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Some biomarkers of ageing in Ayurvedic perspective

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ABSTRACT

Ageing is a process that can affect almost all the systems in the body. Some people live up to the age of 85 in a very good physical and mental condition while others live with extensive cognitive and physical disorders already by the age of 60 or even before. This is a fact to think logically that why a person's biological age is more indicative of their health than their chronological age. Why are some people more susceptible to develop physical as well as mental deterioration as they get older, while others remain healthy and sharp to an older age? More research is being conducted into the process of ageing and ways in which the process can be slowed. Although researchers explored many interesting possible biomarkers of ageing, no biomarker was successfully identified and validated. Ayurveda has not only paid attention towards healing of ailments, but also retarding of ageing & healthy longevity for which multi-dimensional strategy known as Rasayana has been introduced. According to Ayurveda, all humors (Tridosha), essential tissues (Saptadhatu), indriya (Organs), Srotas (Body channels) and Agni (Digestive & Metabolic capacity) are affected in ageing process. Though most of those features are subjective, they could be measured by careful assessment and suitable grading. This paper demonstrates gradation of bodily changes crated by deranged Tridosha and Saptadhatu in association with ageing.

Key Words: Ageing, Biomarker, Ayurveda, Rasayana, Tridosha, Saptadhatu, Srotas, Indriya, Agni.

INTRODUCTION

Ageing is a process that can affect almost all the systems in the body. With increasing age, physically and mentally healthy adults gradually become less fit and more vulnerable to illness and death. However, these changes happen at different rates in different people. Human being is subjected to functional, material and morphological changes with age that are predictable. These changes permit classifying an individual as young, adult, active or unwell. But this estimation is not always correct. Some appears younger, some older than expected from their chronological age. But what is ageing and how can it be measured? For this, so called bio-markers of ageing are used which are measurable indicators of ageing in living beings [(1)].

Scientists are looking for a more complete understanding of the mechanisms of Ageing, to answer questions about the biological processes that account for an inevitable decline in physical vitality. More research is being conducted into the process of Ageing and ways in which the process can be slowed. In order to test new interventions (whether they be drugs, or other techniques), there has to be a way to determine if the intervention is having an impact on the underlying process of Ageing. Ideally, there would be a set of these biomarkers that would identify biological age.

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This is why there is a need to identify the effects of these certain programs have not only in the body's systems, but in the general ageing process. The determination of a person's biological age and assessment the effect of different anti-ageing techniques depends on the so-called biomarkers of ageing. Bio-markers are physical properties in human body which indicate that the body is ageing. They are indicators of normal phenomenon of growing old. They are not however, simple things which change with age. In order to be called a bio-marker, a factor has to satisfy a number of criteria. The best marker will be the one which are not susceptible to influence from the outside environment. Thus, a true bio-marker would satisfy the following criteria [2];

A. The marker must predict the rate of ageing and be a better predictor of life-span than the chronological age.
B. It must be able to be tested on a regular basis.
C. It must work for both human and other species such as laboratory animals.
D. There must be support from human clinical assessment and complimentary research studies.
E. The studies must be based on a significant representative sample.
F. The result must be a clear association with ageing.
G. A relative narrow standard deviation must be present.

Till to date, around 33 factors have been met the criteria and can be considered bio-markers. They may be indicated for both males and females but the figures may vary between the sexes. Following is the list of them [3], [4], [5];

1. 17 ketosteroid/17hydroxy-corticosteroid ratio (for male)
2. Ascorbic acid
3. Basal Metabolic Rate
4. Blood pressure-pulse
5. Blood pressure-systolic
6. Body Mass Index (for female)
7. Caries Index
8. Creatinine clearance
9. Dehydroepiandrosterone Sulphate
10. Fibrinogen
11. Hair baldness (for male)
12. Hair grayness
13. Handgrip power
14. Hemoglobin A1C
15. Lung capacity-FEV1(Aerobic capacity)
16. Lung capacity-FVC (Aerobic capacity)
17. Maximum oxygen uptake
18. Near vision (near point vision)
19. Plasma Noradrenalin (for male)
20. Periodontal index
21. Total PSA (for male)
22. Skin elasticity
23. Free testosterone (for male)
24. Serum Zink
25. Bone Mineral Density
26. Body temperature Regulation
27. Body Fat Content
28. Cholesterol/HDL Ratio
29. Muscle Mass
30. Immune Function
31. Skin Fold Thickness
32. Auditory threshold
33. Sex hormones level

In addition, there are also a number of factors which may be considered partially bio-markers of ageing. The main problem with them is that their reliability has not been confirmed scientifically through clinical and experimental data. These include:

1. Body flexibility
2. Blood urea nitrogen (BUN)
3. LDL cholesterol
4. Melatonin level
5. Static balance
6. Serotonin level
7. Many others

They are to a certain degree indicative of a person's biological age, but should not be confused with other general health factors, which do not have a clear association with age.

