



“Lifelong Learning to Beat AD”:
Educational Attainment and Alzheimer’s Disease

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Abstract

Alzheimer's disease (AD) affects people around the world, and there is no cure. Not only is AD a significant contributor to health care costs, it also has a deep emotional impact on society.

There is a seemingly universal fear of AD which contributes to stigma against those who have this disease, a stigma that prevents people from seeking a medical diagnosis or help. There are modifiable risk behaviors that may delay the effects of AD for those who have the disease, one of which is educational attainment. Educational attainment appears to have an impact on an individual's cognitive reserves, a phenomenon which becomes a significant factor in delaying the effects of AD. In this paper, I review current research on AD and educational attainment.

With the research literature as a base, I then develop a public health campaign targeting younger people that stresses the importance of delaying Alzheimer's disease by continuing educational activities throughout life.

Keywords: educational attainment, Alzheimer's disease, public health campaign

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Introduction: Alzheimer's Disease and the Effects of Educational Attainment

Imagine a brain disease that is prevalent among the world populations, but doctors and scientists cannot explain how people fall victim to the disease. There is no absolute way to know if you or a loved one will get it, but once a person has it there is no cure. People die from it every day. This describes Alzheimer's disease (AD).

Alzheimer's Disease Facts and Figures:

- 5.7 million Americans are currently living with AD
- By 2050 this is expected to rise to nearly 14 million (see Appendix – Figure 1)
- AD is the 6th leading cause of death in the US
- Every 65 seconds someone in the US develops the disease
- 1 in 3 seniors die with AD or another dementia
- In 2018 AD and other dementia's cost the US \$277 billion
- By 2050 these costs can rise as high as \$1.1 trillion

(Alzheimer's Association, 2018)

Although Alzheimer's disease and dementia are used interchangeably, AD is actually a form of dementia. It is a degenerative brain disease that causes deterioration in the brain's processing capabilities. People with AD can live with the symptoms for several years. The rate of cognitive decline varies, but eventually people can die from its complications. AD is prevalent throughout the world and is not gender specific or race specific. There are approximately 44 million people living with AD or another dementia worldwide (Alzheimer's News Today, 2019). As the population ages the percentage of people with AD will also increase. The number of cases of AD is expected to increase worldwide to over 106.2 million in 2050 (Norton et al., 2014).

Although AD is a major contributor to health care costs, it is extremely complicated to understand and modern medicine has not yet identified any way of preventing it. However, there is a growing research base that links occurrence of diabetes, high blood pressure, obesity, smoking, and low educational level with the onset of Alzheimer's disease (Barnes & Yaffe, 2011). There is evidence that one third of dementia cases can be prevented with management of these risk factors (Cations et al., 2018). Furthermore, a public understanding of these modifiable risk factors could elicit behavior changes during early and midlife that could potentially prevent the disease or at least delay the onset of symptoms in late life, thus reducing health care costs and improving quality of life for millions of people.

David Snowdon's book, *Aging with Grace: What the Nun Study Teaches Us about Leading Longer, Healthier, and More Meaningful Lives* (2001) suggests that, among a group of people with similar demographics and life patterns, lower educational levels are linked – but not definitively -- to those who develop Alzheimer's disease and/or symptoms. Furthermore, people with higher levels of education reach old age with higher levels of cognition (Wilson et al., 2009), which might account for the delay in the onset of AD. Also, a study using three control groups including subjects with Alzheimer's disease, mild cognitive impairment, and healthy age-matched controls suggests more highly educated subjects have larger regional cortical thickness in their brain, which leads to increased brain reserves (Liu et al., 2012). Cognitive reserves indicate how well the brain is able to withstand pathological changes by directing processes to alternative pathways. Higher brain reserves may help people better manage the effects of AD by redirecting neurological processing down different paths when the brain contains the barriers of plaques and tangles associated with AD. This may be the connection between higher educational attainment and Alzheimer's.

A person can have AD without having blatant symptoms. It is diagnosed through cognitive testing but can only be truly confirmed through an autopsy of the brain. Specifying for AD can become complicated because most dementia in aging populations is mixed, meaning patients exhibit symptoms for more than one type of dementia, especially in ages 80 and over (Norton et al., 2014). Current AD research focuses on finding a cure but also determining ways to prevent symptoms from displaying.

A significant number of AD cases worldwide and in the US can potentially be attributed to low educational attainment (Barnes & Yaffe, 2011). Data from 146 countries suggest that 14.8% of all individuals have not received any formal education and 25.2% have only a primary education (considered low educational attainment). In the US, 13.3% of all individuals age 25 and older have completed less than 12 years of formal education (Barnes & Yaffe, 2011). Therefore, addressing the AD risk factor of low educational attainment must also take into account public policy implications. With that being said, it is important to educate the public on the value of education not only for socioeconomic reasons but also for long-term health reasons.

The World Health Organization considers dementia a public health priority and in 2017 published its Global Action Plan on Dementia urging all countries to implement campaigns to raise awareness about dementia (<http://www.who.int/en/news-room/fact-sheets/detail/dementia>, 2018). Countries are encouraged to have at least one public awareness campaign by 2025 with the goal of fostering a society that recognizes and supports members with dementia and their caregivers. When developing the campaign, each country needs to consider the public's current understanding of the disease and the goal of the campaign.

Studies show there are public misconceptions about AD (Herrmann et al., 2018; Cations et al, 2018). People often believe dementia (aka senility) is a normal part of the aging process

and is inevitable. They also fear a diagnosis of AD will bring shame and social isolation. Understanding these common misconceptions is important for developing a public awareness campaign.

Health-related mass media campaigns can have a positive effect on changing people's health behavior (Wakefield et al., 2010). A campaign that focuses on the benefits of education throughout life, its positive effects on brain cognition, and its potential to delay the onset of Alzheimer's symptoms would be a positive message in the fight against this disease.

Because of the expected increase in the prevalence of Alzheimer's disease cases in the next 30 years, I am interested in exploring the link between educational attainment and the onset of AD. In this project I provide a review of recent scientific studies associated with AD and the modifiable risk factor of educational attainment, taking into consideration the factors of age, sex, and race. Furthermore, I research the perception of AD and how it is influenced by the media. In order to address the gap in public awareness surrounding this topic, I also include a strategic plan for a US public health campaign for AD and educational attainment. I conclude with a review of the research and a summary of my findings.

Part I: Associating Education and Alzheimer's Disease

Section I: Modifiable Risk Factors Associated with Alzheimer's Disease

Evaluating factors that contribute to successful cognitive performance leads to the identification of potential risk modifying factors for Alzheimer's Disease (AD). There are several factors that may potentially be associated with cognitive performance. Researchers evaluated data from the Maastricht Aging Study (MAAS) to determine possible effects of age, education,

and sex on cognitive speed, verbal memory, executive functioning, and verbal fluency in healthy older adults (Van Hooren et al., 2007). This study consists of 578 subjects in Europe between the ages of 64-81, divided into four groups categorized by number of years: 65-69, 70-74, 75-79, 80+, with equal distribution of males and females in each group. Race is not noted. Subjects were assigned to one of three groups: Low (elementary/low vocational), Middle (intermediate secondary/intermediate vocational), and High (higher secondary/higher vocational, university education, science education), and members of each of the four age groups are represented in each of the three education groups. Notably, the Low education group contains more subjects, and the group size decreases proportionally with rising education levels. Researchers used 5 tests to assess cognitive performance. Results show as age increases, timed performance decreases for executive functioning, verbal fluency, verbal memory, and cognitive speed. Inhibition control is a part of executive functioning, and it shows a breakdown at greater rates as age increases as compared with other factors tested. Overall, cognitive performance drops every five years, with the largest decrease between age groups 75 and 80 (Van Hooren et al., 2007). When factoring for education levels, scores are higher across all cognitive domains for subjects in the High and Middle education group as compared with the Low group. Reasons for this are not definitive, but it is thought that lower education may result in lower brain reserve capacity. Also, subjects with higher education may have a healthier lifestyle and greater mental stimulation throughout life which better preserves cognitive functions.

