

## CUT-OFF HEIGHTS FOR INDUCTION INTO THE ARMED FORCES OF PAKISTAN: FAIRER CRITERIA FOR STILL-GROWING FEMALES AND MALES<sup>¶</sup>

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### ABSTRACT

This paper proposes fairer induction criteria of cut-off heights for still-growing youth (under-19 females; under-21 males) in the Armed Forces of Pakistan, so that females and males have the same chances of being selected based on their standing heights (statures). These criteria are derived from the measured heights of 1666 students (1163 females; 503 males) enrolled in the Pakistani institutions (Armed Forces and civilian). Their heights were obtained through convenience sampling. CDC percentiles-of-height were computed using box interpolation, separately for females and males, and arranged in the ascending order. Cut-off heights for induction into the Armed Forces of Pakistan are recommended corresponding to the first quartile of each sorted list (separate for females and males) of percentiles. This should provide 75% of the Pakistani females and 75% of the Pakistani males, opportunities to serve in the military and the paramilitary occupations of their country. The existing cut-off heights are 157.48 cm (5 ft 2.00 in) for females and 162.56 cm (5 ft 4.00 in) for males (CDC percentiles 19.35609323536863<sup>P</sup> and 2.718014592103645<sup>P</sup>, respectively), which make 68.44% females and 94.43% males of the selected sample qualify for induction into the Armed Forces of Pakistan. These results are based on an analysis published earlier. The proposed cut-off heights are 156.17 cm (5 ft 1.48 in) for females and 169.51 cm (5 ft 6.74 in) for males (CDC percentiles 14.361756199<sup>P</sup> and 16.7143217848<sup>P</sup>, respectively). The author recommends biannual measuring of standing height and weight, as per internationally-accepted protocols (students stripped to briefs/panties, unclothed from the waist up), of all school-going youngsters aspiring for careers in the Armed Forces of Pakistan (starting from their school entry), to generate their Growth-and-Obesity Roadmaps 4.5 combined with providing 6 month-wise targets for height gain and mass management as well as guidelines for lifestyle adjustment, diet and exercise plans.

**Keywords:** Diet and exercise plans • estimated-adult height • height gain • lifestyle adjustment • mass management

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### LIST OF ABBREVIATIONS

**BMI:** Body-Mass Index (obtained by dividing mass in *kg* by square of height in *m*) • **CDC:** Centers for Disease Control and Prevention • **NGDS:** The National Growth and Developmental Standards for the Pakistani Children • **<sup>P</sup>:** Percentile • **PMI:** Points of Maximum Intensity • **R&D:** Research & Development • **SGPP:** Sibling Growth Pilot Project • **SSG:** Special Services Group (of the Armed Forces of Pakistan)

**Units:** *cm* — centimeter(s) • *ft* — foot (feet) • *in* — inch(es) • *kg* — kilogram(s) • *m* — meter(s)

**Conversion Factors:** 1 *ft* = 12 *in* • 1 *in* = 2.54 *cm*

### INTRODUCTION

Standing height (stature) is one of the most important measurements during childhood and adolescence, provided these are obtained by trained and reproducible anthropometrists, following internationally-accepted protocols, the youngster undressed to short underpants, no clothing worn above the waist. Height gain is a consequence of tissue synthesis. Failure to gain height in childhood is the first indicator that body systems are not working properly or some sort of emotional problems are present, which may include depression, physical, verbal or sexual abuse. These issues need to be identified and addressed as early as possible. In case, one of the youngsters is stunted (short-for-age) and the other has a normal height, there may be a hormonal deficiency present or spinal

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<sup>¶</sup>The superscripts <sup>1, 2, 3,...</sup>, appearing in the text, refer to endnotes given before references. Keywords, list of abbreviations, units and conversion factors are arranged alphabetically.

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deformity (scoliosis, kyphosis, lordosis) may be suspected. Excessively-tall children are at a higher risk to develop scoliosis.

## ANTHROPOMETRY OF THE ARMED-FORCES AND THE CIVILIAN POPULATION

In this section anthropometric studies of personnel of the Armed Forces of various countries as well as the civilian population are described.

