

## A STUDY OF STATUS OF OSSIFICATION CENTRES AT DISTAL END OF RADIUS AND ULNA ALONG WITH DEVELOPMENT OF SECONDARY SEXUAL CHARACTERS IN GIRLS OF 14-16 YEARS AGE, FROM BAGALKOT REGION OF KARNATAKA

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### Abstract

**Background:** Age determination of an individual from the appearance and fusion of the ossification centres is a well-accepted fact in Forensic Medicine. This study aims to know the status of epiphyseal fusion at the distal end of radius & ulna along with development of secondary sexual characters for the evaluation of age. 100 healthy school girls, residents of Bagalkot, 50 each from age group of 14-15 years and 15 to 16 years were selected for the study. In total of 100 girls ageing from 14-16 years, the stage of epiphyseal union at distal end of radius was stage 2 in 26%, stage 3 in 47%, stage 4 in 36% and only 4% were in stage 5 (complete union). Whereas epiphyseal union at distal end of ulna was of stage 2 in 26% girls, stage 3 in 36%, stage 4 in 20% and only 18% in stage 5 (complete union). So, in girls of this region complete union of distal end of radius and ulna takes place later than 16 years of age. Regarding secondary sexual characters; Pubic hair: Out of 100 girls, 10% had developed stage 2 followed by 32% had developed stage 3, maximum i.e., 54% had stage 4 and only 4% were of stage 5 (adult) type pubic hair. Axillary hair: had appeared in the whole study population 11% of girls had developed (Stage 3) adult type. Breast development: majority of girls in the study group 42% girls had stage 3; followed by 27% with stage 2 and 24% with Stage 4. Only 7% of girls had stage 5 development. Mean age of attainment of menarche was 12.25 years.

## INTRODUCTION

Age estimation becomes a valuable tool to assist in administration of many civil and criminal procedures such as identification, consent, criminal responsibility, clinical examination, validity of will, attainment of majority, kidnapping, rape, criminal abortion etc.

The absence of legal documentation often leads the authorities to seek the help of an expert for guidance and assistance in this regard.

The age for fusion of ossification centres is fairly constant with minor variations and a reliable guide for estimation of age. Pubertal period in girls is accompanied by certain well defined changes, which can also be used to estimate the age.

In girls the process of puberty begins about 1-2 years earlier than boys, and reaches completion in a shorter time. Girls progress to adulthood about 4 years after the first physiological change appear.<sup>[1]</sup>

Owing to different variations in climatic, dietetic, hereditary and other factors affecting the people of the different states of India, it is difficult to develop a single uniform database for the whole country.<sup>[2]</sup> Hence this study was undertaken to formulate references in future to estimate the age of females from radiological examination of wrist joint and development of secondary sexual characters in the age group of 14 – 16 years girls.

## MATERIALS AND METHODS

The study was begun after getting clearance from Institutional Ethical committee.

100 girls of age group 14-16 years were listed and then selected 50 each from age group of 14 -15 and 15 -16 years after confirming with documented age. A proforma was prepared for collecting the relevant information from the study group. Informed consent was taken after explaining the procedure and motive of the study.

### Inclusion Criteria

1. Healthy, normal girls between age group who have completed 14 years but not completed 16 years of age.
2. Subjects who had documentary evidence of age in the form of birth certificate issued by Municipal authority and/or school records.
3. Subjects who were born and brought up in Bagalkot district

### Exclusion Criteria

1. Subjects with skeletal deformity, disease, malformation or injury.
2. Subjects with severe malnutrition, endocrinal disorders or chronic illness.

### Method of Collection of Data

Totally 100 girls were selected according to inclusion criteria after general physical examination. According to age divided into two Groups.

Group I.: 50 girls from age group of 14-15 years

Group II.: 50 girls from age group of 15-16 years

Radiological examination and staging of epiphyseal union:

X-ray of the right wrist joint (both AP view and lateral view) of study group girls were taken.

The status of ossification of epiphyses are noted and staging was made as according to the following method (by Galstaun (1930)<sup>3</sup>, McKern and Stewart (1957)<sup>4</sup> and Kothari (1974)<sup>5</sup>)

Stage 0: Not appeared- When epiphyseal cartilage did not begin to decrease in thickness.

Stage 1: Epiphyseal cartilage begins to decrease in thickness.

Stage 2: Beginning-Thickness of epiphyseal cartilage was found to be reduced appreciably.