Educational attainment is included with cognitive inactivity as one of the modifiable risk factors for AD. Therefore, it is important to assess the risk of dementia associated with brain reserves to determine a correlation between low education levels and the risk of AD (Barnes & Yaffe, 2011). This review of cognitive research involves 22 longitudinal studies that include

21,456 subjects. Details of age, sex, and race across the studies are not provided. Results show 19% of AD cases worldwide, and 7% in the US, can be attributed to low educational attainment. The PAR (population attributable risk) for educational attainment in AD is 19.1% worldwide, and 7.3% in the US. Therefore, education is the highest of the evaluated modifiable risk factors worldwide, and the 5th highest in the US.

Norton et al. (2014) ascertain that modifiable risk factors can be interdependent, and research should be evaluated in a way that adjusts for non-independence. Finding results similar to those of a prior research review (Barnes & Yaffe, 2011), they conducted a systematic data review of international articles that relate to AD and the modifiable risk factors, dated 1994 to 2014. The goal was to determine the PAR for each factor using Levin's (1953) formula and project the effect of risk modification over time. As a result, they report 1 in 5 cases of AD worldwide can be attributed to low educational attainment; 1 in 10 for US, UK and Europe. Furthermore, if the risk of each of the seven risk factors is reduced by 10% or 20% per year, it is projected that over 40 years there would be a reduction of AD cases by 8.3% and 15.3%, respectively. Therefore, improving the level of educational attainment can lead to a decrease in AD cases.

In order to evaluate the level of consistency of results pertaining to risk factors and AD, Beydoun et al. (2014) conduct a review of 247 studies between 1990 and 2012; including 52 studies pertaining to the risk factor of educational attainment. To be included in this review, the research sample size requirement had to be greater than 300 subjects. The result consists of 225,989 subjects across all 52 studies, with an average of 4,346 per study. The risk factors identified in each study are evaluated in three broad categories as they relate to cognition and dementia (including AD): socioeconomic, behavioral, and nutritional. The researchers conclude

that lower educational attainment is a particularly strong predictor of incident AD. Furthermore, higher education is found to be a protective risk factor in 21 out of 25 cross-sectional studies.

These studies determine there are modifiable risk factors associated with Alzheimer's disease. Educational attainment is an important factor to consider due to the correlation between years of education and outcomes on cognitive performance tests; subjects with more years of education generally perform better on cognitive tests (Van Hooren et al., 2007; Barnes & Yaffe, 2011; Norton et al., 2014). In addition, more years of education can be associated with having a positive effect on higher levels of cognitive reserves. Of all of the known modifiable risk factors for AD, educational attainment has been found to be one of the top protective risk factors, both globally and in the US (Barnes & Yaffe, 2011; Norton et al., 2014; Beydoun et al., 2014).

Section II: Educational Attainment and the Risk of Alzheimer's Disease

In his book *Aging with Grace – What the Nun Study Teaches Us About Leading Longer, Healthier, and More Meaningful Lives*, author David Snowdon (2001) discusses the idea, that as early as the nineteenth century, British scientists discovered a strong link between health and education. However, it was not clear if better health is due to socioeconomic factors or intellectual development. With the participation of the Sisters of Notre Dame, Snowdon initiated an unprecedented longitudinal study on aging and health, specifically Alzheimer's disease. The sample included 678 nuns who all agreed to regular health and cognitive testing, as well as donation of their brains upon death. Furthermore, the Sisters kept detailed health and social records beginning with their early years of life which enhances the study data. This study resulted in a significant amount of data that provides researchers with critical information about

the onset of Alzheimer's disease. It was an ideal circumstance to show the relationship between risk factors and the ultimate diagnosis of AD.

Snowdon's interests lie in the possibility of determining factors that may reduce the risk of expressing dementia in late life. Using data from the Nun Study, he and a team of researchers published a research paper on the prevalence of dementia associated with head size and education (Mortimer et al., 2003). In this study, there are 297 subjects with the mean age of 89.34 years, all female, all Caucasian, with an average of 15.79 years of education. Because the researchers are interested in brain size, the circumference of the head measurement is used as a related marker. Although they note brain volume would have been a better indicator, that data was not available at that time. The data show that individuals with low brain size and low education are four times as likely to be demented as the rest of the sample. The conclusion is larger head size and/or higher education indicate extra brain reserve which may reduce the probability of dementia. Reasons for this could be greater neuronal connectivity in early life that persists through life course or neuronal growth that could be attributed to lifelong mental stimulation, which generally results only with greater education. Furthermore, low educational attainment may lead to greater exposure to risks that could result in dementia in later life. Because the subjects in the study led a very similar life since young adulthood in terms of environmental influences, Mortimer et al. (2003) deem it more likely the association of higher education with continued stimulation leads to increased neuronal connectivity which provides a buffer against the neuronal deterioration that occurs in Alzheimer's disease. Educational attainment as it relates to cognition is an important factor to consider in Alzheimer's disease research. Furthermore, defining consistent assessment measures for educational attainment in research can aid in clinical diagnosis as well as governmental policies. The

comparison of two educational indexes – number of years of schooling and level of education – can be used to evaluate cognitive functional performance and the probability of developing dementia (Contador et al., 2017). Using data from the Neurological Disorders in Central Spain (NEDICES) index, Contador et al. (2017) assign the 3,816 subjects into one of four groups based on level of education:

Education Level Group	# Subjects	Average Age	% Female
(1) Null/low	481	75.3 y	73.8
(2) Read/write	1614	73.8 y	55.6
(3) Primary school	1251	73.6 y	56.9
(4) Secondary or Higher Education	470	73.5 y	39.1

Race is not provided. The researchers used the Mini-Mental State Exam (Prieto et al., 2012) and the Pfeffer Functional Activities questionnaire (Olazarán et al., 2005) to assess cognitive levels and functional performance. The findings show the prevalence of dementia in subjects with null/low literacy is almost 3 times higher than those who could read/write. In the progression model, based on the cognitive reserve theory, both low literacy and low number of years of schooling are associated with increased likelihood of dementia, but literacy is found to be a better predictor than the number of years of schooling. This could be attributed to the varying levels of quality of education across communities, in which case number of years of schooling may not be the best indicator of educational attainment.

Although the best method to evaluate educational attainment has not been fully vetted by the scientific community, the majority of studies refer to the number of years of schooling for a subject. The effect of years of schooling on the brain (specifically regional cortical thicknesses and volumes) may indicate if education can be used as a preventative factor to reduce the risk of developing AD (Liu et al., 2012). Using data from the AddNeuroMed study, a prospective

longitudinal study in Europe using MRI to measure regional cortical thickness and volume, researchers assign the subjects to a group according to diagnosis:

Diagnosis Group	# Subjects	Average Age	% Female	Education Level
(1) AD	121	74 +/- 6 y	50	8 +/- 4 y
(2) MCI (mild cognitive impairment)	121	75 +/- 6 y	65	9 +/- 4 y
(3) Healthy (control)	113	73 +/- 6 y	55	11 +/- 5 y

Race is not provided. The median number of years of education is 9, which is the number of years used to differentiate between less and more educated. The results indicate differences both within and between the groups by education level. The healthy control group shows higher regional cortical thickness and volumes in their higher education group versus their lower education group. In contrast, after adjusting for cognitive performance differences, the AD group shows a thinner regional cortical thickness for their higher education group as compared with their lower education age group. There are no significant differences between the MCI education levels. The researchers conclude that AD subjects with more education seem to have a better ability to compensate for atrophy than those with less education, and education has a morphological influence on the brain (Liu et al., 2012).

