) < +30\%$
4th-Degree Tall	**4th-Deg Tall**	$STATUS_{\pm}(h) \ge +30\%$

Fig. 2. Status (pertaining-to-height), classification, abbreviation for entering in report and value-range along with color coding

Table 1. Heights, which are considered to determine reference height to generate Growth-and-Obesity Profile of a child

Nomenclature	*Corresponding Percentile*	*Depends on Child's Height*	*Depends on Parents' Heights*	*Based on Country-Wide Standards*
Estimated-Adult Height, $h_{\text{estimated-adult}}$	$P(h)$	Yes	No	No
Target (Adult-Mid-Parental) Height, h_{MP}	P_{MP}	No	Yes	No
Army-Cutoff Height, h_{AC}	P_{AC}	No	No	Yes

The heights, which are important in the career of a child, are summarized in Table 1.

Wasting and Obesity

A child or an adult having lesser (excess) mass-for-height is considered wasted (obese). Both severe wasting and obesity have risks associated with them.

BMI (Body-Mass Index): *BMI* is considered an indicator to determine obesity or wasting. Introduced in 1832 as 'Quetelet Index' by Adolphe Quetelet and renamed in 1972 as 'Body-Mass Index' (Keys *et al.*, 1972), *BMI* (reported in kg/m^2) is obtained by dividing mass, μ (in *kg*), by square of height, h (in *m*). *BMI* range, used for estimating statuses for adults, cannot be employed for children. *BMI* tables are needed to determine percentiles of *BMI*, which are used to classify children as obese or wasted.

Estimated-Adult BMI: Computed by replacing net mass and height by estimated-adult mass and estimated-adult height of a child, respectively, this index was first mentioned by Freedman *et al.* (2001); a rigorous definition and interpretation of the term was given by Kamal and Jamil (2012). It provided a snapshot of obesity status of children, when they would be fully grown. The strong point of this formulation was that prevailing adult scales (instead of *BMI* tables) could be used to classify children.

Optimal Mass and Weight: The word 'optimal mass' first appeared in Kamal *et al.* (2004), with a rigorous definition provided later (Kamal *et al.*, 2011). Defined as the mass corresponding to height percentile for persons aged 30 *years* or less (for persons above 30 *years*, optimal mass was computed by multiplying square of height with reference value of *BMI*, 24 kg/m^2 — prior to multiplication, height must be converted in *m*), if the mass of a person was lesser (more) than optimal mass, then the incumbent was wasted (obese). Algebraic status (pertaining-to-mass) was defined as 100 times the ratio of difference of measured mass and optimal mass to optimal mass and was expressed as percentage. A negative (positive) value indicated wasting (obesity). Quantitative status (pertaining-to-mass) was determined using Figure 3 (Kamal *et al.*, 2015*b*). Optimal weight (in *lb*) was obtained by multiplying

4th-Degree Wasted	**4th-Deg Wasted**	$STATUS_{\pm}(\mu) < -30$
3rd-Degree Wasted	**3rd-Deg Wasted**	$-30\% \le STATUS_{\pm}(\mu) < -20\%$
2nd-Degree Wasted	**2nd-Deg Wasted**	$-20\% \le STATUS_{\pm}(\mu) < -10\%$
1st-Degree Wasted	**1st-Deg Wasted**	$-10\% \le STATUS_{\pm}(\mu) < -1\%$
Normal	**Normal**	$-1\% \le STATUS_{\pm}(\mu) < +1\%$
1st-Degree Obese	**1st-Deg Obese**	$+1\% \le STATUS_{\pm}(\mu) < +10\%$
2nd-Degree Obese	**2nd-Deg Obese**	$+10\% \le STATUS_{\pm}(\mu) < +20\%$
3rd-Degree Obese	**3rd-Deg Obese**	$+20\% \le STATUS_{\pm}(\mu) < +30\%$
4th-Degree Obese	**4th-Deg Obese**	$STATUS_{\pm}(\mu) \ge +30\%$

Fig. 3. Status (pertaining-to-mass), classification, abbreviation for entering in report and value-range along with color coding

Table 2. Childhood and adult obesity indicators

Nomenclature	*Represented by*	*Mathematical*	*References*
Body-Mass Index	*BMI*	μ/h^2	Keys *et al.* (1972)
Estimated-Adult Body-Mass Index	$BMI_{\text{est-adult}}$	$\mu_{\text{est-adult}}/h_{\text{est-adult}}^2$	Freedman *et al.* (2001); Kamal and Jamil (2012)
Optimal Mass	μ_{opt}	$P(\mu_{\text{opt}}) = P(h)$	Kamal *et al.* (2004; 2011)

optimal mass (in *kg*) by the factor 2.205 (Kamal *et al.*, 2013*e*). The indicators, used in determining status of wasting or obesity, are summarized in Table 2.

Pseudo Gain of Height/Mass

'Pseudo-gain' was defined as a physical gain in height/mass over a certain period. However, there was a drop in corresponding percentile during the same period (Kamal *et al.*, 2014).

Nutritional Status

In addition to under-nutrition, over-nutrition and acute malnutrition, which exist in literature, our group introduced

