

Environmental and Cellular Responses to Aging

Brandy Weathers, Animal Science
Mentor: Dr. Hyungchul Han
Kellogg Honors College Capstone Project

Abstract

Aging is a biological construct that dictates our place in society and can have implications on our quality of life. Over time, lifestyle choices, hormonal changes, and stressors of daily life can alter the natural function of cellular processes and accelerate the process of aging. Stressors of everyday life can accumulate to chronic stress, which can cause a gradual resistance to insulin and stimulation of fat buildup in the abdominal region. Stress inducing hormone imbalance of cortisol, catecholamines, and hypothalamic pituitary adrenal axis. In addition, depression negatively impacts aging by inducing diseases, mood disorders, dysfunction of the immune system, cardiovascular morbidity, etc. that can cause physical illness and a decrease in cellular longevity. Lack of sleep can be a contributor or side effect of age-related diseases and depression. Hormone and mood disorders can shorten telomere length, which impacts the lifespan of the cell. Nutritional choices such as a high fat and sugar diet causes oxidative stress in the body contributing to the cause of altered transcriptional and cellular targets and damage to DNA. Methods to improve nutrition such as antioxidants, physical exercise, and a balanced sleep schedule act as preventative methods to slow the process of aging.

Introduction

What is aging?

Aging is a biological process that is affected by a multitude of external and internal factors from cellular senescence, pre-programmed genetic factors, and environmental impacts.

What are environmental impacts of aging?

Environmental impacts are factors that affect the body from extrinsic influence. It can range from overuse and abuse of the body, toxins in our diet, nutritional parameters, stress in our environment, etc.

What are cellular impacts of aging?

Some genetic factors can increase the impact of aging by dictating cellular and molecular pathways in aspects such as cellular repair, insulin intake, cellular metabolism, etc.. Genetic disorders can hinder healthy aging by contributing to health complications and diseases. Free radicals can also occur in the body due to oxidative stress that can cause damage to cells in the body.

Many have a certain attitude towards aging as they get older (Figure 1 and 2), but it occurs to every living organism and is a natural part of life. There is absolutely nothing wrong with getting older.

References

Kouvonen A, Kivimaki M, Cox SJ, Cox T, Vahtera J, 2005 Relationship between work stress and body mass index among 45,810 female and male employees. *Psychosom Med* 67: 577-583.

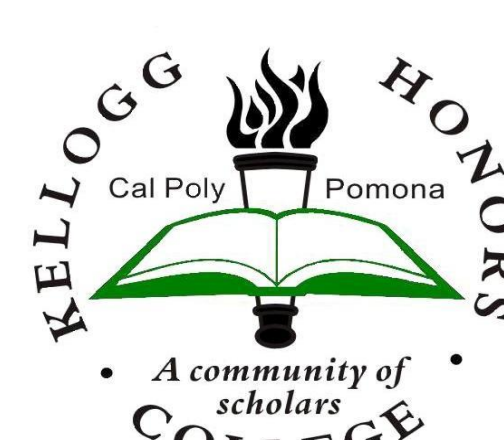
Palmieri VO, Grattagliano I, Portincasa P, Palasciano G, 2006 Systemic oxidative alterations are associated with visceral adiposity and liver steatosis in patients with metabolic syndrome. *Journal of Nutrition* 136: 3022-3026.

Guorgui J, Wang R, Mattheolabakis G, Mackenzie GG. Curcumin formulated in solid lipid nanoparticles has enhanced efficacy in Hodgkin's lymphoma in mice. *Arch Biochem Biophys*. 2018 Jun 15;648:12-19.