Hippocampal atrophy is a key event in the development of AD, and an MRI measures the amount of hippocampal volume in a brain (Shpanskaya et al., 2014). In order to better understand the neural mechanisms associated with the effect of higher educational attainment, higher cognitive reserves, and the development of AD, researchers evaluate the hippocampal volume using MRI data. Shpanskaya et al. (2014) use data from the Alzheimer's Disease Neuroimaging Initiative (ADNI); 675 subjects are divided into three groups:

Diagnosis Group	# Subjects	Age Range; Mean Age	% Female
(1) Normal	201	55-90 y; 70 y	46
(2) MCI (mild cognitive impairment)	329	55-90 y; 70 y	36
(3) AD	146	55-90 y; 70 y	49

The researchers denote education levels for each subject according to number of years: 12 years or less, 13-16 years, and 17-20 years. Also, the APOE-4 genotype, which may be a factor in determining AD (Shpanskaya et al., 2014), is also factored in the analyses. They found the AD group is less educated than other groups and it has the highest percentage of APOE-4 carriers. The researchers compared the data within the diagnosis groups and between the groups. The results show there is a significant positive relationship between education and hippocampal volume in the AD group, but not in the normal or MCI groups. Furthermore, the hippocampal volume score is lowest in the AD group. However, within the AD group, there is an approximate 8% increase in hippocampal volume in someone with 20 years of education as compared with 6 years of education. In addition, there is a weak interaction between APOE-4 and education on hippocampal volume in the AD group. There is no differences between sexes. Overall, the results support the protective effect of educational attainment and cognition on hippocampal volume for subjects with AD.

The Shpanskaya et al. (2014) study found that beginning with the age of 80 years, there is a change in the rate of decrease of hippocampal volume, and that rate change differs by diagnosis group. For the healthy group, the rate of change levels off, but for the MCI and AD groups the rate continues to decrease with age. Furthermore, another study suggests that cognitive performance drops every five years in later life, with the largest drop occurring between 75 and 80 years (Van Hooren et al., 2007). A study from Zahodne et al. (2015) takes a close look at

rates of late life cognitive decline and educational attainment. There are three goals for this study:

1. To quantify the relationship between education and cognitive decline;
2. To determine if education is only associated with cognitive decline in the low-education group;
3. To determine if income drives the association between education level and cognitive decline.

Using data from the Washington Heights-Inwood Columbia Aging Project (WHICAP), the researchers divide 3,435 participants into 2 groups based on by education level:

Group	Education years; Mean	Mean Age	% Female	% Black	% Hispanic
(1) Low	0-8; 5	76.4y	67.5	20.6	71.2
(2) High	9-20; 13	76.2y	66.4	41.7	17.4

The subjects, recruited in two cycles in 1992 and 1994, did not meet the criteria for dementia at baseline. Subjects completed neuropsychological tests at 24-month intervals for 18 years, focusing on memory, language, visuospatial functioning, and processing speed. The researchers analyzed the data and found that higher education equates with higher cognition and a slower rate of decline as compared with lower education. Also, the number of years of education has an impact in both the higher and lower education groups; those with more years of education have a higher level of cognition at baseline as compared with fewer years of education. Furthermore, the more years of education results in a slightly lower rate of decline over time. There are no additional effects on cognitive decline when factoring for income. However, those with 9+ years of education have greater income, which could be considered an advantage. Sex and race appear

to have no impact. Yet, a disproportionately high percentage of subjects with Hispanic ethnicity is a part of the lower education group, and researchers revealed this subset has lower income levels and lower cognition test results as compared with the non-Hispanic subjects.

Using data from the Chicago Health and Aging Project, Wilson et al. (2009) examined the level of education and its effect on the rate of cognitive decline for subjects with AD. Data include results of cognitive tests every 3 years for 14 years for each participant, as well as participant interviews. The participants completed approximately 4 assessments throughout the study. There were 6,533 participants with a mean age of 72.2 at baseline; 61% women, 67% African American and 33% Caucasian; the mean years of education is 12.2. The findings show that the level of education is related to the level of cognition at the baseline – those with more education have a higher level of cognition, but there is no difference based on education level in the rate of cognitive decline as the subjects age. Race and other socioeconomic factors do not have an impact on these results. The researchers note discrepancies in this finding with prior research: half support the relationship between education and cognitive decline, one quarter does not, and one quarter has mixed results. The researchers also report that in studies with 3 or more assessments of cognition over time (as was this one), there is not an association between cognitive decline and education. Therefore, they conclude that educational attainment provides for a higher level of cognition in older age but does not protect against the rate of cognitive decline.

Overall, these studies indicate that educational attainment is generally measured by the number of years of schooling, and there is a correlation between years of education and performance levels on cognitive testing. Only Contador et al. (2017) recognizes the potential difference between years of schooling and quality of education as determined by literacy rates, in

which a low literacy rate is found to be a better predictor of the onset of dementia. Furthermore, the correlation between educational attainment and cognitive testing can be evaluated by studying the brain. This is measured by head circumference (Mortimer et al., 2003), regional cortical thicknesses and volumes (Liu et al., 2012), and hippocampal volume (Shpanskaya et al., 2014). These studies all support the protective effects of educational attainment on the brain with regards to the onset of dementia/AD. However, the results are mixed in terms of the effect of educational attainment on the rate of cognitive decline (Wilson et al., 2009).

Section III: Sex and Alzheimer's Disease as Related to Educational Attainment

The structure of the brain and its function can vary by sex (Mielke et al., 2014). Furthermore, the normal aging process differs by sex, and research supports differences in the prevalence of Alzheimer's disease between men and women. It is suggested that an estimated two-thirds of individuals diagnosed with AD are women. Although women live longer than men and therefore have more time for the symptoms of AD to present, this may also be due to gender differences that affect the risk modifiers, such as education. Educational attainment has been shown to have a protective effect on AD, and historically, men have a higher level of education as compared with women (Mielke et al., 2014). This may account for a lower prevalence of AD in men.

Other studies that evaluate the effect of educational attainment and the development of dementia or AD (Contador et al., 2017; Zahodne et al., 2015) report that sex has no effect on the results. Mielke et al. (2014) recognize the majority of AD research in the US report no effect of sex on the development of AD, but they cite differences in studies that could affect results, such

as varying sample sizes across age ranges, different diagnostic testing procedures, and distinctive cultural influences.

In summary, there is a significant difference in AD diagnosis rates between women and men (Mielke et al., 2014). Furthermore, educational attainment, a mitigating risk factors for AD, differs between men and women. Much of the research studies associated with educational attainment include an approximately equal ratio of women to men, yet when noted, the studies do not report a significant difference between men and women. In order to better address ways to manage and/or prevent AD, further research on gender differences related to aging and AD is needed.

Section IV: Age and the Impact of Cognitive Activities as Related to Alzheimer's

“Use it or lose it” as it relates to cognitive aging refers to exercising the mind regularly by engaging in forms of cognitive enrichment which will preserve cognitive functioning. Hertzog et al. (2009) evaluates this theory as it applies to the risk reduction of dementia and AD. The researchers develop a conceptual framework depicting the varying levels of cognition one may experience over the course of aging as related to a functional threshold; for any given age, there is a range of cognition that is based upon unique factors such as genetics, health, and socioeconomic conditions. In general, the range expands and increases until age 60, where the lowest level hits the functional threshold and the range begins a downward trajectory, becoming narrower every 10 years until age 100 when the highest level of cognition measures at the functional threshold (see Appendix – Figure 2.) Plasticity refers to the ability to move throughout this range, and it is influenced by experiences and learning, which builds upon knowledge. Moreover, the researchers determine that mentally stimulating activity in early and midlife may

help mediate the association of educational attainment and the risk of dementia in old age. They also note that cognitive decline begins earlier in those with low education as compared with mid to high education, but once decline begins in those with high education, the rate of decline is faster than that of the low education group.

