Ind. J. Phys. Anthrop. & Hum. Genet. Vol. 36. No. 1, (2017) : 71-83

MORPHO-PHYSIOLOGICAL VARIABILITY AND FAT PATTERNING AMONG MALES AGED 30-69 YEARS OF KALPA VALLEY, DISTRICT KINNAUR, HIMACHAL PRADESH

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ABSTRACT

The aim of the present study is to assess the morpho-physiological variability and fat patterning among 170 males ranging in age from 30 to 69 years, residing in Kalpa valley of District Kinnaur, Himachal Pradesh. The subjects were selected randomly from Kalpa village. Seven anthropometric (weight, stature, waist circumference, hip circumference, upper arm circumference, sub-scapular skin fold and triceps skinfold) measurements and three physiological variables (blood pressure, pulse rate and vital capacity) were taken on each subject after the techniques given by Weiner & Lourie (1981). Percent fat, visceral fat and basal metabolic rate were measured using body fat analyzer. Results clearly indicated a decreasing trend in stature, weight, BMI, hip circumference, upper arm circumference and skin folds after 49 years of age. Percent body fat and visceral fat witnessed an increasing trend with age. Fat free mass and fat free mass index declined after 49 years. Waist/hip ratio increased with the advancing age showing an android fat distribution. Systolic blood pressure showed a regular increase all through ages but diastolic blood pressure decreased after 60 years. Pulse rate declined after 60 years. Vital capacity and basal metabolic rate showed considerable decline with the advancing age.

Keywords: Fat patterning, Kalpa valley, Blood pressure, Body Mass Index

INTRODUCTION

Human body undergoes a gamut of changes since birth till adulthood in morphological, cognitive, motor and physiological variables under the influence of genetic, hormonal and environmental factors. First year of growth witnesses the maximum velocities in height and weight followed by adolescence. Adulthood is characterized by relatively smaller changes. The biological ageing process in humans

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involves a progressive decline in the functional capacity of their organs and tissues and a reduction in the ability to adapt to environmental changes (Adams & Whithe, 2004). At physiological level, changes occur throughout the ageing process and there is redistribution of various tissues responsible for bringing a change in size, shape and body composition (Arking, 1998). Blood pressure increases with age and there is reduction in the vital capacity. Most of the physical body dimensions attain their peak values from 20 to 35 years. However, there are population variations in the timing, tempo and magnitude of growth while attaining the peak. Ageing is not a single entity but a collective term representing the sum of cumulative local effects at the molecular, cellular and tissue level and is associated with regressive changes in biological parameters. Anthropometric characteristics provide a better understanding of the growth process by describing changes in the body size, morphology and body composition through ages. Changes in body composition with age have been well documented, particularly in men. A gain in body weight has been commonly observed after the age of 20 and until the age of 50, which has been attributed primarily to gains in adipose tissue. This increased adipose tissue is distributed in a typical pattern, with a large part of the increase occurring in the central abdominal sites, an area associated with cardiovascular disease and metabolic complications (Ross & Després, 2009; Arsenault *et al*., 2010), while subcutaneous fat tends to be lost from the limbs (Chien *et al*., 1975; Kuczmarski, 1989). Body composition is affected by a decrease in the metabolically active body lean mass caused by muscle mass loss (sarcopenia) (Rosenberg, 1997; Baumgartner, 2000), by the loss of cells from different tissues and organs, as well as by skeleton demineralization (Harper & Crews, 2000)**.** Height is a basic biologic characteristic known to change with aging. Height loss is related to aging changes in the bones, muscles, and joints. People typically lose about 1 cm (0.4 inches) every 10 years after age 40. Height loss is even more rapid after 70 years of age.

There is great individual variation in the ageing process, observed through changes in physical, psychological and social variables among individuals sharing the same chronological age (Fernandez-Ballesteros, 2008). Age, sex, physical activity, socio-economic status, education, nutritional habits and ethnicity have a direct bearing on ageing process. Body mass index, waist circumference and waist/height ratio have been used as the markers of adiposity to study their relation to chronic diseases (Janssen *et al*., 2004). Waist/hip ratio is an indirect measure to study fat distribution pattern in a population. High blood pressure is one of the risk factors for cardiovascular diseases, and the cause of death among middle and old age adults in India. **T**he relationship between BMI and BP has long been the subject of epidemiological research. Several studies indicate that high BP is associated with age and modernization (Schall, 1995). In view of significant changes associated with ageing it is necessary to understand the age changes in body composition, physiological parameters and fat distribution pattern of middle aged and elderly people residing in different parts of India and examine the influencing factors. Assessing these changes in total and regional fat distribution with ageing may be

