Age Changes in Muscle and Fat Distribution among the Oraon Tea Garden Labourers of Alipurduar District, Northern West Bengal

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ABSTRACT: Human morphological changes do not follow universal pattern and vary between/among individuals and other socio-cultural parameters. Study on age related changes in muscle and fat distribution are still insufficient considering particular occupational group like tea labourers. Present study explored the nature and magnitude of age changes in selected anthropometric and body composition traits in adult Oraon tea garden labourers of Alipurduar district. The anthropometric and body composition traits including 12 variables were collected from 712 healthy individuals. Study group was divided in 4 age cohorts. Sexual dimorphism was observed in the nature and magnitude of age changes in body composition traits. ANOVA showed differences between/among age groups for fat and fat free components traits. Pearson's correlation showed positive relationship of age with fat components and negative relationship with height, weight, fat free components. Tea garden laborers showed unique nature and magnitude of age changes in muscle and fat starting immediately after young age.

INTRODUCTION

Morphological features in human changes over time throughout one's life (Susanne,'80; Strickland and Ulijaszek,'93; Orr *et al*., 2001). However, the nature and magnitude of these changes vary between/ among individuals due to gene-environment interaction. Humans experience marked morphological changes up to late adolescence caused by growth and development but during adulthood and later ages these changes are slow primarily due to osteological, fat or muscle tissue changes (Shimokata *et al*.,'89; Strickland *et al*.,'93; Orr *et al*., 2001; Bose, 2002). It is primarily known as age related changes (Das and Roy, 2010).

It is well-documented that body composition traits like fat mass (Hughes *et al*., 2004), muscle mass (Gallagher *et al*.,'97), total body water, bone minerals (Singhal *et al*.,'88) as well as visceral fat, subcutaneous fat and skeletal muscles (Boneva-Asiova and Boyanov, 2011), do not reach at the optimum at similar age or at similar rate. Das and Roy (2010) and Tian *et al.* (2016) mentioned that height reaches its peak at early adulthood whereas weight reaches its peak much later.A number of longitudinal (Shimokata *et al*.,'89; Sorkin *et al*.,'99; Jackson *et al*., 2012) and cross-sectional (Strickland and Ulijaszek,'93; Manandhar *et al*.,'97; Kehayias *et al*., '97; Kyle *et al*., 2001; Dangour, 2003; Das and Roy, 2010; Yamada *et al*., 2014) studies also found that age related body composition changes vary acrossgenders (Strickland and Ulijaszek,'93; Kotani *et al*.,'94; Teh *et al*.'96; Bisai *et al*., 2008), vary due to different physical activities (Emery *et al*.,'93; Hughes *et al*., 2004), across ethnic groups (Teh *et al*.,'96; Tian *et al*., 2016; Chumlea *et al*., 2002) and so on. Das and Roy (2010) mentioned that age of

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males generally reaches their optimum height and weight earlier than females. Several studies also mentioned that Asian populations attained highest fat mass much earlier than White populations (Kotani *et al.*, '94; Teh *et al.*,'96). A number of studies were carried out on age-related body composition changes in Indian non-tribal populations (Singhal and Sidhu,'83; Bose and Chowdhury, 2003; Das and Roy, 2010) as well as on tribal populations (Roy and Pal, 2003; Bose *et al.*, 2006; Bisai *et al.*, 2008; 2009). However, the nature and extent of age related changes in muscle and fat distribution are still insufficient in the Indian context, especially on the tribal populations.

In view of the above, muscle and fat changes with increased age are unique and population specific and nature of occupation plays a major role in such changes.Therefore, present study is planned to be conducted in specific population group considering their occupation and in specific sexes, more specifically tried to examine the nature and magnitude of age related changes in anthropometric and body composition traits among the adult Oraon tea garden labourers of Alipurduar district, West Bengal.

MATERIALS AND METHODS

Population and Area: The study was carried out as a part of a large bio-medical project. Cross-sectional Anthropometric data collected from 712 healthy adult Oraon (marginal/tribal group) tea garden labourersof both sexes (323 males and 389 females).The labourers were engaged in two tea gardens namely Birpara (under Birpara police station) and Tasati (under Falakata police station) of Alipurduar district, West Bengal, India. The study was restricted to a single ethnic group i.e. Oraons (endogamous)to eliminate possible ethnic/genetic effect(s) on body composition traits. 'Oraons belong to the Dravidian linguistic group (Roy, 2004; '15). Oraons are scheduled tribe, concentrated mainly in the states of eastern part of India, namely of Bihar, Jharkhand, Orissa, West Bengal, Uttar Pradesh, Madhya Pradesh (Mandal *et al.*, 2002 *cited in* Chakraborty and Bose, 2008). They are the 2nd highest scheduled tribe population of West Bengal having highest concentration in Alipurduar and Jalpaiguri district. Present tea garden Oraons are considered as a migrant population in Alipurduar district, West Bengal (Karmakar, 2005).

