Dynamics of anthropometric characteristics and body composition growth among adolescents (12-15) years old .

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Introduction

Growth is a natural phenomenon to all living organisms; it is distinguished by the length of its growth period. This phenomenon is including several phases as morphological, psychological, mental and social. Physical development and body growth are dynamic processes that involves a wide range of cellular and physical maturations (Alan D Rogol,2003). Most researchers have focused on linear growth (change in length over time), but their studies indicated that the relative alterations body and its composition (regional distribution of body fat (lower body versus upper body, appendicular versus axial, and visceral versus subcutaneous) are fundamental components of physical growth and sexual maturation (Alan D Rogol,2003). Others defined the growth that composes of measurable changes in size, physical and body composition, and various systems of the body (Indranil Manna,2014).

Therefore, studying the Anthropometric Characteristics and Body Composition is considered one of the most reliable means in describing the human body and following up the development of physical growth processes in various stages of age, especially adolescence. Therefore, it is possible to identify what adolescence might be at a certain age and contribute to determining future health risks that may accompany it during old age such as orthopedic deformities, overweight, obesity, and undernutrition diseases. Moreover, studying the Anthropometric Characteristics and Body Composition during adolescence period has other dimensions. The adolescence during this stage doesn't realize the culture of dealing with the natural mutations of the growth of his body or what we might call it (the culture of Body perception). In addition to psychological,

behavioral and social changes, which may lead to adolescents forming a negative image of the nature of their bodies during this stage and their feeling of dissatisfaction with the shape and composition of the body. Therefore, adolescent's may resort to behaviors of some of which we may see healthy such as (the trend towards exercising - performing a violent physical activity - going to the gym for bodybuilding), But others unhealthy behaviors such as (moving away from physical activity altogether - eating unhealthy foods - laziness and lethargy during leisure time - playing video games - staying up late and sleeping late) which would both lead to a disruption in normal growth processes during this stage. It may result in health problems such as malnutrition or overweight and obesity. Although moderate levels of physical activity are associated with cardiovascular health and desirable changes in body composition, excessive or aggressive levels during childhood and adolescence could negatively affect physical growth development. Sports that emphasize strict weight control and high energy output as (scholastic wrestling, gymnastics) are of concern for growth disorders (Alan D Rogol et al.,2000). There is no positive or negative effect of regular training on growth. However, intensive training in this period of life should be avoided, because the excessive physical activity may result in a negative impact on growth (Malina RM,1994). Based on the effect of the training intensity and duration more than the type of physical exercise itself. The moderate levels of physical exercise have a stimulating effect on physical growth. Although the exhausting levels represents stress which can suppress the physical growth. (Georgopoulos N et al.,1999).

Moreover, traditional anthropometric methods can measure aerobic and anaerobic exercise performances and changes in cardio-respiratory function. Their traditional anthropometric repertory has increased for estimation of body composition based on four-component (bone, muscle, fat and residual volumes) (János Mészáros1 et al.,2000).

Linear growth and physical maturation are dynamic processes which involving cellular, somatic, molecular, and organismal developmental changes. Traditionally, stature has been primarily used for growth assessment, but changes in body proportion and composition are also essential elements of growth (Alan D Rogol et al.,2000).

Although the accurate prediction of the future growth of children and adolescents is still a challenge for all those interested in studying the growth processes for those ages, moreover adolescent's represent future human resources, economic growth so the developed world countries are interested in everything new to invest in generating their generations in general and caring for adolescent's. They are directing all their human, material and scientific energy and capabilities to ensure the growth of their children and adolescents naturally and comprehensively in all physical, mental, emotional and social aspects.

Regarding many researches, it became clear that the previous anthropometric research lacked the study of the Anthropometric Characteristics and Body Composition of any of the different categories (children - adolescents - youth - women - elderly - disabled) within the Egyptian society. It was limited only to athletes, as well as the lack of information and standards for adolescents. That's why I directed my study trying to gain an accurate knowledge about the dynamics of the anthropometric characteristics and body composition growth to provide important information that helps the concerned authorities to better understand the risk factors associated with the growth processes during adolescence.

Aims of my study

1- Identify the differences in the anthropometric characteristics and body composition between adolescents according to location (rural or urban).

2- Identify the dynamics of the anthropometric characteristics and body composition growth in adolescents.

3- Identify the maximum growth rates of the anthropometric characteristics and body composition growth in adolescents.

Materials and methods

A prospective observational study was performed during the academic year (2017-2018). The sample from preparatory students (12-15 Y) was chosen from schools belonging to (3) different educational administration (Tukh- Benha- Qaha) in the Qaliubiya governorate. This study based on (600) student, which divided into (6) groups (100 student for each group) based on age/year as follow (12-12.6), (12.6-13), (13-13.6), (13.6-14), (14-14.6), (14.6-15), All measurements were performed at schools.

Anthropometric measurements

Anthropometric characteristics and Body composition variables were measured by using some devices (electronic weighing scale - portable stadiometer - tape measure - Body Fat Burer as follows: Total Body Fat (TBF%) – Total Body Water (TBW%)– Mass Muscle (MS%) – Bones % - BMR (Calorie).