important as fat distribution has substantive effects on morbidity and mortality risks. Such studies have the potential to develop appropriately timed and effective strategies to optimize body composition for healthy ageing. A review of literature shows meager recent data on age changes in biological variables among males from different regions of India (Ghosh *et al*., 2001; Otsuka *et al*., 2005; Bose *et al*., 2006; Singh *et al*., 2008; Tyagi *et al*., 2008; Amitabh *et al*., 2009; Das and Roy, 2010). Therefore, information on age related variability in body composition especially on regional populations is necessary to augment data in this direction. The present study explores age changes in morpho-physiological variables and fat patterning among males aged 30-69 years residing in Kalpa village of District Kinnaur.

MATERIALS AND METHODS

The present cross-sectional study is based on a sample of 170 males from scheduled tribe, ranging from 30 to 69 years and belonging to Kalpa Village of District Kinnaur (Himachal Pradesh). The data were collected from 23 September to 1st October, 2013 from Kalpa village, Reckong peo, District Kinnaur by the second author. Kalpa is a small village situated in the Sutluj river valley, above Reckong Peo in the Kinnaur district of Himachal Pradesh inhabited by Kinnauri people. Kalpa is at 31.53°N 78.25°E. It has an average elevation of 2,960 meters (9,711 feet). It is located 265 kilometers (165 m) beyond Shimla on the NH-22 in Kinnaur District. This area of Kalpa experiences a temperate climate due to its high elevation, with long winters from October to May, and short summers from June to September. During winters temperature goes below freezing point around -15 degree to - 20 degree.

The staple food of the subjects was rice, pulses, vegetables, and barley which are local produce. The principal pulses consumed were peas, black peas, mash and rajmash. The vegetables usually consumed were cabbage, turnips, peas, beans, pumpkin, potato, okra and tomato besides some locally available wild green vegetables leaves. People were non-vegetarian, and they relished goat and ram's meat along with chicken. Taking of alcoholic drinks in their day to day life and also on the ceremonial or festive occasions was quite common among them. Alcohol is distilled at the household level. It is made out of fruits like grapes, apple, pear etc. grown locally and of barley.

To assess the morpho-physiological variability, body composition and fat distribution pattern of males (30-69 years) of Kalpa village, 7 anthropometric measurements and 3 physiological variables were taken on each subject using standardized techniques given by Weiner and Lourie (1981). These included height, weight, waist circumference, hip circumference, upper arm circumference, sub scapular skinfold, triceps skinfold, systolic blood pressure, diastolic blood pressure, pulse rate and vital capacity. Percent Body fat, Visceral fat and BMR (kcal per day) were obtained with the help of body fat analyzer. Care was taken to include only normal healthy individuals, who were not suffering from any chronic diseases or physical deformity. Age in years has been obtained from the date of birth, which

only few men could recall, whereas in majority of the males age had to be known by association with some important events like age at marriage, age of the first child, any important festival etc. With this cross-questioning, efforts were made to ascertain nearly the correct age of subject. The subjects were divided into three age groups with an interval of ten years. The prior consent of the subjects was obtained before collecting the data. Permission from the relevant authorities was also obtained beforehand. Additional information was also collected on age, sex, caste, family structure, family income, educational and occupational background and dietary habits by using interview based schedule.

To study body composition, body mass index (BMI), fat mass index (FMI) and fat free mass index (FFMI) were calculated. From percent body fat, fat mass was computed and fat free mass was calculated by subtracting fat mass from the body weight. Waist/hip ratio and ratio of sub scapular/triceps skinfold were employed to study fat distribution pattern. By subtracting the mean of the preceding age group from that of the succeeding group the whole year mean annual increments were obtained (Tanner, 1962). Statistical analysis has been done by using both Microsoft Excel 2007 and SPSS version 16.

