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Ageing dynamics in morpho-physiological characteristics among males of India

Satwanti Kapoor*, Prerna Bhasin, Meenal Dhall, Deepali Verma, Anup Kumar Kapoor

Department of Anthropology, University of Delhi, Delhi, India

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Abstract

Objectives: *To evaluate the association between age and nutritional & functional status among elderly adult males from different populations of India, and to understand their health problems.* ***Method:*** *This study is a cross sectional survey conducted among the adult males of 10 different populations (n=1403) inhabiting different geographical areas of India having their own way of life within social and cultural settings, purely being ruled by their own local conditions and ethos and each group is a distinctly homogenous entity. The nutritional status (weight, height, waist, hip, and mid-upper arm circumferences), cardiovascular health (SBP, DBP, PR) and muscular strength (AGS-average grip strength), was assessed. To compute the extent of change with age, each variable was expressed in the form of a unique and novel percentage termed as "ageing index," in the text, computed as* $(X_{20} - X_n)/ X_{20}$*, where n denotes means at ages 50, 60, 70, and 80 years.* ***Results:*** *Nearly, all populations indicated a declining trend in stature, body weight, body mass index and average grip strength with advancing age whereas, the cardiovascular features showed an increasing trend with ageing.* ***Conclusions:*** *Various populations take different channels to ageing process. They vary in onset and intensity of ageing. Populations with high physical activity level have huge lacunae between the intake of nutrition and energy output as age advances; hence a systematic approach for taking care of nutritional needs of the older people would minimize this gap leading to healthier ageing not merely delayed.*

Keywords: *ageing index; nutritional status; sunset syndrome*

Abbreviations: *BMI- Body Mass Index; AGS- Average Grip Strength; PTG- Primitive Tribal Groups; SC-Scheduled Castes; CV- Cardiovascular; CED- Chronic Energy Deficiency; PAL-Physical Activity Level; SBP-Systolic Blood Pressure; DBP-Diastolic Blood Pressure; PR-Pulse Rate; ST- Scheduled Tribe; OBC-Other Backward Class; WHR-Waist/hip ratio; WHtR-Waist/height ratio.*

* Corresponding author: Department of Anthropology, University of Delhi, Delhi 110007, India (**e-mail:** satwanti@yahoo.com)

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Introduction

Ageing, a multidimensional and inevitable phenomenon is discerned by progressive deterioration of physiological functions with psychological and social change like decreased physical activity, decrease in lean body mass and consequently the decreased energy intake which may be associated with risk of disease (Gariballa et al., 1998).This inherent age-related process limits our normal functions. The ageing process also involves nutritional changes that are manifested by height loss (Dey et al., 1999), muscular mass loss and fat mass increase (Sanchez-Garcia et al., 2007). Some major biological changes seen among elderly people occur primarily as a result of the biological process of ageing. However, many health problems and physiological changes experienced by older people, attributable to the ageing process, are now being recognized to be linked to lifestyle or environmental factors. Good nutrition and lifestyle factors, such as being physically active and not smoking, are essential to ensure that people may have long, healthy and active lives, continuing to live independently for as long as possible(Gariballa, 2004).

Nutritional status of the elderly is an apparent indicator of their functionality and health risks. Deterioration of the nutritional status affects and is affected by disease, especially among the elderly (Oliveira et al., 2009). Health analysis of the elderly and the identification of factors that contribute to their health status are, therefore, essential. Anorexia and weight loss are common among the elderly. Decrease in appetite, dental problems, mobility issues, reduced physical activity, social isolation (Tyagi et al., 2008), loss of spouse, prescription drugs and mental health problems are all associated with impaired health and nutritional status in elderly(Jenkins et al., 2007; Zohoori, 2001), affecting their quality of life.