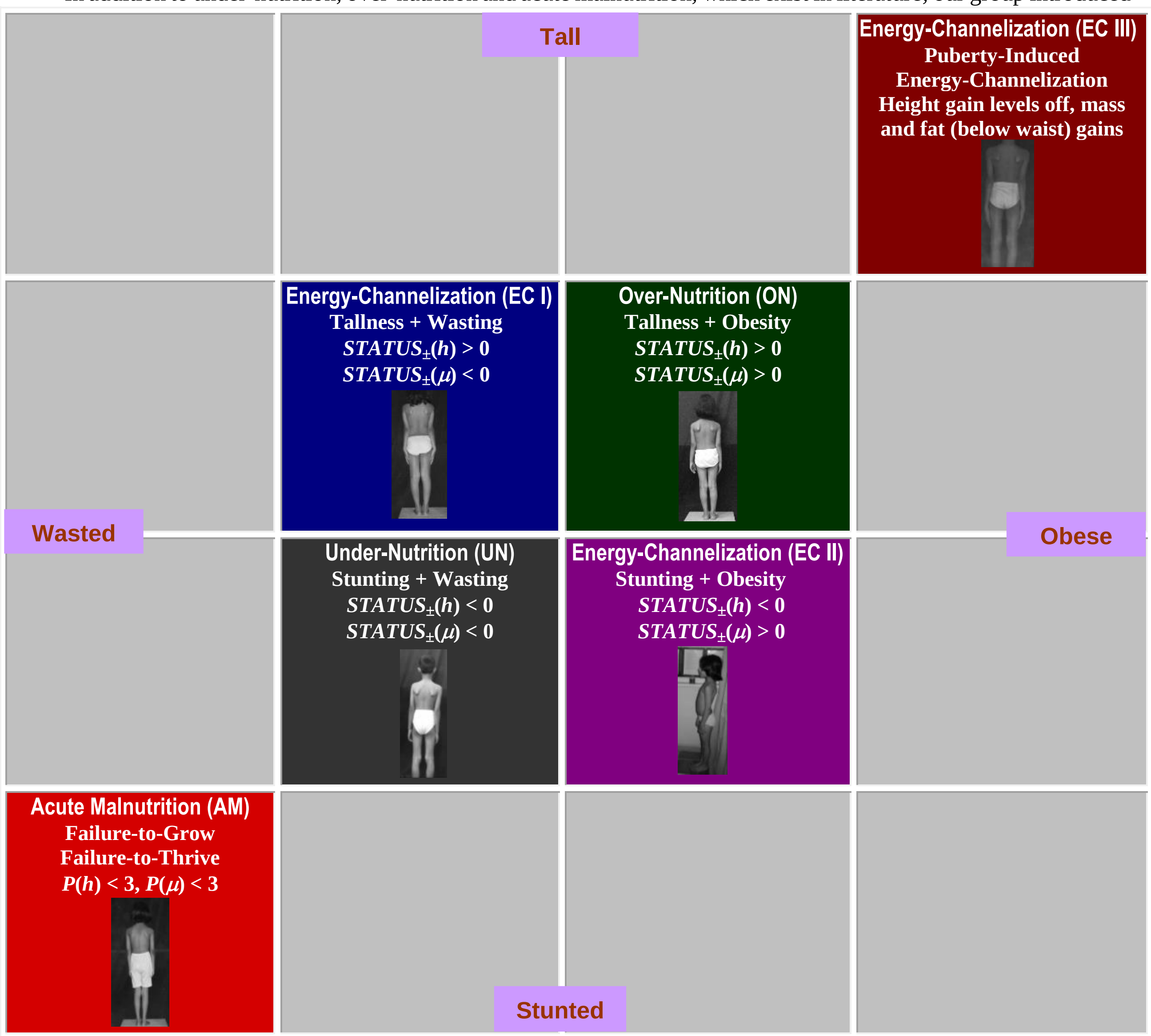


Fig. 4. Nutritional-status classification

duced energy-channelization I-III to classify nutritional status (Figure 4). Numerical examples of each of these are presented in Kamal and Jamil (2014) as well as Additional File of Kamal (2014).

Acute Malnutrition (AM): Our group defined 'acute malnutrition' as the limiting case of under-nutrition, characterized by both height and mass percentiles lying below 3, exhibiting severe stunting and associated wasting (Kamal and Jamil, 2014). In the coördinate-plane representation of nutritional status, AM lies in the bottom-left portion of 3rd quadrant (Figure 4). Severity of acute malnutrition may be, mathematically, expressed as a percentage, using the following equation

(3) $$\textit{Severity of Acute Malnutrition} = 100\left(1 - \frac{P(h)+P(\mu)}{6}\right)\%$$

where $P(h)$ and $P(\mu)$ are percentiles of height and mass, respectively.

Under-Nutrition (UN): 'Under-nutrition' is characterized by coexistence of stunting and wasting — both algebraic status (pertaining-to-height) and algebraic status (pertaining-to-mass) have negative signs. In the coördinate-plane representation of nutritional status, UN lies in 3rd quadrant (Figure 4).

Energy-Channelization I (EC I): First mentioned in Kamal *et al.* (2014), energy-channelization I is characterized by coexistence of tallness and wasting — algebraic status (pertaining-to-height) has a positive sign, whereas algebraic status (pertaining-to-mass) has a negative sign. In EC I, a large amount of micronutrients flow through a single channel of absorption, mostly, contributing to tissue synthesis. In the coördinate-plane representation of nutritional status, EC I lies in 2nd quadrant (Figure 4).

Energy-Channelization II (EC II): First introduced in Kamal *et al.* (2014), energy-channelization II is characterized by coexistence of stunting and obesity — algebraic status (pertaining-to-height) has a negative sign, whereas algebraic status (pertaining-to-mass) has a positive sign. In EC II, micronutrients in large quantities, all flowing through one channel of absorption. The phenomenon of obesity with stunting is, generally, caused by storage of most micronutrients. In the coördinate-plane representation of nutritional status, EC II lies in 4th quadrant (Figure 4).

Over-Nutrition (ON): 'Over-nutrition' is characterized by coexistence of tallness and obesity — both algebraic status (pertaining-to-height) and algebraic status (pertaining-to-mass) have positive signs. ON amplifies tissue-synthesis rate and storage in the body. In the coördinate-plane representation of nutritional status, ON lies in 1st quadrant (Figure 4).

Energy-Channelization III (EC III): First described in Kamal (2014), Our group defined 'energy-channelization III' as the limiting case of over-nutrition, also called 'puberty-induced energy-channelization', which is characterized by leveling off of height gain accompanied by mass and fat gains, in particular, below the waist (Kamal and Jamil, 2014). EC III is manifested in children entering puberty, when the release of sex hormone, depicts a temporary decrease in height velocity. After a short transition period, the child picks up height rapidly, which is termed as 'adolescent growth spurt'. This behavior is consistent with ICP model of child growth (Karlberg, 1967). In the coördinate-plane representation of nutritional status, EC III lies in the top-right portion of 1st quadrant (Figure 4).