RESULTS

Table 1 summarizes descriptive statistics of various anthropometric measurements and indices among males of Kalpa village. Mean value of stature increased from 164.59 cm to 165.23 cm from age group 30-39 to 40-49 years after which a decreasing trend with the increasing age was witnessed. Maximum decrease of 5.92 cm was seen between the last two age groups. Weight also showed a similar trend as that of stature. It increased from 63.20 kg to 65.70 kg from age group 30-39 till 40-49 followed by a gradual decrease till 50-59 years. Maximum decrease of 5.06 kg was experienced during age group 60-69 years. Waist circumference of males witnessed a continuous increase at all age groups except for the minor decrease (0.60 cm) seen in the age group 60-69 years. Hip circumference of the subjects showed an increase from 30-39 till 40-49 years followed by a very gradual decrease till 50-59 years but it witnessed a decline of 1.31 cm. in the last age group. Waist hip ratio of males showed an increasing trend with the advancing age showing greater deposition of abdominal fat. Mean values of upper arm circumference fluctuated within very narrow range (24.44 cm at 30-39 years to 24.22 cm at 50-59 years), but a loss of 2.34 cm was seen in this circumference between age groups 50-59 and 60-69 years. Both sub scapular and Triceps skinfold thicknesses increased from 30-39 years to 40-49 years, thereafter, a gradual decline in the mean value was observed from 50-59 years followed by the maximum loss (2.33 mm in sub scapular and 1.01 mm in triceps skinfold) from 60-69 years. Sub-scapular/triceps skinfold ratio also depicted similar trend of increase from 30-39 years till 40-49 years followed by a gradual decrease in the last two age groups. Percent body fat among males of Kalpa increased regularly from 23.43% to 26.56% from age group 30-39 till 60-69 years. Visceral fat at age group 30-39 was 10.72% and it increased to 12.46% at age

group 40-49 by showing a gain of 1.74% thereafter, it increased very slowly and registered a value of 12.77% between 50-59 years and witnessed a decline of 0.63% from 60-69 years. Fat mass also witnessed continuous increase till 50-59 years followed by a gradual decline. Mean values for fat mass index increased regularly from 5.54 till 6.38 from age group 30-39 till 60-69. Fat free mass and Fat free mass index experienced a regular increase among males of Kalpa village from 30-39 years till 40-49 years followed by a substantial decline till 60-69 years. Body mass index of the subject showed an increase in the mean values till 40-49 years followed by a very minor decline till 60-69 years. ANOVA revealed significant differences between age groups for stature, waist circumference, upper arm circumference, waist/hip ratio, percent body fat, visceral fat and fat free mass.

Table 2 present descriptive statistics of blood pressure, pulse rate, vital capacity and Basal metabolic rate of males of Kalpa village. It is evident from the table that the mean values of systolic blood pressure increased regularly from 125.90 mmHg to 133.05 mmHg from age group 30-39 till 60-69 and diastolic blood pressure also increased till 50-59 years followed by a decline till 60-69 years. Pulse rate showed an increase from 73.93 bpm to 75.75 bpm till 50-59 years, whereafter, it fell to 71.81 bpm from 60-69 years. Vital capacity and Basal metabolic rate of the subjects witnessed a decline with the advancing age. ANOVA revealed significant differences between age groups for vital capacity and basal metabolic rate.

DISCUSSION

Assessment of body composition is of utmost importance because of its applications in clinical and population based studies. Remodeling of tissues takes place in the middle and old age groups and noticeable changes occur in body composition and shape. Knowledge of body composition is extremely relevant to assessing populations with increased risk of developing cardiovascular disease and to monitoring nutrition based diseases (Kyle *et al*., 2003; Rosa *et al*., 2007).

Results of the present study clearly indicate a gain in height, weight and Body mass index till 49 years followed by a decline in the mean values with the increasing age. However, maximum decrease in height (5.92cm), weight (5.06kg) and BMI (0.18 Kg/m^2) was seen between age groups 50-59 and 60-69. Both cross-sectional (Forbes & Hursh, 1963; Frontera *et al*., 1991) and longitudinal (Flynn *et al*., 1989; Hallfrisch *et al*., 1990) studies suggest that these gains in body weight are followed by a modest decrease after the age of 50 years and have been attributed to a decline in fat free mass (FFM) rather than a decrease in weight. The lower height values observed in the older age group are mainly due to a decrease in height at (Menezes and Marucci, 2005), intervertebral disc compression, loss of bone mass of innersole curvature (Abrams, 2003). The apparent decrease in BMI occurs at the expense of losing muscle mass, a decrease in height and an increase in waist circumference. The results of the present study are in concordance with the earlier studies on different ethnic groups of the world.