Undernutrition among the elderly is an important issue as the major demographic transition in the world is attributed to a considerable increase in the number of older people, a trend experienced worldwide. This has been especially true and more pronounced in the case of developing countries like India, where ageing is occurring more rapidly due to the decline in fertility rates combined with increase in life expectancy of people achieved through medical interventions. About 60 percent of the elderly live in the developing world, projected to rise to 70 percent by 2010.The total aged (60years and above) population of India is approximately 110 million, or approximately 11% of the total population. This percentage is projected to increase to 14.8% by the year 2020 (Ghosh, 2004). There is relatively little data on the prevalence of undernutrition among the elderly in the developing world.

Long term predisposition to nutrition risk leads to subclinical and eventually overt undernutrition which is manifested in anthropometric measures (Teh et al., 2010). BMI is the most established anthropometric indicator used for assessment of adult nutrition status (Lee et al., 2007), as it also showcases the socioeconomic condition of a population (Shetty et al., 1994). A BMI<18.5 kg/m^2 is widely used as a practical measure of CED (Chronic Energy Deficiency) –a "steady" underweight in which an individual is in energy balance irrespective of a loss in body weight or body energy stores (Khongsdier, 2005) which in turn is associated with morbidity or other physiological and functional impairments (Shetty et al., 1994; Khongsdier, 2005; World Health Organization, 1995). Though aging is always associated with decreased physical activity, a population with high physical activity level (PAL) may experience delayed onset of ageing.

Our objective is to evaluate the association between age and nutritional & functional status among elderly adult males from different populations of India, and to understand their health problems. There is a dire need to develop database on the

diet and nutritional status of the elderly from different parts of the country in order to initiate strategies for the healthy ageing.

Area and people

The people of India exhibit a unique range of socio-cultural, linguistic, religious, ethnic and biological diversity. Several waves of people of different ethnic stocks, cultures and languages either invaded India or migrated to India from different directions and contributed significantly to the present-day gene pool of the subcontinent (Balgir, 2005).These people not only settled in India but also gradually merged and mingled with the autochthonous local populations (Balgir, 2006). As a result they amalgamated within population of India, as numerous religious sects, caste groups, ethnic and tribal communities. Some of these populations live in virtually inaccessible forests and hilly areas completely isolated from the general stream society. They have evolved their own morphogenetic characteristics in their respective ecological niches, consequently creating a heterogeneous group.

The population of India is classified as SC, ST, OBC based on their socio-economic condition. Most tribal communities in India are quite vulnerable with respect to malnutrition, morbidity and mortality. Tribal health is further compounded by poverty, illiteracy, ignorance of causes of diseases, hostile environment, poor sanitation, lack of safe drinking water, faith in traditional beliefs etc (Balgir, 2006).

Populations studied

Car Nicobarese

Located in the Bay of Bengal, the Andaman and Nicobar Islands are the homeland of many primitive communities of India one of which is Car Nicobarese, of mongoloid origin. They have fully accepted the value of modern civilization and life, and are in pursuit of acquiring modern technology, education. They also have jobs in government sector. Economically and educationally they are the most developed tribe in Andaman and Nicobar Islands. They are availing the benefits of welfare measures in the areas of education, health and cooperative movements.

Nolias

Nolias of Orissa who are recognized as the 'sea people,' are constitutionally categorized under the OBC. They sustain themselves by fishing and related activities and their households depend entirely on fishing which involves strenuous physical activity. Adult men go into the sea, women and children help them on the beach while old people mend fishing nets and train young ones for fishing.

Tadavis

Tadavis of Gujarat are the subgroup of the "Dhanka" tribe and are believed to be the descen-dents of the Rajputs. They mostly work as agricultural laborers. Some work as casual laborers earning meager sums.

Rajis

Sometimes known as Vanrawats (forest lords), the Rajis of Uttranchal were recognized as ST in 1967 and as PTG in 1975 by the Government of India. Rajis were completely nomadic in the past, and pursued a life of hunter gathering, taking shelter in caves or temporary huts. The traditional hunter-gatherer economy, now a days is practiced by 40% of the males and 78% of the females; rest earn wages as labourers in agriculture/fishery and carpentry.