Stage 3: Advanced- when epiphysis begins to fuse with the shaft and complete union was well underway.

Stage 4: Recent union- when epiphyseal cartilage was bony in architecture and density indistinguishable from the epiphysis and diaphysis in its surroundings, but an epiphyseal line called an epiphyseal scar could still be distinguished.

Stage 5: Complete union with absence of epiphyseal scar.

### Physical Examination

Standard height measuring instrument was used to measure the height in centimeters where the subject was asked to stand straight without footwear, heels together, shoulder, buttocks and heel touching the scale and subject looking straight.

The weight was calculated in kilograms on the standardized weighing machine without footwear.

For knowing the appearance and development of secondary sexual characteristics, the subjects were examined in a private room with cubicle curtain.

Tanner has described sequence of somatic and physiologic changes occurring at puberty which give rise to the sexual maturity rating or Tanner stages of breast pubic hair & axillary hair development<sup>6</sup>. The staging was noted accordingly

Menstruation: Menarche typically occurs about two years after thelarche<sup>1</sup>. Age of menarche was noted.

### Data Analysis

The findings obtained were tabulated and statistically analyzed with aid of SPSS (17.0). The results were compared with similar studies in other parts of India and abroad.

### Statistical Methods Used

The data was analyzed using percentages, mean, Chi square test and Fisher's exact test.

## RESULTS

**Table 1: Ossification status at distal end of Radius & Ulna**

Ossification status	14-15 years Girls		15-16 years Girls		Total	
	n	%	N	%	n	%
Distal end of Radius						
Stage 0	0	0	0	0	0	0
Stage 1	0	0	0	0	0	0
Stage 2	13	26	0	0	13	13
Stage 3	29	58	18	36	47	47
Stage 4	8	16	28	56	36	36
Stage 5	0	0	4	8	4	4
Total	50	100	50	100	100	100
Distal end of ulna						
Stage 0	0	0	0	0	0	0
Stage 1	0	0	0	0	0	0
Stage 2	24	48	2	4	26	26
Stage 3	20	40	16	32	36	36
Stage 4	3	6	17	34	20	20
Stage 5	3	6	15	30	18	18
Total	50	100	50	100	100	100

Above table (table no.1) shows the ossification status around wrist joint among girls in 14-15 and 15-16 years age groups.

In 14-15 years girls, epiphyses for distal end of radius was in Stage 3 union among 58% of individuals while 26% individuals were in stage 2 and 16% were in Stage 4 union. None of the girl showed complete union (Stage 5).

In the 15-16 years age group 56% of girls were still in the stage 4 and 36% were in stage 3 of epiphyseal union while only 4 girls showed stage 5 of epiphyseal union

For the distal end of ulna, at 14 years, 48% of the girls were in Stage 2 of union while 40% girls were observed in Stage 3 of epiphyseal union. At age 15, 34% of girls had epiphyses for distal end of ulna in Stage 4 of union and 32 % in Stage 3 while 30% of girls showed complete union.

**Table 2: Pubic hair staging in Girls**

Pubic Hair Staging	14-15 Years Girls		15-16 Years Girls		Total	
	n	%	n	%	N	%
Stage 1	0	0	0	0	0	0
Stage 2	8	16	2	4	10	10
Stage 3	17	34	15	30	32	32
Stage 4	24	48	30	60	54	54
Stage 5	1	2	3	6	4	4
Total	50	100	50	100	100	100%

Table no.2 shows that Most of the girls from both the age group had Stage 4 (54%) of pubic hair growth, 34% girls of 14 years age had Stage 3 while 30% girls from 15 years age group had developed Stage 3. Only one girl of 14 years and 3 girls of 15 years had developed adult like (Stage 5) pubic hair. Out of 100 girls, 10% had developed Stage 2 followed by 32% had developed Stage 3.

**Table 3: Breast Development staging in Girls**

Breast development Staging	14-15 Years Girls		15-16 Years Girls		Total	
	N	%	n	%	N	%
Stage 1	0	0	0	0	0	0
Stage 2	17	34	10	20	27	27
Stage 3	26	52	16	32	42	42
Stage 4	6	12	18	36	24	24
Stage 5	1	2	6	12	7	7
Total	50	100	50	100	100	100

The table no.3 depicting breast development stages in females denotes that, majority of girls from age group of 14 years had Stage 2 and Stage 3 in 34% and 52% respectively. Majority of 15 years girls had Stage 3 and Stage 4 in 32% and 36% respectively.