Cognitive activities during mid- and late life may have an impact on the onset of Alzheimer's disease. However, much of the critical brain development occurs during early life when there is greater neural plasticity (Ko et al., 2018). Furthermore, the brain has different pathological properties during different stages of life, and life experiences can have different impacts. In this study, the cerebral pathology of 321 subjects from the Korean Brain Aging Study for Early Diagnosis and Prediction of Alzheimer's Disease (KBASE) are evaluated to determine the effects of cognitive activity throughout life as a protective measure against the onset of Alzheimer's disease. There are 254 cognitively normal subjects and 67 with mild MCI. The mean age is 69.6. Sex, race, and education levels are not noted. Participants underwent brain imaging to evaluate the cerebral amyloid-beta pathology which determines the degree of AD-related neurodegeneration. The participants also completed four clinical memory tests to assess their current cognitive status and an auto-biographical lifetime questionnaire to report their cognitive activities. The results of this study show that cognitive activities in young adult life may have a protective effect on AD-related neurodegeneration, but mid- and late life show little to no effect.

There are few studies that correlate the timing of cognitive activities throughout one's life with the protective effects of cognitive activities on AD in late life. Conceptually, individuals progress through time with varying levels of cognition, and all will experience cognitive decline with age; the level and rate may be determined by learning and experiences (Hertzog et al. 2009).

Early life educational attainment has an effect on levels of cognition in late life: however, the effects of cognitive activities during mid- and late life offers mixed results. More studies are needed in order to determine if maintaining an intellectually stimulating lifestyle (i.e., the “use it or lost it theory”) will develop cognitive skills that can be associated with a reduced risk of developing AD in late life.

Section V: Discussion

Although there is no known cause of Alzheimer’s disease and no known cure, research indicates there are associated mitigating risk factors for AD. Understanding these risk factors and the impact they may have on the onset of AD can affect public policy and individual behaviors. Especially as the number of people affected by AD is expected to significantly increase over the next few decades, the importance of public knowledge and understanding of the risk factors becomes more critical.

Educational attainment is one of the risk factors associated with the effects of Alzheimer’s disease. Education appears to have a compensatory effect on brains that have AD neuropathology but remain cognitively spared (Mortimer et al., 2003). Learning is a cognitive activity that is related to the build-up of cognitive reserves in the brain. This may be most influential in early life when the brain has the most plasticity and results in greater capacity to build up reserves, but midlife education and experiences may also benefit cognitive reserves.

Cognitive reserves are linked to the brain’s capacity to deal with damage, which can be incurred in many ways throughout life. There are two reserves against brain damage: brain reserve (individuals with larger brain volumes can sustain more damage before symptoms are displayed) and cognitive reserve (the ability for the brain to compensate for damage) (Liu et al.,

2012). Therefore, cognitive reserves may serve as protection against the onset of AD in late life. When the brain is compromised, it relies on cognitive reserves to find new ways to function. The greater the cognitive reserves, the greater the options are for continued functioning.

Early life education is accepted as one of the surrogate markers for cognitive reserve and socioeconomic attainment (Shpanskaya et al., 2014). There is a significant difference in outcomes between low and middle/high education levels, and low education level is one of the most significant risk factors that can impede brain functions. There are two theories that connect early life education and the subsequent impact on later life cognitive levels (Beydoun et al., 2014). The “reserve capacity” theory contends education in early life has a direct effect on the brain structure and function, thus increasing synapses and positively affecting cognitive reserve, which may also affect the pace of cognitive decline in later life. Second, the “use it or lose it” theory asserts the more educated you are throughout life the more you continue to seek education; this mental stimulation leads to beneficial neurochemical or structural alterations in the brain that protect it from cognitive issues in later life.

Unfortunately, early life conditions vary by socioeconomic and cultural differences around the world. Low socioeconomic position (SEP) is related to low educational attainment (Beydoun et al., 2014). This results in poorer cognitive function in adulthood and cognitive decline in old age. Therefore, there is a greater risk or prevalence of dementia and AD among those with a lower SEP. The majority of the world has low education rates, which makes the challenge put forth by the World Health Organization for countries to develop a strategic plan for AD that much more challenging. If they are to address AD, countries will need to consider the factors that can mitigate the risks of developing AD, and the most influential risk is related to educational attainment, which is a separate and large problem to address.

Furthermore, throughout the world there are contrasting stereotypes of old age: negative social stereotypes related to senility demonstrated by bad behavior and memory loss; and positive social stereotypes related to wisdom and experience (Hertzog et al., 2009). In order to develop a strategic plan to address AD, the stigma associated with old age and specifically AD need change. As explained in Part II, current public messaging surrounding AD is not clear and contributes to the fear and stigma of AD.

Part II: Alzheimer's Disease Awareness and Education

Section I: Public Messaging – Influencing Perception of Alzheimer's Disease

In today's technologically sophisticated society, mass media is one of the most important sources of information for the public, and the formulation of the public perception of a disease can be influenced by the media and online information. Comparing media reports with testimonials from care givers of dementia patients helps to evaluate the role the media plays on influencing public perception about dementia (Peel, 2014). Peel reviewed 350 articles published in the British print media between October 2010 and September 2011 using the terms 'dementia' or 'Alzheimer's' in both the headline and a major mention. To add to this research, she conducted 1 to 2-hour interviews with 12 dementia caregivers in order to understand their perception of the disease and how it is portrayed in the media. The subjects interviewed have a mean age of 63 years; there are 8 women and 4 men; race is Caucasian; and the education level is not reported. The results show that the media discourse does not match the caregiver's expressions of their experiences with dementia. The media messages are mixed; to summarize: dementia is a normal part of aging, not everyone is going to get it, it is something to be feared, you have the ability to

prevent it, and if you get it you are to blame. Furthermore, the media often engage in a panic discourse, for example, a headline reading “The Living Death of Alzheimer’s” virtually equates living with AD and death. The caregivers describe the media messages as being focused on fear with emphasis on individual responsibility for getting the disease. They do not have the same attitude towards the disease, nor do they express their views using the same language as the media articles. As a result of inaccurate media messaging, the public who do not have firsthand experience with AD may develop a warped perception of the disease and may formulate negative stereotypes associated with AD.

The Internet has become a widely available option for the public to research information regarding health, and online public health messages are an important way to share information about a disease. Individuals look online for details regarding symptoms, warning signs, diagnoses, advice, preventive measures, and support services. Lawless et al. (2018) evaluated eight websites representing the most prominent Alzheimer’s disease nonprofit organizations, as determined by Alzheimer’s Disease International (see Appendix – Figure 3). These sites provide information specifically about risk and prevention in addition to information for those living with the disease and their caregivers. The researchers analyzed the content of each site by using a coding system in addition to a finer-grained discourse analysis. The analysis resulted in two recurrent themes: (1) the audience is positioned as being at risk for dementia, and (2) the audience is positioned as being responsible for managing their risk prevention. Also, the researchers found the AD content to be commonly presented in a two-part concession structure, which offers a leading statement of fact followed by a contrasting statement with an unexpected element of surprise. In general, the content begins with quantifiable statistics with regard to the risk of developing the disease, which serves the purpose to identify AD as a serious concern and

demonstrates susceptibility. Then risk mitigation activities are offered as a way to actively prevent the development of the disease. This formulaic discourse plays into fear and does not take into account the audience's unique socioeconomic status, education, health, and environmental factors (Lawless et al., 2018). These factors may play a role in the development of the disease, and positioning the risk equally among the audience can lead to misconceptions about AD.