Bhotias

Bhotias showing affinities to Mongolian stock are living in relatively isolated areas of Uttrakhand. They stand out clearly on account of their distinct cultural trait and highly specialized adaptation to a mountain environment embracing rugged and wild topography. Seasonal nomadism was, once the only way of life for Bhotias, as the trans-Himalayan trade with Tibet shaped their entire course of socio-cultural life along with terrace cultivation, pastoralism, woollen industry etc. Agriculture has been subsidiary occupation of Bhotias.

Desia Khonds

The Desia Khond is a tribal group of Orissa who belongs to the Dravidian race. The main occupation of the Khonds is agriculture labor. They also supplement their income by collecting edible roots, tubers and leaves from the forest, fishing and as daily wage laborers.

Scheduled Castes

SC is not an anthropological isolate but a small community which is excluded from larger, mainstream society. The data on SC was collected in Delhi, an urban centre. By occupation, they were always associated with jobs like sweeping/scavenging but now majority have been engaged as a part of industrial/urban workforce.

Minas

Known to be the largest, tribal group of Rajasthan, agriculture is the predominant activity of Minas. Men plough the field and thrash the crop, men and women sow, harvest and weeding is done by women and children. A few of them also go out of their villages to work as laborers in mines, factories and transport companies to supplement income.

Rajputs

Rajputs of Himachal Pradesh (middle altitude) and Haryana (plains) were also included in the study. The key point here is that these are genetically similar population inhabiting two different environments. They are agriculturists and most find jobs in army and other forces (warriors).

Subjects and methods

The present study is based on a cross-sectional survey conducted among 1403 adult males of 10 different populations inhabiting diverse geographical areas of India. They have their own way of life within social and cultural settings, purely being ruled by their own local conditions and ethos.

For the sake of convenience the different age groups have been referred to as 20 years (20-29 yr), 50 years (50-59 yr), 60 years (60-69 yr), 70 years (70-79 yr), and 80 years (Table 1).

Table 1: Sample size by age group and local populations

Age groups (years)	Study populations									
	Car Nicobarese	Nolias	Rajis	Desia Kondhs	Scheduled Castes	Tadavi	Bhotias	Minas	Haryana Rajputs	Himachal Rajputs
20	30	28	20	34	30	27	25	15	39	43
50	48	48	23	35	54	47	50	65	28	25
60	48	50	20	16	54	43	43	49	54	25
70	39	29	-	6	44	27	33	31	26	17
≥80	-	-	-	-	-	-	-	-	15	20

The nutritional status (weight, height, waist, hip, and mid-upper arm circumferences), cardiovascular health (SBP, DBP, PR) and muscular strength (AGS), was assessed through following measurements, using standard techniques after obtaining their informed written consent, and ethical clearance, as per rules. None of the subjects were measured immediately after ingesting their breakfast. Prior to taking physiological measurements; each subject was given 30 minutes of rest. The maximum grip strength of both the hands, right and left was taken with the help of dynamometer to assess the muscular strength. The mean of the maximum right and left hand grip strengths was used in the study and has been referred to as average grip strength. A standard prototype was followed while taking measurements (Weiner and Lourie, 1981) by trained anthropologists. Only visibly physically fit subjects were recruited for the study.

BMI was computed using the following formula weight (kg)/height^2 (m^2) and analysed using WHO cut-offs (WHO, 2003) to evaluate the nutritional status. AVERAGE GRIP STRENGTH (AGS) was taken to highlight the effects of ageing on muscular strength. WHR (waist circumference/hip circumference) and WHtR (waist circumference/height) were also calculated. The data was statistical analyzed using SPSS 17.0.

To compute the extent of change with age, each variable was expressed in form of a unique percentage termed as "ageing index", in the text is computed as (X_{20} - X_n)/ X_{20}, where n denotes means at ages 50, 60, 70, and 80 years.