Data and Methods: No statistical sampling attempted for the selection of participants because of obvious suspicion in the field. Individuals of both sexes approached with aim and objectives of the study, who volunteered to participate were measured. Written consent was obtained from the study participants during data collection. Information on age obtained from either written records or by cross-verifying with reference to some significant local events in case of those who had no written birth records. Anthropometric and body composition data collected by a single investigator (AM) following standard instrument and techniques (Weiner and Lourie, '81). Height was measured to the nearest 0.01 cm andbody weight (light apparel) measured using a weighing scale to the nearest 0.01 kg (Bose and Chaudhuri, 2003).

Percentage Body Fat (PBF), visceral fat and subcutaneous fat and skeletal muscle percentage for trunk, arms and legs measuredfollowing standard technique with Omron HBF-375 Karada Scan (body fat monitor).

Fat mass (FM) and fat free mass (FFM) were computed using the following equation-

FM (kg) = (PBF/100) X Weight (kg) [Where, PBF = % body fat]

FFM (kg) = Weight (kg) - FM (kg)

Total body water (TBW) was computed using the sex-specific equation of Watson et al. (1980)

TBWfor males= 2.447 - (0.09156 X age) + (0.1074 X height) + (0.3362 X weight)

TBW for females= -2.097 + (0.1069 X height) + (0.2466 X weight)

Data Analysis: Individuals of both sexes were classified into 4 groups with 10- year age cohort. 1^{st} group consisted individuals of<25 years (young).2^{nd} group had individuals of 25-34 years (young and mid-aged). 3^{rd} and 4^{th}respectively involved individuals of 35-44 years (middle aged) and >44 years (elderly). It would have been ideal to classify with each age for understanding age changes but was not possible due to small number of samples.

Descriptive statistics calculated for anthropometric and the body composition traits and one-way ANOVA calculated to see the differences between/among age cohorts in terms of mean values for all the traits, separately for either sex. Significant ANOVA results were further analysed with post-hoc analysis (Scheffe's test) to find out exact mean differences between age cohorts. Further, Pearson's correlation was performed between age and body composition traitsto explore any existing relationship. All statistical analysis done using SPSS 18.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

Table 1 showed descriptive statistics pertaining to anthropometric and body composition traits of 4-age cohorts of male Oraon tea garden labourers. The young group (<25 years) showed higher mean values in height, fat free mass, total body water and skeletal muscle percentage of trunk, arms and legs. The 2nd group (25-34 years) shows higher mean values only in weight. The 3rd group (35-44 years) showed no higher mean values for any body composition traits. Elderly group (>44 years) showed higher mean values in fat mass, visceral fat percentage and subcutaneous fat percentage of trunk, arms and legs. Results of ANOVA showed significant difference in meanvalues between/among 4 age cohorts in almost all the traits except visceral fat percentage.

TABLE 1

Descriptive statistics pertaining to anthropometric and body composition traits of four age cohorts of male tea garden labourers

Variables	Age-groups (in years)								F(df=3,319)
	Gr. 1 (n=65)		Gr. 2 (n=92)		Gr. 3 (n=83)		Gr. 4 (n=83)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Height (cm)	164.21	5.93	163.59	6.51	163.34	5.52	160.61	6.10	5.550*
Weight (kg)	52.74	6.09	53.19	6.73	52.34	6.56	49.65	7.57	4.561*
FM (kg)	7.18	2.10	9.14	3.35	9.64	3.27	9.85	2.93	11.471*
FFM (kg)	45.56	5.41	44.05	5.66	42.70	5.25	39.80	6.23	14.366*
TBW	35.89	2.43	35.23	2.60	34.12	2.64	31.71	2.99	36.729*
VF (%)	3.32	1.29	3.95	2.29	4.10	2.18	4.11	2.70	1.977
			Subcutaneous fat (%)						
Trunk	7.85	2.09	10.28	4.14	10.53	3.09	11.42	2.98	15.636*
Arms	15.49	2.84	18.68	6.96	18.62	4.57	18.96	4.60	7.083*
Legs	14.38	3.38	17.51	6.13	17.86	5.33	18.44	4.59	8.945*
			Skeletal muscle (%)						
Trunk	31.02	2.22	28.43	3.46	27.17	3.06	25.24	3.02	46.834*
Arms	41.4	4.73	40.02	3.31	38.90	3.04	37.68	2.04	17.221*
Legs	53.12	2.88	50.65	4.60	49.37	4.65	46.70	5.14	26.524*