Age related changes in waist circumference have important consequences for predicting disease risk particularly in elderly populations. It is reported that aging is associated with increases in waist circumference of approximately 0.7cm per year (Noppa *et al*., 1980). In the present study increases in waist circumference of approximately 2.36 cm to 2.16 cm per decade have been observed till 60 years. Hip circumference of males of the present study increased till 49 years after which a decrease in this dimension is seen till 69 years. Aging is associated with a higher percentage of body fat and body fat redistribution. The redistribution of fat from lower body to subcutaneous fat in the abdominal and visceral part is the most frequent among the elderly people despite an apparent decrease in BMI (Milanovic *et al*., 2011). Similar findings have been reported in the present study as is evident from the increasing waist/hip ratio with the advancing age. Although waist circumference is positively related with increased visceral adiposity in men and women, cross sectional studies also report that ageing is associated with increase in visceral adipose tissue independent of waist circumference (Kotani *et al*., 1994).The lowest values of upper arm circumference by age are found in the higher age groups in the present study. The minimum mean value of 21.88 cm has been witnessed at 69 years. It indicates muscle loss with increasing age. Similar results have been shown by many earlier studies (Kuczmarski *et al*., 2000; Ghosh, 2004; Lopez *et al*., 2011). Subscapular skinfold and triceps skinfold thickness decreases after 49 years in the males of the present study. Subscapular triceps ratio is also maximum at 49 years, where after, a minor decrease in the ratio is seen. Among the males of Kalpa village, percent body fat shows a continuous increase in the mean values and a similar trend is being witnessed in the visceral fat. Gallaghar *et al*. (1996) reported that despite a stable BMI, aging is associated with an increase in percent body fat of approximately 1% per decade. Aging related changes in tissue hydration and potential redistribution of fat from subcutaneous to internal sites, notably intra abdominal accumulation of fat reflects changes in compressibility of skin and subcutaneous tissue (Forbes & Reina, 1970; WHO, 1988). Similar findings have been reported by the present study.

Although BMI is considered a useful index of obesity in a population but it does not distinguish between FFM and FM. To resolve this issue both FFM and FM can be normalized for stature. Moreover, the advantage of these indices is that one can judge whether the excess or deficit of body weight is selectively due to change in FFM or FM, or both combined. In the present study, fat mass increased with age till 59 years followed by a decline of 0.83 kg till 69 years. Fat free mass showed an increase till 49 years followed by a gradual decline till 69 years. Fat mass index showed a continuous increase in the mean values and fat free mass shows a general trend of decline with age. The results are in consensus with the earlier studies which demonstrate a decline in fat free mass and increase in fat mass with aging (Rosenberg, 1997; Bemben, 1998; Baumgartner, 2000; Jannssen *et al*., 2000).

The mean values for systolic blood pressure increased continuously with the increasing age. Diastolic blood pressure also exhibited almost similar trend up till 59

years followed by a slight decrease in the mean values among subjects of 60-69 year age group. Hypertension is the most common condition seen among elderly people and an increase in the blood pressure with increase in age is a factual phenomenon. Franklin *et al*. (1997) studied age related changes in blood pressure among 2036 participants from the original Framingham heart study and reported a linear rise in SBP from age 30 through 84 years and concurrent increases in diastolic blood pressure up till 50 years and after the age of 50 to 60 years DBP declined. The late fall of DBP after the age of 60 years associated with a continual rise in SBP is consistent with increased large artery stiffness. Present study also shows similar results. Earlier studies also indicated that high blood pressure is associated with age (Franklin *et al*., 1997). Resting pulse rate falls progressively from approximately 140 beats per minute (bpm) in neonates to stabilize gradually at normal adult levels of 50 to 90 bpm. (Spodick *et al*., 1992; Ceconi *et al*., 2011). Pulse rate among the subjects of the present study shows an increasing trend up till 59 years where after a declining trend is seen. Longitudinal data from the Framingham Study suggest that RPR continues to decline with advancing age, particularly in the oldest old. (Yashin *et al*., 2006; Arbeev *et al*., 2011).

Differences in pulmonary function in normal people may be due to ethnic origin, physical activity, environmental conditions, altitude, tobacco smoking, age, height, sex, and socioeconomic status (Woolcock *et al.*, 1972). The wide range of geographical and climatic conditions in a large country such as India may be associated with regional differences in lung function in healthy individuals, as shown in previous studies (Kamat *et al*., 1967; Jain and Ramaiah, 1969). A decline in vital capacity of males with advancing age has been demonstrated in the present study. Their basal metabolic rate also declines with age. Rexhepi *et al*. (2011) while, studying the physical characteristics of Kosovo population observed that among the older adults heart rate and vital capacity starts decreasing as has been stated by other studies (De Vries, 1986; McArdle, 1996; Scott and Edward, 2001). Some of the more prominent Indian studies have suggested that age related decrease in VC starts at about 40 years, and these changes become pronounced after 50 years (Jain & Gupta, 1967; Mathew *et al*., 1984).