CLASSIFICATION OF BUILD

According to Fabian Gorodzinsky of University of Western Ontario, pattern of a child is defined by parameters of weight, length and head circumference. A child, who is on the bottom of the growth chart for all three, is 'small child' and one, who is on the top, is a 'big child'. However, both are normal.

Build of a child is significant in making sport teams. It was, recently, suggested to form academic sections of a class, also, on the basis of build to avoid bullying/necessity of seating big-build students on the back seats and allowing exchange of seats once during a session to keep students interactive and attentive (Kamal, 2015*c*).

A mathematical criterion to classify build was proposed, recently (Kamal and Khan, 2015) and used to assign build in 'Growth-and-Obesity Roadmap' of a child participating in gymnastics (Kamal, 2015*a*) as well as a marginally obese child (Kamal, 2015*b*). Build of a child was obtained by summing percentiles of height, $P(h)$, and mass, $P(\mu)$. These criteria are described below.

Small Child

A value of $P(h) + P(\mu)$ less than 50 represented 'small' build. In such children, brain functions dominate body functions. Such children are, usually, better in intellectual work, innovative tasks, planning and development assignments. Children suffering from acute malnutrition would have 'small' build as $P(h) + P(\mu) < 3$ for such children — as per definition given above, $P(h) < 3$ and $P(\mu) < 3$ in a child indicated acute malnutrition.

Table 3. Classification of a child's build, useful in forming sport teams

Classification	*Sum of Percentiles*	*Dominance*	*Suitable for*
Small	$0 \le P(h) + P(\mu) < 50$	Brain function	Intellectual work, planning and development tasks
Medium	$50 \le P(h) + P(\mu) < 150$	Equal contribution	May adapt to brain- or body-dominating tasks
Big	$150 \le P(h) + P(\mu) < 200$	Body function	Tasks involving strength and speed

Child of Medium Build

A value of $P(h) + P(\mu)$ equal to or more than 50 but less than 150 indicated 'medium' build. In such children, brain and body functions are equally dominating. They could be trained to do intellectual work or tasks involving strength and speed.

Big Child

A value of $P(h) + P(\mu)$ equal to or more than 150 suggested 'big' build. In such children, body functions dominate brain functions. Such children are suitable for tasks involving strength and speed. Table 3 summarizes these ideas.

THE NGDS PILOT PROJECT

Project Protocols

The NGDS (National Growth and Developmental Standards for the Pakistani Children) Pilot Project (http://ngds.uok.edu.pk) was initiated in 1998 after the proposal went through 'Institutional Review Process', which incorporated human-right and ethical standards (opt-in policy) applicable in Pakistan (Kamal *et al.*, 2002). The project was implemented in 4 representative schools (one civilian and one each operated by the Armed Forces of Pakistan — the Pakistan Air Force, the Pakistan Army and the Pakistan Navy). A subproject of the NGDS Pilot Project, named as SGPP (Sibling Growth Pilot Project) served local families, who came to SF-Growth-and-Imaging Laboratory along with their 5-10-*year*-old children, for detailed checkups. Checkups were conducted giving due regard to comfort, confidentiality, dignity, privacy and safety of participants.

Anthropometric Techniques and Examinations

Data-collection techniques are described, briefly. Detailed protocols are available in the official document of the NGDS Pilot Project (Kamal, 2006). Children were screened for factors, which may contribute to growth abnormalities, including anemia, trunk deformities, in particular, scoliosis, lordosis and kyphosis (Kamal *et al.*, 2015*a*) as well as a through examination of heart at *Points of Maximum Intensity* (*PMI*) — aortic (*A*), pulmonary (*P*), tricuspid (*T*) and mitral (*M*), to mathematically determine shape of heart according to the models developed by the author (Kamal and Siddiqui, 1992; 2002). In addition, static and dynamic exams of knees were conducted to rule out knees joining and knees knocking conditions. Gaits were observed both from back and front to look for spastic gait or limp as well as toes inward or outward (Kamal *et al.*, 2013*c*).

Heights and masses were measured by anthropometrists, with documented reproducibility, to least counts of 0.1 *cm* (1998-2011, wall-mounted engineering-tape and setsquares); 0.01 *cm* (2012 onward, wall-mounted engineering-tape and setsquares, with Vernier scale pasted on edge) and 0.5 *kg* (1998-2011, bathroom scale); 0.01 *kg* (2012 onward, improvised beam scale and set-squares, with Vernier scale pasted on edge), respectively, before noon, as children were 1-1.5 *cm* taller in the morning as compared to the afternoon. Parents were measured wearing minimal indoor clothing and children were required to strip totally except briefs or panties. Everyone took off accessories, shoes and socks for measurements. A suitable clothing correction was subtracted from 'gross mass' (mass recorded in indoor clothing) to compute 'net mass' (mass with zero clothing on), μ, for mother and father. Children were measured wearing only short underpants, all clothing above the waist removed, barefoot. Their recorded masses were used without any clothing correction as they were very close to net masses.

For measuring height (stature), h, subject was told to stand touching the engineering tape (mounted on wall, vertical alignment checked through plumb line) and instructed to align hands with body, palms touching thighs and heels together. Height was measured, when the incumbent fully inhaled so that the incumbent's chest was expanded and tummy was in (attention position). The anthropometrist held a pencil at eye level to make sure that chin of the subject was parallel to floor. For measuring mass (weight), the subject stood in center of beam scale, palms on thighs and feet separated, looking straight and breathed in to trap maximum air (stand-at-ease position). A standard

100-*cm* ruler and a standard 2-*kg* mass were used to calibrate height- and mass-measurement instruments at the beginning of each daily session along with noting down of zero errors.