Statistical analysis

Descriptive statistics summarized the age, location and values which were expressed as means (m) and Standard Deviation (SD). Comparison between locations (rural and urban) in the same age stage were assessed using independent samples (T-test).

Results

Tables (1A, 1B,1C) summarized the differences between measurements of anthropometric characteristics among adolescents at different age stages according to the location (rural-urban). There were statistically significant differences among adolescents in the age group (12.6-12 Y) between rural and urban areas in most body composition measurements (height - weight - arm length - forearm length - palm length - thigh-length - leg length - neck circumference – calf circumference) (Table 1A). In addition study reported that there were statistically significant differences among adolescents, in the age (12.6 -13 Y) in following anthropometric characteristics measurements (arm length - upper arm length - forearm length - palm length - thigh-length - leg length - upper arm circumference – forearm circumference - thigh circumference - waist circumference - pelvic circumference). Moreover, the age stage (13-13.6 Y) had statistically significant differences in the measurements of (palm length - thigh-length - chest circumference) (Table 1B). The results indicated that there are statistically significant differences between the urban and rural adolescents in the age stage (14.6-15 Y) in the measurements of (palm length - thigh-length - foot length - thigh circumference - chest circumference - pelvic circumference) (Table 1C). While there were no statistically significant differences in the anthropometric characteristics between rural and urban adolescents in the two age stages (13.6-14 Y) and (14-14.6 Y). The age stage (14.6-15 Y) showed differences between adolescents in rural and urban areas in the anthropometric characteristics.

Regarding the body composition variables, there were statistically significant differences in the measurements of (Bones-TBW-MS) variables, between rural and urban adolescents in the age stage (12-12.6 Y). The two age stages of (12-12.6 Y) (13-13.6 Y) showed that there were statistically significant differences in (TBF-Bones-TBW-MS) variables, respectively. Moreover, there was a statistically significant difference appeared among adolescent's in rural and

urban areas (14.6-15Y) in measurements of (TBF-TBW-MS) variables, while there were no statistically significant differences between rural and urban adolescent's in stages (13.6-14 Y) and (14-14.6 Y), respectively (Table 2).

Table (3A,3B,4) showed the dynamics of the growth of anthropometric characteristics and body composition variables, there is an increase in its rates, but in varying proportions. As the growth rates appear in some measurements rapidly at one of the age stages, while it was slowly at another stage. The maximum rates of growth processes for this measurement among adolescents appeared at different periods according to the age and location (rural-urban). The maximum growth rates for some anthropometric characteristics (height – weight - arm length - thigh circumference - calf circumference-chest circumference - pelvic circumference), were during the age stage (14 → 15 Y) for an adolescent's in rural as well as urban (Table 3). While the highest rates of growth of upper arm length and palm length for an adolescent's in the rural area were during the age stage (14 → 15 Y), and for adolescents in the urban area (12 → 13 Y).

As well as the maximum rates of growth (thigh - leg length) for the adolescent's in the rural area was in the stage (13 → 14 Y) and for adolescent's in urban in the stage (14 → 15 Y), the maximum growth rates (Foot length - neck circumference - forearm circumference - waist circumference) in stage (12 → 13 Y) for urban adolescent's, in rural areas in stages (12 → 13 Y) and (13 → 14 Y) (Table 3).

As for the body composition variables, Figure (1) indicates that the maximum growth rate for the variable (TBF) for the rural adolescent's in the stage (13 → 14 Y) and for the adolescent's in urban areas during the stages from 14 Y till 15 Y, while the maximum growth rate in (TBW) for the adolescent's in urban and rural at the same stage (12 → 13 Y). The maximum growth rates of the variable (Bone - BMR) for the adolescent's in urban age stage (12 → 13 Y) and

the adolescent's in rural areas in the stage (14 → 15 Y), as for (MS) variable it was the maximum growth rate for the urban adolescent's in the stage (12 → 13 Y). and for the adolescent's in rural areas in the stage (13 → 14 Y).

Table (1A)

