



## MATERIAL AND METHODS

### *Project Protocols*

In 1998, the NGDS (National Growth and Developmental Standards for the Pakistani Children) Pilot Project (<http://ngds.uok.edu.pk>) was initiated after 'Institutional Review Process', incorporating ethical and human-right standards (opt-in policy) applicable in this region (Kamal *et al.*, 2002; 2004). Four representative schools (one civilian and one each serving the families of servicemen belonging to Pakistan Army, Pakistan Air Force and Pakistan Navy) were included in this study. A subproject of the NGDS Pilot Project, named as SGPP (Sibling Growth Pilot Project), served local families, who reported to SF-Growth-and-Imaging Laboratory along with their 5-10-year-old children, for detailed checkups ([http://www.ngds-ku.org/ngds\\_URL/subprojects.htm#SGPP](http://www.ngds-ku.org/ngds_URL/subprojects.htm#SGPP)). Measurements were carried out giving due regard to comfort, confidentiality, dignity, privacy and safety of participants.

### *Laboratory Techniques*

Laboratory techniques employed for data collection are described, briefly. Detailed protocols are available, elsewhere (Kamal, 2006). Boys and girls were screened for factors, which may be responsible for growth retardation, including anemia, cardiac disease and spinal deformities, in particular, kyphosis, lordosis and scoliosis (Kamal *et al.*, 2015a). In addition, knees joining (static exam) and knees knocking (dynamic exam) were checked and gaits were observed both from front and back to look for toes outward, toes inward as well as limp or spastic gait.

Heights and masses were measured by reproducible anthropometrists to least counts of 0.1 cm (1998-2011, setsquares and wall-mounted engineering-tape); 0.01 cm (2012 onward, modified setsquares and wall-mounted engineering-tape) and 0.5 kg (1998-2011, bathroom scale); 0.01 kg (2012 onward, modified set-squares and improvised beam scale), 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 undress completely except short underpants. Everyone took off shoes and socks as well as accessories for measurements. A suitable clothing correction was taken off from 'gross mass' (mass obtained in indoor clothing) to compute 'net mass' (mass with no clothing on),  $\mu$ , for mother and father. Children were measured wearing only underwear, 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.

Undressing of children helped anthropometrists to ascertain standard posture during measurements, making sure that knees were not flexed and toes 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 and spinal deformities in the stripped children.

### *Growth-and-Obesity Roadmaps*

Data were processed using model developed by our group (Kamal *et al.*, 2015b), a generalization of earlier models (Kamal *et al.*, 2011; Kamal and Jamil, 2012). Following are the salient features:

- a) The model and the associated software took as input, parents' heights, child's gender, birth date, checkup date, height and mass to generate target height, height and mass percentiles, body-mass index (BMI), *estimated-adult BMI*, optimal mass, statuses expressing degrees of obesity/wasting and tallness/stunting as well as month-wise recommendations to manage height and mass (specific targets on given dates).
- b) BMI was calculated by dividing mass in kilograms with square of height in meters. Introduced by Adolphe Quetelet in 1832 (called 'Quetelet index' by contemporaries) and renamed body-mass index by Ancel Keys in 1972; merits, demerits and history of this index are given elsewhere (Kamal and Jamil, 2014).
- c) *Estimated-adult BMI* was computed by replacing estimated-adult values (computed at the age of 20 years) with the current values of mass corresponding to percentile of height. This gives snapshot of obesity status, when the child turns into an adult (Kamal and Jamil, 2012).

Table 1. Nutritional-status classification

<i>Classification</i>	<i>Description</i>	<i>STATUS<sub>±</sub>(h)</i>	<i>STATUS<sub>±</sub>(μ)</i>
Energy-Channelization I	Tallness + Wasting	Positive	Negative
Under-Nutrition	Stunting + Wasting	Negative	Negative
Energy-Channelization II	Stunting + Obesity	Negative	Positive
Over-Nutrition	Tallness + Obesity	Positive	Positive

- d) Optimal mass (for persons below or equal to the age of 30 years) was defined as the mass corresponding to percentile-of-height (Kamal *et al.*, 2011), which was considered as the reference mass to be achieved (of course, not using the current value but the value 6 month down the road). For persons above the age of 30 years, optimal mass was computed by multiplying square of height (in *m*) with reference BMI value, 24 kg/m<sup>2</sup>.
- e) Nutritional status was determined by examining signs of algebraic status (pertaining-to-height), *STATUS<sub>±</sub>(h)*, and algebraic status (pertaining-to-mass), *STATUS<sub>±</sub>(μ)*. Table 1 lists criteria for classification (Kamal *et al.*, 2015b).
- f) Build of child (given consideration in forming sport teams) was obtained by summing percentiles of height, *P(h)*, and mass, *P(μ)*, a value of *P(h) + P(μ)* less than 50 represents ‘small’ build (brain functions dominate body functions — generally good at intellectual work as well as planning and development tasks), whereas a value of *P(h) + P(μ)* equal to or more than 50 but less than 150 indicates ‘medium’ build (brain and body functions are equally dominating — could be trained to do intellectual work or tasks involving strength and speed). Finally, a value of *P(h) + P(μ)* above 150 suggests ‘big’ build (body functions dominate brain functions — suitable for tasks involving strength and speed). Details are given elsewhere (Kamal and Khan, 2015).
- g) The percentile-of-reference height, *P<sub>ref</sub>*, used to generate month-wise recommendations to gain height and put on/shed off mass (weight), was chosen as maximum of 3 percentiles — *P(h)*, percentile-of-height; *P<sub>MP</sub>*, percentile-of-mid-parental height; *P<sub>AC</sub>*, percentile-of-army-cutoff height (Kamal *et al.*, 2015b). Mathematically,  $P_{ref} = \max(P(h), P_{AC}, P_{MP})$ .
- h) The above percentiles corresponded to estimated-adult, target (adult-mid-parental) and army-cutoff heights, respectively (Table 2).
- i) For a girl, target height was evaluated by subtracting 6.5 cm from average heights (in cm) of father and mother and army-cutoff height (for induction into the Armed Forces of Pakistan) is fixed at 5 ft 2 in (157.48 cm), corresponding to 19<sup>th</sup> (19.36 to be exact) percentile.
- j) Month-wise recommendations were prepared to pick up height (in both centimeters and inches) and gain/lose mass (in kilograms), corresponding to weight (in pounds and ounces).
- k) In a separate table, recommendations to achieve certain values of height and mass (weight), were listed for a given date (the date in the month of most-rent checkup) of each month (for 6 months following month of checkup).
- l) Guidelines made available for lifestyle adjustment, diet and exercise plans to achieve the above quantitative objectives.