Bio-markers of ageing could be divided in to three main categories:

1. One which determine the biological age, i.e. skin elasticity and visual accommodation.
2. One which predict the remaining life expectancy, i.e. DHEA-S and hand-grip power.
3. One which determine disease susceptibility, i.e. systolic BP and glucose tolerance test.

All these bio-markers can be classified as laboratory tests (eg. blood and urine tests) or as physical tests undertaken in a clinic [6].

ASCOBIC ACID, HEAMOGLOBIN, SERUM ZINK & BASAL METABOLIC RATE

These are associated with nutritional status of ageing people. Loss of appetite, reduced smell, taste and thirst sensation has been reported in old age. Absorption of certain nutrients such as calcium and iron due to reduced solubility result in diminished production of gastric acid. BMR declines 3-4% per decade over life-span resulting in less energy requirement in old age [7], [8]. Older people may be at risk of Calcium, Zink, magnesium, Folate, Vitamin B-6 and Vitamin D deficiency [9]. In summary, older people seem to be more at risk of malnutrition than overweight in both developed and developing countries.

BODY MASS INDEX

Thinning of the vertebrae also results in a reduction in height. Regarding the body weight, an increase is often seen in middle-age, while weight decrease is observed in old age.

PROSTATE SPECIFIC ANTIGEN (PSA)

PSA is a protein of men normally secreted in to blood in increasing amounts with ageing. It is secreted in much greater quantities by the prostate when a man has prostate cancer. Men with elevated levels of PSA (> 4 ng/ml) were 12 times more likely to be diagnosed with prostate cancer. Prostate cancer is the most prevalent cancer in western countries and the third leading cause of cancer deaths in men [10]. Benign Prostatic Hypertrophy (BPH) is the progressive non-malignant growth of the prostate gland of male. BPH may be present in up to 10% of 40-year-old men and 80% of 80-year-old men [11].

DEHYDROEPIANDROSTERONE-SULPHATE (DHEA-S)

DHEA is a natural steroid in the body produced by the adrenal glands and is the sole precursor and regulator for the natural production of every steroid and sex hormone in the body. In other words, without ample amounts of DHEA, the body may not be able to produce healthy levels of all other hormones that need for a healthy life. DHEA is the most common sterone in human blood, but amounts decline rapidly with age. Secretions are higher during the early twenties and begin to decline at around age 25, by the time we reach 70 years of age, DHEA production is only a small fraction of what it was 50 years earlier [12].

The Ageing process is inevitably tied to a decrease in beneficial hormones, such as growth hormone, thyroid hormones, DHEA, insulin and cortisol. One of the primary changes felt with Ageing is fatigue. As such, a sense of frustration may occur along with becoming short tempered, being unable to concentrate and growing intolerant to change. And DHEA seems to be a key to understanding this fatigue that occurs with Ageing. For DHEA is necessary for the production of energy as it drives the energy producing parts of the cells.

DHEA is also vital to burning fat. That is why along with fatigue, elderly individuals often gain weight and store the fat thus gained in the abdominal region. Additional fat deposits are also found around the heart and in the blood vessels causing arteriosclerosis. In the medical literature, patient population with chronic complaints of fatigue, headache, obesity, and depression, show low DHEA blood levels. The low DHEA values are expected in very old individuals. As such, further research may find that many illnesses thought to be psychosomatic are, in fact, precipitated by a state of DHEA deficiency.

Research has shown a correlation between low DHEA levels and a declining immune system, and DHEA is being used in the fight against HIV, cancer and senile dementia. Further, it is known that Alzheimer patients have low DHEA levels, when compared to their healthy counterparts. The amount of DHEA the body produces drops dramatically as people age. When the average person reaches 70 years of age, their body is producing only 10% of the DHEA it was at 25 years of age. This is why many medical researchers believe that regaining younger levels of DHEA is an important step in the area of natural anti-ageing.

The dramatic drop in DHEA levels observed during ageing parallels the development of degenerative syndromes such as immunosenescence, atherosclerosis, osteoporosis, cognitive decline, depressed mood and increased risk of cancer. The elderly suffer from a decline in DHEA secretion. Those with very low levels of DHEA and higher levels of cortisol are most likely to suffer from dementia. The neuroprotective effects of DHEA replacement may be the most important anti-ageing benefit, since ultimately there is nothing as important as slowing down the ageing of the brain.