Differences of Anthropometric Characteristics between Urban and Rural areas

Anthropometric Characteristics	Age Stage (12 – 12.6 Y)			Age Stage (12.6 – 13 Y)		
	Urban M SD ±	Rural M SD ±	*P*- value	Urban M SD ±	Rural M SD ±	*P*-value
Hight	149.3 5.7	149.8 7.83	**0.000**	151.2 6.62	152.2 9.34	NC
Weight	41.9 15.8	42.32 18.01	**0.000**	43.92 21.43	44.91 18.12	NC
Arm length	68.9 5.68	69.32 5.54	**0.001**	69.35 5.56	71.18 5.49	**0.000**
Upper arm length	28.98 2.68	29.07 1.67	**0.003**	30.28 7.69	29.37 3.61	**0.000**
Forearm length	27.12 0.63	26.09 2.68	**0.000**	28.23 8.05	26.78 2.82	**0.000**
Palm length	18.77 1.77	17.57 1.65	**0.001**	18.31 10.42	17.88 1.82	**0.000**
Thigh-length	39.36 2.26	38.54 2.13	**0.000**	40.02 9.62	39.86 2.64	**0.000**
Leg length	37.26 2.36	36.84 2.05	**0.002**	37.59 5.16	37.28 2.49	**0.000**
Foot length	23.01 2.68	23.41 2.19	NC	24.14 2.49	24.12 2.49	NC
Neck circumference	30.08 6.72	30.24 3.29	**0.027**	30.95 3.83	30.68 3.67	**0.001**
Upper arm circumference	25.55 3.97	25.06 4.79	NC	26.32 14.18	25.62 5.29	**0.000**
Forearm circumference	21.72 4.79	22.51 4.92	NC	22.16 3.71	22.94 3.81	**0.000**
Thigh circumference	42.12 8.34	41.72 9.42	NC	42.94 21.68	42.87 10.37	**0.000**
Calf circumference	34.62 6.16	34.26 5.54	**0.047**	35.04 22.08	34.86 6.15	**0.000**
Chest circumference	73.74 12.11	71.06 14.33	NC	75.26 14.15	72.78 13.96	NC
Waist circumference	65.74 12.34	65.36 8.50	NC	68.34 30.25	67.12 13.83	**0.000**
Pelvic circumference	71.24 11.24	70.49 14.16	NC	74.54 23.75	72.12 13.27	**0.000**

NC: Not Significant**, Y:** years old, *P*-value<0.05

Table (1B)

Anthropometric Characteristics	Age Stage (13 – 13.6 Y)			Age Stage (13.6 – 14 Y)		
	Urban M SD ±	Rural M SD ±	P- value	Urban M SD ±	Rural M SD ±	P-value
Hight	160.1 9.33	160.40 9.03	NC	161.3 8.45	161.80 9.18	NC
Weight	45.42 20.1	45.87 17.48	NC	48.15 17.45	47.77 18.46	NC
Arm length	72.14 4.91	73.03 5.58	NC	74.12 5.53	74.41 5.03	NC
Upper arm length	30.46 2.78	30.44 2.55	NC	30.74 3.65	30.58 3.45	NC
Forearm length	28.39 3.17	28.72 2.35	NC	28.53 3.41	28.88 3.41	NC
Palm length	18.46 0.678	18.42 0.77	**0.000**	19.34 1.93	18.63 1.21	NC
Thigh-length	41.12 4.92	41.04 4.61	**0.006**	41.98 4.07	42.42 4.55	NC
Leg length	37.86 4.46	38.38 3.12	NC	38.69 3.21	39.16 3.68	NC
Foot length	24.98 2.61	24.43 2.79	NC	25.23 2.86	24.86 2.61	NC
Neck circumference	31.11 4.36	31.12 3.83	NC	31.41 4.06	31.58 4.04	NC
Upper arm circumference	26.61 6.56	26.48 6.82	NC	27.54 5.67	26.75 6.17	NC
Forearm circumference	23.45 3.93	22.32 3.95	NC	24.21 8.54	23.01 2.63	NC
Thigh circumference	43.65 12.56	43.22 11.23	NC	44.17 10.19	44.27 11.28	NC
Calf circumference	35.68 7.24	34.92 6.66	NC	35.88 6.23	35.16 6.45	NC
Chest circumference	77.86 12.36	73.45 12.78	**0.019**	79.14 11.94	75.12 11.99	NC
Waist circumference	68.87 9.18	70.82 14.31	NC	74.54 13.45	74.38 11.01	NC
Pelvic circumference	76.14 13.86	74.92 14.07	NC	80.87 13.46	78.42 13.66	NC

NC: Not Significant**, Y:** years old, *P*-value<0.05

Table (1C)

Anthropometric Characteristics	Age Stage (14 – 14.6 Y)			Age Stage (14.6 – 15 Y)		
	Urban M SD ±	Rural M SD ±	*P*- value	Urban M SD ±	Rural M SD ±	*P*-value
Hight	165.3 8.06	164.20 8.61	NC	167.60 7.44	169.3 7.08	NC
Weight	54.81 16.45	54.25 16.42	NC	60.73 14.71	59.88 12.44	NC
Arm length	75.91 4.76	77.18 5.49	NC	78.06 5.21	79.26 4.95	NC
Upper arm length	30.84 4.16	30.82 4.88	NC	31.26 4.74	33.1 4.91	NC
Forearm length	28.54 3.51	28.98 4.17	NC	29.06 3.52	29.54 3.45	NC
Palm length	19.86 1.62	19.03 1.55	NC	20.43 1.28	20.11 1.56	**0.002**
Thigh-length	43.04 4.41	44.51 4.58	NC	45.81 3.89	45.76 4.32	**0.033**
Leg length	39.11 3.78	40.04 4.09	NC	40.02 3.92	39.86 3.42	NC
Foot length	25.58 2.31	25.3 1.52	NC	25.82 2.57	25.12 2.19	**0.040**
Neck circumference	31.64 4.03	31.62 3.78	NC	31.74 4.21	31.66 3.58	NC
Upper arm circumference	26.92 5.45	26.68 5.71	NC	27.24 5.23	27.01 4.28	NC
Forearm circumference	24.88 4.41	23.52 4.91	NC	25.49 5.32	24.21 4.54	NC
Thigh circumference	44.96 10.81	44.58 10.57	NC	47.13 10.38	46.32 7.36	**0.025**
Calf circumference	36.31 6.51	36.02 4.37	NC	36.87 5.04	36.86 5.79	NC
Chest circumference	76.09 12.31	77.16 12.92	NC	82.15 10.73	83.94 12.96	**0.023**
Waist circumference	79.16 11.23	78.45 12.49	NC	81.18 11.42	79.97 9.47	NC
Pelvic circumference	84.71 165.3	82.04 13.66	NC	90.18 14.44	86.31 10.99	**0.003**