Results

The fundamental data of all populations indicated an age related declining trend with respect to stature, body weight, BMI (Fig. 1) and AGS. Meanwhile BP and PR showed an escalating trend with advancing age. Except for Bhotias and SC of Delhi, the basic data for all populations has already been published with respect to various other aspects (Kapoor et al., 2009; Kapoor et al., 2010*a,b,c*). The basic descriptive data for Bhotias and SC of Delhi has been given in Table 2 and 3. The percent changes ("Ageing Index") in different variables among populations studied are shown in Table 4. Prevalence of undernutrition and prehypertension/hypertension increased with age (data not shown).

Among Car Nicobarese, weight, stature and AGS declined with age between 20 to 70years, by 6.49%, 2.30% and 53.16% respectively. BMI increased by 7.20% and 3.97% in 5th and 6th decade, but decreased later by 2.34%.

Nolias were tallest, heaviest at the age 20 and shortest, lightest at 70years. The change in stature and weight was 3.38% and 20.62% respectively. BMI declined gradually throughout the aging by 14.92%. AGS showed a decrease of 23.97% at 70 years. A reverse trend of increasing values with age was seen in CV features. SBP, DBP and PR changed by a factor of 8.56%, 11.86% and 6.77%respectively. The DBP and PR experienced a more pronounced effect of age at 60 years (as against 70) with DBP changing by 12.07% and PR by 7.96%.

Rajis showed a negative association between weights, stature, BMI, AGS and positive association between SBP, DBP, PR with ageing. The ageing effect was clearly displayed among different variables at the 6thdecade of life. The change in weight, stature, BMI, AGS, SBP, DBP and PR between 20 to 60years was 17.93%, 4.69%, 9.68%, 40.10%, -27.57%, -18.46% and -14.89% respectively.

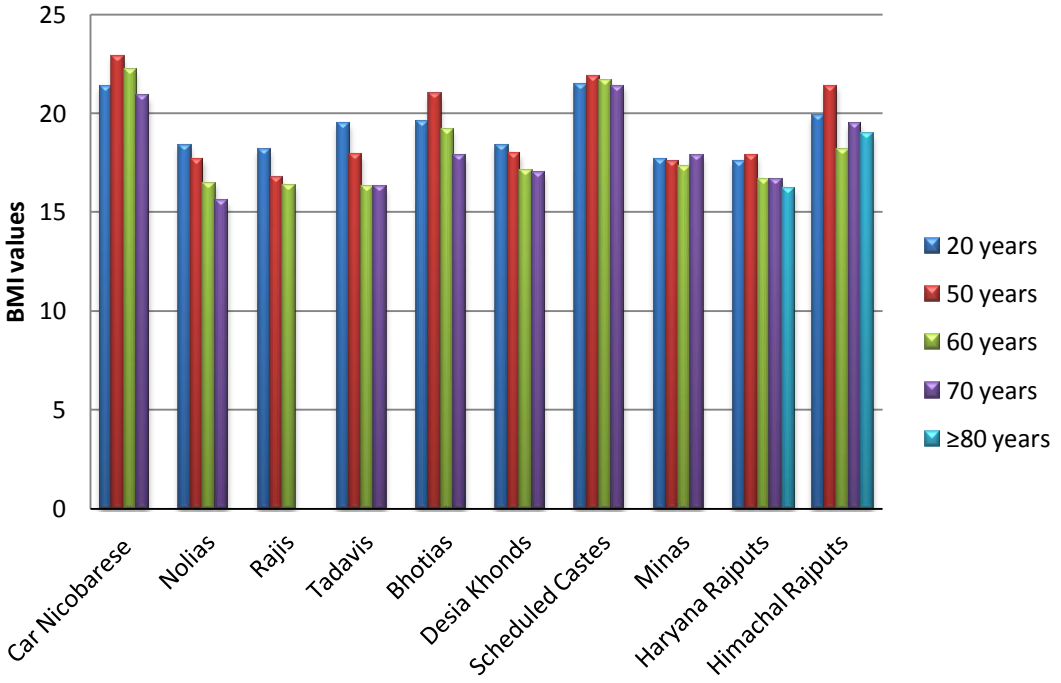

Fig. 1: Effect of ageing on BMI among different populations.