In both of these studies, the public is positioned as being responsible for managing their own risk prevention (Peel, 2014; Lawless et al., 2018). The content speaks to one type of audience and does not take into account the differing socioeconomic and individual health status of its audience. This approach leads the audience to believe the misconceptions that everyone is at risk of contracting AD, and they must take the same course of action to protect themselves. Furthermore, the audience may inadvertently form stigmatizing attitudes towards those who do have the disease, making the assumption they did not do enough to prevent it. The media and online health information sources are a resource for the public, and the content providers have an ethical obligation to their audience to present information accurately. On one hand, they should present a clear, more nuanced picture of the disease instead of focusing mainly on the more shocking aspects of the disease. On the other hand, the nature of simply describing the effects of AD make it challenging to not paint a picture of fear.

Section II: Dementia/AD-related Stigma – Perceptions, Attitudes and Effects

By 2025, the US hopes to have an effective therapy for Alzheimer's disease in which the key to success will be early detection and diagnosis (Stites et al., 2016). Yet stigmatizing attitudes cause isolation, discrimination, and patronization, which prevent people from seeking

clinical help. Stigmatization also makes it difficult to educate the public on the disease. To better understand the characteristics used by the general public to base the stigmatizing attributions of AD, Stites et al. (2016) conducted a study of 627 random adults from the United States general population. The median age of the study participants is 49; 49% are female; 80% are Caucasian (20% not noted); and 65% have less education than a college degree. A portion of the participants (317) read a vignette depicting an older white male with mild AD symptoms and an explicit diagnosis of AD; the other portion (310) read a similar vignette but it excluded the explicit diagnosis of AD. All participants responded to a series of multivariable questions designed to assess their feelings towards the person in the vignette. The results of the questionnaire were compared with the Family Stigma in Alzheimer's Disease Scale (FS-ADS). The stigma attributions assessed by the FS- ADS are:

- Structural Discrimination – worrying that a person is discriminated against by companies or doctors
- Negative Severity Attributions – expecting certain symptoms (such as incontinence and speaking repetitively)
- Negative Aesthetic Attributions – expecting poor self-care and outward appearance in ways that provoke negative judgement
- Antipathy – endorsing that the person evoked feelings of disgust
- Support – expecting others to feel concern and willingness to help
- Pity – expecting others to feel sympathy or sadness
- Social Distance – feeling the person would be ignored and have social contacts limited by others

The researchers hypothesized that older people, women, and those who view AD as a mental illness will endorse stronger stigmatizing attributions. The study results conclude that with each successive decade of age, the responders are less likely to believe the public would be supportive of people with AD, and people with AD are more likely to be victims of discrimination.

Furthermore, older responders believe that people with AD would receive less support, have social interactions limited by others, and face institutional discrimination. Females are more likely than males to believe others would feel sympathy, sadness and pity towards a person with AD. Also, females are more likely than males to feel compassion towards a person with AD. In addition, those who believe strongly that AD is a mental illness (a misconception) rate symptoms more severely and associate it less as a physical etiology. Furthermore, there are no differences in results when taking into consideration the varying education levels of the participants. When comparing the results of the two vignettes, the situation for the subject without the explicit diagnosis of AD is perceived to be less severe, and the older respondents reported less concern about the issue of social distance for the subject. Therefore, the label of AD invokes negative reactions that lead to stigmatism as hypothesized by the researchers.

AD campaigns often show people in more advanced stages of the disease when subjects are confused, unable to care for themselves and are a burden to family (Stites et al., 2016). This evokes negative emotions by feeding on pity, which may work to attract attention to the disease and can be helpful when the goal is to raise funds. However, this approach may contribute to the stigma against those with the disease. Because attitudes towards AD differ by age and gender (Stites et al., 2016), messaging that targets by age and incorporates specific beliefs, attitudes, and behaviors may induce a greater awareness of the disease, versus relying solely on an emotional response evoked by stigmatizing perceptions.

Herrmann et al. (2018) conducted a literature review of the effects of stigma on dementia and AD, specifically evaluating in racial and ethnic subgroups how the stigma presents itself, how it is assessed, and how it is managed. This study included 97 articles primarily from the US and Europe published between January 2004 and December 2015 with a specific focus on AD stigma or dementia attitudes. The researchers conclude that AD stigma can be found worldwide, and a public lack of knowledge and understanding of the disease contributes to this. First, they cite it is a common belief that having dementia/AD is a normal part of the aging process. Also, when considering a diagnosis of AD, individuals express feelings of shame, fear of judgement, and even punishment from a higher being. However, their research also shows that having a personal connection with the disease may alter these feelings. For example, one study of an intervention involving social interaction between young subjects and older subjects diagnosed with MCI (mild cognitive impairment) and AD shows that over time the stigma is reduced as are feelings of negativity, social isolation, and shame. Additionally, the researchers report there is a belief that the media and cinema contribute to stigma attitudes. Also, this study shows that online ads depicting a negative view of AD (death and degeneration) receive greater attention than those that reflect “more positive or human-centered” messaging.

Overall, there is no uniform way to measure and clearly articulate the public’s understanding and misconceptions of Alzheimer’s disease. However, there is a recognized need to address the stigma not only broadly but also by targeting those who tend to have greater misconceptions of the disease (Herrmann et al, 2018). Furthermore, understanding AD differs by gender, age, and experience with the disease. Therefore, it may be effective for AD campaigns to use targeted messaging by gender and age.

Section III: Using Media to Change Perceptions

Mass media campaigns may have an influence over individuals' actions as they pertain to their health (Wakefield et al., 2010). These campaigns can reach a large group of people by using different channels to reach their target audience(s). Content can be delivered via the Internet, television, radio, billboards, posters, magazines, newspapers, and social media platforms. It can be direct or indirect; passive or active; short or long in duration. Campaigns can stand alone or be combined with related programming or policy announcements. Overall, they call on an emotional response to affect an individual's decision-making processes. The outcome of a mass media health campaign is to remove barriers to change, adopt healthy behaviors and/or recognize unhealthy social norms (Wakefield et al., 2010). Short-term behavioral changes can be sustained, but long-term changes are difficult to maintain due to competing influences and easy access to alternative behaviors.

The anti-tobacco campaigns are the most assessed public health campaigns, and evidence shows they had a strong influence on changing behaviors (Wakefield et al., 2010). These campaigns elicited negative emotions such as fear and shame and were combined with programs in schools and the community to reach lower socioeconomic populations. Another widely assessed campaign is the prevention of heart disease through nutrition and activity. This campaign success is attributed to the focus on what people can do to prevent heart disease as well as the methods that were used to assess the resulting health changes (Wakefield et al., 2010).

Exposure to a multimedia campaign addressing the stigma associated with AD may have an effect on people's behaviors towards individuals with AD (Werner & Schiffman, 2018). To evaluate this theory, Werner & Schiffman (2018) conducted a research poll in Israel of 510 participants who were selected through an internet polling company, PanelView. The participants

have a mean age of 56 years; 56% are female; and 59.4% reported less than a college education. In 2013, Israel launched an Alzheimer's disease awareness media campaign as part of its National Strategic Plan to Address Alzheimer's Disease and other Dementias. Administered by the Ministry of Health, the campaign was distributed through TV and radio and stressed what people with AD can do versus what they cannot do. The campaign also provided details on where to go for more information. The poll collected information about the participants reaction to the campaign in order to gain insight on their emotional reactions. The researchers assessed emotional responses to the campaign as well as emotional responses to the person with AD in the ad. Furthermore, they evaluated whether the emotional responses contribute to discriminatory behavior towards people with AD based on the identified emotions. Feelings of fear, uneasiness, disgust, and ridicule play into discriminatory behavior, versus emotions of pity, help, and concern which indicate a positive response towards a person with AD (Werner & Schiffman, 2018). The participants were divided into two groups: those who reported exposure to the ad campaign and those who reported no exposure to the campaign. Those who reported exposure have a mean age 3 years greater than the unexposed group; they also have a higher percentage of knowing someone with AD, and they reported higher levels of worry about developing AD. Furthermore, those exposed to the campaign expressed greater positive emotions towards AD than those who were not exposed to the campaign. Overall, the researchers conclude that personally knowing someone with AD can make a person more aware of the disease, and an ad that paints the disease in a more positive light evokes more positive emotions towards AD. Also, fear of the disease is an emotion felt by all participants, regardless of having a personal connection with someone who has AD.