NC: Not Significant**, Y:** years old, *P*-value<0.05

Table (2)

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Differences of Body Composition Variables between Urban and Rural areas

Body Composition	Age Stage (12 – 12.6 Y)			Age Stage (12.6 – 13 Y)		
	Urban M SD ±	Rural M SD ±	*P*-value	Urban M SD ±	Rural M SD ±	*P*-value
TBF	13.52 5.86	12.79 7.38	NC	14.64 20.47	13.47 7.78	**0.000**
TBW	49.65 10.59	53.69 5.72	**0.008**	54.39 10.39	59.81 6.34	**0.000**
MS	38.25 9.69	38.47 8.5	**0.000**	40.68 8.34	41.58 8.22	**0.000**
Bone	11.13 1.61	10.97 2.1	**0.002**	12.03 1.59	11.34 2.05	**0.000**
BMR	1524 323.6	1553 315.1	NC	1649 516.2	1592 365.4	NC
Body Composition	Age Stage (13 – 13.6 Y)			Age Stage (13.6 – 14 Y)		
	Urban M SD ±	Rural M SD ±	*P*-value	Urban M SD ±	Rural M SD ±	*P*-value
TBF	18.24 11.33	14.52 9.45	**0.000**	19.79 10.24	17.67 10.91	NC
TBW	53.69 7.02	56.49 8.18	**0.002**	54.93 10.77	59.61 8.71	NC
MS	44.87 7.49	45.36 11.16	**0.001**	47.24 9.94	49.21 10.57	NC
Bone	12.22 1.83	11.67 1.92	**0.000**	12.42 2.01	11.95 1.81	NC
BMR	1638 614.4	1770 699.8	NC	19.79 10.24	17.67 10.91	NC
Body Composition	Age Stage (14 – 14.6 Y)			Age Stage (14.6 – 15 Y)		
	Urban M SD ±	Rural M SD ±	*P*-value	Urban M SD ±	Rural M SD ±	*P*-value
TBF	19.52 10.76	18.96 11.07	NC	22.57 11.43	20.27 8.37	**0.000**
TBW	51.97 6.91	53.03 8.12	NC	54.12 8.66	57.61 5.91	**0.000**
MS	47.38 15.35	47.88 7.94	NC	48.43 7.47	49.69 5.56	**0.001**
Bone	12.42 1.71	12.08 1.65	NC	12.63 1.91	12.71 1.51	NC
BMR	1697 509.7	1635 397.5	NC	1759 318.6	1698 352.3	NC

NC: Not Significant**, Y:** years old, *P*-value<0.05

Table (3A)

The Growth Rate Dynamic Percentage of Anthropometric Characteristics

Anthropometric Characteristics	Age Stage	Urban			Rural		
		A.I. R	A.I. S	A.I.P%	A.I. R	A.I. S	A.I.P%
Hight	12 → 13 Y	1.9		35.2	2.4		26.9
	13 → 14 Y	1.2	**5.4**	22.2	1.4	**8.9**	15.7
	14 → 15 Y	2.3		42.6	5.1		57.3
Weight	12 → 13 Y	2.06		19.2	2.59		25.6
	13 → 14 Y	2.73	**10.71**	25.5	1.9	**10.12**	18.8
	14 → 15 Y	5.92		55.3	5.63		52.9
Arm length	12 → 13 Y	1.48		26.4	1.86		34.9
	13 → 14 Y	1.98	**5.61**	35.3	1.38	**5.32**	25.9
	14 → 15 Y	2.15		38.3	2.08		39.1
Upper arm length	12 → 13 Y	1.3		65	0.3		11.02
	13 → 14 Y	0.28	**2**	14	0.14	**2.72**	5.15
	14 → 15 Y	0.42		21	2.28		83.3
Forearm length	12 → 13 Y	1.11		62.7	0.69		48.9
	13 → 14 Y	0.14	**1.77**	7.9	0.16	**1.41**	11.34
	14 → 15 Y	0.52		29.4	0.56		39.7
Palm length	12 → 13 Y	0.46		24.1	0.31		19.4
	13 → 14 Y	0.88	**1.91**	46.1	0.21	**1.6**	13.1
	14 → 15 Y	0.57		29.8	1.08		67.5
Thigh-length	12 → 13 Y	1.32		25.4	1.32		33.4
	13 → 14 Y	1.1	**5.19**	21.2	1.38	**3.95**	34.9
	14 → 15 Y	2.77		53.4	1.25		31.6
Leg length	12 → 13 Y	0.33		15.9	0.44		31.4
	13 → 14 Y	0.83	**2.07**	40.1	0.78	**1.4**	55.7
	14 → 15 Y	0.91		43.9	0.18		12.8
Foot length	12 → 13 Y	1.13		69.7	0.71		53.8
	13 → 14 Y	0.25	**1.62**	15.4	0.43	**1.32**	32.6
	14 → 15 Y	0.24		14.8	0.18		13.6
Neck circumference	12 → 13 Y	0.87		68.5	0.44		46.8
	13 → 14 Y	0.3	**1.27**	23.6	0.46	**0.94**	48.9
	14 → 15 Y	0.1		7.9	0.04		4.3