As a total in the study group 42% girls had Stage 3; followed by 27% with Stage 2 and 24% with Stage 4. Only 7% girls had Stage 5 of breast development.

**Table 4: Axillary hair staging in Girls**

Axillary Hair Staging	14-15 Years Girls		15-16 Years Girls		Total	
	n	%	N	%	n	%
Stage 1	3	6	0	0	3	3
Stage 2	43	86	43	86	86	86
Stage 3	4	8	7	14	11	11
Total	50	100	50	100	100	100

Table no.4 shows the axillary hair development

In 14 years age group (table no. 4) 86% girls had Stage 2, and 8% had stage 3. While in 15 years age group 14% had Stage 3 of axillary hair development. In the whole study population axillary hair had not appeared in 6% of girls and 11% of girls had developed (Stage 3) Adult type

**Table 5: Menarche in girls**

Menarche		14-15 years Girls		15-16 years Girls		Total	
		n	%	n	%	N	%
Not attained		0	0	0	0	0	0
Attained	<1 years ago	5	10	1	2	6	6
	1-2 years ago	13	26	4	8	17	17
	2-3 years ago	29	58	16	32	45	45
	>3years ago	3	06	29	58	32	32
Total		50	100	50	100	100	100
Mean age (years)		12.25		12.43		12.34	

Table no. 5 shows age of attainment of Menarche in girls

Menarche was attained by 58% of girls 2-3 years ago (12 yrs) and 26 % of girls 1-2years (13 yrs) ago by girls of 14 years age. 58% of 15 years girls had attained menarche more than 3 years ago (12yrs). 4 girls had attained menarche 4 years ago that is at around 11 years of age. All the girls had attained menarche, and mean age of

attainment of menarche was 12.25 years in girls of 14-15 years and 12.43 in girls of 15-16 years and for the entire study group it was 12.34 years.

## DISCUSSION

**Table 6: Comparison of ossification of distal end of radius with other studies**

Study	Age												Age of ossification of Distal end of Radius
	14-15 years						15-16 years						
	No. of girls examined	union in girls	%	No. of boys examined	Union in boys	%	No. of girls examined	union in girls	%	No. of boys examined	Union in boys	%	
<b>Indian studies</b>													
Galstun (Bengal-1937) <sup>3</sup>	51	22	43.1	26	2	7.6	35	19	54.2	64	2	3.12	M:18 yrs F:16-17 yrs
Lal and Townsend (Lucknow-1939) <sup>7</sup>	21	3	14.2	-	-	-	19	9	47.3	-	-	-	19 yrs
Aggarwal and Pathak (Punjab-1957) <sup>8</sup>	25	1	4	-	-	-	24	14	58.3	-	-	-	15-17 yrs
Kothari (Marwar - 1974) <sup>5</sup>	14	0	0	16			23	3	13.0	10			M: 18-19 yrs F: 17-18 yrs
Prasad R (Bihar-1979) <sup>9</sup>	5	0	0	-	-	-	10	0	0	-	-	-	18-19 yrs
Banerjee and Agarwal (Delhi-1998) <sup>10</sup>	15	1	6.6	15	0	0	15	7	46.6	15	0	0	M: 19-20 yrs F: 18-19 yrs
Kagane (Marathwada-1999) <sup>11</sup>	27	1	3.70	-	-	-	28	8	28.5	-	-	-	17-18 yrs
Nemade et al (Vidharbha-2007) <sup>12</sup>	3	0	0	-	-	-	5	1	20	5	0	0	M: 20-21 yrs F: 19-20 yrs
Bhise (Mumbai-2011) <sup>13</sup>	-	1	8.3	-	0	0	-	4	33.4	-	3	13.3	M: 17-18 yrs F:16-17 yrs
<b>Present study (Bagalkot)</b>	<b>50</b>	<b>0</b>	<b>0</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>50</b>	<b>4</b>	<b>8</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>Above 16 yrs</b>

### Distal end of Radius

In the present study, (table no.6) none of the girl showed complete fusion of lower end of radius, in 14-15 yr age group and only 8% girls of 15-16 years of age showed complete fusion.