Note: FM=Fat mass; FFM=Fat free mass; TBW=Total body water; VF=Visceral fat; *p<0.05

Table 2 shows descriptive statistics pertaining to anthropometric and body composition traits of four age cohorts of female Oraon tea garden labourers. Youngest group (<25 years) showed higher mean values in fat free mass and skeletal muscle percentage of trunk, arms and legs. The 2nd group (25-34 years) showed higher mean values in height, weight and total body water. The 3rd group (35-44 years) showed higher mean values only in subcutaneous fat percentage in legs. Elderly group (>44 years) showed higher mean values in fat mass, visceral fat percentage and subcutaneous fat percentage of trunk and arms. Results of ANOVA showed significant mean values between/among 4 age cohorts in almost all the traits.

TABLE 2

Descriptive statistics pertaining to anthropometric and body composition traits of four age cohorts of female tea garden labourers

Variables	*Age-groups (in years)*								*F(df=3,385)*
	Gr. 1 (n=65)		*Gr. 2 (n=92)*		*Gr. 3 (n=83)*		*Gr. 4 (n=83)*		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Height (cm)	150.16	5.76	151.55	5.18	150.75	4.76	150.14	5.29	1.330
Weight (kg)	43.98	5.66	45.10	6.80	43.85	6.43	43.07	7.26	1.414
FM (kg)	10.65	2.83	11.85	3.30	11.66	3.60	12.08	4.17	2.983*
FFM (kg)	33.32	4.37	33.25	4.39	32.19	3.93	30.99	4.17	6.814*
TBW	24.79	1.84	25.22	2.04	24.83	1.83	24.57	2.12	1.616
VF (%)	2.08	1.16	2.55	1.71	2.65	1.82	2.99	2.08	4.648*
Subcutaneous fat (%) 5.48									
Trunk	16.20	4.14	17.52	3.93	17.67	4.41	18.92	5.48	5.960*
Arms	35.47	6.16	36.87	5.75	37.18	5.83	38.00	6.52	2.990*
Legs	31.37	5.43	31.89	4.65	31.40	5.07	31.02	5.57	0.414
Skeletal muscle (%)									
Trunk	23.06	2.17	21.84	1.76	21.17	2.15	19.56	2.34	47.070*
Arms	32.47	4.16	31.42	3.29	30.37	4.10	29.49	3.24	11.944*
Legs	38.60	3.27	37.58	3.05	36.74	6.94	34.88	4.07	11.175*

FM=Fat mass; FFM=Fat free mass; TBW=Total body water; VF=Visceral fat; *p<0.05

Table 3 showed Scheffe's test (post-hoc) between/among 4-age cohorts of tea garden labourers of either sex. Variables with significant ANOVA results were only computed. In males, significant difference existedfor Group 1 vs Group 4 and Group3 vs Group4in height. Again significant difference existed only between Group2 vs Group4 in weight. Fat mass showed significant differences between Group1 vs Group2; Group1 vs Group3 and Group1 vs Group4. Fat free mass and total body water showed significant difference between Group1 vs Group3; Group1 vs Group4; Group2 vs Group4 and Group3 vs Group4. Significant differences exist in subcutaneous fat percentage of trunk, arms and legs between Group1 vs Group2; Group1 vs Group3 and Group1 vs Group4. Skeletal muscle for arms showed significant difference between Group1 vs Group4 and Group2 vs Group4. Significant differences exists also in skeletal muscle for trunk and legs between Group1 vs Group2; Group1 vs Group3; Group1 vs Group4; Group2 vs Group4 and Group3 vs Group4.