Like other anti-ageing hormones, such as HGH, DHEA is produced by the body in abundant supplies during youth, reaching a peak around age twenty-five, and then falling to much lower levels in later life. In the youthful prime of life, men produce approximately 31 mg DHEA daily, and women product approximately 19 mg. Sixty-five-year-old people only have 10 to 20 percent as much circulating DHEA as 20 year old. Caffeine (from coffee, tea, sodas, chocolate, candy, medications, etc.) raises cortisol and lowers DHEA. Some of the reported benefits of DHEA may be related to DHEA's role in stimulating production of HGH and insulin-like growth factor (IGF-1). Some researchers express the opinion that while DHEA may slow some of the problems of ageing, DHEA cannot reset the cellular clocks of ageing, nor can it extend the maximum life span.

CARIES INDEX & PERIODONTAL INDEX

There has been no systemic evaluation of oral health status in the elderly on the global level and limited information is available at the WHO Global Oral Data bank and a few national surveys that included some data on ageing population. It can be concluded that the major problems of the elderly are tooth loss, widespread and severe periodontal disease, dental root caries, facial pain, jaw joint pain and burning mouth, hypersalivation and a high need for extractions. Poor oral hygiene may be a risk factor for respiratory tract among the elderly [13] [14].

BODY FAT CONTENT

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. During ageing, the increase in adipose tissue is distributed in a typical pattern, with a large part of the increase occurring in the central abdominal sites, while subcutaneous fat tends to be lost from the limbs (male android patterning) [15]. There is also an age-related internalization of body fat. Both cross-sectional and longitudinal data 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 fat weight.

IMMUNE FUNCTIONS

Unless specific pathologies develop, the endocrine system usually continues to function adequately during the Ageing process. Most of the endocrine glands decrease their secretions with age, but normal Ageing usually does not lead to serious hormonal deficiencies. There are decreases in the adrenal cortical hormones; but the levels are usually sufficient to maintain homeostasis of water, electrolytes, and nutrients. Changes in fluid balance or pH are often the result of disease or damage to a particular organ.

After puberty, the thymus gland involutes (shrivels up) and is replaced by connective tissue. This means there is a decrease in the amount of thymosin produced, resulting in a decline in the defense mechanisms of the body. As the immune system becomes less effective in combating disease, the elderly become more prone to infections. This diminished capacity can be as much as 50% of that of a younger person.

T-cells are less responsive to antigens; therefore, fewer cytotoxic T-cells respond to an infection. This is partly because of the gradual decrease in size of the thymus gland and its reduced production of the hormone, thymosin. Because the helper T-cell production is reduced, B-cells become less responsive, and antibody levels do not rise as quickly after antigen exposure. Depressed lymphocyte function is also accompanied by a decrease in macrophage activity. The result is an increased susceptibility to viral and bacterial illnesses. Increased cancer incidences also indicate a decline in immune system surveillance, causing tumor cells to proliferate instead of being destroyed. In addition, the elderly frequently take drugs or have therapies that depress the immune system. For instance, the use of steroids in the treatment of arthritis and the use of drugs and radiation in the treatment of cancers all cause immune-suppression, leaving them open to secondary infections and diseases.

A decreased secretion of growth hormone leads to a decrease in muscle mass while at the same time, increasing fat storage. Levels of circulating autoantibodies (antibodies directed against self) increase in the elderly and explain why they are more prone to the development of autoimmune diseases. As the thyroid slows its secretion of thyroxine, the result is a lower basal metabolic rate [16].

AUDITORY THRESHOLD

Hearing changes that are common as we age include a decrease in sensitivity to high frequency tones and decreased discrimination of similar pitches. These changes are usually the result of normal changes to the bones and cochlear hair cells of the inner ear. Significant hearing loss, while relatively common in the elderly population is not a normal part of the Ageing process. Approximately 30% of all elderly persons have some hearing impairment. Such loss is usually the result of: damage to the hearing organ, the peripheral nervous system, and the central nervous system.

Depending upon the specific cause and location of the problem, different types of hearing loss may result: high tone loss, flat hearing loss, and difficulty understanding or distinguishing words. Because most hearing changes are not responsive to medical or surgical intervention, hearing aids and auditory rehabilitation are usually suggested, although not all types of hearing loss are correctable.

CARDIOVASCULAR CHANGES I- BLOOD PRESSURE (SYSTOLIC) & PULSE

People who are Ageing experience significant overall change by reduced blood flow to the body, which typically becomes serious in the eighth decade. This results from a number of factors including: normal atrophy of the heart muscle, especially in the left ventricle which pumps oxygenated blood out to the body, calcification of the heart valves, loss of elasticity in artery walls (arteriosclerosis), and intra-artery deposits (atherosclerosis).