### **Growth-and-Obesity Roadmap of a Marginally Obese Girl**

Z. H. Z., female, was enrolled in our growth-and-obesity monitoring program through the NGDS Pilot Project after ‘The Informed Consent Form’ ([http://www.ngds-ku.org/ngds\\_folder/Protocols/NGDS\\_form.pdf](http://www.ngds-ku.org/ngds_folder/Protocols/NGDS_form.pdf)) was received duly signed by both parents, allowing measurements to be performed on the school premises. For checkups in SF-

Table 2. Heights important for a child’s growth and professional career

<i>Nomenclature</i>	<i>Depends on Child’s Height</i>	<i>Depends on Parents’ Heights</i>	<i>Based on Country-Wide Standards</i>	<i>Corresponding Percentile</i>
Estimated-Adult Height	Yes	No	No	<i>P(h)</i>
Target (Adult-Mid-Parental) Height	No	Yes	No	<i>P<sub>MP</sub></i>
Army-Cutoff Height	No	No	Yes	<i>P<sub>AC</sub></i>

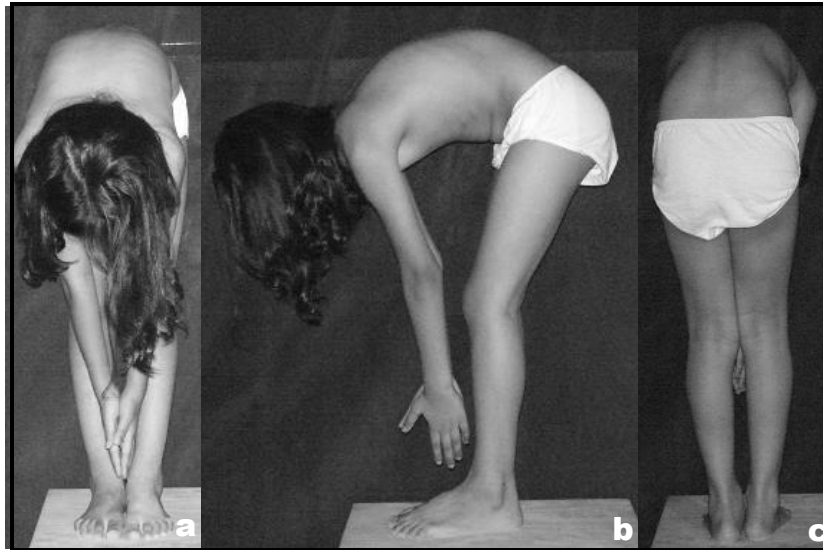


Fig. 1a-c. Forward-bending test of Z. H. Z. conducted on May 13, 2012. Left side elevated, when the child was facing the examiner — lumbar-region asymmetry (a) and right side elevated, when child's back was towards the examiner — thoracic-region asymmetry (c); raising strong suspicion of S curve

Growth-and-Imaging Laboratory, the parents filled out and put their signatures on 'The SGPP Participation Form' ([http://www.ngds-ku.org/SGPP/SGPP\\_form.pdf](http://www.ngds-ku.org/SGPP/SGPP_form.pdf)).

Z. H. Z. is an only child living with biological parents. After a normal pregnancy of 9 months, she was born on June 16, 2005 through cesarean section (birth weight 7 lb; blood group B+). When 9-month old, she had sore throat and measles. She suffered from jaundice at 6 years of age. Her daily routine consists of 3 meals and 1 snack, all relaxed, screen time 2-3 hours (mostly TV, rarely computer) and sound sleep of 8-9 hours. She is active in co-curricular activities and sports. At times, she becomes irritable during interaction with family. Overall, she is independent and bold. Her 1<sup>st</sup> checkup was conducted on May 4, 2011 (age 5 years 10 months 8 days) with regular follow-ups. Her 5<sup>th</sup> and the most-recent checkup took place on November 23, 2014 (age 9 years 5 months 7 days). All of her checkups were conducted with the child barefoot and completely undressed except panties. She was relaxed and cooperative during every checkup. Adam's forward bending test was positive in the last 4 checkups, (Figures 1a-c). However, moiré fringe topography (identifies at-risk cases of scoliosis) was negative. Figures 2a-f show posture and moiré photographs of Z. H. Z. Figures 1a-c first appeared in (Kamal *et al.*, 2015a) and Figure 2e in (Kamal and Jamil, 2014), both of them published in this journal.