Disrobing of children helped anthropometrists to ascertain standard posture during measurements, making sure that knees and elbows were not flexed. Also, care was exercised to ascertain that toes or heels were not lifted. The measurers were able to verify that the measurements were performed while the child properly inhaled before recording, as height and mass values differed slightly between complete inhalation and complete exhalation. Further, the examiners were able to better determine malnutrition, poor posture, crooked gait and spinal deformities in the undressed children.

Growth-and-Obesity Roadmaps

Anthropometric data were fed using software based on Growth-and-Obesity model published this year (Kamal *et al.*, 2015*b*), which is a generalization of earlier models (Kamal *et al.*, 2011; Kamal and Jamil, 2012). The following explains methods of generating entries in the Growth-and-Obesity Roadmaps presented later in this paper**:**

*Dress Code***:** Measurements, examinations and observations were effected by the nature and the amount of clothing present on a child or an adult. Dress code was entered with the findings (descriptive or quantitative) as a fraction, numerator (denominator) representing clothing superior (inferior) to transverse plane passing through the naval. '0' is indicative of absence of clothing and '3' describes maximum amount of clothing. Dress code '1.5/2' (father), mentioned in 'Growth-and-Obesity Roadmap' (included in this paper), meant he was measured wearing T-shirt and trousers, barefoot, '2/2' (mother) meant she was barefoot and wearing 'shalwar/kameez' ('shalwar' is a garment resembling athletic trousers and 'kameez' is a piece of clothing like a long shirt) without 'dupatta' (a sheet put on shoulders on top of 'kameez') at the time of measurement. (Female) child's dress code '0/0.5' meant she was barefoot and examined completely undressed wearing only panties (Kamal et al., 2002; Kamal, 2006).

*Behavior Code***:** Behavior code was '0', when the child was relaxed and coöperative, '1' when the youngster was timid and shy, but coöperative, and '2', when the incumbent was resistant and nagging. The optimal value for all the measurements was '0' (Kamal et al., 2002; Kamal, 2006).

*Cumulative-Scoliosis-Risk Weightage (CSRW)***:** A numerical value, which was assigned on the basis of family history, age and results of different tests conducted — statuses of being tall and/or wasted, forward-bending tests (child facing the examiner and with back towards the examiner), non-alignment of plumb-line, shoulder drooping, uneven scapulae, shape of midline of back (C or S), unequal body triangles, uneven spinal dimples, positive moiré (back and front), with the weightage of each factor increasing if the condition persisted during more than one examination. Child was considered to be at risk for scoliosis if CSRW exceeded '5.5' (after 1st checkup), '6.5' (after 2nd checkup) and '7.5' (after 3rd checkup). Details are given elsewhere (Kamal *et al.*, 2013*d*; 2015*a*).

*Extended-Gender-Specific-Height and -Mass Tables***:** These tables (Kamal and Jamil, 2014) contained heights and masses corresponding to 0.01th, 0.1th, 1st, 99th, 99.9th and 99.99th percentiles, in addition to values given in CDC Growth Tables (http://www.ngds-ku.org/Papers/J34/Additional_File_3.pdf).

*Dates of Birth and Checkups***:** The first step was to convert dates of birth and dates of measurement in fractional form and finding difference to compute age. Dates of birth and checkup were recorded as *YYYY-MM-DD* — *year* in four digits-*month* in two digits-*day* in two digits; ages as *YY-MM-DD* (*year* in two digits). Detailed procedure is available in Appendix A of (Kamal *et al.*, 2011).

*Children's Growth-and-Obesity Profiles***:** 'Linear interpolation' was used to determine percentiles of target height for son or daughter from age-20-height values. Percentiles of army-cutoff-height values were computed using 'linear interpolation' (extended table was needed to compute percentile for males, as the value fell below 3rd percentile). Child's height (mass) percentile was evaluated by the technique of 'box interpolation' (Kamal *et al.*, 2011). Estimated-adult height (mass) was computed through 'linear interpolation' using age-20 values (Table 1) and *estimated-adult BMI* obtained. Constant-age route was followed to compute optimal mass and, subsequently, determine obesity profile. A similar procedure was used to evaluate current-age-mid-parental height. Algebraic status (pertaining-to-height), $STATUS_{\pm}(h)$, as well as algebraic status (pertaining-to-mass), $STATUS_{\pm}(\mu)$, computed and qualitative statuses (pertaining-to-height) as well as (pertaining-to-mass) were determined (Figures 2 and 3), nutritional status classified (Figure 4) and build assigned (Table 3). For children suffering from acute malnutrition, severity was computed using equation (3).

*Children's Growth-and-Obesity Roadmaps***:** To construct 'Growth-and-Obesity Roadmaps' of boys or girls, one needed more than one profile — each profile represented a checkup. To determine percentile of reference height, $P_{\text{ref,}}$ select the larger value from the pair of values consisting of percentile of current height, $P(h)$, and maximum of gender-specific-army-cutoff-height percentile, $P_{\text{army-cutoff}}$ (for the Pakistani males its value comes out to 2.718014592103645… and for the Pakistani females 19.35609323536863…), as well as gender-specific-mid-parental-height percentile, P_{MP} (Table 1). Optimal mass, after 6 *months*, was computed based on estimated-reference height (6 *month* ahead in time scale). Recommendations to pick up height and gain or reduce mass (weight) were generated from the most-recent profile. Difference of measured height (current value) and reference height (after 6 *months*) was considered as guideline to set short-term goals to gain height within the next 6 *months*. Similarly, difference of measured mass (current value) and optimal mass (after 6 *months*) was considered as guideline to set short-term goals to gain (lose) mass within the next 6 *months*, if the value was negative (positive). Monthly recommendations to gain height or acquire (reduce) mass were prepared, taking care of the principle that a child should not be required to lose more than 10 *kg* within the next 6 *months*, in order to avoid any adverse health effects from a rapid loss of mass. 6 recommendations (on date of checkup of each successive month) to achieve specific values of height were obtained by adding monthly recommendation (to pick up height) multiplied by a factor (1 to 6, representing the number of successive month) to measured height (in *cm*) and converted into *ft* and *in*. In a similar manner, 6 recommendations (on date of checkup of each successive month) to achieve specific values of mass (weight) were obtained by adding monthly recommendation (to put on or shed off mass) multiplied by a factor (1 to 6, representing the number of successive month) to measured mass (current value in *kg*) and converted into weight (in *lb* and *oz*).