A.I. R: Annual increasing Rate, **A.I. S:** Annual increasing Sum, **A. I.P%:** Annual increasing Percent, Y: years

Table (3B)

Anthropometric Characteristics	Age Stage	Urban			Rural		
		A.I. R	A.I. S	A.I.P%	A.I. R	A.I. S	A.I.P%
Upper arm circumference	12 → 13 Y	0.77		38.1	0.56		48.3
	13 → 14 Y	0.93	**2.02**	46.04	0.27	**1.16**	23.3
	14 → 15 Y	0.32		15.8	0.33		28.4
Forearm circumference	12 → 13 Y	0.44		24.3	0.43		23.7
	13 → 14 Y	0.76	**1.81**	41.9	0.69	**1.81**	38.1
	14 → 15 Y	0.61		33.7	0.69		38.1
Thigh circumference	12 → 13 Y	0.82		23.4	1.15		29.2
	13 → 14 Y	0.52	**3.51**	14.8	1.05	**3.94**	26.6
	14 → 15 Y	2.17		61.8	1.74		44.2
Calf circumference	12 → 13 Y	0.42		35.6	0.6		35.7
	13 → 14 Y	0.2	**1.18**	16.9	0.24	**1.68**	14.3
	14 → 15 Y	0.56		47.4	0.84		50
Chest circumference	12 → 13 Y	1.52		17.1	1.81		17.6
	13 → 14 Y	1.28	**8.86**	14.4	1.67	**10.26**	16.3
	14 → 15 Y	6.06		68.4	6.78		66.1
Waist circumference	12 → 13 Y	2.6		25.3	1.76		25.7
	13 → 14 Y	5.67	**10.29**	55.1	3.56	**6.84**	52.1
	14 → 15 Y	2.02		19.6	1.52		22.2
Pelvic circumference	12 → 13 Y	3.3		24.4	1.63		14.7
	13 → 14 Y	4.73	**13.5**	35	3.5	**9.4**	37.2
	14 → 15 Y	5.47		40.5	4.27		45.4

A.I. R: Annual increasing Rate, **A.I. S:** Annual increasing Sum, **A. I.P%:**

Annual increasing Percent, Y: years

Table (4)

The Growth Rate Dynamic Percentage of Body Composition Variables

Body Composition	Age Stage	Urban			Rural		
		A.I. R	A.I. S	A.I.P%	A.I. R	A.I. S	A.I.P%
TBF	12 → 13 Y	1.12		19.6	0.68		19.7
	13 → 14 Y	1.55	5.72	27.1	1.46	3.45	42.3
	14 → 15 Y	3.05		57.8	1.31		37.9
TBW	12 → 13 Y	4.74		58.3	6.12		44.3
	13 → 14 Y	1.24	8.13	15.2	3.12	13.82	22.6
	14 → 15 Y	2.15		26.4	4.58		33.1
MS	12 → 13 Y	2.43		41.5	3.11		35.4
	13 → 14 Y	2.37	5.85	40.5	3.85	8.77	43.9
	14 → 15 Y	1.05		17.9	1.81		20.6
BONE	12 → 13 Y	0.9		68.7	0.37		28.9
	13 → 14 Y	0.2	1.31	15.3	0.28	1.28	21.8
	14 → 15 Y	0.21		16	0.63		49.2
BMR	12 → 13 Y	125		52.9	39		28.7
	13 → 14 Y	49	236	20.7	34	136	25
	14 → 15 Y	62		26.3	63		46.3

A.I. R: Annual increasing Rate, **A.I. S:** Annual increasing Sum, **A. I.P%:**

Annual increasing Percent, Y: years

Figure (1)