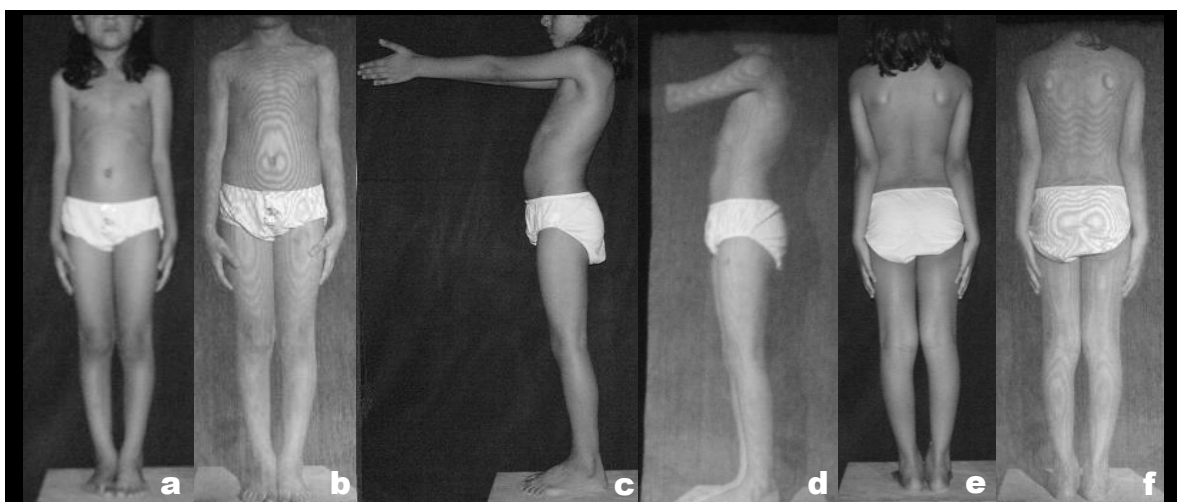


Fig. 2a-f. Posture and moiré photographs of Z. H. Z. taken on May 13, 2012. Drooping left shoulder is visible in posture (e) and moiré (f) photographs.

Table 3a. Adult-mid-parental (Target) and army-cutoff heights for Z. Family

Father's Height: † 178.20 cm • Mother's Height: † 170.78 cm

Adult-Mid-Parental (Target) and Army-Cutoff Heights	Boy †		Girl †	
	Target	Army-Cutoff	Target	Army-Cutoff
<b>Case Number</b>	<b>SGPP-KHI-20110412-01</b>			
Height (cm)	180.99	162.56	167.99	157.48
Height (ft-in)	5 ft 11.26 in	5 ft 4.00 in	5 ft 6.14 in	5 ft 2.00 in
Percentile	73.72	2.72	76.12	19.36

Growth-and-Obesity Roadmap shows that Z. H. Z. was wasted during her first 3 checkups, but became obese afterwards. However, she remained stunted (with respect to current-age-mid-parental height) throughout this period — her parents being tall (father 178.20 cm; mother 170.78 cm), the target (adult-mid-parental) height came out to be 167.99 cm (5 feet 6.14 inches) lying at 76<sup>th</sup> percentile (76.12 to be exact) according to Growth Charts and Tables published by our group (Kamal and Jamil, 2014), which are extensions of CDC (Centers for Disease Control and Prevention) Growth Charts and Tables.

Parents' obesity statuses were, also, determined, which showed that father was obese, whereas mother was wasted. Hence, Z. H. Z.'s marginal obesity trend during the last 2 checkups may have familial basis (Kamal *et al.*, 2011; Ajslev *et al.*, 2014).

Z. H.Z.'s heights and masses (weights) were monitored from the age of 5.88 years to 9.44 years. Her height climbed from 46<sup>th</sup> percentile (46.42 to be exact) at 1<sup>st</sup> checkup to 58<sup>th</sup> percentile (58.22 to be exact) at 5<sup>th</sup> checkup, with an anomaly at 4<sup>th</sup> checkup (the value of percentile 4.54 may be due to measurement or recording error).

Table 3a lists target and army-cutoff heights as well as corresponding percentiles. Table 3b gives Obesity Roadmaps of parents. These are different from Obesity Profiles given in (Kamal *et al.*, 2011), as the current computations include recommendations for month-wise mass management.

Since both parents are above the age of 30, their optimal masses were computed by considering 24 kg/m<sup>2</sup> as reference body-mass index (BMI). Optimal mass was evaluated by multiplying this value with square of height, expressed in meters. In fact, for persons older than 30 years, values of height and mass read from extended-gender-specific tables for the age of 20 years ([http://www.ngds-ku.org/Papers/J34/Additional\\_File\\_3.pdf](http://www.ngds-ku.org/Papers/J34/Additional_File_3.pdf)) may be misleading to compute percentiles. Actually, distribution of weight changes, significantly, as years are added up to an individual's age. Hence, it is not recommended to compute such percentiles, as they are not needed to generate Obesity Roadmaps.