Parents' Obesity Profiles: To compute Parents' Obesity Profiles, percentiles of heights and masses of father and mother were determined by 'linear interpolation' from lesser and greater age-20 values of heights and masses read from extended-gender-specific tables.

Parents' Obesity Roadmaps: Father (Mother) was advised to put on mass (weight) corresponding to the difference obtained by subtracting net mass from optimal mass, if the value of former was lesser than that of later (weight in *lb* and *oz* was obtained using the relations: 1 *kg* = 2.205 *lb*; 1 *lb* = 16 *oz*). In case, value of net mass was greater than optimal mass, father was suggested to lose mass corresponding to that difference, provided the value was under-10 *kg*, otherwise he should shed off 10 *kg* within the next 6 *months*. For mothers (married at the time of check up or divorced/widowed in the near past), the recommendation to lose mass was computed by adding 5 *kg* to gross mass, to take care of possible pregnancy and the associated fetal mass. Monthly as well as date-wise recommendations to manage mass (weight) were generated following procedures given for children's roadmaps.

Lifestyle Adjustment, Diet and Exercise Plans

To achieve recommended targets (mass targets for the entire family; additional height targets for each child), customized lifestyle adjustment as well as diet plans for increasing height (Kamal *et al.*, 2013*b*) and maintaining optimal weight (Kamal *et al.*, 2013*e*) were included in the report handed out to parents. Guarded-graduated exercises were recommended to accompany diet plans (Kamal and Khan, 2014). Since diet plans are not effective in children suffering from vitamin-D deficiency, measures were suggested to remedy this problem (Kamal *et al.*, 2013*a*).

CASE PRESENTATION

G. R., female, is the second of 3 children (an older sister and a younger brother) living with biological parents. Father, born December 21, 1971 (blood group B+), mother born November 17, 1975 (blood group O+). Maternal grandfather had cardiac problems. She was observed in SF-Growth-and-Imaging Laboratory during the period 2011-2013 (age range 6.47-8.53 *years*). Figures 5*a-f* show posture and moiré photographs of G. R.

History: After a normal pregnancy of 9 *months*, she was born (normal delivery) on November 2, 2004 (birth

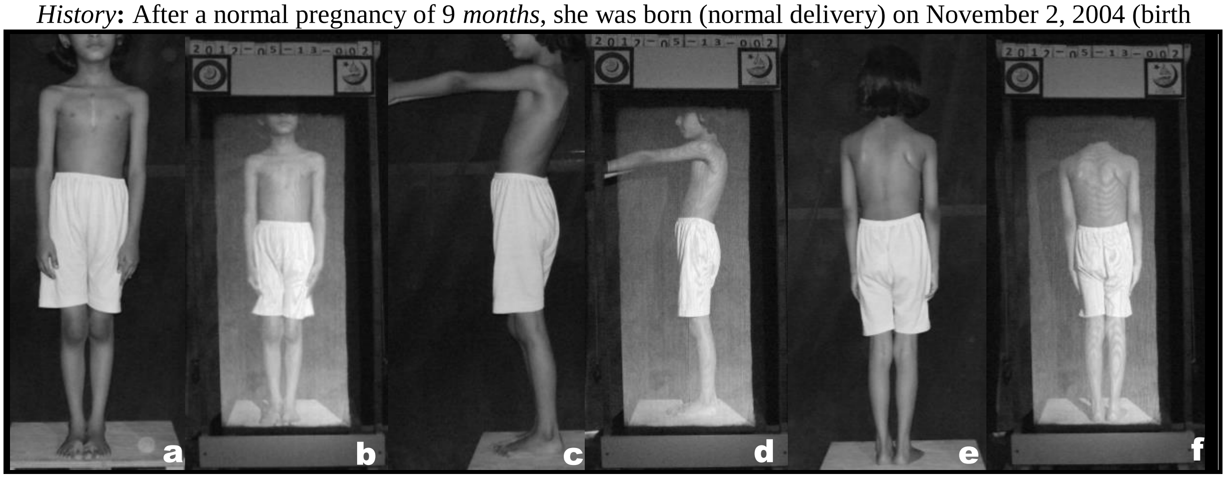


Fig. 5*a-f*. Posture and moiré photographs of G. R. taken on May 13, 2012; surgical scar visible in (*a*) — Posture photographs first appeared in Kamal and Jamil (2014), published in the same journal

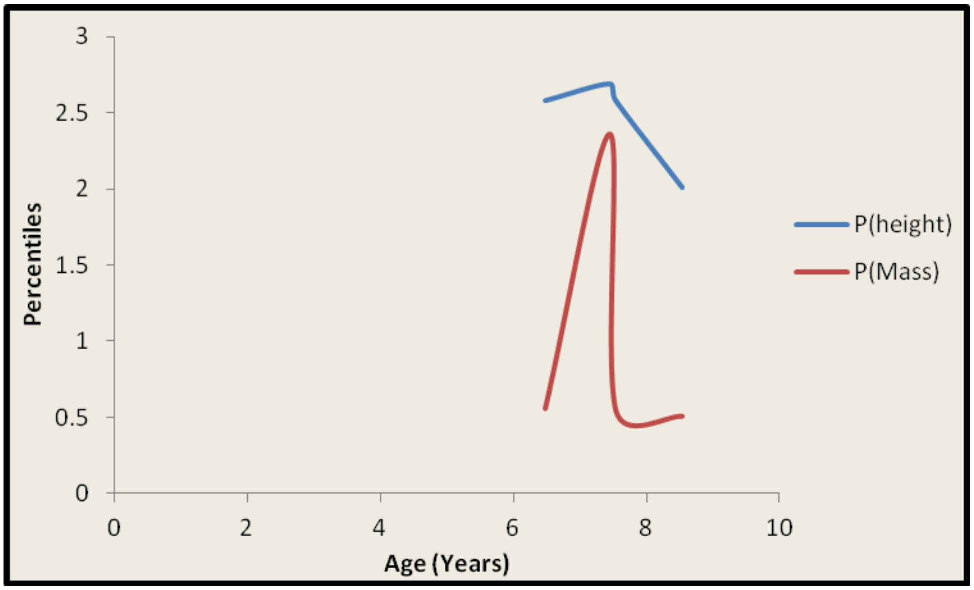


Fig. 6. Height- and mass-percentile trajectories of G. R. in the age range 6.47-8.53 years.