Olde Rikkert MG, Rigaud AS. Melatonin in elderly patients with insomnia: a systematic review. *Z Gerontol Geriatr* 2001;34:491-7

Pandi-Perumal SR, Zisapel N, Srinivasan V, et al. Melatonin and sleep in aging population. *Exp Gerontol* 2005;40:911-25.
Melov, S., Tarnopolsky, M. A., Beckman, K., Felkey, K., & Hubbard, A. (2007). Resistance exercise reverses aging in human skeletal muscle. *PLoS one*, 2(5), e465

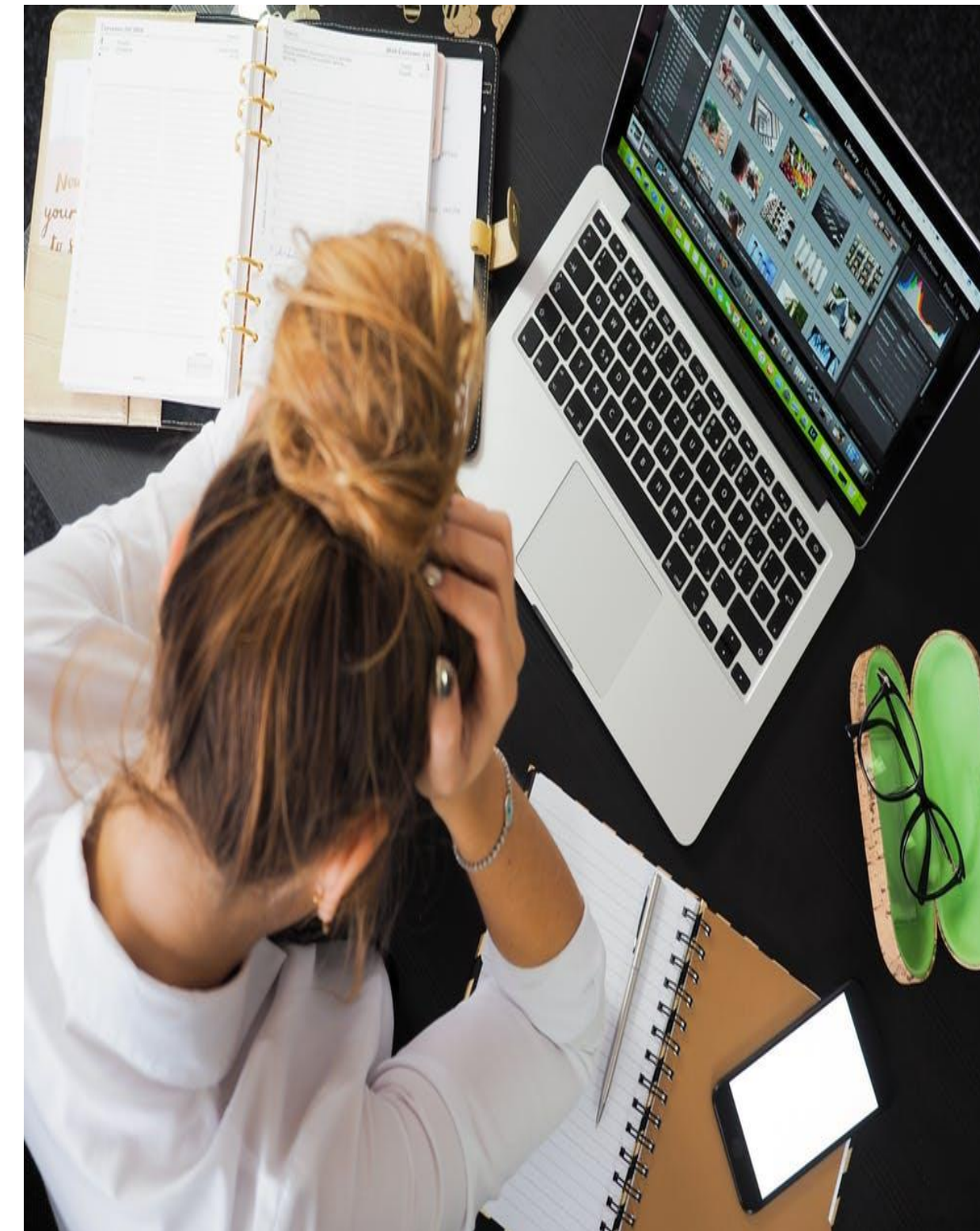
Acknowledgements



Analyzed Parameters

Stress

- Stress comes from many aspects of a person's life such as school, work, or home.
- Chronic stress causes an altered response in the body and changes regulatory systems.
- A chronic stress environment can cause a decreased immune system and an increase in abdominal adiposity, a sought after target in stress responses (Kouvonen et. al, 2005).
- Insulin resistance, increase in fat, and obesity are all related to stress.
- Increase in the thickness of abdominal fat can be related to increased oxidative stress-characterized by low antioxidants and high lipid markers - and an increase in inflammation (Palmieri et. al, 2006).



Nutrition

- Diets high in fat cause increased fat storage, which can alter appropriate regulatory pathways in the body. Overeating also causes accelerated storage of fat.
- Too high of insulin levels contribute to oxidative stress.
- Daily consumption of fruits and vegetables such as onions, tomatoes, garlic, onion, etc. can help with metabolism and potentially prevent diseases due to its phytochemical properties.
- Vitamins, minerals, plants, and animal extracts function as nutraceuticals which help fight diseases (ex. Curcumin found in turmeric can aid in the suppression of tumor growth in Hodgkin's Lymphoma) (Guorgui et. al, 2018)



Sleep