TABLE 3

Scheffe's test (Post-hoc) between/among four age cohorts of tea garden labourers of either sex in anthropometric and body composition traits with significant F-values

Variables	Males						Females					
	1 vs 2	1 vs 3	1 vs 4	2 vs 3	2 vs 4	3 vs 4	1 vs 2	1 vs 3	1 vs 4	2 vs 3	2 vs 4	3 vs 4
df	155	146	146	173	173	164	163	200	204	181	185	222
Height (cm)	0.939	0.859	0.005*	0.995	0.015*	0.039*	–	–	–	–	–	–
Weight (kg)	0.982	0.989	0.060	0.877	0.009*	0.092	–	–	–	–	–	–
FM (kg)	0.001*	0.001*	0.001*	0.763	0.489	0.977	0.207	0.267	0.044*	0.988	0.979	0.849
FFM (kg)	0.439	0.027*	0.001*	0.480	0.001*	0.013*	1.000	0.304	0.001*	0.424	0.005*	0.205
TBW	0.514	0.001*	0.001*	0.062	0.001*	0.001*	–	–	–	–	–	–
VF(%)	–	–	–	–	–	–	0.411	0.152	0.004*	0.985	0.414	0.349
Subcutaneous fat (%)												
Trunk	0.001*	0.001*	0.001*	0.967	0.148	0.375	0.342	0.163	0.001*	0.497	0.250	0.253
Arms	0.002*	0.004*	0.001*	1.000	0.988	0.980	0.542	0.269	0.034*	0.994	0.677	0.799
Legs	0.003*	0.001*	0.001*	0.975	0.690	0.912	–	–	–	–	–	–
Skeletal muscle (%)												
Trunk	0.001*	0.001*	0.001*	0.057	0.001*	0.001*	0.005*	0.001*	0.001*	0.241	0.001*	0.001*
Arms	0.076	0.175	0.001*	0.175	0.010*	0.140	0.364	0.001*	0.001*	0.324	0.008*	0.379
Legs	0.010*	0.001*	0.001*	0.313	0.001*	0.002*	0.604	0.050*	0.010*	0.709	0.003*	0.039

FM=Fat Mass; FFM=Fat Free Mass; TBW=Total Body Water; VF=Visceral Fat; **Significance level specified*

In females, significant differences exist in fat mass, visceral fat, subcutaneous fat for trunk and arms between Group1 vs Group4. Significant difference exists in fat free mass betweenGroup1 vs Group4 and Group2 vs Group4. Significant difference exists in skeletal muscle for trunk betweenGroup1 vs Group2; Group1 vs Group3; Group1 vs Group4; Group 2 vs Group4 and Group3 vs Group4.Significant difference exists also in skeletal muscle for arms and legs between Group1 vs Group3; Group1 vs Group4 and Group2 vs Group4.

Results of Pearson's correlation coefficients presented in Table 4, to show relationship between age and body composition traits of tea garden labourers of either sexes. In males, height, weight, fat free mass, and total body water, skeletal muscle percentage for trunks, arms and legs showed significantly negative correlation with age. Whereas fat mass, subcutaneous fat for trunks, arms and legs showed significantly positive correlation with age. In females, fat free mass and all skeletal muscles showed significantly negative correlation with age. Whereas fat mass, visceral fat and subcutaneous fat for trunk and arms showed significantly positive correlation with age.Figure 1 depicts age-wise changes in the selected body composition traits for both male and female Oraon tea garden labourers.

TABLE 4

Pearson's correlation showing relationship between age and body composition traits of tea garden labourers of either sexes

	Age (in years)			
	r#	Sig.*	r#	Sig.*
Variables	Male		Female	
Height (cm)	-0.199	<0.001	-0.019	0.702
Weight (kg)	-0.183	0.001	-0.052	0.303
FM (kg)	0.266	<0.001	0.151	0.003
FFM (kg)	-0.350	<0.001	-0.208	<0.001
TBW	-0.591	<0.001	-0.015	0.339
VF (%)	0.101	0.070	0.208	<0.001
Subcutaneous fat (%)				
Trunk	0.322	<0.001	0.225	<0.001
Arms	0.183	0.001	0.167	<0.001
Legs	0.232	<0.001	-0.018	0.723
Skeletal muscle (%)				
Trunk	-0.563	<0.001	-0.541	<0.001
Arms	-0.393	<0.001	-0.302	<0.001
Legs	-0.436	<0.001	-0.301	<0.001

Figure 1 to 12 show the age changes in anthropometric and body composition traits in the Oraon tea garden labourers of Alipurduar district of the West Bengal

