

Assessment of Skeletal Maturation in Egyptian School Girls Using Middle Phalanx of the Middle Finger MP3 and its Relationship with Body Mass Index Percentile in Giza Governorate: Cross sectional study

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Introduction:

The aim of this study was Assessment of Skeletal Maturation in Egyptian School Girls Using Middle Phalanx of the Middle Finger MP3 and its Relationship with Body Mass Index Percentile in Giza Governorate.

Methods: The study included 1403 adolescent females (ages ranged from 8 to 14 years). The sample was divided into 6 groups according to their age. Middle phalanx of the middle finger (MP3) of each subject was radiographed and the developmental stages were evaluated by the method of Rajogobal and Kansal.

Results: A statistically significant difference was found between mean age values at different MP3 growth stages. Pair-wise comparisons showed that the mean age at Stage (F) was 9.4 years while Stage (FG) was 10.3 years. At Stage (G) the mean value of the pubertal spurt age was 11.2 ± 0.98 years while the mean age for Stage (H) was 12.1 years, Stage (HI) 12.6 years and Stage (I) 13 years of age. There was a statistically significant direct correlation between MP3 stages and BMI percentiles in each age group. An increase in MP3 stages is associated with an increase in BMI percentile and vice versa.

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Conclusions:

The mean skeletal maturity age of MP3-G stage (that represents the onset of the peak of pubertal growth spurt) was found to be 11.17years \pm 0.98 years. There was a statistically significant positive correlation between MP3 stages and BMI percentiles in each age group.

Child maturity status is best determined relative to specific stages of physiologic maturity than chronological age. Physiological age is estimated by maturation of one or more tissue systems which can be estimated by somatic, sexual, skeletal and dental maturity¹. Skeletal maturity assessment consists of visual inspection of the developing bones, their initial appearance, subsequent ossification and related changes in shape and size. Different areas of the skeleton have been used such as the hand wrist, hip, frontal sinus, foot, ankle, elbow, and the cervical vertebrae.²

In daily orthodontic procedures, hand wrist, middle phalanx of the middle figure (MP3) and cephalometric radiographs

Have been used for assessing skeletal maturation, morphology and direction of growth patterns.

Increase in children's body weight is a nationwide problem due to today's modern life style. In growing girls, body weight increase can result in early onset of puberty and considerable accelerated linear growth. Increase in body mass in growing children and adolescents can cause increase in bone size, vertebral bone density and acceleration of skeletal growth. Body mass index (BMI) is the preferred method for expressing body fat percentile in epidemiologic studies. Determining the onset of the pubertal growth spurt is necessary for taking a correct decision as when to begin growth modification for skeletal jaw discrepancies in orthodontic practice.

MATERIAL AND METHOD

A total number of 25 primary and preparatory schools were randomly selected,

which provided a total number of 1304subjects for study.

For the second variable of relationship between skeletal maturation and body mass index percentile, a total sample size of 46 subjects from each age group was sufficient with power 95% and 5% significant level.

The sample was divided according to age into six groups. Group 1: >8to 9 years of age Group 2: >9 years to 10years of age Group 3: >10 years to 11 years of age Group 4: >11 years to 12 years of age Group 5: >12 years to 13 years of age Group 6: >13 years to 14 years of age.

Each subject was radiographed using digital dental radiography technique of a high clarity and good contrast for the MP3 (middle phalanx of 3rd left finger). The X-ray was taken with a Digital Dental Portable X- Ray Machine System the developmental stage of the middle phalanx of the third finger (MP3) was evaluated for each digital radiograph according to the method described by **Rajagopal and Kansal (2002)**.³

The height and weight for 46 females which were randomly selected were measured. Body mass index (BMI) is the preferred method of expressing body fat percentile in epidemiologic studies. BMI equal weight divided by height squared, BMI calculation is different for individuals that are less than 20 years old .It is calculated the same as adults ,but compared with typical values for other children of same gender and age (BMI percentile) BMI less than 5thpercentile is considered as underweight and above 95th is considered obese. And BMI between 85th and 95th is considered to be overweight and BMI between 5th and 85th is considered normal weight.

RESULTS

1. MP3 Growth Stages in the Total Sample:

Stage (F) was found in 308 females (23.6%) while, 265 (20.3%) girls had Stage (FG), 127 (9.7%) were Stage (G), 183 (14%) had Stage

(H), 248 (19%) were Stage (HI) while 173 (13.3%) had Stage (I). The distribution of MP3 growth stages of the total sample is presented in (Figure 18).

2. Mean age values at different MP3 growth stages:

A statistically significant difference was found between mean age values at different MP3 growth stages. Pair-wise comparisons showed that the mean age at Stage (F) was 9.4 years while Stage (FG) was 10.3 years. At Stage (G) the mean value of the pubertal spurt age was 11.2 ± 0.98 years while the mean age for Stage (H) was 12.1 years, Stage (HI) 12.6 years and Stage (I) 13 years of age (Fig. 1).

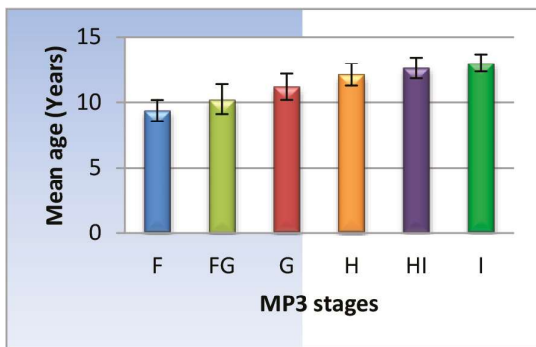


Figure 1: Bar chart representing mean and standard deviation for age values at Different MP3 growth stages.