Table 2: Anthropometric, physiological and derived measurements for Bhotias of Uttrakhand

Variables	Age groups (years)			
	20-29	50-59	60-69	70-79
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.
Weight(kg)	52.12 ± 1.03	53.77 ± 2.24	48.09 ± 1.44	43.72 ± 3.43
Stature (cm)	163.01 ± 1.73	160.18 ± 1.99	158.37 ± 2.94	156.19 ± 2.65
Waist Circumference (cm)	67.70 ± 1.39	76.74 ± 2.14	75.68 ± 1.64	71.13 ± 2.65
Hip circumference (cms)	86.02 ± 3.15	88.20 ± 2.53	83.61 ± 2.91	78.46 ± 2.89
Mid- upper arm cir. (cm)	24.09 ± 0.79	26.34 ± 1.92	25.47 ± 0.79	21.83 ± 2.56
Pulse rate (beaps/min)	71.17 ± 5.94	76.61 ± 7.44	79.54 ± 7.64	77.00 ± 7.05
Systolic Blood Pressure (mm/Hg)	120.13 ± 3.25	130.70 ± 19.93	129.00 ± 9.00	134.50 ± 11.31
Diastolic Blood Pressure (mm/Hg)	80.00 ± 3.63	86.93 ± 9.54	84.63 ± 6.40	90.59 ± 9.60
BMI (kg/m^2)	19.62 ± 0.47	20.97 ± 1.04	19.19 ± 0.86	17.92 ± 1.39
WHR	0.79 ± 0.03	0.87 ± 0.03	0.91 ± 0.02	0.91 ± 0.02
WHtR	0.42 ± 0.01	0.48 ± 0.02	0.48 ± 0.01	0.46 ± 0.02
AGS (kg)	45.71 ± 1.97	39.13 ± 3.20	30.40 ± 3.34	23.03 ± 5.11

Among Tadavis, weight and stature decreased with increasing age with most pronounced effect at 70 years where the drop was 24.14% and 4.82% respectively. The change in BMI between 20-70years was 16.49%. AGS declined by 56.05% between 20 to 70 years. SBP showed a gradual increase by 12.57% and DBP 17.79%. Throughout the aging process, PR altered itself by an increase of 18.72%.

Among Bhotias weight, stature and BMI at 70 years were lesser than those documented at 20 years but cardiovascular features showed a reverse trend. However, these values did not show a steady increase or fall with age except in AGS. BMI increased by 6.88 % till 60 years and later decreased by 8.66 %. AGS showed a decrease of 49.62% by 70 years of age. Meanwhile, SBP and DBP increased by 11.96% and 13.24% respectively between 20-70 years.

Table 3: Anthropometric, physiological and derived measurements for SC's of Delhi

Variables	Age groups (years)			
	20-29	50-59	60-69	70-79
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.
Weight (kg)	57.20 ± 5.57	57.34 ± 7.24	55.10 ± 5.00	52.06 ± 9.67
Stature (cm)	163.19 ± 5.30	161.79 ± 5.48	159.17 ± 3.47	155.75 ± 4.56
Pulse rate (beaps/min)	68.00 ± 6.63	70.88 ± 7.67	76.42 ± 7.92	74.55 ± 9.32
Systolic blood pressure (mm/Hg)	120.24 ± 7.46	122.16 ± 8.94	131.49 ± 10.59	135.30 ± 12.57
Diastolic blood pressure (mm/Hg)	80.72 ± 8.41	82.22 ± 8.49	89.00 ± 8.73	91.82 ± 12.54
Waist circumference (cm)	72.90 ± 7.74	76.18 ± 5.98	75.95 ± 5.73	74.80 ± 7.38
Hip circumference (cm)	86.60 ± 5.65	89.67 ± 5.14	87.55 ± 4.83	88.99 ± 8.28
Mid- upper arm circumference (cm)	26.02 ± 1.75	26.14 ± 1.50	25.20 ± 1.48	24.46 ± 2.49
BMI (kg/m^2)	21.55 ± 2.56	21.87 ± 2.11	21.74 ± 1.76	21.36 ± 3.28
WHR	0.84 ± 0.05	0.85 ± 0.04	0.87 ± 0.05	0.84 ± 0.04
WHtR	0.45 ± 0.05	0.47 ± 0.03	0.48 ± 0.04	0.48 ± 0.04
AGS (kg)	-	-	-	-