The fusion of distal end of radius is in advanced stage in the studies conducted by Galstaun (1937),<sup>[3]</sup> in Bengali girls, by Lal and Townsend(1939),<sup>[7]</sup> in girls from Lucknow and by Banerjee and Agarwal (1998)<sup>[10]</sup> on girls from Delhi as compared to our study, Galstaun (1937).<sup>[3]</sup> also observed that fusion was 1-2 years earlier in female than male.

A work in Marwar region of Rajasthan by Kothari (1974).<sup>[5]</sup>, Study of girls of Munda and Oraon tribes

by Prasad.R(1976).<sup>[9]</sup>, by Kangne (1999).<sup>[11]</sup> from Marathwada region, by Nemade (2007).<sup>[12]</sup> at Vidharbha region and study by Bhise (2010).<sup>[13]</sup> in Mumbai region of Maharashtra, all are consistent with present study.

Ossification of distal end of radius is earlier by 1-2 years as compared to our findings in Punjab population as from study by Aggarwal and Pathak (1957).<sup>[8]</sup>

The age range of epiphyseal union of distal end of radius with shaft for females could not be determined in the present study due to limitation of the age of the study groups.

## Distal end of ulna

**Table 7: Comparison of ossification of distal end of ulna with other studies**

Study	Age												Age of ossification of Distal end of Ulna
	14-15 years						15-16 years						
	No. of girls examined	union in girls	%	No. of boys examined	Union in boys	%	No. of girls examined	union in girls	%	No. of boys examined	Union in boys	%	
<b>Indian studies</b>													
Galstun (Bengal-1937) <sup>3</sup>	51	8	15.6	26	1	3.84	35	8	22.8	64	1	1.56	M:18 yrs F:17 yrs
Lal and Townsend (Lucknow-1939) <sup>7</sup>	21	5	23.8	-	-	-	19	9	47.3	-	-	-	19yrs
Aggarwal and Pathak (Punjab-1957) <sup>8</sup>	25	1	4	-	-	-	24	16	66.6	-	-	-	15-17 yrs
Kothari (Marwar - 1974) <sup>5</sup>	14	0	0	16	-	-	23	5.9	26	10	-	-	M: 18-19 yrs F: 17-18 yrs
Prasad R (Bihar-1979) <sup>9</sup>	5	0	0	-	-	-	10	0	0	-	-	-	18-19 yrs
Banerjee and Agarwal (Delhi-1998) <sup>10</sup>	15	1	6.6	15	0	0	15	7	46.6	15	0	0	M: 19-20 yrs F: 18-19 yrs
Kangne (Marathwada-1999) <sup>11</sup>	27	02	7.41	-	-	-	28	12	42.8	-	-	-	16-17 yrs
Nemade et al (Vidharbha-2007) <sup>12</sup>	3	0	0	-	-	-	5	0	0	5	0	0	M: 19-20 yrs F: 19-20 yrs
Bhise (Mumbai-2011) <sup>13</sup>	-	1	12.5	-	-	0	-	2	25	-	2	9.1	M: 17-19 yrs F: 16-17 yrs
<b>Present study (Bagalkot)</b>	<b>50</b>	<b>3</b>	<b>6</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>50</b>	<b>15</b>	<b>30</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>Above 16 yrs</b>

Table no.7 shows that among the subjects of age group 14-15 years, 6% of the girls showed complete fusion of lower end of ulna and 30% girls of 15-16 years age showed complete fusion.

Observations by Galstun (1937).<sup>[3]</sup> in Bengali girls, by Lal and Townsend(1939).<sup>[7]</sup> in his study on girls from Lucknow, findings are similar as that of our study.

Findings in Punjab population as from study by Aggarwal and Pathak (1957).<sup>[8]</sup> was that in girls of age group between 14-15 years, only 4% showed fusion, whereas 66.6% girls of 15-16 years showed fusion of distal end of ulna with shaft which is earlier compared to our study.

Other studies by Kothari(1974).<sup>[5]</sup> in Marwar region of Rajasthan, study of girls of Munda and Oraon tribes by Prasad.R(1976).<sup>[9]</sup> in Bihar, by Kangane (1999)<sup>11</sup> from Marathwada region, Nemade (2007).<sup>[12]</sup> at Vidharbha region and study by Bhise (2010).<sup>[13]</sup> in Mumbai region of Maharashtra, all are consistent with present study.

The age range of epiphyseal union of distal end of radius with shaft for females could not be determined in the present study due to limitation of the age of the study groups.