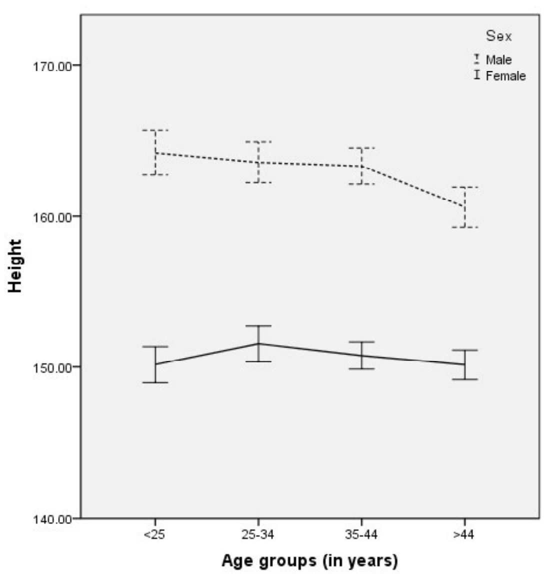


Figure 1

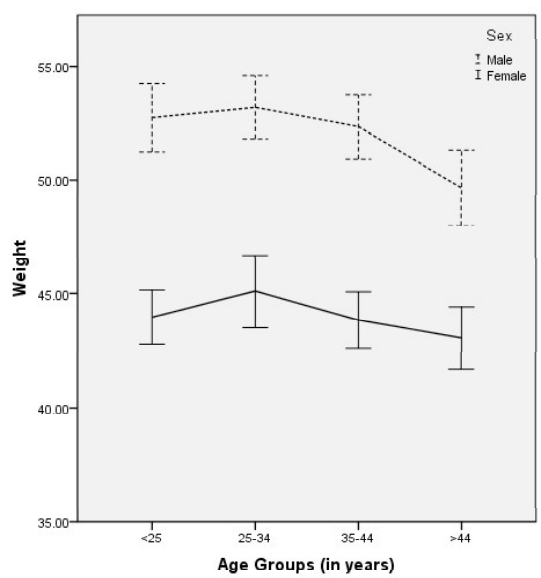


Figure 2

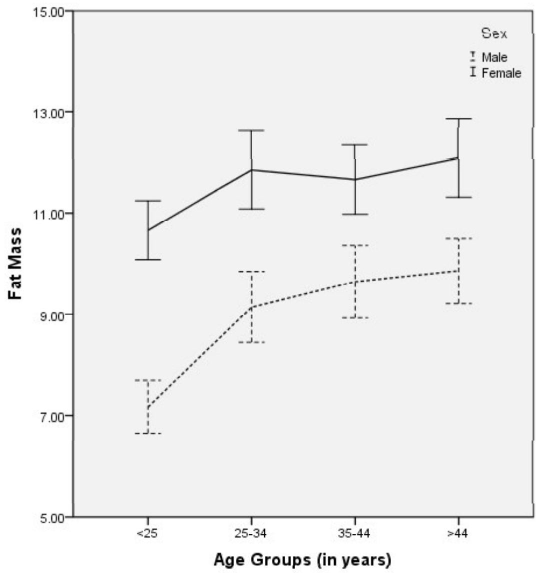
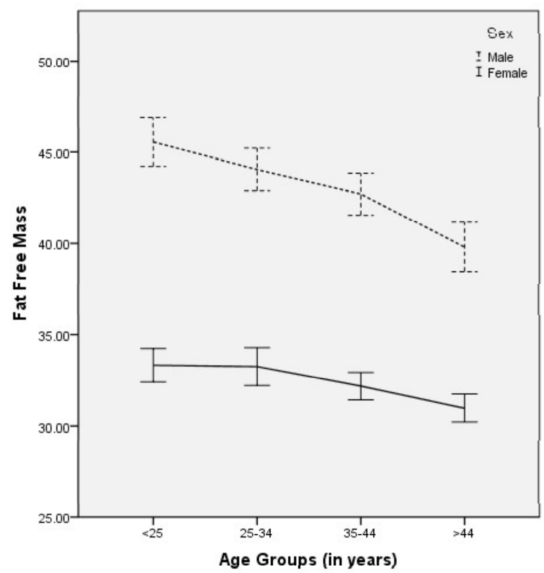