weight 2.5 *kg*; blood group O+). Breastfeeding discontinued after 6 *months* due to problems in breathing. She was good both academically and in social interactions. However, she lacked independence and got tired, easily. Her daily routine consisted of 9-*hour* sleep, 3 meals (relaxed) and 1 snack (relaxed). She did not participate in co-curricular activities and sports. She had cardiac surgery when 5-*day* old. When 5-*year* old, she was diagnosed to have Pulmonary Atresia with Ventricular Septal Defect (VSD). She had corrective surgery for closure of VSD and formation of right ventricle to pulmonary artery continuity by using a valved conduit. At the age of 7 *years*, she had another surgery.

Examinations: All of her checkups were conducted with the child barefoot and completely undressed except underwear. She was relaxed and coöperative during every checkup. She was right-handed, hair rough, nails white and teeth yellow. Her lips were black at 2nd checkup and blue at 3rd checkup (indicative of cyanosis). She had normal heart sounds at four locations at 1st checkup, heart beat not OK at 2nd and 3rd checkups, thumping heart but normal sounds at 4th checkup. Surgical scar was seen at 1st checkup, which showed healing at 2nd and 3rd checkups, a new surgical scar on chest observed at 4th checkup.

Growth-and-Obesity Roadmap: Growth-and-Obesity Roadmap shows that G. R. was suffering from acute malnutrition during the entire period of observation (6.47-8.53 *years*). Mid-parental percentile was 7.77, which made her 1st-degree stunted for all her 4 checkups. Her height and mass percentiles both were below 3rd for all her 4 checkups. Figure 6 displays height- and mass-percentile trajectories of G. R. There were pseudo gains of height from 2nd to 4th checkup (height gain from 113.46 *cm* to 117.46 *cm*; percentile of height dropping from 2.69 to 2.01). Both height and mass percentiles have maximum values just after her 7th birthday (not exactly at the same age, mass percentile hitting maximum a little later than height percentile; mass-percentile curve never crosses or touches height- percentile curve, suggesting that optimal mass was never achieved — mass-percentile curve below height-percentile curve throughout the period of observation, indicative of persistent wasting, physical loss of mass between 2nd and 3rd checkup), after which both show a drop in values. Mass percentile reaching lowest just before her 8th birthday, after which there was a slight upward trend. *Severity of Acute Malnutrition* was computed using equation (3), which increased from 47.67% to 58.00% (1st to 4th checkup), with a drop at 2nd checkup. Table 4 lists target and army-cutoff heights as well as the corresponding percentiles. Growth-and-Obesity Roadmaps of G. R. are

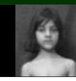
Table 4. Adult-mid-parental (Target) and army-cutoff heights for R. Family

Father's Height: ♂ 167.90 *cm* • Mother's Height: ♀ 153.02 *cm*

Adult-Mid-Parental (Target) and Army-Cutoff Heights	*Boy* ♂		*Girl* ♀	
	Target	*Army-Cutoff*	*Target*	*Army-Cutoff*
Case Number	**SGPP-KHI-20110412-02**			
Height (*cm*)	166.96	162.56	153.96	157.48
Height (*ft-in*)	5 *ft* 5.73 *in*	5 *ft* 4.00 *in*	5 *ft* 0.61 *in*	5 *ft* 2.00 *in*
Percentile	8.87	2.72	7.77	19.36

Table 5*a*. Growth-and-Obesity Roadmap of G. R. (1st to 4th checkups)

Gender**:** Female • Date of Birth (*year-month-date*)**:** 2004-11-02 • School**:** Withheld • GR Number**:** Withheld