The growth rates of anthropometric Characteristics and Body composition variables based on location
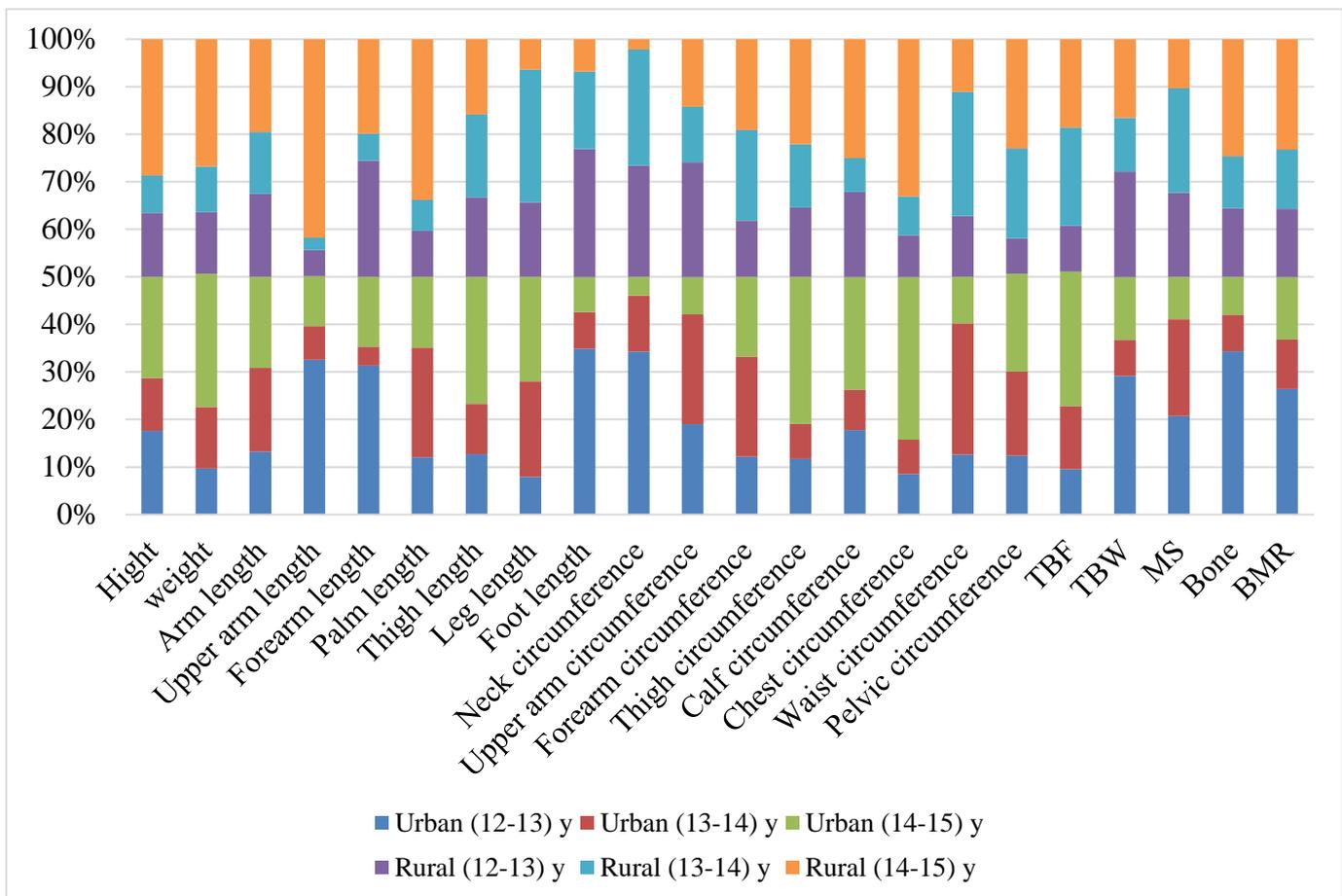
Figure Caption

growth rates of anthropometric Characteristics and Body composition variables based on location. That showed the growth rates of the adolescent are in the rural areas of some anthropometric characteristics and body composition variables better than the growth rates adolescent's in the urban areas.

Discussion

This study indicated that the main reasons for the presence of differences in the measurements of anthropometric characteristics and body composition variables among rural and urban adolescents, especially during the two age stages of (12-12.6 Y) and (12.6-13 Y). Those periods represent the first stage for the emergence of growth spurts of the skeleton. The growth spurts during this stage are the result of internal physiological processes such as the growth hormone. This means that other external influences, such as the difference in the adolescent's environment or daily lifestyle, have less effect on the growth and development of the body during this period. There were individual differences between adolescence in groups with common characters of the same sex and age, a phase when physiological differences become more evident. Other variables, as some metabolic diseases, nutritional and endocrine status affect physical growth and development of adolescent.

The stable height and weight growth patterns represent early and middle childhood stages which end with adolescent growth spurt. Males spurs begin about two years later, at an average age of about 12 years, averaging about 10 cm/year. The onset of adolescence is marked by a sudden and rapid increase in height velocity, with unequal peaks at early infancy, followed by a period of slower decline in height velocity in childhood (Coutinho S et al.,1993).