### The styloid process of the ulna

A separate center for the ulnar styloid process was seen in the present study in two cases (1 in 14 yrs and 1 in 15 yrs age group) out of 100 cases. This appeared slightly below the lower epiphysis in radiograph.

A similar finding seen by Galstun(1937)<sup>3</sup> in 3 cases out of 100.

Davies and Parson (1927).<sup>[14]</sup> in England, found double epiphysis for styloid process of ulna in 2 cases out of 45 cases, the two centers being side by side.

Flecker (1932).<sup>[15]</sup> in Melbourne population found a separate ossicle representing the detached styloid process of ulna in one boy.

The ossification of bones was found to occur earlier in present study when compared to that with the

population of temperate climate. There was no statistically significant association of ossification process of bones with socioeconomic class, exercise and diet, which did not affect it.

This finding was contrary to the observation by Bokaria(2009)<sup>16</sup> in Jodhpur (Rajasthan) which states that ossification is delayed in the individuals taking non-vegetarian diet than vegetarian.

### Secondary sexual characteristics in girls

**Table 8: Various stages of Breast development and their comparison with other studies**

Study	14-15 years (%)					15-16 years(%)					Breast development stage
	BD 1	BD 2	BD 3	BD 4	BD 5	BD 1	BD 2	BD 3	BD 4	BD 5	And age
<b>Indian Studies</b>											
Choudhury (2006-Orissa) <sup>17</sup>	11.4	-	48.6	25.7	14.3	2.6	-	27.1	44.7	31.6	BD 2:12.60 yrs
Potdar AB (2012 Bagalkot) <sup>18</sup>	4	46	42	6	2	0	40	42	8	10	BD 2-3: 14-16 yrs
Singh.D (2012-Punjab) <sup>19</sup>	-	-	38	62	0	-	-	11	78	11	BD 3-4: 14 yrs
											BD 3-5: 15 yrs
											BD 4-5: 16 yrs
Kollur.L.R (2013-Karad) <sup>20</sup>	0	6.2	43.8	50	0	0	0	33.3	58.3	8.3	BD 2:11.4
											BD 3:14.3
											BD 4:16.7
											BD 5:-17.7
Present study (Bagalkot)	0	34	52	12	2	0	20	32	36	12	BD 2-3: 14-15 yrs
											BD 3-4: 15-16 yrs

In the present study girls belonging to 14-15 years age group, 34% and 52% girls had Stage 2 and Stage 3 of breast development respectively, while 2% of the girls had Stage 5. Breast development was observed to be in Stage 2 and 3 among 20% and 32% of the girls respectively belonging to age group 15-16 years, while 36% had Stage 4 and only 12% had Stage 5(Adult type) development.

Work by Choudhury (2006).<sup>[17]</sup> in Orissa, development of breast is 1 year earlier as compared to our study.

Studyby Potdar AB (2012).<sup>[18]</sup> in Bagalkot, by Singh.D (2012).<sup>[19]</sup> in Punjabi girls & by Kollur.L.R (2013).<sup>[20]</sup> on Karad girls findings are consistent with our study.

**Table 9: Various stages of Pubic hair development and their comparison with other studies**

Study	14-15 years (%)					15-16 years(%)					Age of Pubic hair development stage in years
	PH 1	PH 2	PH 3	PH 4	PH 5	PH 1	PH 2	PH 3	PH 4	PH 5	
<b>Indian studies</b>											
Choudhury (2006-Orissa) <sup>17</sup>	62.9	8.6	20	5.7	2.8	31.6	10.5	18.4	26.3	13.2	PH 2: 14.42 yrs
Potdar AB (2012-Bagalkot) <sup>18</sup>	0	20	32	46	2	0	12	38	46	4	PH3-4: 14-16 yrs
Singh.D (2012-Punjab) <sup>19</sup>	0	0	25	63	12	0	0	0	33	67	PH 3-5: 14 yrs
											PH 4-5: 15 yrs
											PH 5: 16 yrs
Kollur.L.R (2013-Karad) <sup>20</sup>	0	31.2	43.8	6.2	0	0	8.3	33.3	41.7	0	PH 2:12.0
											PH 3:15.1
											PH 4:17.0
											PH 5:18.5
Present study (Bagalkot)	0	16	34	48	2	0	4	30	60	6	PH 3-4: 14-16 Yrs

Note:\*PH=Pubic Hair

In the present study group 34% girls were in Stage 3 and 48% girls had Stage 4 of pubic hair development in the girls of age group between 14-15 years. Among the girls aged between 15-16 years, 30% had Stage 3 and 60% had Stage 4 of pubic hair development. In the present study majority of girls in the age group between 14-16 years were in between Stage 3-4 of pubic hair development.