The reduced blood flow results in less strength since: less oxygen is being exchanged, reduced kidney and liver function, and less cellular nourishment. As a consequence, the individual is more vulnerable to: drug toxicity, has a slower rate of healing, and a lower response to stress. Other consequences of these cardiovascular changes are: hypertension with an increased risk of stroke, heart attack, and congestive heart failure [17].

HAIR GRAYNESS

Premature hair graying is associated with premature or accelerated ageing and osteoporosis etc. In a study of postmenopausal women has confirmed that early graying of hair and osteoporosis tend to occur together. There is a clear connection between low BMD and premature graying of hair. In many studies, BMD was significantly lower in those with the majority of their hair graying during their thirties [18]. In other hand, people with gray hair by age 40 are 4.4 times more likely to suffer from osteoporosis [18]. In addition to premature ageing, premature graying of hair is a result of many other conditions. Generally ageing of graying of hair is genetically programmed [19], time and speed of gray hair onset is due in part of genetics and premature gray hair can run in families. Smoking and graying hair and even balding has clear-cut connection in males [20].

Khalitya (Falling of hairs)

a. No hair falling - 0
b. Hair falling once in the morning combing - 1
c. Hair falling during every time combing - 2
d. Visible baldness - 3

Palitya (Graying of hairs)

a. No graying of hairs - 0
b. Very few gray hairs - 1
c. Partial graying of hairs - 2
d. Sufficient graying of hairs - 3

DIFFICULTIES IN IDENTIFYING BIOMARKERS OF AGEING

1. The National Institute of Ageing of USA have been continued researches in finding biomarkers of ageing since 1981, no biomarker has yet been successfully identified [21]. One difficulty has to do with the overlap between ageing and disease. Both the ageing process and diseases can cause changes in the body, which affect life span. The idea of biomarkers is to measure the ageing process, but it has been difficult to separate this out from the effects of a disease if one is present. As ageing predisposes a person to many diseases, it has never been clear if a biomarker reflects Ageing or a pre-morbid condition more common in the aged. Possibly, serological markers like cholesterol and C-reactive protein (CRP) measure some aspects of ageing and predict the onset of certain age-related diseases.
2. Another obstacle is the facts that some age related changes cause no harm to the normal physiological systems, while others do. It isn't entirely known which changes are harmful and which are benign. This makes it more difficult to pinpoint exactly what to look for.
3. From 1988-1998, the National Institute of Ageing of USA sponsored a 10-year initiative encourAgeing research into biomarkers of ageing. Although researchers explored many interesting candidates for possible biomarkers and contributed to the body of knowledge on Ageing and caloric restriction, no biomarkers were successfully identified and validated [39]. Since then, obtaining funding for biomarkers research has become more difficult.

AYURVEDIC VIEW OF AGEING

In Ayurveda, the last period of life is commonly known as Jara which is beyond 60 years of age (Su.Su.35/35). It has been prologued in Ayurveda that the Jara or old age has been considered natural phenomenon which occurs in

each and every human being. However, old age is associated with significant Doshic imbalance (humors), loss of certain tissues (Dhatu kshaya) due to the increased catabolic activities. Hence, old age does not come under the healthy (Swastha) in which proper functions and balance of Dosha, Dhatu, Mala and Agni; and excellent state of mental condition are prerequisites (Su.Su.15/48). On the other hand, Charaka has said that Jara is one of the naturally occurring diseases (*Swabhavabalapravrutta Vyadhi*) (Ch.Su.1/33) and Sushruta has mentioned that these natural diseases are incurable (Nishpratikriya) (Dalhana on Su.Ch/1.1).

According to Ayurveda, in old age muscles become flabby, joints become loose, blood become decomposed, fats get liquefied, and the individual become sleepless, torpor and sluggish, desperate, breathing hard. Such a man is rendered incapable of any bodily and mental labor, depriver of memory, intelligence and body luster and turned in to a home of diseases, fails to enjoy his full measures of life (Ch.Ch.1/2/3). On the basis of doshic predominance, childhood, young & middle age and old age is Kapha, Pitta and Vata dominant respectively (Su.Su.35/38). Naturally, all three Doshas are affected in old age by disturbing its normal functions as when they were in normal balanced state in the young and childhood.