Figure 3



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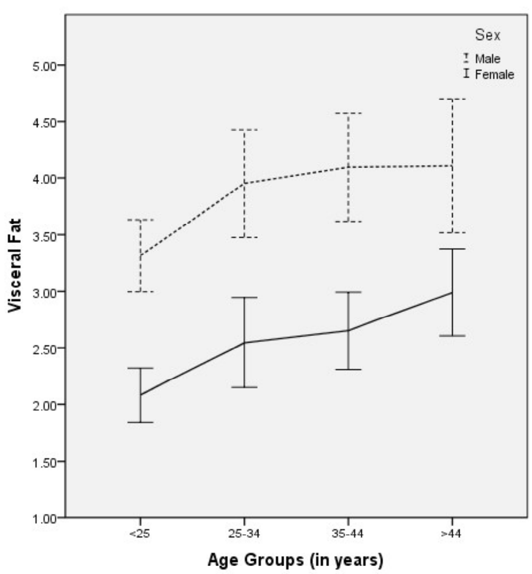

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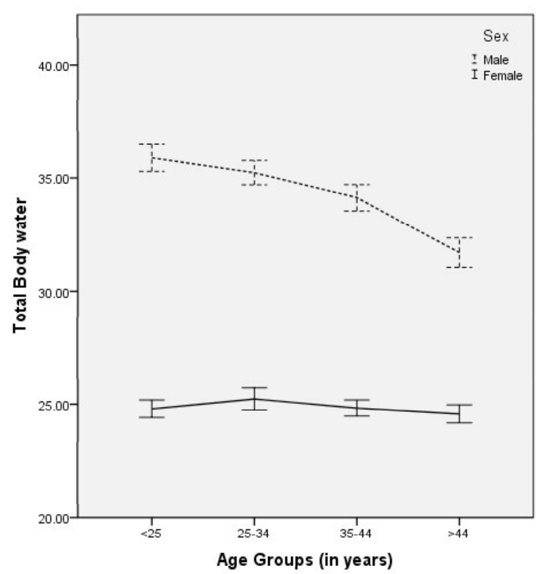

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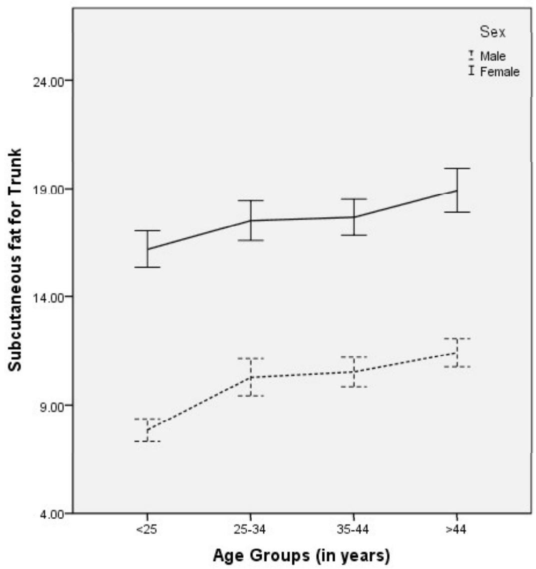

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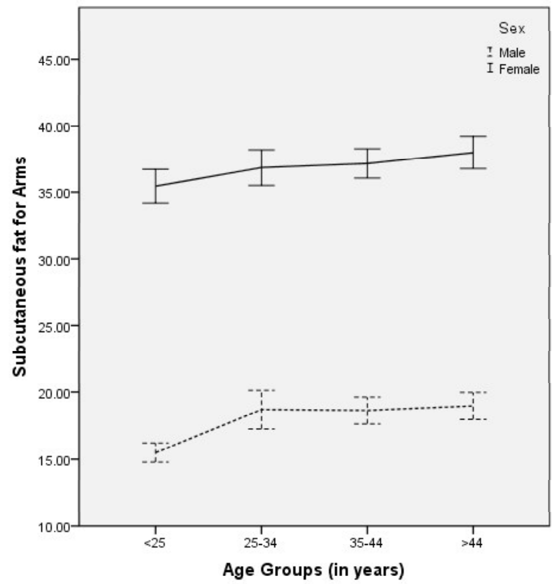

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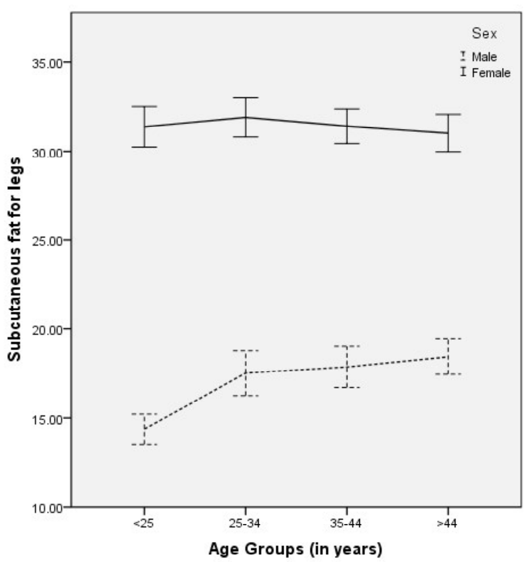