Table 3b. Obesity Roadmaps of parents of Z. Family

Father's Date of Birth (year-month-date): † 1977-10-23 • Mother's Date of Birth (year-month-date): † 1980-06-10

	Father †	Mother †
<b>Case Number</b>	<b>SGPP-KHI-20110412-01</b>	
Date of Checkup (year-month-date)	2012-05-13	2012-05-13
Age (year-month-date)	34-06-20	31-11-03
Age (decimal years)	34.56	31.92
Dress Code <sup>a</sup>	1.5/2	2/2
Height, <i>h</i> (cm)	178.20	170.78
Height (ft-in)	5 ft 10.16 in	5 ft 7.24 in
Gross Mass (kg)	92.80	61.63
Clothing Correction (kg)	0.30	0.30
Net Mass, $\mu$ (kg)	92.50	61.33
Net Weight (lb-oz)	203 lb 15.40 oz	135 lb 3.72 oz
BMI: Body-Mass Index (kg/m <sup>2</sup> )	29.13	21.03
Optimal Mass (kg)	76.21	70.00
$\Delta$ Mass-for-Height	+16.29	-8.67
Algebraic Status (pertaining-to-mass), $STATUS_{\pm}(\mu)$	+21.38%	-12.38%
<b>Qualitative Status (pertaining-to-mass)<sup>b</sup></b>	<b>3<sup>rd</sup>-Deg Obese</b>	<b>2<sup>nd</sup>-Deg Wasted</b>
6-Month-Mass Management (kg)	-10.00	+8.67
<b>Month-wise Mass Management (kg/month)</b>	<b>-1.67</b>	<b>+1.44</b>
Month-wise Weight Management (lb-oz/month)	-3 lb 10.80 oz	+3 lb 2.97 oz

Table 3c. Growth-and-Obesity Roadmap of Z. H. Z. (1<sup>st</sup> to 3<sup>rd</sup> checkups)Gender: Female † • Date of Birth (*year-month-date*): 2005-06-16 • School: Withheld • GR Number: Withheld



Checkup	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>
<b>Case Number</b>	<b>SGPP-KHI-20110412-01/01</b>		
Photograph <sup>c</sup>			
Scanned Signatures <sup>c</sup>	ZHZ	ZHZ	ZHZ
Class	KG	I	I
Date of Checkup ( <i>year-month-date</i> )	2011-05-04	2012-03-20	2012-05-13
Age ( <i>year-month-date</i> )	05-10-18	06-09-04	06-10-27
Age ( <i>decimal years</i> )	5.88	6.76	6.91
Dress Code <sup>a</sup>	0/0.5	0/0.5	0/0.5
Behavior Code <sup>d</sup>	0	0	0
Cumulative-Scoliosis-Risk Weightage <sup>e</sup>	0.50	1.00	6.50
Height, <i>h</i> (cm)	113.4	119.42	120.45
Height ( <i>ft-in</i> )	3 ft 8.65 in	3 ft 11.02 in	3 ft 11.42 in
Percentile-of-Height, <i>P</i> ( <i>h</i> )	46.42	46.65	47.02
Estimated-Adult Height (cm)	162.71	162.75	162.82
Estimated-Adult Height ( <i>ft-in</i> )	5 ft 4.06 in	5 ft 4.08 in	5 ft 4.10 in
CA-MP (Current-Age-Mid-Parental) Height (cm)	117.64	123.90	124.92
Δ Height w. r. t. CA-MP Height (cm)	-4.24	-4.48	-4.47
Algebraic Status (pertaining-to-height), <i>STATUS</i> <sub>±</sub> ( <i>h</i> )	-3.60%	-3.61%	-3.58%
<b>Qualitative Status (pertaining-to-height)<sup>f</sup></b>	<b>1<sup>st</sup>-Deg Stunted</b>	<b>1<sup>st</sup>-Deg Stunted</b>	<b>1<sup>st</sup>-Deg Stunted</b>
CA-AC (Current-Age-Army-Cutoff) Height (cm)	109.45	115.19	116.12
Δ Height w. r. t. CA-AC Height (cm)	+3.95	+4.23	+4.33
Reference Height (cm)	117.64	123.90	124.92
Percentile-of-Reference-Height	76.12	76.12	76.12
Age of Prediction, <i>A+</i> ( <i>years</i> )	6.39	7.26	7.41
Reference Height at <i>A+</i> (cm)	121.28	127.28	128.24
6-Month-Height Management (cm)	+7.88	+7.86	+7.79
<b>Month-wise Height Management (cm/month)</b>	<b>+1.31</b>	<b>+1.31</b>	<b>+1.30</b>
Month-wise Height Management ( <i>in/month</i> )	+0.52	+0.52	+0.51
Gross Mass (kg)	18.3	20.14	20.74
Clothing Correction (kg)	0	0	0
Net Mass, $\mu$ (kg)	18.3	20.14	20.74
Net Weight ( <i>lb-oz</i> )	40 lb 5.62 oz	44 lb 6.54 oz	45 lb 11.71 oz
Percentile-for-Net-Mass <i>P</i> ( $\mu$ )	26.81	26.09	29.25
Estimated-Adult Mass (kg)	52.89	52.73	53.45
Estimated-Adult Weight ( <i>lb-oz</i> )	116 lb 10.08 oz	116 lb 4.26 oz	117 lb 13.89 oz
<i>BMI</i> : Body-Mass Index ( $\text{kg}/\text{m}^2$ )	14.23	14.12	14.30
Estimated-Adult <i>BMI</i> ( $\text{kg}/\text{m}^2$ )	19.98	19.91	20.16
Optimal Mass (kg)	19.70	21.86	22.26
Δ Mass-for-Height (kg)	-1.40	-1.72	-1.52
Algebraic Status (pertaining-to-mass), <i>STATUS</i> <sub>±</sub> ( $\mu$ )	-7.12%	-7.86%	-6.85%
<b>Qualitative Status (pertaining-to-mass)<sup>b</sup></b>	<b>1<sup>st</sup>-Deg Wasted</b>	<b>1<sup>st</sup>-Deg Wasted</b>	<b>1<sup>st</sup>-Deg Wasted</b>
Optimal Mass for Reference Height at <i>A+</i> (kg)	23.88	26.68	27.18
6-Month-Mass Management (kg)	+5.58	+6.54	+6.44
<b>Month-wise Mass Management (kg/month)</b>	<b>+0.93</b>	<b>+1.09</b>	<b>+1.07</b>
Month-wise Weight Management ( <i>lb-oz/month</i> )	+2 lb 0.81 oz	+2 lb 6.46 oz	+2 lb 5.87 oz
Nutritional Status	Under-Nutrition	Under-Nutrition	Under-Nutrition
Build	Medium	Medium	Medium