Vata, Pitta, and Kapha and its subtypes produce various symptoms in old age which are tabulated as follows. (AH.Su/12/4-5, 6, 7, 8, 9; Su. Ni.1/17-18)

Type of Vata	Normal functions	Deranged functions in old age
Pranavata	Swallowing, Respiration (exhalation & Inhalation)	Dysponea, Dysphagia, Excess Eructation, Hiccups etc.
Udanavata	Produce speech, enthusiasm, strength, complexion, memory etc.	Dyspnoea, loss of enthusiasm, strength, complexion, memory etc.
Samanavata	Food digestion & Elimination,	Constipation, loss of appetite etc.
Vyanavata	Movements, Blinking of eyes, flexion & extension etc, Sweating & bleeding.	Loss of functional ability, loss of sweating, bleeding etc.
Apanavata	Defecation, Urination, Ejaculation of semen, Discharge of menstrual blood & foetus.	Constipation, dysuria, ejaculatory problems, menstrual abnormalities etc.

After the advent of old age, Pitta Dosha also gets deranged its functions in different ways. Types of Pitta and its normal and abnormal functions in old age are as follows (AH.Su.12/10-14).

Type of Pitta	Normal functions	Deranged functions in old age
Pachaka pitta	Digestion, Absorption, Assimilation & metabolism	Indigestion, loss of appetite, Malabsorption etc.
Ranjaka pitta	RP converts Rasa Dhatu into Rakta Dhatu.	Mild Aneamic condition may be obvious.
Alochaka pitta	AP Induces normal vision.	Visual defects (Glucoma, Cataract & Presbiopia etc).
Sadhaka pitta	Maintain memory & intelligence	Deranged intelligence, loss of memory
Bhrajaka pitta	Maintain complexion & luster	Loss of complexion, discoloration, loss of elasticity & appearance of wrinkles

As the other two Dosha, Kapha also undergoes some degenerative changes thereby functional abnormalities. The normal physiological functions and abnormalities experienced in old age has been mentioned bellow. (AH.Su.12/15-18).

Type of Kapha	Normal functions	Deranged functions in old age
Bodhaka kapha	BK induces taste sensation.	Loss of taste
Sleshaka kapha	SK maintains intactness & prevents friction in joints.	Loss of movements, pain & rigidity of joints, degenerative Joint diseases (eg. OA)
Tarpaka kapha	TK regulates the higher functions of brain.	Deranged higher functions such as sleep, memory etc.
Kledaka kapha	KK facilitates proper digestion by mixing & diluting the food in stomach.	Disturbed digestion.
Avalambaka kapha	AK strengthens & nourishes the heart & other seats of Kapha.	Weakened functions of heart & other Kapha dominant organs.

Sapta Dhatu is also involved in ageing process adapting some age related degenerative changes in an individual. Each Dhatu has some specific role in maintaining the healthy body and those will be degenerated in gradual manner with the advancement of age (Ch.Ch/15; Su.Su/11,14,15; AH.Su/11,19; Ch.Su/17,24; Su.Sh/5,7; AS.Sh/5). Depletion (Kshaya) of quality and quantity of each dhatu is gradually evident in ageing.

Dhatu	Normal functions	Degenerated Features in Ageing
Rasa Dhatu	Nourishes Rakta, provides satisfaction & Preenana, Growth &Development, and Sustains the body.	Weakness, roughness, fatigue, wasting, chest pain, tremors, ex: thirsty,
Rakta Dhatu	Nourishes Mansa, provides complexion, strength, longevity, well-being, nourishment, Sensation	Roughness of skin, affection towards sour & cold things, prominent blood vessels, cracked skin,
Mamsha Dhatu	Nourishes Meda &body, increases muscle bulk, covers Sandhi, Asthi, Sira & Snayu	Wasting in Buttocks, thighs, Shoulders etc, vague pain, joint pain.
Medas Dhatu	Nourishes Asthi, provides with Snehana & sweating, make eyes Snigdha	Joints & eyes become dry, weakness, loss of sensation, muscle wasting
Asthi Dhatu	Nourishes Majja, provides with the structural support to the body	Pain in bones & teeth, falling of hair, nails, teeth, weakness, looseness of joints
Majja Dhatu	Nourishes Shukra, fills up bones & provides strength, & complexion, to the body	Osteoporosis, weakness of bones, Vertigo, Syncope, oligospermia & susceptibility to vataroga
Shukra Dhatu	Enhance body strength, & virility, sexual satisfaction, produces fertility.	Weakness, fatigue, dry mouth, roughness of the body, Agnimandya, napunsakata, pain in scrotum, Impotence

AGE AND AGEING PROCESS

The ancient classics give a detailed version on the chronological aspect of ageing starting from growth & puberty to senility. The classics have divided age into *Balya* (immature), *Madhyama* (mature) and *Vriddha* (old), which extend from birth to 30 years, 30 to 60 years and above 60 respectively. It has been observed that changes of particular faculties of the body starts from very beginning of life indicating that ageing process is a dynamic process from birth to death. Vagbhatta was the first one to record such an observation, which was followed later by Sharangadhara. It is clear that ageing does not occur simultaneously in all the tissues. Different body tissues are affected ageing at different time period. Gradual declination of a particular faculty takes place in each decade of life and by the end of decade, that particular faculty is lost. Following table shows the loss of body tissues during various decades of life (AS.Sha.8/25, Sha.Pu.7/19).