- Destructive sleep habits greatly affect a person's day and their overall quality of life (Figure 4).
- Destructive sleep habits are also linked to depression in some individuals (Buysse, 2014).
- Treatment of sleep-related illnesses can improve the quality of life of individuals . Natural sleep remedies also can prevent negative behaviors associated with sleeping. For example it can combat "sundowning" in older patients with Alzheimer's Disease (Rikkert and Rigaud, 2001).
- Proper conditions for adequate sleep include: only using the bedroom for sleep and sexual activities, prioritize the quality of sleep by establishing a routine, ensure the environment is restful, and developing bedtime rituals.
- Avoid naps before 3:00pm, overthinking during bedtime, and avoid caffeine to obtain an optimal sleep (Pandi-Perumal, et al, 2005).



Exercise

- Atrophy in skeletal muscles and gradual impairment is a natural result of aging. Some people exercise to combat this atrophy (Figure 3).
- Mitochondrial dysfunction is a contributor to this process. However, resistance exercise allows for regenerative results in physical ability.
- In a study conducting exercise training for 6 months, older adults were 59% weaker than younger adults before, and after, they were only 38% .
- Resistance training can improve mitochondrial and muscle health ; there is still a chance to reverse transcriptomic impairment associated with aging (Melov et. al, 2007).



Figures

Percent of generation that describe themselves as "very" or "somewhat" concerned about getting older.

Boomers (ages 38-56)	40
Matures (ages 57+)	33

Figure 1. Response from adults on their concern of aging. n_{boomers}=515 | n_{matures}=520

Percent of generation that "strongly agree" they "look better than my parents did when they were my age."