Table 3c lists Growth-and-Obesity Roadmap of Z. H. Z. for the first 3 checkups, a child of medium build, who showed signs of under-nutrition (coexistence of stunting and wasting). Mass percentile dropped from 1<sup>st</sup> to 2<sup>nd</sup> check-

Table 3d. Growth-and-Obesity Roadmap of Z. H. Z. (4<sup>th</sup> and 5<sup>th</sup> checkups)Gender: Female † • Date of Birth (*year-month-date*): 2005-06-16 • School: Withheld • GR Number: Withheld

Checkup	4 <sup>th</sup>	5 <sup>th</sup>
<b>Case Number</b>	<b>SGPP-KHI-20110412-01/01</b>	
Photograph <sup>c</sup>		
Scanned Signatures <sup>c</sup>	ZHZ	ZHZ
Class	II	IV
Date of Checkup ( <i>year-month-date</i> )	2013-06-02	2014-11-23
Age ( <i>year-month-day</i> )	07-11-16	09-05-07
Age ( <i>decimal years</i> )	7.96	9.44
Dress Code <sup>a</sup>	0/0.5	0/0.5
Behavior Code <sup>d</sup>	0	0
Cumulative-Scoliosis-Risk Weightage <sup>e</sup>	5.75	11.50
Height, <i>h</i> (cm)	117.84	136.56
Height ( <i>ft-in</i> )	3 ft 10.39 in	4 ft 5.76 in
Percentile-of-Height, <i>P</i> ( <i>h</i> )	4.54	58.22
Estimated-Adult Height (cm)	152.30	164.77
Estimated-Adult Height ( <i>ft-in</i> )	4 ft 11.96 in	5 ft 4.87 in
CA-MP (Current-Age-Mid-Parental) Height (cm)	131.65	139.81
$\Delta$ Height <i>w. r. t.</i> CA-MP Height (cm)	-13.81	-3.25
Algebraic Status (pertaining-to-height), $STATUS_{\pm}(h)$	-10.49%	-2.32%
<b>Qualitative Status (pertaining-to-height)<sup>f</sup></b>	<b>2<sup>nd</sup>-Deg Stunted</b>	<b>1<sup>st</sup>-Deg Stunted</b>
CA-AC (Current-Age-Army-Cutoff) Height (cm)	122.27	129.44
$\Delta$ Height <i>w. r. t.</i> CA-AC Height (cm)	-4.43	+7.12
Reference Height (cm)	131.65	139.81
Percentile-of-Reference-Height	76.12	76.12
Age of Prediction, <i>A+</i> (years)	8.46	9.93
Reference Height at <i>A+</i> (cm)	134.54	142.52
6-Month-Height Management (cm)	+16.70	+5.96
<b>Month-wise Height Management (cm/month)</b>	<b>+2.78</b>	<b>+0.99</b>
Month-wise Height Management ( <i>in/month</i> )	+1.10	+0.39
Gross Mass (kg)	25.12	33.06
Clothing Correction (kg)	0	0
Net Mass, $\mu$ (kg)	25.12	33.06
Net Weight ( <i>lb-oz</i> )	55 lb 6.23 oz	72 lb 14.36 oz
Percentile-of-Net-Mass <i>P</i> ( $\mu$ )	46.25	63.50
Estimated-Adult Mass (kg)	57.36	62.34
Estimated-Adult Weight ( <i>lb-oz</i> )	126 lb 7.56 oz	137 lb 7.37 oz
<b>BMI</b> : Body-Mass Index ( $kg/m^2$ )	18.09	17.73
<i>Estimated-Adult BMI</i> ( $kg/m^2$ )	24.73	22.96
Optimal Mass (kg)	19.85	32.12
$\Delta$ Mass-for-Height (kg)	+5.27	+0.94
Algebraic Status (pertaining-to-mass), $STATUS_{\pm}(\mu)$	+26.54%	+2.94%
<b>Qualitative Status (pertaining-to-mass)<sup>b</sup></b>	<b>3<sup>rd</sup>-Deg Obese</b>	<b>1<sup>st</sup>-Deg Obese</b>
Optimal Mass for Reference Height at <i>A+</i> (kg)	31.16	37.94
6-Month-Mass Management (kg)	+6.04	+4.88
<b>Month-wise Mass Management (kg/month)</b>	<b>+1.01</b>	<b>+0.81</b>
Month-wise Weight Management ( <i>lb-oz/month</i> )	+2 lb 3.52 oz	+1 lb 12.67 oz
Nutritional Status	Energy-Channelization II	Energy-Channelization II
Build	Medium	Medium

up, indicating pseudo gain (Kamal *et al.*, 2014). Table 3d gives Growth-and-Obesity Roadmap of Z. H. Z. for the last 2 checkups, her build remained medium, but nutritional status shifted to energy-channelization II (coexistence of