### *Population of the Armed Forces*

It is difficult to find many anthropometric surveys of young persons of military age. Karpinos reported findings on data of heights and weights, which were extracted from reports of medical examinations of persons hailing from the United States. These aspirants were examined for service in the United States Armed Forces during the period, January 1943 to January 1944 (Karpinos, 1958) and January 1957 to September 1958 (Karpinos, 1961). Out of all young men reporting for induction, those selected were taller and heavier. Papadimitriou *et al.* (2008) obtained heights and weights of 3982 enlistees, 18-26-year old, during 2006 and 2007 from pre-selected army camps throughout Greece. Dăbolița *et al.* (2017) collected anthropometric data of 150 men from the Armed Forces of Latvia employing non-contact anthropometric methods (3D-anthropometric scanner). Bailey *et al.* (2016) reported health status as well as statures of enlisted males belonging to England and Wales (for serving in Army during World War I), born in the decade following 1890. Banjevic (2020) studied the functional and the morphological characteristics of the Army inductees as well as professional servicemen of the Armed Forces of Montenegro. Willams *et al.* (1959) conducted a nutrition survey of the personnel of the Armed Forces of Korea during June and July 1956. They found that, in general, the nutritional status of servicemen was better as compared to that in 1953. Valaoras (1970) studied stature of Army conscripts in Greece as well as conducted their biometric studies. Steegman, Jr. (1985) studied 18<sup>th</sup> century British infantry regiment and found that male growth stops at the age of 21 years. Among the factors influencing stature are environmental cold, migration, occupation as well as urban or rural residence. Maldonado and Calero (2017) described anthropometric and body-composition profiles through overweight indicators on 153 male applicants to Escuela de Formación de Soldados del Ejército (the Army Soldiers Training School), Ecuador (age range 19-24 years).

### *The Civilian Population*

Bozooli *et al.* (2009) constructed a model of selection and short-for-age height, in which they demonstrated that burden of under-nutrition and disease during earlier years of life, not only, accounts for mortality in childhood, but also, has lasting risks for health of survivors, resulting in short stature, when they reach adulthood as well as diseases appearing during the old age. Proportional growth is much more important than simply gaining height. Baten and Blum (2012) conducted research on anthropometric welfare in 156 countries during the period 1810-1989 and published their findings as well as background evidence. Capocasa *et al.* (2019) described trends of height and weight for the inhabitants of island of Crete before and after its annexation by Greece. Raut and Tripathy (2020) studied how anthropometric measurements were related to fundamental skills. Iwamoto *et al.* (2021) obtained anthropometric measurements of college female long-distance runners belonging to Japan to learn about their metabolism and menstrual status. Kagawa (2021) looked into differences in the ability of 19 anthropometric parameters to screen for obesity in young Japanese females. Gibson and Ashwell (2020) surveyed 4112 British adults aged 18+ years in the context of waist-to-height ratio (WHtR) to assess the cardio-metabolic risk. The cut-off WHtR 0.5 in early screening means that the waist of a person should be less than half of stature to minimize such risks.

Some of the Pakistani studies on children's heights include work of Shafqat *et al.* (2013) that investigated how socio-demographic factors were linked to malnutrition in 0-5-year-old children as well as that of Haq *et al.* (2019), who looked at anthropometric characteristics and physical fitness of 8-10-year-old girls.

### *Army and Civilians*

Moradi (2009) applied a powerful measure of nutritional status (mean population height) on African Army recruits and civilians during 1880-1980, and gave an objective account of nutritional status in the colonial Kenya. Their findings indicate large regional inequalities, but only minor differences in the mean height of cohorts born two decades pre- and post-colonization. Secular improvements started two decades after the start of the twentieth century continuing after independence. Singh *et al.* (2016) analyzed data of 678 students (371 defense background; 307

civilian background), approximately 37% females, at one of the Armed Forces schools to assess and to compare the anthropometric status of children from the defense back-ground (Army/Navy/Air Force) with those having the civilian background. The author and his co-workers, also, reported builds of 1666 students from 3 institutions run by the Armed Forces of Pakistan, one each from the Pakistan Army, the Pakistan Navy and the Pakistan Air Force as well as a civilian school, builds determined from anthropometric data obtained during 1998-2016 (Kamal *et al.*, 2021c).