In order to better understand the global knowledge and attitudes about prevention and treatment of dementia, Cations et al. (2018) analyzed the results of international population surveys of 34 studies from MEDLINE, EMBASE, and PsychINFO; and 4 grey literature items (published between 2012 to May 2017). Overall, there are 36,519 participants; the demographic details for each study are identified in the review. Dementia is Latin for ‘out of one’s mind’, and the name leads to bad connotations that stigmatize those who suffer and their caregivers (Cations et al., 2018). This research review revealed there is a general public misconception that dementia is a normal part of aging and many individuals feel there is no value in pursuing treatment. Furthermore, the stigmatism associated with dementia contributes to social isolation and emotional distress for those who suffer and their caregivers. While it is true that the multiple contributing factors for dementia can be a cause for public confusion and fear, the public needs to understand the preventable risk factors as powerful strategies for increasing protection against dementia. Moreover, educating younger people can lead to a better understanding and acceptance across generations and will better prepare future caregivers.

Gorp et al. (2012) conducted a study to evaluate people’s perceptions towards AD by comparing their reactions to different types of online ad messages. The participants in this study consist of 1,000 residents of Belgium identified through an internet study company, *iVox*. The participants are grouped by age: 12% are under 29, 53% are 30-49, and 35% are over 50; 49% are female; race is not indicated. Also, education levels are identified as 25% junior high, 36% high school, and 39% college or university. The ad messages were developed specifically for this study. The ads have basic commonalities with key messaging differences. The ads use a close-up photo of an aging adult; there are three versions using Caucasian subjects - two different women (one with glasses) and one man (see Appendix – Figure 4). The researchers note that using a

photo of a person connects the disease to a person, and furthermore, offering a name of the subject makes the message more personal. Each ad uses the same slogan -- "Behind every person with Alzheimer's is a living person" -- offers the same short explanation of illness in the body copy, and provides a directive to visit a website. The point of differentiation among the 3 variables is the headline of the ad. This study tests the different framing and counter-framing techniques in the headlines, which serve the purpose of attracting the reader and drawing them to read the body copy, which in this case is designed to invoke a discussion about AD. Framing uses socially constructed principles to give meaning to a reality, and three specific frames/counter frames are developed for this study: (1) Dualism, (2) Death and Degeneration, and (3) Control.

(1) "Helga is losing her memories little by little, but she still cheats at whist."/

"Despite the deterioration in their memory, people with Alzheimer's remain sensitive to emotions and the quality of their relationships."

- The frame is focused on a material body and immaterial spirit or mind; the message is AD deprives the body of its mind.
- The counter frame is focused on the body and mind as one and on equal footing; the message depicts a rich emotional life recognizing people as individuals with specific memories and stories.

(2) "Helga, already buried by her family and friends, yet she is still alive."/ "Help them to find happiness in the little things of life."

- The frame is focused on death and degeneration; people fear death and people with AD are considered the living dead.

- The counter frame is focused on the idea of *carpe diem*; there is still time left to live and people with AD can find comfort in life's simple pleasures.

(3) No headline; the ad has the same body copy, photo, and slogan as the other two.

Respondents are shown one of the three online ads and then answered several questions related to ad evaluation, comprehension, attitude, experience with AD, and feelings towards the person depicted in the ad. Results show the ad with the greatest impact and determined to be the most credible is (2) themed Death and Degeneration. In other words, the participants believe it to be more credible that family would give up on a person with AD than a person with AD could cheat at cards. Furthermore, after reading any of the ads, 90% of the participants report believing that someone with AD remains a human being in his or her own right and can be helped to continue to enjoy life to the fullest. The researchers believe this is due to the use of alternative framing. Also, women are more likely than men to find the ads impactful, easy to understand, and credible. This is also true for participants age 30 and younger. Men with a direct experience with AD provide more positive results than men without direct experience. Women who have a direct experience with AD give less favorable results than women with indirect experience, but overall women view the ads more favorably than men.

Section IV: Discussion

The public looks to the media and online content providers to determine information about their health. They are also influenced by the stories they read and the ads they see. Furthermore, mass media health campaigns have been shown to influence health behaviors (Wakefield et al., 2010). However, AD campaigns can be misleading and provide inaccurate information by broadly speaking across socioeconomic demographics, this inevitably leads to

public misconceptions about AD (Peel, 2014; Herrmann et al., 2018; Stites et al., 2016).

Furthermore, the media tends to emphasize negative effects of AD through the use of repetitive negative imaging (Gorp et al., 2012). Inadvertently, this negative view of the disease generates fear and produces harmful behaviors that may contribute to stigmatization. Stigmatization associated with dementia and AD contributes to social anxiety and isolation of those who suffer and their caregivers. Additionally, the misunderstanding that everyone will someday suffer from AD and there is no cure leads to reluctance to seek medical help. Therefore, it is important to consider an alternative approach to AD messaging.

In an effort to correct inaccurate beliefs and reduce stigmatization towards AD, media messages can be altered to provide more positive, nuanced content related to the disease. They can be used to educate the public on the modifiable risk factors for AD and the variability of outcomes with AD (Herrmann et al., 2018). Furthermore, the campaigns can be adjusted to account for differences between women and men, ages, and those who have personal experience with the disease. For example, a campaign to influence a younger audience may be done through social media using the assumption that they may not have personal experience with AD, which delivers a different emotional response to the content as compared with an older audience (Werner et al., 2018).

In the Diagnostic and Statistical Manual for Mental Disorders V, dementia is relabeled as major neurocognitive disorder to help change the stigmatism (Cations et al., 2018). Taking a fresh approach to a public understanding of dementia can lead to a more positive approach to the fight against Alzheimer's disease. Reframing the public's understanding of the disease by reaching the various segments of the public with relatable content can be the first step to destigmatizing AD. With a new frame focused on knowledge and less on fear, the public may be

more open to learning about the modifiable risk factors and making changes that can lead to better management of those who do have the disease and greater support for their caregivers.

Part III: Campaign Strategy – Learning to beat AD

Research indicates that educational attainment likely has a positive effect on the delayed onset of symptom's related to Alzheimer's disease. However, the general public in the United States may not be aware of this connection. In an effort to potentially improve a person's quality of life in older age, which in turn can decrease the strain on family and society, and lower associated healthcare costs, it is important for the public to be informed of the association between education and AD. With this knowledge, a long-term goal is for people to modify their behavior in a way that normalizes the participation in educational activities throughout one's lifetime.

Section I: A Primer on Public Health Campaigns

A public health campaign has three basic stages: planning, implementation, and assessment. The planning stage outlines the roadmap for the campaign based on the goals and objectives. Forming the steps to achieve these goals is guided by research on the health issue and the affected populations. This research contributes to the definition of the target audience(s) and their behavioral characteristics as related to the health issue. Once the steps for implementing the campaign are identified, the assessment protocols are defined. This provides a framework to evaluate whether the campaigns goals and objectives are being met. After the campaign plan is complete, the steps are put into action. The effort, cost, and timeframe for accomplishing a

campaign are dependent upon the project scope and the anticipated ability to influence the target audience.