Decade	Loss of Tissues	
	Vagbhata	Sharngadhara
I	Childhood	Childhood
II	Growth	Growth
III	Complexion	Complexion
IV	Intellect	Intellect
V	Skin	Skin
VI	Reproductive Capacity	Vision
VII	Vision	Reproductive Capacity
VIII	Hearing	Valour
IX	Mind	Knowledge
X	Sensory & Motor organs	Motor organs
XI	-	Mind
XII	-	Life

Vagbhatta limits the life span of human beings to 100 yrs whereas Sharngadhara extends it further by 20 yrs. On the basis of above clinical features which are associated with the Doshic and Dhatu derangement in ageing, some subjective parameters could be created to measure the state of ageing and those could be used as Ayurvedic biomarkers of ageing (jara). According to the severity of the findings, those biomarkers could be graded as follows. Some of them are very closely correlated with one of few newly identified potential biomarkers. These changes with their underlying scientific background have been discussed bellow.

GRADATION OF SIGNS AND SYMPTOMS OF AGEING

(Devangi Shukla & Chandola H.M) [22]

SKIN ELASTICITY

These signs are associated with skin elasticity. A significant problem for many people is ageing skin. As we get older, our bodies change in dramatic ways. The ageing of the skin is one of the most dramatic changes and tends to define the age of the person. The healthy and beautiful skin that may have been present during our youth eventually disappears [23].

Vali (Wrinkling)

a. No wrinkling - 0
b. After skin raising, wrinkle subsides early - 1
c. After skin raising, wrinkle persist for longer duration - 2
d. Wrinkle visible even without missing the skin - 3

Twak Parushata (Dryness of skin)

a. No dryness - 0
b. Scratches can be made on the skin - 1
c. Skin looks dry but not cracked - 2
d. Skin looks dry with cracks - 3

Prabha hani / chhavi hrasa (Changes in complexion)

a. No changes in complexion - 0
b. Mild changes in complexion - 1
c. Moderate changes in complexion - 2
d. Severe changes in complexion - 3

MUSCLE MASS

Muscle mass is one of biomarker in which loss of muscle mass or sarcopenia with ageing is well documented [24]. Excretion of urinary creatinine (reflecting muscle creatinine and total muscle mass) decreases by nearly 50% between the ages 20-90 years [25]. These changes are more pronounced in women than in men [26]. Reduction of muscle strength is common with ageing.

Advancing adult age is associated with profound changes in body composition. One of the most prominent of these changes is sarcopenia, defined as the age-related loss in skeletal muscle mass, which results in decreased strength and aerobic capacity and thus functional capacity. Sarcopenia is also closely linked to age-related losses in bone mineral density (BMD), basal metabolic rate (BMR), and increased body fat content (BFC).

A generalized withering of all muscles is normal in later years accompanied by a replacement of some muscle tissue by fat deposits. This results in some loss of muscle tone and strength. Some specific implications are; reduced ability to breathe deeply, reduced gastrointestinal activity which can lead to constipation, and bladder incontinence, particularly in women. Tendencies to gain excessive weight and be inactive cause the person with a disability to have accelerated and significant problems in later years with their muscle mass. Muscles, bones and joints become strained over time, making it more difficult to handle the stress and weight of the person's body.

Slatha sara (Flabbiness of the body)

a. Never feels body loose & weak - 0
b. Occasionally feels body loose & soft - 0
c. Often feels body weak - 2
d. Always feel loose & weak body - 3

Slatha Mamsa (Decreased muscle tone)

a. Do not feel tired after exertion - 0
b. Occasionally feel tired after exertion - 1
c. Often feel tired after exertion - 2
d. Always feel tired even at rest - 3

Utsaha hani (Decreased Enthusiasm)

a. No decrease in enthusiasm - 0
b. Occasionally feels decrease in enthusiasm - 1
c. Often feels decrease in enthusiasm - 2
d. Always feels decrease in enthusiasm - 3

Parakrama hani (Decreased physical strength)

a. No decrease in physical strength - 0
b. Occasionally feels de: in physical strength - 1
c. Often feels decrease in physical strength - 2
d. Always feels decrease in physical strength - 3

BONE MINERAL DENSITY

Loss of bone mineral density (BMD) and the directly related increased risk of bone fracture have considerable socio-economic implications. Age related osteoporosis begins at around age 40 and continues for the rest of the life-span. Because of their dramatic hormonal changes, osteoporosis is more common in women than in men [27].