Checkup	*1st*	*2nd*	*3rd*	*4th*
Case Number	**SGPP-KHI-20110412-02/02 (NGDS-BLA-2010-4660/F)**			
Photograph				
Scanned Signatures	GR	GR	GR	GR
Class	KG	I	I	II
Date of Checkup (*year-month-date*)	2011-04-21	2012-04-11	2012-05-13	2013-05-16
Age (*year-month-date*)	06-05-19	07-05-09	07-06-11	08-06-14
Age (*decimal years*)	6.47	7.44	7.53	8.53
Dress Code	0/0.5	0/0.5	0/0.5	0/0.5
Behavior Code	0	0	0	0
Cumulative-Scoliosis-Risk Weightage (CSRW)	0.50	5.00	6.50	7.50
Height, *h* (*cm*)	107.6	113.48	113.72	117.46
Height (*ft-in*)	3 *ft* 6.36 *in*	3 *ft* 8.68 *in*	3 *ft* 8.77 *in*	3 *ft* 10.24 *in*
Percentile-of-Height, *P*(*h*)	2.58	2.69	2.58	2.01
Estimated-Adult Height (*cm*)	150.20	150.44	150.19	148.94
Estimated-Adult Height (*ft–in*)	4 *ft* 11.13 *in*	4 *ft* 11.23 *in*	4 *ft* 11.13 *in*	4 *ft* 10.64 *in*
CA-MP (Current-Age-Mid-Parental) Height (*cm*)	110.54	116.38	116.88	122.07
Δ Height *w. r. t.* CA-MP Height (*cm*)	–2.94	–2.90	–3.16	–4.61
Algebraic Status (pertaining-to-height), $STATUS_{\pm}(h)$	–2.66%	–2.49%	–2.70%	–3.77%
Qualitative Status (pertaining-to-height)	**1st-Deg Stunted**	**1st-Deg Stunted**	**1st-Deg Stunted**	**1st-Deg Stunted**
CA-AC (Current-Age-Army-Cutoff) Height (*cm*)	113.25	119.27	119.79	125.17
Δ Height *w. r. t.* CA-AC Height (*cm*)	–5.65	–5.79	–6.07	–7.71
Reference Height (*cm*)	113.25	119.27	119.79	125.17
Percentile-of-Reference-Height	19.36	19.36	19.36	19.36
Age of Prediction, *A+* (*years*)	6.97	7.94	8.03	9.04
Reference Height at *A+* (*cm*)	116.43	122.09	122.58	127.59
6-Month-Height Management (*cm*)	+8.83	+6.61	+8.86	+10.13
Month-wise-Height Management (*cm/month*)	**+1.47**	**+1.44**	**+1.48**	**+1.69**
Month-wise-Height Management (*in/month*)	+0.58	+0.43	+0.58	+0.66
Gross Mass (*kg*)	13.3	17.65	14.51	15.57
Clothing Correction (*kg*)	0	0	0	0
Net Mass, μ (*kg*)	13.3	17.65	14.51	15.57
Net Weight (*lb-oz*)	29 *lb* 5.22 *oz*	38 *lb* 14.69 *oz*	31 *lb* 15.91 *oz*	34 *lb* 5.31 *oz*
Percentile-of-Net-Mass $P(\mu)$	0.56	2.36	0.55	0.51
Estimated-Adult Mass (*kg*)	35.06	42.97	35.02	34.24
Estimated-Adult Weight (*lb–oz*)	77 *lb* 4.91 *oz*	94 *lb* 11.98 *oz*	77 *lb* 3.51 *oz*	75 *lb* 8.06 *oz*
*BMI***:** Body-Mass Index (kg/m^2)	11.49	13.71	11.22	11.29
Estimated-Adult BMI (kg/m^2)	15.54	18.99	15.53	15.63
Optimal Mass (*kg*)	16.30	18.06	18.07	19.07
Δ Mass-for-Height (*kg*)	–3.00	–0.41	–3.56	–3.50
Algebraic Status (pertaining-to-mass), $STATUS_{\pm}(\mu)$	–18.38%	–2.27%	–19.69%	–18.37%
Qualitative Status (pertaining-to-mass)	**2nd-Deg Wasted**	**1st-Deg Wasted**	**2nd-Deg Wasted**	**2nd-Deg Wasted**
Optimal Mass for Reference Height at *A+* (*kg*)	19.91	22.12	22.34	25.01
6-Month-Mass Management (*kg*)	+6.61	+4.47	+7.83	+9.44
Month-wise-Mass Management (*kg/month*)	**+1.10**	**+0.75**	**+1.30**	**+1.57**
Month-wise-Weight Management (*lb-oz/month*)	+2 *lb* 6.87 *oz*	+1 *lb* 10.28 *oz*	+2 *lb* 14.04 *oz*	+3 *lb* 7.51 *oz*
Nutritional Status	**AM**	**AM**	**AM**	**AM**
$P(h) + P(\mu)$	3.14	5.05	3.13	2.52
Severity of Acute Malnutrition	**47.67%**	**15.83%**	**47.83%**	**58.00%**
Build	**Small**	**Small**	**Small**	**Small**

listed in Table 5*a*. Date-wise recommendations for G. R. to pick up height and put on mass (for the next 6 *months*)

Table 5*b*. Month-wise-height and -mass (-weight) management for G. R. based on her last checkup

Targets (*on specific dates of each month*)	*Height Management*		*Mass (Weight) Management*	
	cm	*ft-in*	*kg*	*lb-oz*
June 16, 2013	119.15	3 *ft* 10.91 *in*	17.14	37 *lb* 12.82 *oz*
July 16, 2013	120.84	3 *ft* 11.57 *in*	18.72	41 *lb* 4.32 *oz*
August 16, 2013	122.53	4 *ft* 0.24 *in*	20.29	44 *lb* 11.83 *oz*
September 16, 2013	124.21	4 *ft* 0.90 *in*	21.86	48 *lb* 3.34 *oz*
October 16, 2013	125.90	4 *ft* 1.57 *in*	23.44	51 *lb* 10.85 *oz*
November 16, 2013	127.59	4 *ft* 2.23 *in*	25.01	55 *lb* 2.35 *oz*

are given in Table 5*b*. Table 5*c* suggests lifestyle adjustment, diet and exercise plans for G. R. Parents' obesity

Table 5*c*. Lifestyle adjustment, diet and exercise plans for G. R. to achieve month-wise targets

	Height Management	*Mass (Weight) Management*
Lifestyle Adjustment	Recommended daily dose of vitamin D (600 IU) through 10-15 minute guarded-graduated sun-exposure (early morning or late afternoon) with the child minimally dressed, 10-hour night-time sound sleep	
Diet Plans	3 relaxed and balanced meals, 10-12 glasses of water daily	
	To gain height diet plan should include calcium-, protein- and fiber-rich diet (milk, fresh fruit, chicken and fish)	To put on mass (weight) diet plan should include milk, potato items and protein-rich diet
Exercise Plans	Guarded-graduated exercises preceded by warm-up and followed by cool-down routines	
	To pick up height child should perform light-stretching exercises (bar hanging, mild-stretching, summersault, cartwheel)	To increase mass (weight) heavy exercises performed for shorter duration, consistently

statuses were, also, determined, which revealed that father was obese, whereas mother was wasted (Table 6*a*). Date-wise recommendations for parents to manage weight (for the next 6 *months*) have been prepared and listed in Table

Table 6*a*. Obesity Roadmaps of parents of G. R.