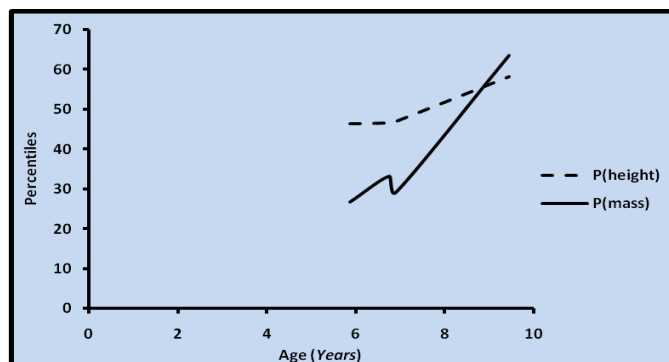


Fig. 3. Height and mass percentiles of Z. H. Z. in the age range 5.88-9.44 years. Height percentile 4.54 (4<sup>th</sup> checkup) is considered as outlier and not included in drawing graph.

stunting and obesity). Figure 3, graphically, depicts percentile trajectories of height and mass for her 5 checkups. It could be noted that mass-percentile trajectory crossed height-percentile trajectory when Z. H. Z.'s age was 8.91 years. Hence, she momentarily achieved optimal mass, but did not maintain the same.

Table 4. Month-wise height and mass (weight) management for Z. H. Z. based on her most-recent checkup

Targets (on specific dates of each month)	Height Management		Mass (Weight) Management	
	cm	ft-in	kg	lb-oz
December 23, 2014	137.55	4 ft 6.15 in	33.87	74 lb 11.03 oz
January 23, 2015	138.55	4 ft 6.55 in	34.69	76 lb 7.70 oz
February 23, 2015	139.54	4 ft 6.94 in	35.50	78 lb 4.38 oz
March 23, 2015	140.53	4 ft 7.33 in	36.31	80 lb 1.05 oz
April 23, 2015	141.53	4 ft 7.72 in	37.12	81 lb 13.73 oz
May 23, 2015	142.52	4 ft 8.11 in	37.94	83 lb 10.40 oz

Although, Z. H. Z. was tall by community standards, she was advised to gain height as well as mass based on percentile of mid-parental height. Her mass climbed from 27<sup>th</sup> percentile (26.81 to be exact) at 1<sup>st</sup> checkup to 64<sup>th</sup> percentile (63.50 to be exact) at 5<sup>th</sup> checkup. She was 7.12% (1<sup>st</sup>-degree) wasted and 3.60% (1<sup>st</sup>-degree) stunted at her first checkup. However, at her most-recent (5<sup>th</sup>) checkup, she was 2.94% (1<sup>st</sup>-degree) obese as well as 2.32% (1<sup>st</sup>-degree) stunted. Mother seemed to be concerned about her obesity. She was given specific targets to achieve particular values of height and mass on given dates, so that she attains and maintain optimal mass-for-recommended height (6 month down the road), which in her case is the height corresponding to mid-parental height on May 23, 2015 (Table 4). In order to achieve these targets, she was provided guidelines, which included changes in lifestyle as well as appropriate diet and exercise plans (Table 5).

Table 5. Lifestyle adjustment, diet and exercise plans for Z. H. Z. to achieve month-wise targets

	Height Management	Mass (Weight) Management
<b>Lifestyle Adjustment</b>	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; 8-hour night-time sound sleep	
<b>Diet Plans</b>	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
<b>Exercise Plans</b>	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



## DISCUSSION AND CONCLUSION

This paper highlighted the issue of obesity among children. Discretion is advised, when suggesting children to reduce mass (weight), as an overemphasis on body image may bring about tendencies of anorexia nervosa or, worse still, bulimia nervosa. Certainly, cases exist, in which an excessively obese child is advised to shed off mass (Kamal *et al.*, 2015c). However, in most of the other cases, a better strategy is to manage height according to mass, so that the child, not only, possesses optimal mass for a short span of time, but also, maintains the same throughout life. Actually, maintenance of optimal mass is possible when values as well as slopes match for percentile curves of height and mass (dynamical-system approach). Such a concept has, already, been applied by the author in the context of a control law for satellite-launch vehicles — matching of positions and velocities (Kamal and Mirza, 2006). In fact, optimal-mass management is an optimal solution (Kamal *et al.*, 2013; 2014) of diet, exercise and lifestyle adjustment (optimization approach).

The obesity epidemic progressed at a rapid pace not only in the Western world but also as a pandemic in other parts of the globe with the exception of those areas, which have food shortages as well as famines (Sørensen, 2009). Han *et al.* (2010) are of the opinion that there is a need of reassessment of intake of calories and recommendation of physical activities so that there is an improved quantification at a population level because of sedentary lifestyles of youngsters these days. Sørensen (2014) mentions that the biggest challenge in learning about obesity development is uniting the evidence about the apparent multitude of determinants.