A public health campaign generally involves creating awareness of a health issue and an attempt to modify the behavior of the target audience. Therefore, it is important to understand the behavioral characteristics of the target audience as they relate to the health issue. There are several behavioral change models to help determine the factors that contribute to behavior and define the ways to influence behavior modification.

This first behavioral change model recognizes that human behavior has multiple influencing factors (McKenzie et al., 2017). It outlines the socio-ecological factors of influence to be defined for the target audience(s). These factors are:

- Intrapersonal – personally held knowledge, attitudes, and beliefs
- Interpersonal – beliefs of family, friends, colleagues, and peers
- Community – local institutions, policy, and social networks
- Culture – the practices of a population; shared beliefs
- Physical environment – structures and geography

With a deep understanding of these influences, effective steps to motivate behavioral change are developed and incorporated into the messaging details of the campaign.

It is also important to understand what motivates humans to engage with a health promotion plan. The Health Belief Model (HBM) (Rosenstock et al., 1988) developed in 1950s at the U.S. Public Health service serves to explain why an individual would or would not want to use public health services. In general, there is a typical thought process that an individual follows when determining whether or not to take action with regard to a health matter. It takes into consideration 1) the existence of a health issue; 2) the perception of the health issue as a threat,

leading to a sense of urgency; and 3) an evaluation of the barriers to overcome in order to make a behavioral change that may alter the health threat. In other words, when an individual is contemplating whether to seek an AD evaluation, s/he would contemplate: AD is a terrible disease, and I am having symptoms; is it worth seeking a diagnosis if there is no cure and nothing I can do to stop it? For a successful campaign, the answer is “yes!”

Another model, the Information-Motivation-Behavioral (IMB) Skills Model (Fisher & Fisher, 1992), developed as a theoretical basis for the planning of HIV/AIDS prevention efforts, offers the connection between information and behavior (McKenzie et al., 2017). Fundamentally, the promotion design provides the relevant information required to generate the motivation to act in accordance with the pre-determined behavior guidelines. This ensures the campaign message appropriately communicates the health issue at hand and delivers it in a way that provokes the intended action.

Overall, the use of these models contributes to the development of effective messaging as well as the most appropriate methods for distributing the message to the target audience. The second campaign stage, implementation, begins once the research is complete and the plan is clearly defined. The priority in this stage is to communicate the key message to the target audience(s). The methods for distributing the message may include fresh website content, search engine optimization, and running ads on the Internet, TV, and radio. Depending on the target audience(s), print materials and public relations efforts may be effective in spreading the message. Also, social media campaigns and educational programs may be used to actively engage the audience.

The third stage of a public health campaign is assessment. The best methods to assess the effectiveness of the campaign are defined during the planning stage and may be collected

throughout the implementation phase. There are different methods to collect assessment data, such as online surveys and in-person interviews. Once collected, the data are measured and compiled into a report. The effectiveness of the campaign may not be realized until after the campaign has ended.

Section II: A Public Health Campaign Plan to Develop Awareness of Educational

Attainment and AD

Background

Free public education through high school is a protected right in the US, although each state governs the permissible guidelines for dropping out of school, generally between the ages of 15 and 17 with parental and school administration approval. In the US, 13.3% individuals age 25 and older have completed less than 12 years of formal education (Barnes & Yaffe, 2011). Furthermore, the percentage of high school dropouts for all races has decreased in the US from 27.2% in 1960 to 6.1% in 2016 (National Center for Education Statistics, 2019). Therefore, today more people in the US are completing a high school education than in the past. In terms of continuing formal education after high school, enrollment in degree-granting postsecondary institutions increased 14% between 2005 and 2015 to 20 million people. In addition, in the fall of 2015, about 412,000 students attended non-degree-granting postsecondary institutions (National Center for Education Statistics, 2019).

The Health Issue

The prevalence of AD is expected to rise dramatically in the next 30 years and will affect nearly 14 million Americans (see Appendix – Figure 1). With no known cure, treatment, or

prevention, this disease generates a large emotional and financial strain on the public and the health system. Considering this trajectory, the younger generation needs to develop an awareness of AD and the modifiable risk factors they can engage in to provide protection against the onset of AD as they age.

Research supports a link between educational attainment and a delay in the onset of symptoms of AD. Although statistics show more people in the US are completing education through high school, and many individuals continue with advanced education, engagement in educational activities throughout young adulthood into middle age and old age competes with work, family, and other obligations. Therefore, regular and continuous educational activity is presumed to be less of a priority for most individuals after the completion of the required formal education. However, the value of maintaining educational activities throughout one's lifetime can have a significant impact on the onset of AD in later life. In order to give themselves the best protection against AD, the younger generation has the opportunity to change their behavior by pursuing higher levels of educational attainment than the current norm and committing to a lifetime of engagement in educational activities.

Campaign Goal and Objectives

The goal of this campaign is to generate awareness for younger people, and their parents and grandparents, that lifelong education is an essential component in the effort to delay the onset of Alzheimer's disease in older age. The objectives are:

- 1) Develop an in-school educational program that teaches the basic details of Alzheimer's disease in a manner that can be understood by pre-teens and teens and

establish the connection between lifelong engagement in educational activities and long-term brain health.

- 2) Develop a social media platform to promote the campaign to a wide audience, provide relevant information, and build community support networks.
- 3) Develop an “Education & AD” fact sheet to influence parents and grandparents to support lifelong educational activities for the young people in their family. Use content to reframe the disease in a way that does not contribute to attitudes of fear but rallies them to fight the disease.

Desired Outcome

Scientifically, no exact formula exists for the types of educational activities that will achieve the goal of protecting the brain from the effects of AD. However, research has shown that learning has the effect of building cognitive reserves in the brain that may serve as a protection against the onset of AD in late life (Mortimer et al., 2003; Liu et al., 2012; Shpankaya et al., 2014; Beydoun et al., 2014). Therefore, until more is known about the types of educational activities that influence cognition levels, this campaign will focus on a wide scope of learning with an emphasis on continuity throughout life.

The desired outcome of the campaign is two-fold: one, for the younger generation to learn more about their brains, AD, and the association between educational attainment and AD; and two, to begin to shift the current perception that engaging in educational activities happens only through school in order to get a job, to participating in lifelong learning through a variety of outlets for better health. Secondarily, another campaign goal is to help parents and grandparents

see AD in a new light and realize they can help to protect their loved ones by supporting lifelong educational habits.

The Target Audience(s)

Younger people, age 11 to 18 years, are the primary target audience for this campaign because they have the greatest ability to achieve higher educational attainment and incorporate more years of education throughout their life versus those in middle and old age (age 35 and older). Yet, those in middle and old age are a secondary target market due to their potentially strong influence over the behavioral choices for their children and grandchildren. In addition to providing the support needed for younger people to continue education throughout life, older people can demonstrate this behavior by also participating in educational activities.

Research is needed to better understand what the primary target market currently understands about Alzheimer's disease. Specifically, what do younger people believe about AD? Do they have an understanding of the health-related benefits of continuing education throughout life? How is education embraced by their family and the broader community? Is education perceived to be only of value as a way to advance job opportunities? For the sake of this exercise, the following generalized assessment will be made for the target populations.

Currently, younger people do not have a strong awareness of AD or the long-term value of education outside of the notion that it is needed for employment. Furthermore, the elementary and middle school curriculum teaches the basics of health and science, which provides a platform to build upon for more advanced sciences in high school, where educational paths begin to divide based on student interests. In general, younger people do not have a deep understanding of the impact of education on cognitive reserves, nor how their personal educational attainment

may affect them in later life. Furthermore, the guidance provided for postsecondary options, whether vocational or advanced education, are geared towards employment. The notion of continuing with education for the sake of educating one's mind (and not necessarily related to one's career) is not common.