Father's Date of Birth (*year-month-date*): 1971-12-21 • Mother's Date of Birth (*year-month-date*): 1975-11-17

	Father	*Mother*
Case Number	**SGPP-KHI-20110412-02**	
Date of Checkup (*year-month-date*)	2012-05-13	2012-05-13
Age (*year-month-date*)	40-04-22	36-05-26
Age (*decimal years*)	40.39	36.49
Dress Code	1.5/2	2/2
Height, *h* (*cm*)	167.90	153.02
Height (*ft-in*)	5 *ft* 6.10 *in*	5 *ft* 0.24 *in*
Gross Mass (*kg*)	82.80	44.64
Clothing Correction (*kg*)	0.30	0.30
Net Mass, μ (*kg*)	82.50	44.34
Net Weight (*lb-oz*)	181 *lb* 14.60 *oz*	97 *lb* 12.32 *oz*
BMI: Body-Mass Index (kg/m^2)	29.27	18.94
Optimal Mass (*kg*)	67.66	56.20
Δ Mass-for-Height	+14.84	–11.86
Algebraic Status (pertaining-to-mass), $STATUS_{\pm}(\mu)$	+21.94%	–21.10%
Qualitative Status (pertaining-to-mass)	3rd-Deg Obese	3rd-Deg Wasted
6-Month-Mass Management (*kg*)	–10.00	+11.86
Month-wise-Mass Management (*kg/month*)	**–1.67**	**+1.98**
Month-wise-Weight Management (*lb-oz/month*)	–3 *lb* 10.80 *oz*	+4 *lb* 5.71 *oz*

Table 6*b*. Month-wise-mass (-weight) management for parents of G. R.

Targets	*Father*		*Mother*	
(on specific dates of each month)	*kg*	*lb-oz*	*kg*	*lb-oz*
June 13, 2012	80.83	178 *lb* 3.80 *oz*	46.32	102 *lb* 2.05 *oz*
July 13, 2012	79.17	174 *lb* 9.00 *oz*	48.29	106 *lb* 7.79 *oz*
August 13, 2012	77.50	170 *lb* 14.20 *oz*	50.27	110 *lb* 13.50 *oz*
September 13, 2012	75.83	167 *lb* 3.40 *oz*	52.25	115 *lb* 3.26 *oz*
October 13, 2012	74.17	163 *lb* 8.60 *oz*	54.22	119 *lb* 9.00 *oz*
November 13, 2012	72.50	159 *lb* 13.80 *oz*	56.20	123 *lb* 14.74 *oz*

6*b*. Table 6*c* suggests lifestyle adjustment, diet and exercise plans for parents to help achieve goals listed in Table 6*b*. To process data of this patient, Growth Charts and Tables were extended to include height and mass percentiles below 3rd percentile (http://www.ngds-ku.org/Papers/J34/Additional_File_3.pdf), generated by mathematical modeling and data of CDC (Centers for Disease Control and Prevention) Growth Charts and Tables (Kamal and Jamil, 2014).

DISCUSSION AND CONCLUSION

This work described case of a female child, whose was monitored in SF-Growth-and-Imaging Laboratory. She was suffering from Pulmonary Atresia with Ventricular Septal Defect, for which she had to undergo 3 cardiac surgeries, which resulted in her 'Failing-to-Grow' (both height and mass percentiles lying below 3rd for all her 4 checkups). She presented with acute malnutrition resulting in small build. Constant medical supervision combined with recommended lifestyle adjustment, diet and guarded-graduated exercise plans should improve quality of life for this child. A much more sophisticated mathematical-computer modeling of heart function beyond the electrical, the mechanical and the acoustic approaches may bring out better treatment options for such children. While the existing models have established framework for linking the structure and the function of cardiac cells and tissue to the integrated behavior of the intact heart, a lot of other aspects of physiological functioning, which include metabolic and signal-transudation pathways, should be considered before significant progress can be made in understanding cardiac problems.

Additional File (http://www.ngds-ku.org/Papers/J40/Additional_File.pdf) contains color-combination keys for labeling qualitative statuses and nutritional statuses as well as pictures showing auscultation of heart and measurement of height and mass.

Informed Consent and Confidentiality Standards: G. R. participated in our growth-and-obesity monitoring program through the NGDS Pilot Project. 'The Informed Consent Form' was received duly signed by both parents and the participating child (http://www.ngds-ku.org/ngds_folder/Protocols/NGDS_form.pdf), allowing measurements to be performed on the school premises. R. Family was invited to come to SF-Growth-and-Imaging Laboratory after the Project Director received 'The SGPP Participation Form' (http://www.ngds-ku.org/SGPP/SGPP_Form.pdf). To safeguard R. Family's privacy, the photographs, included in G. R.'s Growth-and-Obesity Roadmap, do not show the actual child, whose profile is presented. These photographs are selected from the set of children, enrolled in Growth-and-Obesity-Obesity-Monitoring Program conducted at SF-Growth-and-Imaging Laboratory. In addition, family label (R.) and initials of child (G. R.) are

Table 6*c*. Lifestyle adjustment, diet and exercise plans for parents of G. R. to achieve month-wise targets

	Father	*Mother*
Lifestyle Adjustment	Active and carefree lifestyle, lesser screen time, outdoor activities combined with light reading and social interactions, 6-hour night-time sound sleep	
Diet Plans	3 relaxed and balanced meals, 10-12 glasses of water daily	
	To shed off mass (weight), diet plan should include salad, yogurt and skimmed milk	To put on mass (weight), diet plan should include milk, potato items and protein-rich diet
Exercise Plans	Guarded-graduated exercises preceded by warm-up and followed by cool-down routines	
	To shed off mass (weight), mother should perform light exercises longer duration, consistently	To put on mass (weight), father should perform heavy exercises for shorter duration, consistently

different from first letters in actual names (according to our group's confidentiality standards). Same holds for the case number appearing in this report and the main document. Further, in place of scanned signatures, initials are given, again, to protect privacy.

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