A humble attempt has been made by our group to generate month-wise recommendations to gain height and pick up or shed off mass (weight) through Growth-and-Obesity Roadmaps (Kamal *et al.*, 2015c) as well as suggest diet and exercise plans to achieve these objectives (Kamal and Khan, 2014). Our group recommended national-level programs for height and mass monitoring of 3- to 10-year-old boys and girls (Kamal *et al.*, 2004), which could be linked to each other through telemedicine technologies (Kamal *et al.*, 2002), combined with a comprehensive approach to manage pediatric obesity (Miller and Silverstein, 2007).

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## ENDNOTES

<sup>a</sup>Dress Code is explained in (Kamal, 2006; Kamal *et al.*, 2002). Father's dress code 1.5/2 means barefoot, T-shirt and trousers, mother's dress code 2/2 means barefoot, 'shalwar' (trousers) and 'kameez' (shirt) without scarf. Z. H. Z.'s dress code 0/0.5 means barefoot, panties only, stripped-to-waist

<sup>b</sup>Qualitative status (pertaining-to-mass) is assigned from sign and value of algebraic status (pertaining-to-mass),  $STATUS_{\pm}(\mu)$ , negative sign means wasting and positive sign obesity, 1% deviation (on either side) is considered normal, (1-10)% is considered first degree, (10-20)% second degree, (20-30)% third degree and more than 30% fourth degree (Kamal *et al.*, 2015b).

<sup>c</sup>Photographs and scanned signatures on the day, check up was conducted. In order to protect the privacy of Z. Family, the photographs, inserted in Z. H. Z.'s Growth-and-Obesity Roadmap, do not show the actual child, although they are from the set of patients, who reported to SF-Growth-and-Imaging Laboratory for checkups. Further, family label and child's initials (Z. H. Z.) do not correspond to first letters in actual names (as per confidentiality standards established by our group). Same is true about the case number appearing in this document. Instead of scanned signatures, initials are printed, again, to safeguard privacy. Photographs of children shown for 1<sup>st</sup> and 5<sup>th</sup> checkups first appeared in (Kamal *et al.*, 2011) and those for 2<sup>nd</sup> to 4<sup>th</sup> checkups in (Kamal *et al.*, 2015b), both papers published in this journal.

<sup>d</sup>Behavior code is explained in (Kamal, 2006; Kamal *et al.*, 2002). A behavior code 0 means child was relaxed and coöperative.

<sup>e</sup>Cumulative-Scoliosis-Risk Weightage (CSRW) is described in (Kamal *et al.*, 2015a).

<sup>f</sup>Qualitative status (pertaining-to-height) is assigned from sign and value of algebraic status (pertaining-to-height),  $STATUS_{\pm}(h)$ , negative sign means stunting and positive sign tallness, 1% deviation (on either side) is considered normal, (1-10)% is considered first degree, (10-20)% second degree, (20-30)% third degree and more than 30% fourth degree (Kamal *et al.*, 2015b).

