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Research Article

CHANGES IN SLEEP, NON EXERCISE ACTIVITY THERMOGENESIS AND FOOD TRENDS AND ITS EFFECT ON AGING, HEALTH AND LONGEVITY

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ABSTRACT

Modern day lifestyle trend has been severe cause to many health issues and resulting in cardiovascular diseases, obesity, Endocrine related disease and many others. Today people are adapting healthy lifestyle like engaging in physical activity, Improved Food patterns, and Work styles but still the longevity is in lower range in many countries. We made a literature review from different data available on Sleep time and habits, Non-Exercise activity thermogenesis (NEAT), Food pattern and food trend to discuss the suggestive effect on factors like cortisol, Telomere, Obesity, Cardiovascular factors, Change in circadian rhythm and others that causes increased mortality rate and decreased health index with compared to earlier century lifestyle. The review finds that lower average sleep time and differed sleep time affects cortisol cycle, Glymphatic system cycle. Increased consumption of processed food and sugar sweetened beverages resulted in high empty calorific consumption than RDA and resulting Telomere shortening and obesity which may lead to early aging, weakened immunity and mortality. Lower NEAT affects the obesity as well as overrides the benefits of Exercise. Thus indicating decreased Health index and may be cause of decreased longevity compared to ancient life styles.

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INTRODUCTION

Longevity is an important aspect of healthy living. Food, sleep and exercise are three most important parameters of a human body that decide the Longevity or healthy life span. Today people are adapting healthy lifestyle like engaging in physical activity, Improved Food patterns, and Work styles but still the longevity is in lower range in many countries. People are engaged in comfort sleeping products and devices for good sleep. There is much awareness about exercise and nutrition. But still the rate of mortality is not much difference with respect to non-effluent factors compared to earlier centuries. There has been susceptible change in modern day immune system decline and increased obesity than earlier centuries even though there are high personal regimes of food and exercise are maintained. In this study we tried to summarize and analyze the available literature and predict the changes that could be affected by the modern day life style and trend. We tried to find the correlation with Glymphatic system and cortisol hormone with respect to change in sleep trend, calorific burn and obesity with respect to Non-Exercise activity thermogenesis, Effect of SSB's on Telomere and subsequently on aging and immunity.

Observations

Sleep: Sleep is the important aspect of health. Most of the important functions like memory consolidation, Waste clearance, etc. happen during sleep. The hypothalamus, a peanut-sized structure deep inside the brain, contains groups of nerve cells that act as control centers affecting sleep and arousal. Within the hypothalamus is the suprachiasmatic nucleus (SCN) – clusters of thousands of cells that receive information about light exposure directly from the eyes and control your behavioral rhythm. The pineal gland, located within the brain's two hemispheres, receives signals from the SCN and increases production of the hormone melatonin, which helps put you to sleep once the lights go down. Circadian rhythms synchronize with environmental cues (light, temperature) about the actual time of day, but they continue even in the absence of cues. Genes may play a significant role in how much sleep we need. Recent studies have identified several genes involved with sleep and sleep disorders, including genes that control the excitability of neurons, and "clock" genes such as *per*, *tim*, and *Cry* that influence our circadian rhythms and the timing of sleep^[19].

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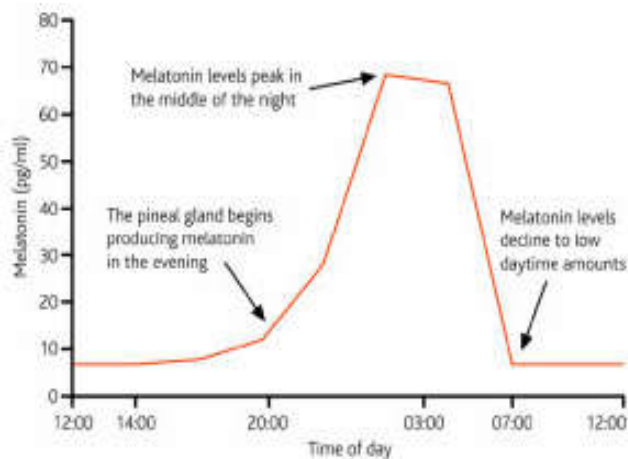


Fig 1 Melatonin rise and low as per time of day.^[42]