The joints also undergo changes. In fact, arthritis, the degenerative inflammation of the

joints, is the most common chronic condition in the elderly. The two most common forms are; osteoarthritis (degeneration of the joint cartilage), and rheumatoid arthritis (a disease of the connective tissue). These conditions can impair mobility and the performance of daily activities of living. For persons with disabilities this condition may occur at an earlier age [28].

Beginning at around age 35 in both men and women, calcium is lost and bones become less dense. This can result in osteoporosis and a reduction of weight bearing capacity, leading to the possibility of spontaneous fracture. Thinning of the vertebrae also results in a reduction in height. In addition, the vertebrae calcify, resulting in postural changes and increasing rigidity, making bending difficult [28].

The first age-related changes that can affect mobility are anthropometric changes. Cross sectional studies have shown that stature and range of motion in the joints tend to decline with age [29]. People between 65-74 years of age are approximately 3% shorter than people between 18- 24; this is thought to be due primarily to the shortening of intervertibral discs spaces and associated kyphosis. Gait disturbances have been documented extensively among older people. However, it is controversial whether these changes are due to a normal ageing process or whether they are pathological changes accompanying old age [30],[31].

Slatha Asthi (Bone weakness)

a. No bony pain - 0
b. Occasional bony pain on pressure - 1
c. Often feel discomfort and bony pain during light exertion - 2
d. Dull aching pain even during rest - 3

Slatha Sandhi (Flaccid joint)

a. No pain in the joint - 0
b. Occasionally feels pain & crackling sound in the joints during movement - 1
c. Often feels pain & crackling sounds in the Joints during movement - 2
d. Always feel pain & crackling sounds in the joints during movements - 3

Kayasya Avanamanam (Bending of the body)

a. No bending of the body - 0
b. Mild bending of the body - 1
c. Moderate bending of the body - 2
d. Severe bending of the body - 3

Karmendriya hani (Decreased Loco motor activites)

a. No decrease inloco motor activities - 0
b. Mild decrease in loco motor activities - 1
c. Moderate decrease in loco motor activities - 2
d. Severe decrease in loco motor activities - 3

Vepathu (Tremors)

a. No tremors - 0
b. Occasional tremors - 1
c. Often tremors - 2
d. Always tremors - 3

FEV & FEV_1

As with the cardiovascular system, there is also a reduction in the efficiency of the respiratory system in later life. The airways and lung tissue become less elastic with reduced cilia activity, resulting in decreased oxygen uptake and exchange. The muscles of the rib cage also atrophy, further reducing the ability to breathe deeply, cough, and expel carbon dioxide.

These changes worsen if the individual smokes or lives in a polluted environment. The result of these changes can include lower stamina with shortness of breath and fatigue, which in turn may impair one's ability to perform activities of daily living. Lack of oxygen can also increase anxiety [32].

Kasa (Coughing)

e. No coughing - 0
f. Occasional coughing - 1
g. Recurrent coughing - 2
h. Always coughing - 3

Shwasa (short breath)

i. No breathlessness - 0
j. Occasionally breathlessness - 1
k. Often breathlessness on exertion - 2

l. Breathlessness even without exertion - 3

MENTAL HEALTH

Research on the human brain has documented dramatic decreases in brain size and efficiency throughout our lives, beginning virtually from the time of birth. Yet, in spite of these anatomical and physiological declines, studies have found evidence of only limited decreases in actual intellectual functioning associated with the ageing process. This section examines some of these known decreases in two basic areas of cognitive functioning; Intelligence, and learning and memory.

The fact that older persons experience virtually no functional impairment despite their cognitive limitations is a testimony to the redundancy built into the human brain, as well as the ability of humans to find ways to compensate for potential cognitive limitations. It also reflects the fact that intellectual ability is only one of many factors affecting functioning in later life. Individuals with disabilities abilities to function independently will be affected at an earlier age [33]. Memory impairment that associated with ageing is known as mild cognitive impairment (MCI) which is a potent risk factor of Alzheimer's disease (AD) in future [34]. Studies comparing the effects of ageing on episodic memory, short term memory, semantic memory, short-term memory and priming find that episodic memory is especially impaired in normal ageing [35], [36].