The fastest and most intense growth spurt of height and weight at the adolescent stage of the human life cycle. This growth practically occurs in all long bones and other skeletal elements increase the skeletal growth velocity. The pubertal growth spurt begins on average at (11-12.0 Y) for males (Melmed S et al.,2012). Moreover, another study reported that boys' adolescent growth spurt starts around age 12.5 years, early maturation for boys at this age (but changes

can begin as late as 15.5 years) (The Pennsylvania Child Welfare Training Program,2005).

(American psychological association,2002) confirmed that growth spurt, which involves rapid skeletal growth, usually begins at about ages 10 to 12 in girls and 12 to 14 years old in boys. The patterns of a growth spurt are similar between children. The child age percentiles change very impressive role, as some children are growing rapidly at one time while others are not (James O. Sanders et al.,2017). Interpretation of anthropometric data becomes more complicated for adolescents who enter puberty and reach sexual maturation, which affects growth and body composition at different ages. Because of the large variability of growth spurts timing for individual children as well as different populations. Age is often a poor indicator of physiological maturity and nutritional needs (Woodruff, B.A et al.,2000). In addition to individual variations, there might be differences in growth potential across ethnicities that make it difficult to establish meaningful cut-offs that are applicable worldwide. While other study indicated that these clear differences in a growth patterns for adolescents may be due to the difference in social support from society and families to adolescents as (nutritional status - physical activities - healthy behavior). Social institutions as the school, which has an important role in teaching student's healthy behavior, providing nutritional diversity, and caring for physical activity (Annamaria Zsakai et al.,2014).

Regarding there were no statistically significant differences in measurements of anthropometric characteristics and body composition variables among urban and rural adolescents in the stages (13.6-14 Y) and (14-14.6 Y). This is because that period the growth rates became slower than before, which begins from the age group (13-13.6 Y), and it appears clearly during the two stages (13.6-14 Y), (14.6-14 Y), which makes the pattern of growth among adolescent's (rural-urban) during these age stages very similar.

Once puberty approaches, growth velocity slows before its acceleration during mid puberty. Marked acceleration in the growth of height for about two years in adolescence, reaching its maximum rate in growth velocity at the point of peak height velocity of the spurt (PHV) (Grumbach MM et al.,2011).

The results indicated also the role of the dietary intake during these age stages, it has a great effect on adolescent's growth processes. Figure (1) indicates that the lowest annual rate of increase in BMR variable during the stage of (13 → 14 Y), whether in the urban or rural areas. As well as the annual increasing percent of BMR variable was the lowest during the age stage (13 → 14 Y) in urban and rural areas, which results in slow metabolic rate and growth rate of adolescent's bodies during this stage.

Poverty-related malnutrition is the most common cause of growth retardation. In the US, nutritional growth retardation and delayed pubertal development adolescents more often resulted from the self-induced restriction of nutrient intake. Nutritional status also has a significant modulating effect on the timing of adolescent sexual development (Georgopoulos N et al.,1999). Predominately among adolescent males, the transient period of motor incoordination may occur during growth spurt (12–14 Y), the incoordination period typically lasts up to 6 months (Malina RM,1994).

As for the age stage (14.6-15 Y), which showed differences between adolescents in urban and rural areas in the measurements of anthropometric characteristics and body composition variables. The result indicated that this stage represents another growth spurt of adolescence, which is consistent with both physiological processes as other variables, the growth spurt during this stage is consistent with age progress. Healthy and normal child skeletal maturation will advance in parallel with chronologic age and with pubertal milestones (Liora Lazar et al.,2012). The differences between pupils in adolescence appear in

parallel to the level of age progresses, especially in the variables (skeletal structure - muscle mass - bone mass) compared to the younger ones (Seung-min Yang et al.,2013).

This age stage also indicated the adolescent's interest in their body's health and a lot of them participated in various sports activities and popular games, whether in the streets or the fields and youth centers among adolescents in the rural areas, others participate at the competitive level in clubs, youth centers and academies specialized in sports activities, that are widespread in urban areas. This means that the adolescent's' bodies will be exposed to training loads, that wasn't there before, those push bodies of adolescents to grow for adaption to the type of sports activity practiced. Moreover, we cannot be overlooked the daily lifestyle of adolescents during this stage it has high effects on the growth rates. Life in the rural areas that adolescent assists the family in their daily work, whether inside the home or in the agricultural fields and that type of work is difficult and requires a high physical exertion then after the period of work, it will have an effect on adolescent's bodies in the rural areas, whether on anthropometric characteristics or body composition variables. Regarding adolescents, in urban areas they have a different lifestyle, the youth centers, clubs and specialized sports academics are the facilities for adolescents during holidays and free time. Many cultural and socio-economic factors of the surrounding environment affect the body composition and fat patterning and deposition (Fiori, G et al.,2000).