In ancient times there was significant less availability to artificial light in evening and night time. Some of the places where out of electricity reach. In ancient time there was no availability of mobile phones or television sets. People in villages or even in dominant places in earlier centuries slept early with the sun schedule or had biphasic sleep^[19]. External and artificial light has direct impact shift in circadian rhythm. Ancient people had long duration as well as good quality sleep.^[20] Exposure of artificial light like mobile phone screens, Laptops, Television late night delays the sleep process by inhibiting melatonin production as it is dependent on external light intensity. Smartphones—like laptops, tablets, and televisions—emit something called blue light, which is a type of light that the brain interprets as daylight. The blue light actually suppresses melatonin *fig.1*, a hormone that affects circadian rhythm and should increase when you are preparing for bedtime^[21]. This not only makes us sleep difficultly but also hampers the quality of sleep. There are innumerable research papers that demonstrate the health detriments of a desynchronized circadian rhythm. According to study took place from January 13-15, 2016 with 9th, 10th, and 11th grade students enrolled at Konya High School (n=380, 51.6% female, age 16.05±0.87). A questionnaire was used for data collection and the Pittsburgh Sleep Quality Index (PSQI) was used to measure the sleep quality, it was determined that 20.5% of the students with good sleep quality and 79.5% of the students with poor sleep quality delayed their bedtime in favor of continued usage of their phone (p<0.05)^[22]. According to data by Centers for Disease Control and Prevention About one-in-four people age 18 to 24 say that they don't sleep well because of technology^[7]. Data suggests that Americans sleep 6.8 hours per day on average, down more than an hour from 1942^[6]. So from the literature searched it is clear that the average sleep time and sleep quality is declined in recent years due to changes in technology and lifestyle. So invariant of new things added to sleep comfort like comfort mattress, Temperature controls, etc. Many of the people are experiencing health issues that may have been originated from sleep deprivation and low quality sleep that where very less in ancient times. We have figured out some of the issues below:

Effect of sleep on Glymphatic system: Waste removal from the central nervous system is essential for maintaining brain health across the lifespan. The system which works in Brain waste clearing is Glymphatic system. The Glymphatic system is a

glial-dependent waste clearance pathway in the brain, in place of lymphatic vessels, dedicated to drain away soluble waste proteins and metabolic products. Specifically, the Glymphatic network serves as a “front end” for waste clearance, and is connected downstream to an authentic lymphatic network, associated with dura covering the brain as well as cranial nerves and large vessels at the skull exits. The Glymphatic system serves as the brain’s “front end” waste drainage pathway that includes a perivascular network for cerebrospinal fluid (CSF) transport which is connected to a downstream authentic lymphatic network associated with the meninges (dura), cranial nerves, and large vessels exiting the skull. The efficiently functioning Glymphatic system may be important for maintaining brain health across the life span^[10]. The Glymphatic system function mainly during sleep and is largely disengaged during wakefulness. The biological need for sleep across all species may therefore reflect that the brain must enter a state of activity that enables elimination of potentially neurotoxic waste products, including β -amyloid^[11].

According to study Effects of Sleep and Sleep Deprivation on Catecholamine and Interleukin-2 Levels in Humans: Clinical Implications^[12] Sleep onset was associated with a significant ($P < 0.05$) decline of circulating concentrations of norepinephrine and epinephrine, with a nocturnal nadir that occurred 1 h after nocturnal sleep. On the PSD-L night, levels of norepinephrine and epinephrine significantly ($P < 0.05$) increased in association with nocturnal awakening. This burst release of norepinephrine during arousal increases the cellular volume fraction resulting in a decrease in the interstitial space. In turn, the resistance toward convective exchange of CSF and ISF increases and this results in a suppression of Glymphatic fluxes during wakefulness.^[11] Suppression of Glymphatic system may result in non-clearance of Brain waste including β -amyloid which is major peptide in Alzheimer’s Disease and other Neuro degenerative disorders^[13]. This suggests increasing sleep disturbances in modern days and lower average sleep are resulting in different brain related disorders hampering brain health and longevity of life.

Sleep and Impaired Cortisol control and obesity: Cortisol is a steroid hormone that regulates a wide range of vital processes throughout the body, including metabolism and the immune response. The secretion of cortisol is mainly controlled by three inter-communicating regions of the body; the hypothalamus in the brain, the pituitary gland and the adrenal gland. This is called the hypothalamic–pituitary–adrenal axis. When cortisol levels in the blood are low, or there is a stress response a group of cells in a region of the brain called the hypothalamus releases corticotrophin-releasing hormone, which causes the pituitary gland to secrete another hormone, adrenocorticotrophic hormone, into the bloodstream. High levels of adrenocorticotrophic hormone are detected in the adrenal glands and stimulate the secretion of cortisol, causing blood levels of cortisol to rise^[16] According to study by Leproult R *et al*, Sleep loss results in an elevation of cortisol levels the next evening. Even partial acute sleep loss delays the recovery of the HPA from early morning circadian stimulation and is thus likely to involve an alteration in negative glucocorticoid feedback regulation.^[17] Through hyper activation of the HPA axis and changes in the neuroendocrine response, sleep loss and chronic stress can lead to metabolic dysfunction. The HPA axis dysregulation is commonly seen in obesity, sleep deprivation,