### ***Different Growth Standards and Quality Assessment***

Partap *et al.* (2017) investigated the prevalence of underweight, overweight, and obesity in the Malaysian child population in the context of 3 international references and gave their opinion that the reference choice to compute *BMI* may influence conclusions about the anthropometric status and the mal-nutrition prevalence in children. Golja and Pikel (2021) presented a database of anthropometric measurements. During 2012-2014, CDC Growth Charts and Tables were extended to include percentile range from 0.01<sup>P</sup> to 3<sup>P</sup> as well as 97<sup>P</sup> to 99.99<sup>P</sup> (Kamal and Jamil, 2014, Additional File 3). These were renamed as Extended Growth Charts and Tables. With these charts available, all extreme cases encountered to this date were handled. However, these charts were, still, not suitable to deal with anthropometric studies of the Pakistani children. An initial attempt in this direction was made by mapping CDC percentile (percentile-of-height and percentile-of-mass) 40<sup>P</sup> to scaled percentile 50<sup>P</sup> and fitting a parabolic curve to generate other percentiles (Kamal *et al.*, 2017a). The main drawback of this exercise was that the model did not use data from the Pakistani studies. 4-year later, data of 1666 students (1163 females; 503 males), hailing from all provinces and territories of Pakistan, were employed to generate 4 equations by mapping medians of CDC percentiles-of-height and percentiles-of-mass, separately for females and males, to 50<sup>P</sup> suitable to handle the Pakistani data (Kamal *et al.*, 2021a). These percentiles were named as the modified-scaled percentiles. A summary of different growth standards appears in Kamal (2022a). Perumal *et al.* (2020) investigated quality of collected anthropometric data in multi-survey studies of growth of youngsters.

### ***Standardization of Procedures***

Anthropometric data shall be of value only if obtained using laid-down procedures. The author has prepared a manual to assist anthropometrists in obtaining height and mass measurements according to inter-national standards (Kamal, 2016). In addition, step-by-step procedures are listed and explained with labeled photographs (Kamal *et al.*, 2021a, Additional File 1). Since the issue of cut-off height is the main theme of this paper, procedures of measurement of standing height (stature) are described here briefly (Figure 1):

With the least count of height measurement reduced ten times of the original (original measurement protocols employed using standard setsquares on engineering tape, mounted vertically on the wall, vertical alignment checked



Fig. 1a, b. Measurement of height of (a) a girl and (b) a boy; inset of (a): horizontal setsquare used to ascertain that the vertical setsquare is normal to plane of wall — this practice dropped after initial training, inset of (b): setsquare used to check alignment of feet with the marked line

through plumb line, generating results to least counts of 0.1 *cm* — 1998-2011) in 2012 (0.1 *cm* to 0.01 *cm*, engineering-tape measurement with the use of Vernier scale mounted on setsquares — 2012-2015) and twenty times in 2016 (0.1 *cm* to 0.005 *cm*, engineering-tape measurement with the use of enhanced-Vernier scale mounted on setsquares — 2016 to date), it is imperative that pupils completely undress (remove everything except short underpants; cap, chain, hair accessories, mask, if worn, leggings/socks/stockings, scarf, shoes, watch as well as ornaments) to make sure that they are maintaining proper posture (elbows and knees not flexed; child standing in attention position; heels not lifted; body aligned with wall-mounted engineering tape; toes placed symmetrically about the sagittal plane, which contains edge of the mounted engineering tape; weight equally exerted on both feet; top of head tangent to the Frankfurt plane) as well as ascertain complete inhalation during the process of measurement to obtain maximum chest expansion with abdomen in.

Vernier scale, which can measure heights to least counts of 0.01 *cm*, was made by pasting a strip on the edge of one of the setsquares so that 10 graduations on this strip (called the Vernier scale) coincided with 9 graduations on the wall-mounted engineering tape (referred to as the main scale) — the other setsquare used to make sure that the first setsquare was perpendicular to wall. Enhanced-Vernier scale, which can measure heights to least counts of 0.005 *cm*, was constructed by affixing strip on the setsquare edge so that 20 graduations on the Vernier scale have the same length as 19 graduations on the main scale. On a daily basis, the apparatus for measurement of height was calibrated using a standard 1-meter ruler before starting measurements of pupils, along with noting down of zero errors.

For obtaining stature (standing height), the stripped student was instructed to stand touching the mounted engineering tape. Vertical alignment of the tape was checked using plumb line at the time of mounting. Pupil was made to align hands with body, such that palms were touching thighs and heels were together. A pen or pencil was held at eye level to make sure that chin of the examinee was parallel to the floor (Kamal, 2016). Standing height should be obtained before 12 noon as the student is taller during the morning hours (Krogman, 1948).