## REFERENCES

- Ajslev, T. A., L. Ångquist, K. Silventoinen, J. L. Baker and T. I. A. Sørensen (2014). Trends in parent-child correlations of childhood body mass index during the development of the obesity epidemic. *PLoS One*, 9 (10): 1-8
- Baker, J. L., L. W. Olsen and T. I. A. Sørensen (2007). Childhood body-mass index and risk of coronary heart disease in adulthood. *New England Journal of Medicine*, 357 (23): 2329-2337
- Bibbins-Domingo, K., P. Coxson, M. J. Pletcher, J. Lightwood and L. Goldman (2007). Adolescent overweight and future coronary heart disease. *New England Journal of Medicine*, 357 (23): 2371-2379
- Black, R. E., C. G. Victora, S. P. Walker, *et al.*: the Maternal and Child Nutrition Study Group (2013). Maternal and child under-nutrition and overweight in low-income and middle-income countries. *The Lancet*, 382: 427-451
- Han, J. C., D. A. Lawlor and S. Y. S. Kimm (2010). Childhood obesity. *Lancet*, 375: 1737-1748
- Kamal, S. A. (2006, May 23). *Manual for Obtaining Anthropometric Measurements*. University of Karachi, Karachi, Pakistan, full text: [http://www.ngds-ku.org/ngds\\_folder/M02.pdf](http://www.ngds-ku.org/ngds_folder/M02.pdf)
- Kamal, S. A. and A. Mirza (2006). The multi-stage-Q system and the inverse-Q system for possible application in satellite-launch vehicle. *Proceedings of the Fourth International Bhurban Conference on Applied Sciences and Technologies, June 13-18, 2005 (IBCAST 2005)*, edited by S. I. Hussain, A. Munir, J. Kayani, R. Samar and M. A. Khan, National Center for Physics, Islamabad, Pakistan, pp. 27-33, full text: <http://www.ngds-ku.org/Papers/C66.pdf>
- Kamal, S. A., M. Sarwar and U. A. Razzaq (2015a). Effective decision making for presence of scoliosis. *International Journal of Biology and Biotechnology*, 12 (2): 317-328, full text: <http://www.ngds-ku.org/Papers/J36.pdf>
- Kamal, S. A., N. Jamil and S. A. Khan (2011). Growth-and-Obesity Profiles of children of Karachi using box-interpolation method. *International Journal of Biology and Biotechnology*, 8 (1): 87-96, full text: <http://www.ngds-ku.org/Papers/J29.pdf>
- Kamal, S. A., S. A. Ansari and S. S. Jamil (2015b). Generating and validating Growth-and-Obesity Roadmaps for the Pakistani children. *International Journal of Biology and Biotechnology*, 12 (1): 47-61, full text: <http://www.ngds-ku.org/Papers/J35.pdf>
- Kamal, S. A. and S. A. Khan (2014). Primary-physical-education practices in Pakistan and England: Health and safety perspectives. *International Journal of Biology and Biotechnology*, 11 (2&3): 401-419, full text: <http://www.ngds-ku.org/Papers/J33.pdf>
- Kamal, S. A. and S. A. Khan (2015). Hairstyle, footwear and clothing for gymnastic activities in the primary-school setting. *Pumukkale Journal of Sport Sciences*, 6 (3): 29-45, full text: <http://www.ngds-ku.org/Papers/J37.pdf>
- Kamal S. A., S. Burki and S. S. Jamil (2013, September 4, 5). Optimal-weight management through diet, exercise and lifestyle adjustment. *The First Conference on Anthromathematics in the Memory of (Late) Syed Firdous (ANTHRO-MATHEMATICS 2013)*, Department of Mathematics, University of Karachi, Karachi, Pakistan and Government College, Hyderabad, Pakistan, p. 9, abstract#Anthro13-03: [http://www.ngds-ku.org/Presentations/Optimal\\_Weight.pdf](http://www.ngds-ku.org/Presentations/Optimal_Weight.pdf)
- Kamal, S. A., S. Firdous and S. J. Alam (2004). An Investigation of growth profiles of the Pakistani children. *International Journal of Biology and Biotechnology*, 1 (4): 707-717, full text: <http://www.ngds-ku.org/Papers/J26.pdf>
- Kamal, S. A., S. J. Alam and S. Firdous (2002, June 22). The NGDS Pilot Project: Software to analyze growth of a child (a telemedicine perspective). *National Telemedicine Conference Pakistan 2002*, Technology Resource Mobilization Unit (TreMU), Ministry of Science and Technology, Government of Pakistan, Islamabad, Pakistan, p. 2, full text: <http://www.ngds-ku.org/Papers/C52.pdf>
- Kamal, S. A. and S. S. Jamil (2012). A method to generate Growth-and-Obesity Profiles of children of still-growing parents. *International Journal of Biology and Biotechnology*, 9 (3): 233-255, full text: <http://www.ngds-ku.org/Papers/J30.pdf>
- Kamal, S. A. and S. S. Jamil (2014). KJ-regression model to evaluate optimal masses of extreme cases. *International Journal of Biology and Biotechnology*, 11 (4): 623-648, full text: <http://www.ngds-ku.org/Papers/J34.pdf>
- Kamal, S. A., S. S. Jamil and U. A. Razzaq (2014). Stunting induced by wasting — Wasting induced by stunting: A case study. *International Journal of Biology and Biotechnology*, 11 (1): 147-153, full text: <http://www.ngds-ku.org/Papers/J32.pdf>
- Lloyd, L. J., S. C. Langley-Evans and S. McMullen (2010). Childhood obesity and adult cardiovascular disease risk: A systematic review. *International Journal of Obesity*, 34 (1): 18-28
- Ludwig, D. S. (2007). Childhood obesity — the shape of things to come. *New England Journal of Medicine*, 357 (23): 2325-2327
- Miller, J. L. and J. H. Silverstein (2007). Management approaches for pediatric obesity. *Nature Clinical Practice in Endocrinology and Metabolism*, 3 (12): 810-818

- Ng M., T. Fleming, M. Robinson, *et al.* (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, 384 (9945): 766-781
- Ogden, C. L., M. D. Carroll, B. K. Kit and K. M. Flegal (2014). Prevalence of childhood and adult obesity in the United States, 2010-2012. *Journal of the American Medical Association*, 311 (8): 806-814
- Olds, T. S., G. R. Tomkinson, K. E. Ferrar and G. A. Maher (2010). Trends in prevalence of childhood overweight and obesity in Australia between 1985 and 2008. *International Journal of Obesity*, 34 (1): 57-66
- Silventoinen, K., B. Rockholm, J. Kaprio and T. I. A. Sørensen (2010). The genetic and environmental influences on childhood obesity: a systematic review of twin and adoption studies. *International Journal of Obesity*, 34 (1): 29-40
- Sørensen, T. I. A. (2009). Challenges in the study of causation of obesity. *Proceedings of the Nutrition Society*, 68 (1): 43-54
- Sørensen, T. I. A. (2014). Challenges in understanding development of obesity. *Molecular Mechanisms Underpinning the Development of Obesity*, edited by C. Nóbrega and R. Rodriguez-López, Springer International, Switzerland, pp. 1-7, DOI: 10.1007/978-3-319-12766-8
- Stamatikis, E., J. Wardle and T. J. Cole (2010). Childhood obesity and overweight prevalence trends in England: evidence for growing socioeconomic disparities. *International Journal of Obesity*, 34 (1): 41-47
- Tathiah, N., I. Moodley, V. Mubaiwa, L. Denny and M. Taylor (2013). South Africa's nutritional transition: overweight, obesity, underweight and stunting in female primary school learners in rural KwaZulu-Natal, South Africa. *South African Medical Journal*, 103 (10): 718-723

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