and sleep disorders such as OSA and insomnia.[18] Repeated elevation of cortisol can lead to weight gain. One way is via visceral fat storage. Cortisol can mobilize triglycerides from storage and relocate them to visceral fat cells (those under the muscle, deep in the abdomen). Cortisol also aids adipocytes' development into mature fat cells. The biochemical process at the cellular level has to do with enzyme control (11-hydroxysteroid dehydrogenase), which converts cortisone to cortisol in adipose tissue. More of these enzymes in the visceral fat cells may mean greater amounts of cortisol produced at the tissue level, adding insult to injury (since the adrenals are already pumping out cortisol). Also, visceral fat cells have more cortisol receptors than subcutaneous fat.^[15] A second way in which cortisol may be involved in weight gain goes back to the blood sugar-insulin problem. Consistently high blood glucose levels along with insulin suppression lead to cells that are starved of glucose. But those cells are crying out for energy, and one way to regulate is to send hunger signals to the brain. This can lead to overeating. And, of course, unused glucose is eventually stored as body fat^[14]. Obesity is one of the major factors contributing to hampered longevity compared to ancient times. According to Obesity and overweight facts^[5] by world health organization in 2018, worldwide obesity has nearly tripled since 1975. According to the National Institutes of Health, obesity and overweight together are the second leading cause of preventable death in the United States. An estimated 300,000 deaths per year are due to the obesity epidemic.^[5]

Non-Exercise Activity Thermogenesis

Physical activity is an important aspect to health. Physical activity ranges from aerobic activity to Non exercise activity thermogenesis (NEAT). Whenever the physical activity is indulged, it results in changes in many parameters including cardiac output, calorie burn, Muscle hypertrophy, etc. depending upon type of physical activity. In current scenario we can classify physical activity in two types: Self-induced and NEAT. Self-induced activity can be running, working out, doing aerobic activity etc. Non-exercise activity thermogenesis (NEAT) is the energy expended for everything we do that is all activities excluding sleep and exercise. It ranges from the energy expended walking to work, typing, performing yard work, undertaking agricultural tasks and fidgeting.^[1] Sedentary lifestyle decreases calorific burn through lowered NEAT. Many people these days are engaging in daily exercises, workout or intense physical activities but still having the higher Body mass index ratio, and this is real problem of modern lifestyle. NEAT consists of average 30%-43% of calorie consumption in healthy adult who is partly active.

In ancient times, Most of the jobs were near to none or less sedentary. The pattern changed as the timeline progressed. Starting with the Stone Age man to shelter age man, he used to move, walk, run whole day in search of food and hunt. Homo sapiens have dwelled on this earth for some 200,000 years, most of that time as hunter-gatherers and gradually growing in number. Some 10,000 years ago, when people adopted an agrarian way of life, mankind established permanent settlements. In Egypt there are traces of wells, and in Mesopotamia of stone rainwater channels, from 3000 B.C. The first urbanization in Europe occurred during antiquity (500 B.C. – 500 A.D.) around the Mediterranean region.^[25]

Gathering food by hunting and exploring rigorous walking, running behind the prey, hiding around the tress and climbing on trees, etc. Same rigorous daily movement is seen in early life agriculture. As the civilization processed the life became more sedentary.

In 1800's to late 1990's the job became 60% sedentary. In Recent civilization, According to study Occupational changes during the 20th century^[28] in 1910 Fig.2, Farmers and Farm labours consisted of 34% of people where as professional, technical and kindered consisted of 4%. In 2000, Farmers and Farm labours consisted of 34% of people where as professional, technical and kindered consisted of 4%. This indicates high improvement in sedentary lifestyle compared to early age. These results in less calories burn, low metabolic rate thought the day^[3]. In today's lifestyle we are trying to overcome sedentary behavior by approaching workouts and exercise.