#### **Criteria for Induction into the Armed Forces of Pakistan**

The adult-army-cut-off Heights for induction into the Armed Forces of Pakistan are set at 157.48 *cm* (5 *ft* 2.00 *in* — CDC percentile-of-height 19.35609323536863<sup>P</sup>) for females and 162.56 *cm* (5 *ft* 4.00 *in* — CDC percentile-of-height 2.718014592103645<sup>P</sup>) for males. Kamal *et al.* (2017b) proposed that these criteria should be modified for still-growing females, who have not reached their 19<sup>th</sup> birthday, and still-growing males, who have not reached their 21<sup>st</sup> birthday. For such aspirants, it was suggested that standing heights corresponding to the respective CDC percentiles-of-height at their current ages should be considered instead of the suggested cut-off heights for fully-grown individuals. For example, a 16-year-old girl having a height of 156.71 *cm* (5 *ft* 1.70 *in*) should be considered eligible as her height corresponds to CDC percentile-of-height 19.35609323536863<sup>P</sup>. Similarly, a 15-year-old boy having a height of 151.20 *cm* (4 *ft* 11.53 *in*) should be considered eligible as his height corresponds to CDC percentile-of-height 2.718014592103645<sup>P</sup>.

#### **Adequacy of Existing Criteria for Females and Males**

Von Hlatky and Imre-Millei (2022) conducted a gender-based analysis of recruitment and retention in the Canadian Army Reserve. The Canadian Armed Forces have experienced difficulty in maintaining the desired number of personnel. They are trying to reach the mark of 25.1% for females by 2026. Bergman and St J Miller

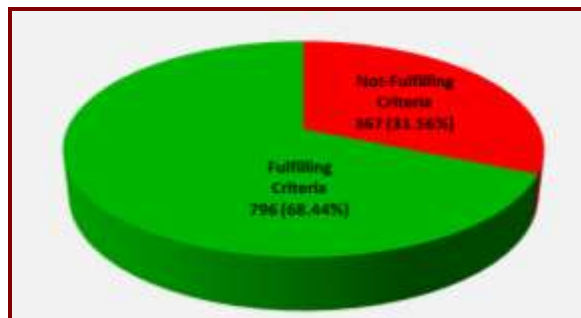


Fig. 2a. Percentage of females fulfilling the criteria of induction into the Armed Forces of Pakistan; the analysis is based on cut-off CDC percentile-of-height 19.35609323536863<sup>P</sup>

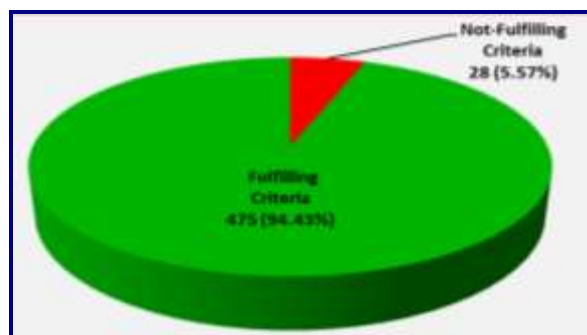


Fig. 2b. Percentage of males fulfilling the criteria of induction into the Armed Forces of Pakistan; the analysis is based on cut-off CDC percentile-of-height 2.718014592103645<sup>P</sup>

(2001) mentioned in their study that there was a higher rate of females, who were medically discharged from service in the British Army. This rate has been monotonically increasing since 1992 from around 0.3% per year to 3.5% per year in 1996. Recently, Kamal and Naz (2021) investigated adequacy of induction criteria in the Armed Forces of Pakistan. Although the cut-off CDC percentile-of-height for females is 7.121408873816131 times higher as compared to that for males, they are at a clear disadvantage, when it comes to the percentage qualifying for forces. Figures 2a-c illustrate results of this study. Note that pie charts are used instead of bar charts as pie charts are considered more appropriate to express percentages according to statisticians (original paper displayed bar charts, Kamal and Naz, 2021).