Table 4: Percent change ('ageing index') in different variables among populations under study

Variable	Ages (years)	Study populations									
		Car Nicobarese	Nolias	Rajis	Tadavi	Bhotias	Desia Khond	SC	Minas	Haryana Rajput	HP Rajput
Weight	20-50	-3.00	6.08	12.30	11.28	-3.17	3.37	-0.24	5.61	5.73	-3.68
	20-60	-0.31	15.26	17.93	21.83	7.73	8.29	3.67	8.43	8.46	12.70
	20-70	6.49	20.62	-	24.14	16.12	9.84	8.99	1.49	11.69	11.28
	20-80	-	-	-	-	-	-	-	-	10.96	17.16
Stature	20-50	2.12	1.31	2.65	1.95	1.74	0.66	0.86	2.42	3.24	1.67
	20-60	1.93	2.97	4.69	3.50	2.85	0.81	2.46	2.90	1.79	1.96
	20-70	2.30	3.38	-	4.82	4.18	1.18	4.56	1.24	3.61	4.60
	20-80	-	-	-	-	-	-	-	-	1.83	6.81
BMI	20-50	-7.20	3.59	7.53	8.19	-6.88	2.12	-1.48	0.68	-1.99	-7.64
	20-60	-3.97	10.02	9.68	16.49	2.19	6.85	-0.88	2.60	5.23	8.45
	20-70	2.34	14.92	-	16.49	8.66	7.72	0.88	-1.19	5.18	1.96
	20-80	-	-	-	-	-	-	-	-	7.74	4.27
SBP	20-50	-4.88	-4.81	-6.47	-6.89	-8.80	-3.33	-1.60	-7.66	-4.56	-4.05
	20-60	-9.44	-7.64	-27.57	-7.91	-7.38	-10.62	-9.36	-12.33	-3.59	2.91
	20-70	-11.11	-8.56	-	-12.57	-11.96	-11.14	-12.52	-2.74	-2.67	-3.01
	20-80	-	-	-	-	-	-	-	-	-4.28	-1.44
DBP	20-50	-4.48	-4.53	-7.70	-8.51	-8.66	-5.99	-1.86	-9.01	-6.17	2.63
	20-60	-8.86	-12.07	-18.46	-12.15	-5.79	-12.92	-10.26	-10.34	-8.63	6.69
	20-70	-9.41	-11.86	-	-17.79	-13.24	-11.86	-13.75	-9.29	-2.17	-5.04
	20-80	-	-	-	-	-	-	-	-	-3.02	8.83
Pulse rate	20-50	-5.53	-1.94	-7.48	-7.08	-7.64	-5.33	-4.24	2.83	-11.14	-9.88
	20-60	-9.21	-7.96	-14.89	-15.13	-11.76	-9.34	-12.38	-2.72	-0.15	-0.86
	20-70	-10.15	-6.77	-	-18.72	-8.19	-6.45	-9.63	4.71	-6.17	2.96
	20-80	-	-	-	-	-	-	-	-	-1.13	3.57
AGS	20-50	11.40	6.97	17.79	17.70	14.40	11.86	-	20.19	-	-0.42
	20-60	33.19	11.91	40.10	37.84	33.49	25.18	-	38.91	-	14.08
	20-70	53.16	23.97	-	56.05	49.62	34.64	-	55.90	-	34.87
	20-80	-	-	-	-	-	-	-	-	-	54.01

Desia Khonds were found to be shortest, lightest and with minimum AGS at 70 years as against being tallest, heaviest and with maximum AGS at 20 years of age. At 70 years, SBP, DBP and PR changed by 11.14%, 11.86% and 6.45% respectively. It is noteworthy that DBP and PR, showed a more pronounced effect of age at 60 years (as against 70 years) with DBP showing an increase of 12.92% and PR by 9.34%.