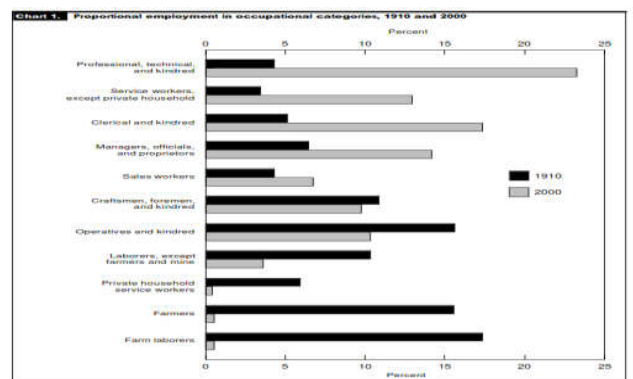


Fig 2 Proportional employment in occupational categories, 1910 and 2000^[28]

According to Akins JD *et al*, In people who are physically inactive and sitting for a majority of the day, a 1-h bout of vigorous exercise failed to improve lipid, glucose, and insulin metabolism measured the next day. It seems that something inherent to inactivity and/or prolonged sitting makes the body resistant to the 1 h of exercise preventing the normally derived metabolic improvements following exercise. [4] So even when in modern age we are trying to stay active through weekly exercises, the sedentary increase may be resulting in metabolic disorders, less thermogenesis, elevated lipids effecting health quality and reducing longevity. According to meta-analysis of available prospective cohort studies, The estimated gains in life expectancy in the US population were 2.00 years for reducing excessive sitting to <3 h/day and a gain of 1.38 years from reducing excessive television viewing to <2 h/day [31]. According to Kyle Mandsager, MD *et al*, the researchers examined the data of 22,007 patients who underwent treadmill testing between 1991 and 2014. They then calculated all causes of mortality in relation to the benefits of exercise and fitness, making sure to include age, sex, height, weight, BMI, medications and other illnesses. They found individuals who did not exercise had a 500% increased risk of death compared to those who did [32].

The sedentary lifestyle may be the cause of increasing obesity, Type 2 diabetes and Cardiovascular diseases as that sedentary behavior contributes to cardiovascular disease and diabetes mellitus risk compared to early age people having less sedentary lifestyle.

Food Trends: The food is major aspect of health and longevity. Food has direct impact on body structure, endocrine and metabolic aspects. We are eating good food, high antioxidants, following diet trends but still the mortality and early aging rate is high compared to previous century people. . Food trends have been changing continuously from ancient times to this current time. Most changes that have been observed in early 1900's to 20th century are consumption of Ultra processed foods and sweetened sugar beverages of SSB's. We will try to correlate the available literature with longevity with respect to telomeres and obesity. Following is the data summarized from different parts of world from the available literature:

According to data by center for disease control and prevention Sugar-sweetened beverages (SSBs) or sugary drinks are leading sources of added sugars in the American diet. In 2011-2014, 6 in 10 youth (63%) and 5 in 10 adults (49%) drank a sugar-sweetened beverage on a given day. On average, U.S. youth consume 143 calories from SSBs and U.S. adults consume 145 calories from SSBs on a given day. Fig 3. [37]

Study evaluated dietary intakes of 9,317 participants from 2009 to 2010 NHANES aged 1+ years. Food items were classified into unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods. The results showed that the average content of protein, fiber, vitamins A, C, D, and E, zinc, potassium, phosphorus, magnesium, and calcium in the US diet decreased significantly across quintiles of the energy contribution of ultra-processed foods, while carbohydrate, added sugar, and saturated fat contents increased [33].

According to Trends in food availability, 1909–2007, Data from 1909 to 2007 show increases in per capita availability of several product classes: added oils increased from 16.1 to 39.4 kg/y, meat increased from 56.3 to 91.2 kg/y, cheese increased from 1.7 to 14.9 kg/y, and frozen dairy products increased from 0.7 to 11.5 kg/y. From 1970 to 2007, per capita availability of sweeteners increased from 54.1 to 62.0 kg/y. carbonated beverage availability has increased, partly at the expense of fluid milk. [36]

As per study published in 2015 by Geetanjali M. Singh *et al*, Of 21 world regions, SSB consumption was highest in the Caribbean (1.9, 95%CI: 1.2, 3.0 servings/day), and lowest in East Asia (0.20, 95%CI: 0.16, 0.25 servings/day). SSB consumption was also high in Central Latin America, high-income North America, and Andean Latin America, with average intakes of over 0.8 servings per day of SSBs [38]

A study was designed to compare secular changes in ultra-processed food (UPF) consumption and expenditure among Taiwanese adolescents aged 16–18 years and the influences of such changes on dietary quality. Compared to 1993–1996, adolescents consumed less energy from original foods (55 vs. 39%) but more from processed foods (12 vs. 18%) and UPFs (21 vs. 25%) in 2011, with no apparent gender differences. Those who consumed more UPFs had the lowest proportions of protein energy intake in both surveys (13.7 and 13.1%). Those who consumed more UPFs had higher levels of saturated fat and lower levels of monounsaturated and polyunsaturated fat, dietary fiber, and micronutrient intakes. [35] 6. According to Total and Free Sugar Content of Pre-Packaged Foods and Non-Alcoholic Beverages in Slovenia, cross-

sectional study aimed at assessing free sugar content for 10,674 pre-packaged food items available from major Slovenian food stores during data collection in 2015, Together, 52.6% of all analyzed products contained free sugar, which accounted for an average of 57.5% of the total sugar content [34]