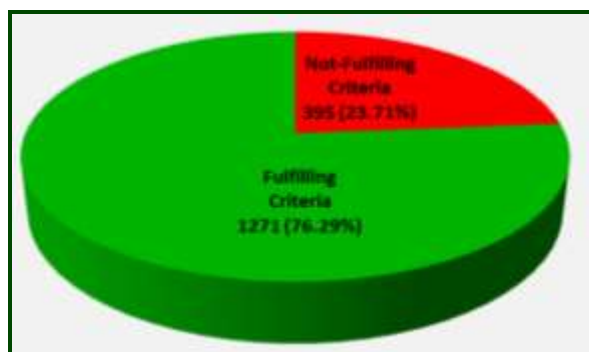


Fig. 2c. Combined data for a sample 1666 children

### Generating Fairer Criteria for Females and Males

There is a desire for gender equity in different professions as well as in the number of students in different programs. In the Faculty of Science of University of Karachi, there is a marked imbalance in the representation of males and females in both the undergraduate and the graduate programs. Females outnumber in almost all programs. However, such is not the case in the military and the paramilitary occupations. May be that is because of the nature of the job, but mainly the reason is inadequate criteria for induction, as described in the previous section. Fairer criteria are generated based on the strategy employed in Kamal *et al.* (2021a), where median of CDC percentiles was mapped to 50<sup>P</sup> of modified-scaled percentiles based on data of 1666 Pakistani youngsters to generate Growth Charts and Tables suitable for the Pakistani population. The same strategy is used in this paper to select CDC percentile-of-height corresponding to the first quartile for females and males. This way 75% of the females and 75% of the males should be afforded the opportunity to serve in the Armed Forces of Pakistan.

## STUDY PARAMETERS

### Subjects

This study, known as the NGDS Pilot Project, is based on statures (standing heights) of 1666 pupils. Four institutions participated in the study; three were administered by the Armed Forces of Pakistan (a representative institu-

Table 1. Descriptive statistics — qualitative and quantitative

<i>Data Collected during 1998-2016</i>	<i>Females †</i>	<i>Males †</i>
Total Number	1163	503
<b>Age</b>		
Mean ± Standard Deviation ( <i>years</i> )	8.51 ± 1.85	6.21 ± 1.70
Median ( <i>years</i> )	8.64	6.27
Mode ( <i>years</i> )	8.27	6.68
Range ( <i>years</i> )	5.01-14.63	3.20-12.07

tion, one each run by the Pakistan Army<sup>1</sup>, the Pakistan Navy<sup>2</sup> and the Pakistan Air Force<sup>3</sup>) and the fourth one is a civilian school<sup>4</sup> located a middle-class community as well as the students reporting to Growth Laboratory accompanied by the parents under the fold of SGPP (Sibling Growth Pilot Project). The students comprised of girls and boys hailing from all over Pakistan. Details of the study protocols are provided elsewhere (Kamal *et al.*, 2016a, Additional File 1). Table 1 shows descriptive statistics (qualitative and quantitative) of 1666 school-going students (1163 females; 503 males) included in the study.

### Methods and Procedures

Kamal *et al.* (2011) introduced a method to compute CDC percentiles-of-height (percentiles evaluated from CDC Growth Charts and Tables) of still-growing females and males using the mathematical-statistical technique of box interpolation. In order to compute CDC percentile-of-height corresponding to the first quartile for females as well as males, data, entered in excel sheet, are sorted according to ascending percentiles. It is to be noted that the number of females and the number of males, whose data are entered in the excel sheets, may be completely divisible by 4 (expressed as  $4N$ , where  $N$  is a non-zero, positive integer), or have remainder 1 upon division (expressed as  $4N + 1$ ), or remainder 2 (expressed as  $4N + 2$ ), or remainder 3 (expressed as  $4N + 3$ ). In the data presented in this paper, the number of females could be expressed as  $4N_F + 3 = 4(290) + 3 = 1163$  and number of males as  $4N_M + 3 = 4(125) + 3 = 503$ , where  $N_F$  and  $N_M$  are non-zero positive integers;  $N_F = 290$ ,  $N_M = 125$ . Computation of the first quartile for this case is explained in detail below.

If the data in the sorted set brings out a remainder 3, when divided by 4, the total number of data entries may be expressed as  $4N + 3$ . Draw three subsets from this sorted data-set. The first one has  $N$  entries starting from the lowest ( $1^{\text{st}}$ ) to the  $N^{\text{th}}$  entry in the actual data rows (note that in many excel sheets, the first entry represents headings of each column; hence actual data entries start from row labeled as  $2^{\text{nd}}$  — this should be accounted for, when counting the correct number of rows). The second subset has three entries, the  $(N + 1)^{\text{th}}$ , the  $(N + 2)^{\text{th}}$  and the  $(N + 3)^{\text{th}}$ , whereas the third subset has  $3N$  entries, from the  $(N + 4)^{\text{th}}$  to  $(4N + 3)^{\text{th}}$ . The first quartile lies at the  $(N + 2)^{\text{th}}$  entry. In the data presented here,  $292^{\text{th}}$  entry ( $N_F = 290$ ) in the actual data rows ( $14.361756199^{\text{P}}$ ) is the first quartile for females and  $127^{\text{th}}$  entry ( $N_M = 125$ ) in the actual data rows ( $16.7143217848^{\text{P}}$ ) for males, corresponding to  $156.16582344783$  cm ( $5$  ft  $1.48260765662606$  in) being the adult-army-cut-off height for females and  $169.508349066505$  cm ( $5$  ft  $6.73557049862417$  in) for males.