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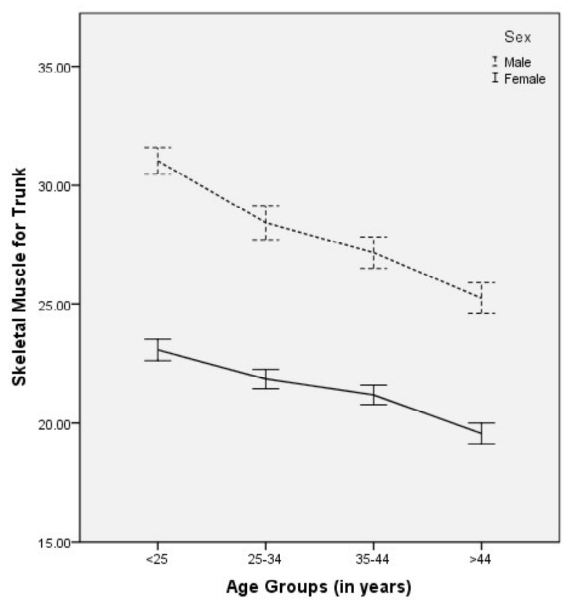

Figure 10

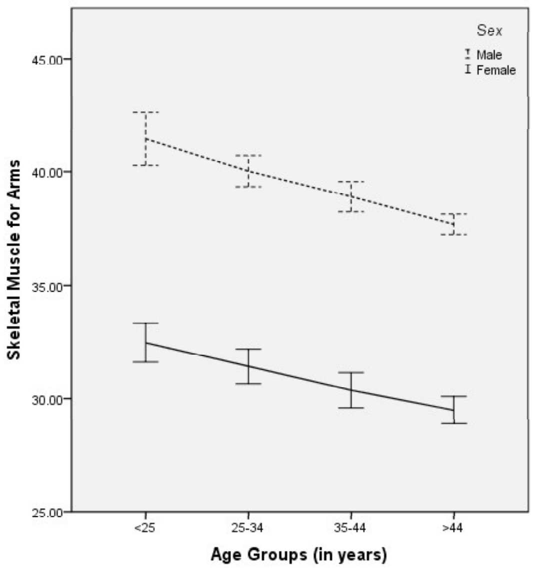

Figure 11

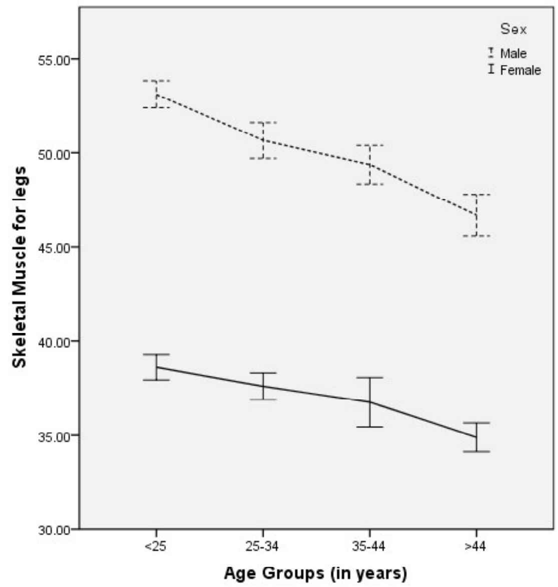

Figure 12

DISCUSSION

Size and proportion of human body morphology changes throughout the period of adulthood (Singhal and Sidhu,'83; Das and Roy, 2010). Body components like fat tissues, muscle tissues and bones undergo major changes even after maturity (Roy and Pal, 2003). However, the process and rate differs across genders, ethnic groups and varying physical activities. Present study tried to see the changes in anthropometric and body composition traits in different age cohorts among adult Oraon tea garden labourers.

Present data includes measurements of height, weight, fat mass, fat free mass, total body water as well as subcutaneous fat and skeletal muscle distribution in trunk and extremities in adult Oraons (believed to be endogamous)of both sexes. The test protocols for data collection were similar for all the participants. The study group share similar socio-economic background and physical environment.In course of analysis, all the data were divided into four age cohorts in both the sexes.