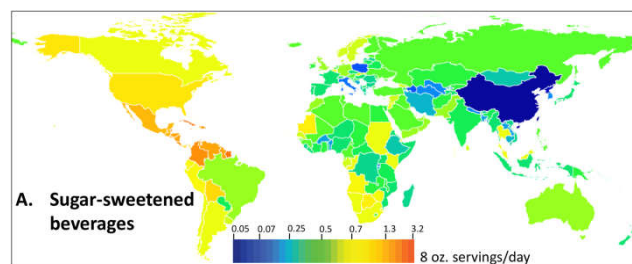


Fig 3 Consumption of non-alcoholic caloric beverages in 187 countries worldwide.^[38]

Effect of SSB on telomeres and aging: A telomere is a region of repetitive nucleotide sequences at each end of a chromosome, which protects the end of the chromosome in a cell from deterioration or from fusion with neighboring chromosomes. They consist of the same sequence of bases repeated over and over. In humans the telomere sequence is TTAGGG. As we age, each time a cell divides, 25-200 bases are lost from the ends of the telomeres on each chromosome. When the telomere becomes too short, the chromosome reaches a ‘critical length’ and can no longer be replicated. Newborn babies tend to have telomeres ranging in length from around 8,000 to 13,000 base pairs. It has been observed that this number tends to decline by around 20-40 base pairs each year. So, by the time someone is 40 years old they could have lost up to 1,600 base pairs from their telomeres [39]. One of the Telomere shortening factors is SSB. According to Noble award winning study [40] the study population included 5309 US adults, aged 20 to 65 years, with no history of diabetes or cardiovascular disease, from the 1999 to 2002 National Health and Nutrition Examination Surveys. Leukocyte telomere length was assayed from DNA specimens. Diet was assessed using 24-hour dietary recalls. Results suggest Independent of adiposity and other individual characteristics, study results suggested that regular consumption of sugar-sweetened sodas was associated with significantly shorter telomeres. Also telomere length is associated with immune system. [41] The immune system is highly sensitive to shortening of telomeres as its competence depends strictly on cell renewal and clonal expansion of T- and B-cell populations. Cells of the immune system are unique among normal somatic cells as they can up-regulate telomerase, the telomere extending enzyme, and limit telomere attrition in the process of cell proliferation undergoing in activated cells. Hence Telomere shortening and ageing of the immune system this suggest higher in takes of SSb's is associated with cell aging, biological aging or premature aging, weakened immune system. Finally all these suppressive factors may contribute to aging and low longevity. Another factor contributing to telomere shortening is oxidative stress. SSB's increase oxidative stress as well.

The above literature and telomere research may be indicative in suggesting that in earlier time due to low consumption of SSB's can be one of the factors that supported stronger immune system and healthy as well as long-life.

Effect of UPF Obesity: As per the literature on the consumption of UPF, there is subsequent increase in UPF consumption and declined in micronutrient aspect. This is one of the major cause in increasing obesity and cardiovascular diseases. Both of these are one of the major reasons of early mortalities. Looking at the data on food consumption trend, in previous centuries there was less to no consumption of UPF and high consumption of real and live food can be reason of their health at good index with respect to aging.

DISCUSSION

From the above literature analysis it is mostly co-relatable that the increased mortality and change in trends of sleep, food and activity may have a direct connection as compared to earlier centuries. Even when there was less awareness and spread about health, their natural aligned with nature life and throughout the day active life style supported longevity. The study of literature has limitation of availability of data from more different parameters that can add more value to analysis. There is also limitation to current aspects correlated in sleep, NEAT, etc. But still existing data can be sufficiently used to draw a suggestive conclusion that lower average sleep time and differed sleep time affects cortisol cycle, Glymphatic system cycle. Increased consumption of processed food and sugar sweetened beverages resulted in high empty caloric consumption than RDA and resulting Telomere shortening and obesity which may lead to early aging, weakened immunity and mortality. Lower NEAT affects the obesity as well as overrides the benefits of Exercise. Thus indicating decreased Health index and may be cause of decreased longevity compared to ancient life styles.

Conflict of Interest: Currently author has no conflict of interest.

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