## RESULTS

Table 2 shows the results based on data of 1666 Pakistani youth, the adult-army-cut-off heights and the corres-

Table 2. Cut-off heights for the Pakistani youth, wishing to opt for the military and the paramilitary occupations

<i>The Adult-Army-Cut-off Heights and the Corresponding Percentiles</i>	<i>Females †</i>		<i>Males †</i>	
	<i>Current</i>	<i>Proposed</i>	<i>Current</i>	<i>Proposed</i>
Height ( <i>cm</i> )	157.48	156.17	162.56	169.51
Height ( <i>ft-in</i> )	5 ft 2.00 in	5 ft 1.48 in	5 ft 4.00 in	5 ft 6.74 in
CDC Percentile-of-Height <sup>§</sup>	19.36 <sup>P</sup>	14.36 <sup>P</sup>	2.72 <sup>P</sup>	16.71 <sup>P</sup>

<sup>§</sup>the values used in calculations are  $19.35609323536863^{\text{P}}$  (females: current),  $14.361756199^{\text{P}}$  (females: proposed),  $2.718014592103645^{\text{P}}$  (males: current) and  $16.7143217848^{\text{P}}$  (males: proposed); because of the shorter column width, the values entered in the table are rounded-off to 2 decimal places

ponding percentiles for the Pakistani females and males have been suggested, which are based on revised criteria, offering equal opportunities to both genders. One notes that the adult army-cut-off height for females is proposed to be decreased by 1.31 cm (0.52 in), corresponding to a decrease in the cut-off CDC percentile-of-height by 4.994337036<sup>P</sup>; for males the adult-army-cut-off height is proposed to be increased by 6.95 cm (2.74 in), corresponding to an increase in the cut-off CDC percentile-of-height by 13.996307193<sup>P</sup>.

## DISCUSSION AND RECOMMENDATIONS

This paper proposes fairer cut-off criteria, which should allow equal opportunities for females and males to be inducted in the Armed Forces of Pakistan. The analysis is based on anthropometric data collected indigenously of children hailing from all provinces and territories of the country. The basic premise is that 75% females and 75% males of Pakistan should be afforded opportunities to serve in the military and the paramilitary occupations. At present, the adult-army-cut-off height is not applicable for occupations in military intelligence, because the nature of that job requires an intense use of a person's brain, not strength of the body. It is suggested that the same relaxation should be given to personnel involved in R&D (Research and Development). It is, strongly, recommended to determine build of a child from the sum of modified-scaled percentiles of height and mass, in order to help the growing student choose a career path suitable according to the youngster's physique (Kamal *et al.*, 2021c). For a person with a small build (sum of modified-scaled percentiles less than 50), the brain dominates the body. Such persons seem to be more suitable for intellectual work as well as tasks involving planning and development. It would be of interest to note that the legendary mathematician and physicist, Issac Newton had a small build. In individuals with a big build (sum of modified-scaled percentiles equal to or more than 150), the body dominates the brain. Such individuals seem to be better in accomplishing tasks involving strength and speed, like active combat and SSG (Special Services Group) commandoes. In people with a medium build (sum of modified-scaled percentiles equal to or more than 50 but less than 150), the brain and the body equally contribute. They may adapt to body- or brain-dominating tasks, depending on their training.