Figure (1) showed that the maximum growth rates of anthropometric characteristics (Hight – weight - arm length - thigh circumference - calf circumference - chest circumference – pelvic circumference) were during the age stage (14 → 15 Y) for adolescents in the urban and rural areas. This age stage represents the last stage of adolescence, in which a growth spurt accompanying with the stage of maturity, that's why the growth rates of anthropometric characteristics and body composition variables appear during this stage. Previous

study confirmed that during adolescence, the maximal rate of linear growth is known as peak height velocity (PHV), the adolescents generally reached PHV by (14 Y) (Needleman RD et al.,2000).

In addition, this stage is the beginning of the benefits of adolescent's engagement in exercise and moderate physical activity, which helps their bodies to increase the growth rates of anthropometric characteristics and body composition variables. Mainly the training intensity and duration have a higher effect than the type of physical exercise itself. The moderate physical exercise stimulates growth, but the exhausting physical training represents stress which suppress the physical growth. There are doubts about the true effect of these exercises on the individual's final statue, on the other hand, the physical exercise may induce significant increases in the growth hormones in children and adolescents (Georgopoulos N et al.,1999). Other researchers confirmed have several biological effects during life, leading to stimulation of the somatic growth during childhood and adolescence which contributing significantly to the energetic supply that acts on the glycidic, protein and lipidic metabolisms (Scheett TP et al.,1999). Others added Approximately half of adult ideal body weight is gained during adolescence (Jamie Stang et al.,2005).

Figure (1) shows the maximum growth rates of (TBF) for the adolescent's in the rural area in the age stage (13 → 14 Y) and for the adolescent's in urban areas during the stage (14 → 15 Y). Table (4) in which the increase in the annual percentage of the (TBF) variable for adolescents in urban from the stage (12 → 13 Y) passing through to stage (13 → 14) and finally of the maximum growth rates appears in stage (14 → 15 Y). The annual increase rate of (TBF) variable appears with varying proportion for the adolescent's in the rural areas. The adolescents who have annual increase rates of (TBF) variable, may continue to increase in the future if we are not taken our necessary precaution to prevent or reduce the risk of increasing the body fat percentage for adolescent's, which may

push them in the future to being overweight or Obese. Regarding (MS variable) the maximum growth rates for the adolescents in the rural area were at the stage (13 → 14 Y) and (12 → 13 Y) for adolescents in urban areas. This previous result agreed with what reported that muscle mass growth occurs during adolescence in males, accompanying a linear increase in muscle strength, males demonstrate an acceleration of muscle strength around age (13 Y) (Patel DR et al.,1998).

The maximum growth rates of TBW variable in the stage (12 → 13 Y) were for adolescents in both urban and rural areas. the maximum growth rates were of (Bone-BMR variables) for adolescents in rural areas at stage (14 → 15 Y) and for the adolescent's in urban areas in the stage (12 → 13 Y). Table (4) has shown the correlation between the maximum growth rates of the variable (BMR) and the maximum growth rates of (Bone) variable among adolescents, despite the difference in the age stage, and this confirms that the dietary intake controls the bone mass of adolescent's during this stage. Increase dietary intake or disturbances in the type and quantity of food, it will directly affect the bone mass and density. Previous study confirmed that eating disorders (ED) are serious mental illnesses that are also characterized by detrimental somatic changes such as reduced physical fitness, altered body weight, and body fat percentage, and poor bone health (Solfrid Bratland-Sanda et al.,2012). Other study added that, some conditions delaying the maturation of the skeleton, such as chronic diseases, malnutrition and growth hormone (GH) deficiency (Kulin HE et al.,1982). While it was reported that the appropriate nutrition and physical activity, including weight-bearing and loading, are essential contributors to optimal bone growth. Lifetime bone mineral density acquisition occurs primarily during the second decade of life (Bailey DA et al.,1996).

Also, the result showed that the growth rates of the adolescent are in the rural areas of some anthropometric characteristics and body composition variables better than the growth rates adolescent's in the urban areas. these good

results not only due to the individual variations between adolescents during adolescence or the difference in the emergence of the growth spurt in some quickly and others it appears late but also due to differences in life (urban-rural) and daily lifestyle. adolescent's in the rural areas accustomed helps their family in daily life works, whether at home or in the fields of agriculture and then walks to school for long distances without using any transportation like available transportation in urban areas. As well fast-food restaurants not spread like urban areas, and the family sticks to the culture of their children getting their meals from home in addition to the culture of the rural family in eating meals together at home. In addition, landscape rural areas, the simple daily life, and no overcrowding all this helps the adolescents to relax and sleep early so their bodies take the necessary time from rest, that opposite of the daily lifestyle in the urban areas, life lasts 24 hours.

In conclusion, based on all previous results of my study, there were differences in growth spurts timing for individual adolescents. Moreover, the adolescent's growth rates in the rural areas of some anthropometric characteristics and body composition variables indicated a good result relative to the urban areas. The adolescent's surrounding environment, daily lifestyle and dietary intake have a great effect on growth rates. Also, the growth rates of anthropometric characteristics are faster than the growth of the body composition variables. Further studies should indicate the related risks of adolescent's training or exposure to high-intensity training during this stage. Finally, it is important to follow the growth of children and adolescents continuously and follow their growth rates with global child growth charts (WHO - CDC).

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