Choudhury (2006).<sup>[17]</sup> conducted a study in Orissa, & study by Potdar AB (2012).<sup>[18]</sup> in Bagalkot, their findings were consistent with our study.

In a study by Singh. D (2012).<sup>[19]</sup> on Punjabi girls, pubic hair appearance is 1-2 years earlier compared to present study.

Whereas in a study by Kollur L.R (2013)<sup>[20]</sup> in Karad, pubic hair appearance is delayed by 1-2 year.

**Table no. 10: Comparison of age of appearance of Axillary hair with other studies**

Study	14-15 years (%)	15-16 years(%)	Age of axillary hair appearance in years
	Present (%)	Present (%)	
Choudhury (2006-Orissa) <sup>17</sup>	54.3	71	14.30
Potdar AB (2012-Bagalkot) <sup>18</sup>	86	100	14 yrs
Singh.D (2012-Punjab) <sup>19</sup>	75	89	10 yrs
Kollur.L.R (2013-Karad) <sup>20</sup>	-	-	11.5
<b>Present study (Bagalkot)</b>	<b>94</b>	<b>100</b>	<b>14 yrs</b>

Axillary hair had appeared (table no.10) in 94% of the girls by the age of 14-15 years in present study, and in all the girls belonging to age group between 15-16 years. Hence axillary hair appears by 14-15 Findings in study conducted by Potdar AB (2012).<sup>[18]</sup> in Bagalkot, & by Singh D (2012).<sup>[19]</sup> in

Punjabi girls are consistent with our study in girls of this region.

In Work by Choudhary (2006).<sup>[17]</sup> in Orissa, age of appearance is 1-2 year later than the present study.

Age of axillary hair appearance is earlier in Karad population compared to our study.

**Table 11: Comparison of Age of attainment of Menarche with other studies**

Study	Age of attainment of Menarche in years
<b>Indian studies</b>	
Lal R and Townsend (1939-Lucknow) <sup>7</sup>	12-14
Choudhury (2006-Orissa) <sup>17</sup>	14.25
Potdar AB (2012-Bagalkot) <sup>18</sup>	12-13
Singh.D (2012-Punjab) <sup>19</sup>	11-12
Kollur.L.R (2013-Karad) <sup>20</sup>	13.4
Present study (Bagalkot)	12-13
<b>Foreign study</b>	
Marshall and Tanner (UK-1969) <sup>1</sup>	13.47

In the present study, (table no.11) the mean age of menarche was 12.34 years.

Another study by Lal R and Townsend (1939).<sup>[7]</sup> in Lucknow, by Potdar AB (2012).<sup>[18]</sup> studied in Bagalkot, their findings are consistent with our study.

In a Study by Choudhury (2006).<sup>[17]</sup> in Orissa girls, by Kollur.L.R (2013).<sup>[20]</sup> in Karad age of menarche is 1-2 years delayed compared to our study where as it is 1-2 years earlier compared to the present study in Punjabi girls as observed by Singh.D (2012).<sup>[19]</sup>

Marshall and Tanner (UK-1969)<sup>1</sup> observed that mean age of onset of menarche was 13.49 which is 1 year delayed compared to the present study.

4. Axillary hair appears by 14-15 years and develops into adult type towards the end of 16years or after the age of 16 years.

5. Development of breast start earlier than 14 yrs and further development completes by 16 yrs or later than 16yrs.

6. Age of attainment of menarche is by 12-13 years (mean age-12.34).

A close estimate range of age can be achieved by using multiple age indicators like ossification and physical examination. However, further similar studies are needed to find out authenticated criteria(s) to narrow down the age range in the estimation of age.

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## **CONCLUSION**

In the Bagalkot region of north Karnataka girls:

1. Complete union of distal end of radius takes place towards the end of 16 years or later than 16 years.
2. Complete union of distal end of ulna takes place towards the end of 16 years
3. Pubic hair appears earlier than 14 yrs and further development completes at a later than 16 yrs of age

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