In order to produce a generation comprising of healthy children and youth (capable to serve the country through rewarding military and civilian occupations), there is a need to establish a solid and a comprehensive health-care program first in all the schools run by the Armed Forces of Pakistan and later in all public- and private-sector-civilian schools. This program should include thorough physical and psychological examinations of all children entering preschool from the age of 3 years onward as well as fitness testing at the appropriate age level (Kamal *et al.*, 2017a). All physical examinations (conducted twice-a-year) should include anthropometric-data collection to generate Growth-and-Obesity Roadmaps 4.5 (Kamal, 2022b), determine enhanced-nutritional status: broken down into 23 categories, *viz.* special categories — normality, obesity, wasting, tallness, stunting; regular categories — over-nutrition, under-nutrition, energy-channelization I-II; extended categories — obesity dominated over-nutrition, tallness dominated over-nutrition, tallness dominated energy-channelization I, wasting dominated energy-channelization I, wasting dominated under-nutrition, stunting dominated under-nutrition, stunting dominated energy-channelization II, obesity dominated energy-channelization II; limiting cases — energy-channelization III (puberty-induced energy-channelization), acute malnutrition, true over-nutrition, true under-nutrition, true energy-channelization I-II (Kamal *et al.*, 2021b — Figure 8), compute height-gain-target-achievement index and mass-management-target-achievement index for the current checkup, evaluated from the recommended values based on previous checkup (Kamal *et al.*, 2020a — Figure 10; Kamal *et al.*, 2021b — Figure 7). For peri-pubertal children (children, who are about to enter puberty), puberty rating should be performed at each checkup (Khadilkar *et al.*, 2022; Kamal *et al.*, 2017a — Table 4; Kamal *et al.*, 2021a — Figure 1 and Table 3). Manggala *et al.* (2018) discussed risk factors for stunting in children till the age of 5 years for the Malaysian children. Such studies should be possible for the Pakistani children once these roadmaps are available. Parents should be given guidelines as to lifestyle adjustment, diet and exercise plans for their children (Kamal *et al.*, 2021a, Additional File 4; Kamal and Khan, 2020a) as well as alerted to pseudo-gains of height and mass, if present — pseudo-gain of height occurs, when a drop in CDC percentile-of-height accompanies height gain for two consecutive checkups, with a similar definition for pseudo-gain of mass (Kamal *et al.*, 2014). Further, the caregivers should be explained the importance of adequate fresh air and sun exposure to maintain vitamin-D level in the bodies of children (Kamal and Khan, 2018). Safe sun-exposure timings for the entire year are listed for the city of Karachi elsewhere (Kamal and Khan, 2020a — Table 6).

These checkups should include posture evaluation (examination should include finding out if knees are joining) and training from the age of 4 years onward (Kamal and El-Sayyad, 1981), gait analysis (examination should include finding out if knees are knocking) and training from the age of 7 years onward (Kamal *et al.*, 2016b), a very thorough scoliosis examination (Kamal, 2022c) and scoliosis-risk classification (high, medium, low) from the age of 8 years onward (Kamal *et al.*, 2020c — Table 5) as well as determination of heart size from the geometry of heart-sound triangle, formed by PMI (Points of Maximum Intensity) of the heart sounds generated from pulmonary, tricuspid and mitral valves (Kamal, 2015; Kamal and Siddiqui, 2002).

Families of the personnel of military and paramilitary organizations as well as those in the civilian set-up, receiving full medical care for self and family from their employers, should be mandated to present themselves for the above-described checkups twice-a-year and maintain optimal weight-for-height (Kamal, 2022d). These measures should reduce medical expenditure of the covered families as well as lesser days off from work or absence from school due to illness.

Involvement in organized physical activity and sport, for example, gymnastics, tennis and football by enrolling children in sport academies (Kamal and Khan, 2020b; Kamal *et al.*, 2020b) and summer camps (Kamal and Khan, 2021), should, not only, develop the student emotionally and socially, but also, help the individual gain height.

## CONCLUSION

On Wednesday, December 15, 2021, Sadia Kibria of Kotler Impact remarked to Nisma Ameer in the program, *Meet the CEO*, that there are best opportunities for women to grow in Pakistan. However, existing induction criteria in the Armed Forces of Pakistan are not supporting her statement. In this paper, a proposal is given to revise these criteria for still-growing females and males (females under the age of 19 years; males under the age of 21 years) by setting the cut-off CDC percentile-of-height at the first quartile of distribution of these percentiles. The criteria have been suggested in such a manner to provide both genders with the same opportunity of being qualified (75% of the female population of Pakistan; 75% of the male population) based on their CDC percentiles-of-height (females 14.361756199<sup>P</sup>; males 16.7143217848<sup>P</sup>) instead of their measured heights at the time of reporting to the selection centers<sup>5</sup>. For grown-up females and males (females 19-year old or older; males 21-year old or older), the actual values of the proposed adult-army-cut-off heights (females 156.17 cm, corresponding to 5 ft 1.48 in; males 169.51 cm, corresponding to 5 ft 6.74 in) should be employed. The paper, also, emphasized the importance of generating estimated-adult heights for females and males from the age of 3 years onward in order to provide sufficient time for the required corrections to be made so that these children are able to attain the required height by end of their growth period. This should be the goal of a stronger, a healthier and a happier Pakistan!