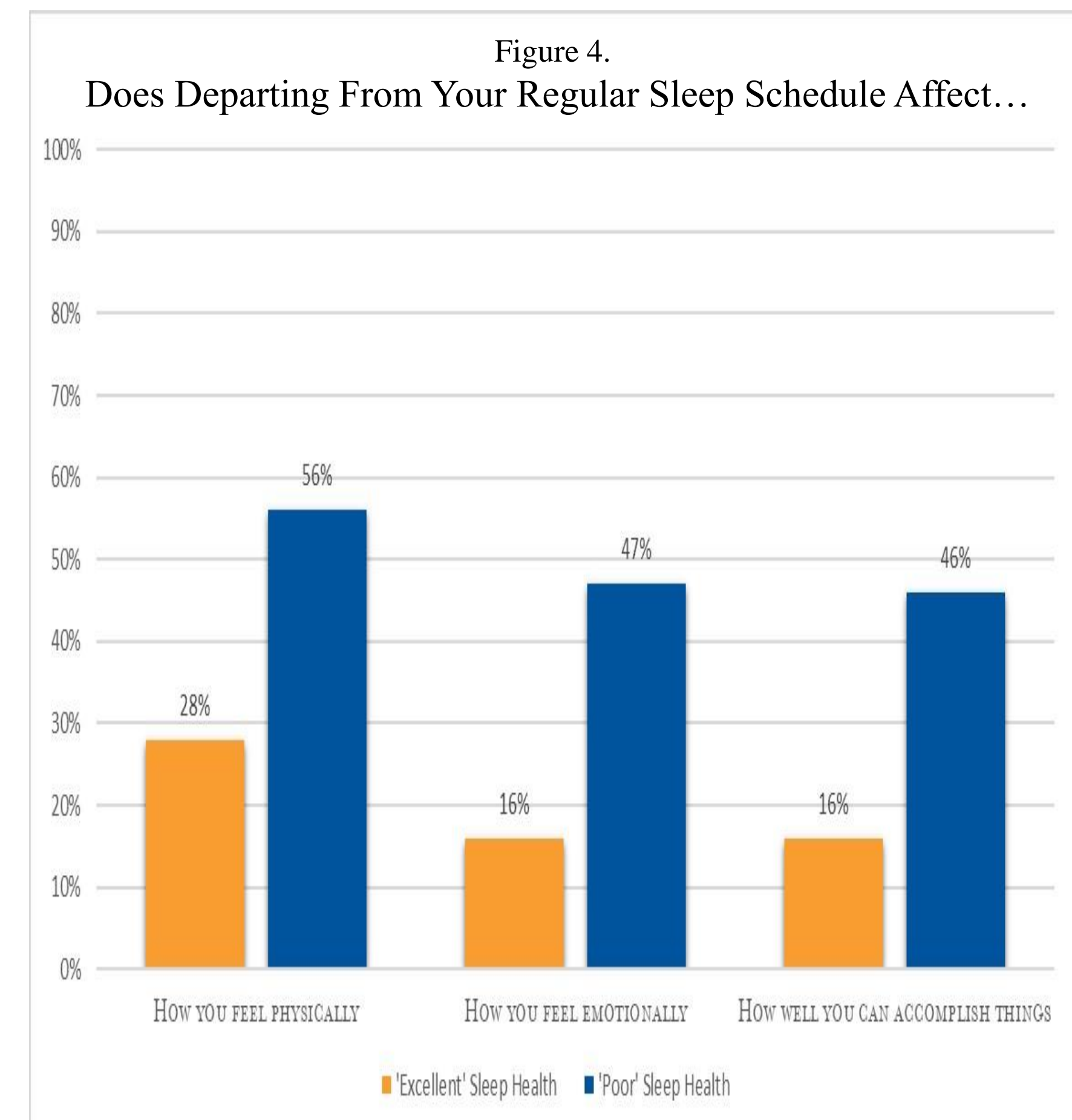
Boomers (ages 38-56)	11
Matures (ages 57+)	11

Figure 2. Response from adults on their concern of aging. n_{boomers}=515 | n_{matures}=520

Percent of generation that has done "some activity to fight getting older."

Boomers (ages 38-56)	89
Matures (ages 57+)	93

Figure 3. Response from adults on their concern of aging. n_{boomers}=515 | n_{matures}=520



Conclusion

Through monitored levels of stress, resistance exercise, proper sleep habits, a low fat diet, and improved nutrition the human body can benefit from more efficient metabolic functions. This allows for an increased ability to fight off diseases and oxidative stress. While some diseases that negatively impact aging cannot be avoided, preventative measures can aid in cellular metabolism and mitochondrial function. The body relies on a relative amount of human intervention and proactive behavior to obtain the necessary nutrients it needs to remain healthy. If we treat our bodies well and stimulate it properly, it can have a better chance of fighting off illnesses and stay healthier and more agile for longer as we get older.