CONCLUSIONS

It can be concluded from above that among males of Kalpa, with ageing there is a negative trend witnessed in almost all the anthropometric dimensions except for percent body fat, visceral fat and waist hip ratio which exhibited an increasing trend. SBP also continuously increased with age. DBP showed a fall after 60 years. Vital capacity and BMR witnessed a regular decline and pulse rate also decreased after 60 years. More studies on larger samples of elderly populations are required to know the population specific factors responsible for negative trends in bodily dimensions which will help us to promote healthy ageing.

Table 1: Mean, Standard deviations (SD) and ANOVA of anthropometric measurements and indices among males of Kalpa village

AGEGROUP (N)	*30-39 (50)*	*40-49 (59)*	*50-59 (40)*	*60-69 (21)*	*ANOVA*	*p-VALUE*
STATURE (cm)						
Mean	164.59	165.23	164.82	158.90	7.05	0.00
SD	6.60	6.54	6.89	6.72		
WEIGHT (kg)						
Mean	63.20	65.70	65.37	60.31	1.78	0.15
SD	9.93	8.93	12.17	9.98		
WAIST CIRCUMFERENCE (cm)						
Mean	82.42	84.78	86.84	86.24	3.14	0.03
SD	6.33	6.60	0.83	8.72		
HIP CIRCUMFERENCE (cm)						
Mean	91.51	92.90	92.26	90.95	0.68	0.57
SD	7.00	4.90	7.62	6.22		
UPPER ARM CIRCUMFERENCE (cm)						
Mean	24.44	24.93	24.22	21.88	8.45	0.00
SD	2.17	1.78	2.93	3.26		
PERCENT BODY FAT (%)						
Mean	23.43	25.17	25.70	26.56	21.22	0.00
SD	4.66	4.72	3.86	2.91		
VISCERAL FAT (%)						
Mean	10.72	12.46	12.77	12.14	2.80	0.04
SD	3.06	3.27	4.86	4.11		
SUBSCAPULAR SKINFOLD (mm)						
Mean	17.94	18.73	18.22	15.89	1.49	0.22
SD	5.51	5.41	5.37	4.45		
TRICEPS SKINFOLD (mm)						
Mean	8.97	9.15	9.12	8.11	1.17	0.32
SD	2.40	2.35	2.31	1.50		
FAT MASS (kg)						
Mean	15.09	16.72	16.95	16.12	1.59	0.19
SD	4.88	4.52	4.68	3.64		
FAT FREE MASS (kg)						
Mean	48.00	48.98	48.41	44.19	2.70	0.05
SD	6.02	5.86	8.50	6.93		
FAT MASS INDEX (kg/m^2)						
Mean	5.54	6.17	6.24	6.38	1.98	0.12
SD	1.74	1.76	1.62	1.38		
FAT FREE MASS INDEX (kg/m^2)						
Mean	17.74	17.94	17.78	17.46	0.29	0.83
SD	1.82	1.92	2.50	2.23		
BODY MASS INDEX (kg/m^2)						
Mean	23.30	24.11	24.02	23.84	0.59	0.62
SD	3.20	3.32	3.75	3.41		
WAIST HIP RATIO						
Mean	0.90	0.91	0.94	0.95	9.34	0.00
SD	0.05	0.05	0.04	0.03		
SUBSCAPULAR TRICEP SKINFOLD RATIO						
Mean	2.01	2.07	2.00	1.96	0.60	0.62
SD	0.73	0.42	0.35	0.38		

Significant at $p < 0.05$

Table 2: Mean, Standard deviations (SD) and ANOVA of physiological variables and basal metabolic rate among males of Kalpa village

AGE GROUP (N)	*30-39 (50)*	*40-49 (59)*	*50-59 (40)*	*60-69 (21)*	*ANOVA*	*p-VALUE*
SBP (mmHg)						
Mean	125.90	129.08	131.53	133.05	1.91	0.13
SD	10.82	13.18	16.87	14.34		
DBP (mmHg)						
Mean	90.74	92.75	95.88	95.05	1.79	0.15
SD	10.82	10.18	12.12	11.41		
PULSE RATE (bpm)						
Mean	73.92	73.73	75.75	71.81	1.66	0.18
SD	5.75	7.91	6.74	4.65		
VITAL CAPACITY (cc)						
Mean	2346.00	1971.19	1780.00	1173.81	20.71	0.00
SD	621.13	567.60	646.47	445.15		
BMR (kcal)						
Mean	1438.08	1440.12	1392.23	1229.00	12.76	0.00
SD	155.14	111.19	155.48	167.03		

Significant $p < 0.05$

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