## KEY POINTS

- The existing criteria for induction into the Armed Forces of Pakistan are minimum heights of the individuals, set at 157.48 cm — 5 ft 2 in (CDC percentile: 19.35609323536863<sup>P</sup>) for females and 162.56 cm — 5 ft 4 in (CDC percentile: 2.718014592103645<sup>P</sup>) for males.
- Based on these criteria only 68.44% of the females qualified for service in the military and paramilitary occupations, whereas 94.43% of the males were eligible, obtained from analysis of data of 1666 students (1163 females, 503 males) hailing from all provinces of Pakistan.
- Fairer criteria are proposed, which should allow 75% of individuals from each gender to be able to serve the Armed Forces of Pakistan (the cut-off heights are set at modified-scaled percentile 25<sup>P</sup> of the indigenously-collected data).
- According to these criteria, the cut-off heights for fully-grown females (19-year old or older) and fully-grown males (21-year old or older) should be 156.17 cm (5 ft 1.48 in) and 169.51 cm (5 ft 6.74 in), respectively.
- For still-growing females (under-19) and still-growing males (under-21), CDC percentiles should be used, 14.361756199<sup>P</sup> (for females) and 16.7143217848<sup>P</sup> (for males), instead of measured heights.

## INFORMED CONSENT

The NGDS Pilot Project was initiated in 1998, taking into account applicable local ethical and human-right protocols, adapted from the North American as well as the European standards. The project was designed as per directives of

Governor Sindh/Chancellor, University of Karachi, a retired Lieutenant General of the Pakistan Army, after ‘Institutional Review Process’ by University of Karachi authorities, which included committees of Chancellor and Vice Chancellor. The project was, later, scrutinized by commanders of the Armed Forces of Pakistan and heads of the participating institutions. A civilian school was added in 2011.

Informed consent was obtained from parent(s) of each participating student for the school-based study (the NGDS Pilot Project) as well as parents and their children for family-centered study (Sibling Growth Pilot Project — SGPP). The consent forms for each of these studies are available on the NGDS Pilot Project website:

*Informed Consent Form (NGDS Study):* [https://www.ngds-ku.org/ngds\\_folder/Protocols/NGDS\\_Form.pdf](https://www.ngds-ku.org/ngds_folder/Protocols/NGDS_Form.pdf)

*SGPP Participation Form:* [https://www.ngds-ku.org/SGPP/SGPP\\_Form.pdf](https://www.ngds-ku.org/SGPP/SGPP_Form.pdf)

## DECLARATION OF COMPETING INTERESTS

The authors declare no conflict of interest. This work contains no libelous or unlawful statements and does not infringe on or violate the publicity or the privacy rights of any third party.

## ENDNOTES

<sup>1</sup>Army Public School and College, ‘O’ Levels, 153 Iqbal Shaheed Road, Saddar, Karachi 74400, Sindh, Pakistan — letter addressed to Corps Commander, 5 Corps, Shara-é-Faisal, Karachi (administering Army Public School and College), number GS/2-55/98 (SO-I)/2531 dated November 25, 1998 from the Coördinator of Governor Sindh/Chancellor, University of Karachi

<sup>2</sup>Bahria College, NORE I, MT Khan Road, Karachi 75400, Sindh, Pakistan — letter addressed to Commander, NORE I (administering Bahria College), number GS/2-55/98 (SO-I)/2530 dated November 25, 1998 from the Coördinator of Governor Sindh/Chancellor, University of Karachi

<sup>3</sup>Fazaia Degree College, PAF Base ‘Faisal’, Main Shara-é-Faisal, Karachi 74350, Sindh, Pakistan — letter addressed to Base Commander, PAF Base ‘Faisal’ (administering Fazaia Degree College), number GS/2-55/98 (SO-I)/2529 dated November 25, 1998 from the Coördinator of Governor Sindh/Chancellor, University of Karachi

<sup>4</sup>Beacon Light Academy, E-24, Street 24, Block 7, Gulshan-é-Iqbal, Karachi 75300, Sindh, Pakistan

<sup>5</sup>Let me re-work the example given in the section ‘Criteria for induction into the Armed Forces of Pakistan’, based on the proposed percentiles: A 16-year-old girl having a height of 155.41 cm (5 ft 1.18 in) should be considered eligible as her height corresponds to proposed CDC percentile-of-height 14.361756199<sup>P</sup>. Similarly, a 15-year-old boy having a height of 158.94 cm (5 ft 2.58 in) should be considered eligible as his height corresponds to proposed CDC percentile-of-height 16.7143217848<sup>P</sup>.

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- Additional File 4 — Lifestyle adjustment, diet and exercise plans: [https://www.ngds-ku.org/Papers/J60/Additional\\_File\\_4.pdf](https://www.ngds-ku.org/Papers/J60/Additional_File_4.pdf)
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