Among the SC, the change in most variables did not follow an orderly trail. BMI increased by 1.48 % and 0.88% at 50 and 60 years, respectively but at 70 years of age a decline (0.88%) was recorded. Effects of ageing were well-defined at 70 years for physiological variables with an increase of 12.52% in SBP and 13.75% in DBP, whereas PR increased by 9.63% at 70 years.

Among Minas, the ageing effect was clearly displayed among all variables at the 6th decade except in AGS which showed a decrease of 55.90% at 7th decade.

Rajputs (Haryana) showed a negative association of age with weight, stature, BMI, AGS but a positive association with SBP, DBP and PR with ageing. In weight and stature, maximum decline was documented at 70 years (11.69% and 3.61% respectively). BMI increased initially by 1.99 % (50 years) but decreased by 7.74% at 80 years.

Among the Himalayan Rajputs, the change in most variables did not follow a systematic path. The effect of ageing was pronounced among anthropometric variables at 80 years of age as weight and stature declined by 17.16% and 6.81% respectively. The decrease in BMI at 80 years was documented as 4.27% but at 60 years, a decrease of 8.45% was recorded. AGS increased by 0.42% between 20-50 years, but decreased by 54.01% between 20 to 80 years of age. Cardiovascular features showed a fluctuating trend with ageing.

Discussion

Developing countries are increasingly faced with the double burden of malnutrition: the persistence of undernutrition, along with a rapid rise in overweight/obesity. The tribal population of India is among India's poorest groups, and a study reported that more than 60% of the tribal men and women over age 60 suffered from a chronic deficiency (Arlappa et al., 2005).

A key aspect that marked ageing in most populations was that with increasing age, the number of individuals falling under chronic energy deficient categories increased. Besides, nutritional health, cardiovascular-fitness also showed a substantial change with ageing. Majority of the populations were seen to become hypertensive (or prehypertensive) under the ageing effect.

Car Nicobarese, Nolias, Tadavis, Desia Khonds and Rajputs of Haryana showed a discernible aging trend from 50 years of age while in other communities the aging affect was witnessed at 60 years or 70 years of age. This ageing trend was determined through the "Ageing index". Most populations under study were rural in essence whereas the Car Nicobarese have fully accepted the value of modern civilization and life and are in pursuit of being urbanized. Car Nicobarese showed early ageing due to their relatively sedentary lifestyle as compared to other tribes studied. This ageing trend also reflects the kind of nutrition associated with a population which directly affects the process of ageing and determines its quality. Ageing can be delayed, healthy or otherwise. It is known that levels of health are generally poorer (Watt et al. 1944) and levels of mortality generally higher (HMSO, 1989) in urban compared with rural areas with respect to ageing due to various factors as sedentary life style, loss of traditional diet, faulty diet, high stress etc. So, urban-rural differences in lifestyle are bound to have a reflective impact on health and survival with ageing where urbanities tend to age earlier than their rural contemporaries.

The ageing process incorporates many health problems and physiological changes which are experienced by older people of different communities at different decades of life. This difference is seemingly associated with nutrition, lifestyle and environmental factors, along with genes that account for just 25% of individual variability (Kirkwood, 2003). Except in Car Nicobarese, SC and Minas, BMI decreased with age whereas BP increased. The relationship between BMI and hypertension is of particular interest to developing countries as excess mortality among lean hypertensive subjects has been reported in some longitudinal studies (Folsom et al. 1994).