Stage (G)

Females aged 11 - 12 years (40.2%) showed the highest prevalence of Stage (G) followed by those aged 10 - 11 years (22.8%) and 12 - 13 years (21.3%). The lowest prevalence of Stage (G) was found in girls 9 - 10 years (15.7%) of age (Figure 2). A statistically significant difference was found between females at different age groups in the MP3 Stage (G).

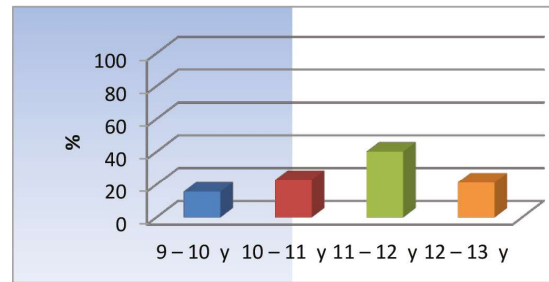


Figure 2: Bar chart representing age categories in subjects with MP3 Stage (G).

Correlation between MP3 stages and BMI

percentiles in each age group:

Results of Spearman's correlation coefficient revealed that there was a statistically significant direct correlation between MP3 stages and BMI percentiles in each age group. An increase in MP3 stages is associated with an increase in BMI percentile and vice versa

DISCUSSION

Evaluation of patient's maturity and estimation of remaining growth potential are necessary elements of orthodontic treatment. Not only will the level of skeletal maturation affect the proper diagnosis and extent of the dentofacial deformity, but it also will significantly influence the timing and protocol of the proposed treatment. So knowing the time of the pubertal growth spurt is very important for orthopedic treatment of skeletal disharmony. Treatment timing can affect treatment outcomes in the craniofacial structures especially that for skeletal Class II where it

must be during the peak in mandibular growth because the response decreases both before and after maximal pubertal growth.⁴

In daily orthodontic procedures the hand wrist, middle phalanx of the middle finger (MP3) and cephalometric radiographs are used for assessing skeletal maturation, morphology and direction of growth patterns. Many

studies were conducted to correlate between cervical vertebrae as described by B. Hassel, A. Farman(1995) and the modified median phalanx (MP3) described by Rajogopal and Kansal (2002) and found a good correlation between the six stages of (CVMI) and those of the (MP3).⁵ MP3 as a maturity indicator has the advantage of being not expensive, has low radiation dose which is devoid from any bony superimpositions and is a periapical radiograph which is available in most dental clinics.

MP3G stage was found in the studied sample at a mean age of 11.2 years which marks the stage of the beginning of the peak of pubertal growth spurt where it is optimal to start orthopedic intervention of mandibular deficiency using functional appliances that modify condylar growth such as the activator.

Regarding gender variations of skeletal maturity age, the Egyptian girls in the present study tended to mature about two years earlier than Egyptian boys at MP3-G stage (signifying the peak of pubertal growth spurt) which was found at a high prevalence in

subjects aged >11-12 years with a mean of age 11.2 years, while in Egyptian boys it was found in subjects aged >13-14 years with a mean of age 13.3 years. This was found to coincide with the results of a previous study by **Soegiharto et al.(2008)**⁶

According to ethnic or racial variations of skeletal maturity age, the Egyptian girls

An increase in MP3 stages was associated with an increase in BMI percentile and vice versa. Results of our study agree with the study conducted by **Mack et al. (2013)**¹⁰ which showed that cervical vertebral stages and dental age were more advanced in subjects with increased body mass index percentile and also concomitant with the study¹¹

matured earlier than Indonesians and white of **Costacorta et al. (2012)**

which found a American girls as shown in a study by relation between skeletal-dental age¹²

Soegiharto et al.(2008)⁶. The pubertal growth spurt for Egyptian girl occurred at a mean of age 11.17years and the pubertal growth spurt occurred at approximately 12.5 years for white American girls and 12.8 years for Indonesian girls. Egyptian girls matured earlier than Saudi females who matured at 11.7 years **Baidas (2012)**⁷ Sudanese girls at 12.0years **Bushra et al.** acceleration and obesity. **Guica et al.(2013)**

results showed that obese subjects exhibited an increase of some craniofacial parameters and alteration of some laboratory parameters that may be involved in the process of skeletal maturation. On the other hand, there are studies that report insignificant acceleration in skeletal age by increasing BMI percentile as ¹³

al. (2016)⁸ and Indian females at 12.13years **Akridge et al. (2007)** and **Hedayati et Madhu et al.(2004)**⁹. These differences between various populations in skeletal maturity age may be attributed not only to ethnic and racial differences, but also to many environmental factors as socioeconomic, climatic and nutritional status that may affect the rate of ossification. Variations in sample size and/or research methodology may also play another role in these skeletal maturity age variations.

Results of correlation between MP3 stages and BMI percentiles revealed that there was direct (positive) correlation between MP3 stages and BMI percentiles in each age group **al.(2014)**¹⁴. So according to our results it is important to assess overweight and obese females who need orthopedic treatment for skeletal jaw discrepancy as treatment may be needed earlier.

Conclusions

1. The mean skeletal maturity age (MP3-G stage) that represents the peak of Pubertal growth spurt in Egyptian females of Giza was found to be 11.17years ± 0.98years

2. The start of the pre-pubertal peak stage (MP3-FG) of pubertal growth was at 10.25

years \pm 1.12 years. So an age range of 10.25

years to 12.10 years which represents the active period of pubertal growth between the (FG) and (H) Stages represents the optimal timing for orthopedic management of skeletal jaw problems.

3. There was a statistically significant positive correlation between MP3 stages and BMI percentiles in each age group. An increase in BMI percentile was associated with an increase in MP3 stages and vice versa. So it is important to evaluate skeletal maturation of overweight and obese females who need orthopedic treatment earlier than normal and underweight.

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