Results indicate that Height showed maximum value in the young group (<25 years) of males and then the values were low in subsequent age cohorts. This finding corroborates with several other studies (Shimokata *et al.*,'89; Bose, 2002; Dangour, 2003; Roy and Pal, 2003; Bose *et al*., 2006; Das and Roy, 2010). Das and Roy (2010) pointed out that the possible reason for such decline might be intervertebral shrinkage and increased curvature of spine.

Again, in females height was maximum in the age-group of 25-34 years and it showed lower values in subsequent age cohorts. Bisai *et al*. (2008) reported similar result in their study. Contrastingly, Dangour (2003) reported that females and males showed maximum height at similar age.

Optimum body weight observed in the age-group of 25 to 34 years in both sexes. In males, weight showed lower values in subsequent age cohorts. Similar results were found by Shimokata *et al*. ('89), Dangour (2003), Bose *et al*. (2006) and Bisai *et al*. (2009). Both Gallaher *et al*. (2000) and Kuk *et al*. (2009) pointed out that the possible reason for progressive decline of weight in males might be due to greater loss in fat free mass than fat accumulation with increased age. Whereas in females, weight remained more or less similar throughout entire adulthood after reaching the optimum level. Weight stability in females throughout adulthood may possibly occurred for balanced accumulation of fat mass with decline in fat free mass (Gallaher *et al.*, 2000). However, Ito *et al*. (2001) observed decline in weight after the age of 50 in both Japanese males and females.

Fat mass was minimum in the young group (<25 years) and showed higher values in succeeding age groups regardless of sexes. Further, fat free mass was maximum in the young age-group and lower in subsequent age cohorts. Enzi *et al*. ('86) mentioned that decrease in physical activity with increased age may be responsible for such results. However, Ito *et al*. (2001) and Chumlea *et al*. (2002) reported contrasting findings.

Visceral fat percentage was maximum in the elderly group regardless of sex. However, mean values were not significantly different between/among age cohorts in males. To our knowledge there is hardly any study to compare the findings. Total body water showed optimum value in the young group and lower values in later age cohorts in males. However, females showed similar values in all the age cohorts unlike males. Singhal *et al*. ('88) found a contrasting result in Jat-Sikh and Bania females that reported lower values in higher age-groups.

Subcutaneous fat percentage in trunk, arms and legs showed highest values in the elderly group lower values in young age-groups in males. Females showed similar trend except in subcutaneous fat in legs.Skeletal muscle percentage in trunk, arms and legs showed maximum values in the young group and lower values in subsequent age cohorts irrespective of sex.The findings, nevertheless, contradicted with Yamada *et al*. (2014) who found that skeletal muscle declined not before 40-44 years in both Japanese males and females. It might be due to disparities in ethnicity, physical activity or other lifestyle factors. Goodpaster *et al*. (2001), Newman *et al*. (2003) and Visser *et al*. (2005) opined that increase in fat mass possibly trigger the decline in skeletal muscle.

CONCLUSION

Result of the present study showed differential characteristics of all the selected anthropometric and body composition traits in the purview of age-related changes between sexes. Optimum values of each of the traits are different in either sex, therefore, different anthropometric and body composition traits reached their optimum figures in different age-group.Total fat and subcutaneous fat values in trunk and extremities showed progressive increase with age among adult tea garden labourers of both sexes and reached at optimum level in elder age-group. Contrastingly, fat free mass and skeletal muscle in trunk and extremities showed progressive decline with increasing age in both sexes. However, the exact age of reaching the optimum value for anthropometric and body composition traits was not possible to determine because of age-cohorts and cross-sectional nature of the study. It would have been ideal to consider all the ages of both sexes for analysis, however, it was not possible for small sample size. Furthermore, it would be better to incorporate physical performance data, diet, life style factors and morbidity in the present analysis to understand the effects on age related body composition traits. However, it was not possible because of the nature of data (cross-sectional), it is also known that all such data have seasonal variation. Therefore, future studies with longitudinal approach and larger sample size may reveal more comprehensive understanding of the present issue. A number of studies (Sorkin *et al*.,'99; Janssen *et al*., 2002; Huang *et al*., 2005) also pointed out the influence of age related changes in body composition traitson health aspects.Therefore, future research may also incorporate health aspects in different groups in order to help policy makers.

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