A remarkable finding of the study is that ageing index can be an essential tool to assess change in various anthropometric, physiological variables with respect to the ageing process. Aging index reflects the change in a particular variable, between any

two standpoints of the ageing curve.

Each biological system has a certain capacity, which increases during the first year of life, reaches its peak in early adulthood and declines thereafter. The acceleration and threshold of this decline is predominantly determined by external factors. A decline in weight, stature and BMI in ageing population has been widely studied, analyzed and universally agreed on but what differs primarily is the age of onset and gradient of this decline in various populations as environment and lifestyle choices exert important effects on physical aging (Antell et al. 1999). The human body is programmed to show a detrimental change in cardiovascular health with ageing as the heart undergoes subtle physiologic modifications and the cardiac muscles undergo fibrous degeneration. The PR also varies due to the atherosclerotic changes as there may be a few extra systoles.

There exists variability in onset and extent of the decline in weight and stature among the present subjects with increasing age. There is a well-known increase in weight and stature in the middle years followed by decrease in the old age. The increase in weight till 5th decade may be a consequent of a little sedentary lifestyle commonly associated with advancing adult age but the steady decline is attributed to the significant decrease in the muscle mass in older people. One of the reasons for reduction in stature with age may be the compression of intervertebral discs that accounts for a decrease in sitting height hence stature (Kapoor et al., 2010).

Nutrition networks powerfully with the ageing process in a number of ways. One becomes more vulnerable to nutrition related health problems in later stages of life. The percentage of CED was found to be at a rise in most study populations.CED is caused by an inadequate intake of energy accompanied by a high level of physical activities, infections (Shetty et al., 1994) and is associated with functional impairments (James et al., 1988). With the exception of SC population and Car Nicobarese, most of the activities of other populations were dependent on nature and involved lots of hard work. They can be approximately assigned a PAL>1.4 based on self reporting and as also assessed through observations on their habitual physical activities (James et al., 1988). This could be one of the reasons for differential aging trend.

The older people are vulnerable to a poor nutritional state due to various reasons creating a gap between intake of nutrition and energy output leading to undernutrition. There is a growing recognition that age related physiological anorexia may predisposes to protein energy under nutrition in older persons (Gariballa, 2004). The collective effect of aging and impaired nutrition becomes most evidently visible on the health of the aged population of any community. The nocuous effect of this decline is distinctly evident in populations with high physical activity level. A decrease in muscular strength was also very well documented in all the study populations in the last decades, as compared to the maximum values in their primes though the degree of decline varies.

There are certain drawbacks of the study as the cross-sectional study design has been used to interpret the results longitudinally. Only those populations that draw similitude in physical activity levels, ageing cohorts and nutritional status were included, hence to a certain extent they were controlled for survival bias or cohort effects. The mathematical formula of so called ageing index does not permit inclusion of any covariates.

The characteristic disparities among the different populations studied for change in various variables could be due to variation in food habits, awareness and degree of isolation but the focus should be on age-related difference. However, varied these changes may be, they signify a phase of decay in the process of ageing and this phase could be called the phase of Sunset Syndrome (Kumar, 1992). This decay is definitely

variable in extent and intensity due to increase in lacunae between the intake of nutrition and energy output as age advances with different physical activity level; but once we bridge this gap by taking care of nutritional needs of the older people would lead to healthier ageing not merely delayed.

Key points

- Ageing signifies a phase of decay and hence can be called as the Sunset Syndrome.
- Ageing index can serve as an exceptional tool to analyze the effects of ageing if covariates are not to be considered. This index helps to quantify any change occurring in various variables, at any standpoint on the ageing curve to the age in questions.
- The effects of ageing are clearly indicated with changing variables as stature and AGS are bound to decline with age. Weight and BMI behave peculiarly with ageing. Meanwhile, the cardiovascular features, BP and PR show an escalating trend with advancing age. Their increase or decrease depends on the lifestyle factors, physical activity level and environment.
- Most populations differ in onset and gradient of ageing as environment and lifestyle choices exert important effects on physical aging.

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