Medha hani (Decreased function of Intellect) Grahana (Grasping Power)

a. No deterioration in grasping power - 0
b. Occasionally fails to grasp the subject - 1
c. Often fails to grasp the subject - 2
d. Always fails to grasp the subject - 3

Dharana (Retention Power)

a. No deterioration in retention power - 0
b. Occasionally fails to retain/hold up the subject - 1
c. Often fails to retain/hold up to subject - 2
d. Always fails to retain/hold up to subject - 3

Smarana (memory Power)

a. No deterioration in memory - 0
b. Occasionally fails to remember the things - 1
c. Often fails to remember the things - 2
d. Always fails to remember the things - 3

Vachana (Speech)

a. No deterioration in speech - 0
b. Occasionally feels problem in speaking - 1
c. Often feels problem in speaking - 2
d. Always feels problem in speaking - 3

Vijnana (Knowledge)

a. Normal function in routine - 0
b. Gradual hampered performance in functions - 1
c. Impaired motivation towards functioning - 2
d. Loss of pace and motivation in functioning - 3

Buddhi hani (Deterioration in wisdom)

a. No deterioration in wisdom - 0
b. Mild deterioration in judgment based on Knowledge & experience - 1
c. Moderate deterioration in judgment based on knowledge & experience - 2
d. Severe deterioration in judgment based on Knowledge & experience - 3

SEX HORMONE LEVEL & FREE TESTOSTERONE LEVEL

Sexual desire and performance may continue well into an individual's seventh, eighth and ninth decade although frequency may decrease in men. Physiological changes in women include: atrophy of the ovarian, vaginal and uterine tissues with decreased production of vaginal fluids where as in men; sperm production is decreased, the prostate enlarges and overall sensitivity declines. Both older men and women generally require more stimulation to become aroused and more time to reach orgasm [28]. Some older men may become less sexually active with age reasons for which include loss of libido (due to decreased androgen), erectile dysfunction (due to vascular changes in erectile tissues), chronic illness and various social and environmental factors [37].

Dhatu Kshaya (Loss of tissues)

a. Absence of Dhatu Kshaya symptoms - 0
b. Mild presence of Dhatu Kshaya symptoms - 1
c. Moderate presence of Dhatu Kshaya symptoms - 2
d. Severe presence of Dhatu Kshaya symptoms - 3

Paurusha hani (Decreased virility)

a. No decreased virility - 0
b. Occasionally feels decreased virility - 1
c. Often feels decreased virility - 2
d. Always feels decreased virility - 3

Shukra Kshaya

a. Absence of shukra kshaya symptoms - 0
b. Mild presence of shukra kshaya symptoms - 1
c. Moderate presence of shukra kshaya symptoms - 2
d. Severe presence of shukra kshaya symptoms - 3

NEAR VISION

Beginning the fourth decade, the pupil begins to decrease in size and in response time to light. Because of these changes, it is estimated that older adults require three times the amount of illumination to see as a younger person. Another normal change is thickening and yellowing of the lens of the eye. This results in light diffraction, increased sensitivity to glare, decreased depth perception, and more difficulty distinguishing colors.

Non-normal age-related changes of the eye include: Cataracts, significant darkening and blurred lens and glaucoma; and various retinal disorders such as: macular degeneration and diabetic retinopathy. Cataracts are the major source of visual impairment in older people. Approximately 905 million of people with cataract live in developing countries 60% of whom are elderly [38]. Macular degeneration is the atrophy of the macular region of the retina. Two types of age-related macular degeneration occur. They are dry or atrophic form and the wet or exudative form. The former causes mild vision loss where as the latter is associated with progressive visual distortion leading to vision loss.

Age-related macular degeneration results from underlying pathologic changes that occur primarily at the level of the retinal pigment epithelium, Bruch's membrane, and the choriocapillaris in the macular region. Drusen (bumps), which are common in elderly people, appear as yellow deposits beneath the pigment epithelium and may be prominent in the macula. No predisposing conditions have been identified; however, some forms of the disorder are hereditary. Macular degeneration is the most common cause of legal blindness in adults, accounting for about 12% of blindness cases in the United States and for about 17% of new blindness cases. It's also one of the causes of severe irreversible loss of central vision in elderly people by age 75; almost 15% of people have this condition. Whites have the highest incidence. Other risk factors are family history and cigarette smoking.

Dristi hrasa (Diminished vision)

a. No diminished vision - 0
b. Mild loss of range of visual accommodation - 1
c. Moderate loss range of visual accommodation - 2
d. Severe loss of range of visual accommodation - 3

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