The research detailing the attitudes and beliefs with regard to AD for the middle and older aged populations in the US shows there are negative misconceptions surrounding AD (Stites et al., 2016). It is a disease that invokes fear because it is not clear how to prevent it or how to manage it once there is a diagnosis. Furthermore, there is a fear of social alienation which drives denial if the symptoms of the disease are present. Although a connection between brain health and educational activities is emerging, it is not clearly presented through media outlets. Furthermore, the notion of educational attainment as a modifiable risk factor for AD is not widely publicized.

It is important to define the influences on the behavior of the target market as related to education. The U.S. educational attainment statistics lend to the belief that overall education is valued in our society, and educational endeavors are supported by policy as well as family and friends. However, the general perception is that education is only necessary for younger people, and to some extent middle age professionals, to develop skills needed to obtain a job. Furthermore, behavior norms and attitudes as related to education are likely to vary based on race, ethnicity, gender, and socioeconomic status. In addition, although there are opportunities for people of all ages to engage in continuing studies for recreational purposes, many of the people who pursue these activities are older aged because they have more available leisure time. For this campaign, the goal is broad and focuses primarily on changing behaviors of younger people in the US of all races, ethnicities, genders and socioeconomic statuses.

In terms of the perceived threat of AD, there are differences between the views of young people and those of middle and older age people. To younger people, AD sounds like a terrible affliction, but it is something that old people get, so they do not worry about it. They may put up barriers to prevention because to them the threat is in the distance. On the other hand, for middle and older age people, the threat of AD is more of a reality. They may have a better understanding of the disease because it is more prevalent in the news and media they are exposed to. Also, they may experience the effects of AD firsthand because they have friends or loved ones who have been diagnosed. They are closer in age to when people realize the symptoms of AD, and they can be fearful of the disease.

One of the objectives of the campaign is to establish the connection between lifelong engagement in educational activities and long-term brain health. The campaign message has to address the preconceived barriers to this behavioral change. There are many barriers for younger people in making a commitment to lifelong education. For one, younger people have spent so much time focused on school that when they complete what is required, they may no longer be interested in continuing with their educational activities, especially if it does not have an impact on their ability to make more money. Furthermore, educational activities take time to pursue which competes with work, other extracurricular activities, and time with friends and family. For many young adults and middle age adults, there may be very little free time or money to devote to continuing educational opportunities.

Another reality is that people are difficult to influence when considering a behavioral change that is needed in the present in order to reap rewards several decades later. There is a conventional path in modern society with common themes at each stage. While in primary and secondary school, younger people are focused on education as well as learning how to grow up

and become an adult. As a young adult, they are focused on getting a job to make money, finding a partner, and perhaps starting a family. In middle age, they are focused on continuing to work in order to support themselves and their family (and often their extended family). In older age, people may be struggling with personal health issues, mobility constraints, and financial limitations. In general, in our modern society many individuals often have very little free time outside of work and family, and they may experience financial constraints. With barriers such as cost, access, and time, it is difficult to make educational activities after secondary school a priority, even if people develop an understanding of the long-term health benefits of educational attainment. Therefore, in order to gain traction and attract the target audience, the campaign must be present the message in a compelling way, include a clear path for the actions needed to meet the desired behavioral change, and the actions must be perceived as manageable.

The Campaign Message: “*Lifelong* LEARNING to beat AD”

As a broad health campaign intended to attract attention from a younger audience that spans all socioeconomic, race, and gender distinctions, the message must not be too simplistic or too complex. The general levels of health literacy (the capacity to obtain, process and understand health information) and health numeracy (the capacity to process health statistics in order to make informed decisions) is low for educational attainment and AD, and the campaign message cannot be so basic as to seem unimportant and not so complex as to lose the target audience’s interest. According to the SMOG readability test (see Appendix - Figure 5) the number of polysyllabic words in 30 sentences can be used to determine readability based on grade level (McKenzie et al., 2017). Therefore, the content for the primary target audience should have a

readability rating between grade 5 level (3 to 6 polysyllabic words per 30 sentences) to grade level 10 (43 to 56 polysyllabic words per 30 sentences).

The slogan “*Lifelong* LEARNING to beat AD” incorporates several themes into one succinct message. First, LEARNING indicates this is new information to process and understand, and it also is tied to education. Second, the use of “AD” instead of the full name of “Alzheimer’s disease” is an attempt to rebrand the disease in a more modern and new light, with the goal of disassociating with the previous negative images and misconceptions connected with Alzheimer’s disease. Third, *Lifelong* is added to reinforce the message that education does not end with high school or postsecondary education – this is an area that requires a change of thought and should be emphasized. Finally, “to beat” indicates the severity of the disease and the notion that there is a battle that can be won. Putting these ideas together makes the connection that is identified in the statement of purpose: make the public aware of the connection between educational attainment and long-term health, specifically as it relates to Alzheimer’s disease.

Implementation Plan

This implementation plan details steps to accomplish the objectives. Each of these steps are connected through the use of the campaign slogan, with all promotions including the logo to develop recognition and build awareness (see Appendix - Figure 6). The logo incorporates the slogan “*Lifelong* Learning to Beat AD” and is assembled around a tree, which symbolizes roots in education and branches that symbolize long life. The colors are purple, blue and green. Purple is the color used by the Alzheimer’s Association (see Appendix – Figure 7), blue represents wisdom, and green represents health.

The 4Ps are the hallmark of traditional marketing plans and they provide a structure for the implementation plan (McKenzie et al, 2017). The 4Ps are product, price, place, and promotion. For this campaign they are described as:

- Product – the tangible item or service
 - The “product” for this campaign is awareness of educational attainment and its protective factor against the onset of AD.
- Price – the cost to the consumer to obtain the product
 - The “price” the consumer pays to develop awareness is free; however, there are optional campaign-related items that can be purchased by the consumer to support the campaign costs related to the educational program development and campaign promotion.
- Place – where the consumer has access to the product
 - The “place” where the awareness message is delivered is through educational programs at middle schools and high schools, and secondarily at doctor’s offices.
- Promotion – the message content and delivery methods that may include many channels that vary by the target population
 - This campaign has many channels to generate awareness: the educational program at schools, the informational brochure, engagement activities and associated public relations events, content on the campaign website, and messaging through the campaign Instagram account.

These are the specifics of the promotion:

Educational Program for Younger People

The core of the promotional plan is the creation and implementation of a health education program to be delivered at middle schools and high schools through special activities and as part of the health and science curriculum. The content is explicitly designed to teach students about the brain and Alzheimer's disease. Specifically, through interactive age-appropriate content, students will learn about cognitive reserves in the brain, the impact of educational activities on cognitive reserves, and how the brain ages. The connection between the AD and protective factors of educational attainment is the culmination of the program. Students are also encouraged to think of ways they can continue with educational activities throughout life outside of school. Program packets are developed by leading AD researchers and young adult educators, and the curriculum is provided to the schools free of charge. The program will kick off with a school assembly and a motivational guest speaker who has a personal connection to AD and promotes lifelong education. Furthermore, the school will designate a peer advocate, perhaps a student who has a grandparent with AD, who is the student responsible for engaging their peers throughout the program and provides motivation for the development of additional related activities. This may develop into a student group that continues to support the goal of the campaign after the campaign program has ended. Also, a teacher/administrator from the school will be assigned as the program advisor. This person is the lead contact for teachers and students and the campaign team.

Campaign Merchandise

Campaign excitement and awareness is visually shared through merchandise that pre-teens and teens are attracted to, such as a Pura Vida bracelet designed especially for the

“Learn to beat AD” campaign (colors are purple, blue, and green) (see Appendix – Figure 8), a branded t-shirt with the tree logo, and a cloth bag with the tree logo and the campaign website. These items are available for purchase on the website but are also used as “giveaways” to develop awareness of the message and encourage participation in the educational program. Identifiable merchandise that is widely used adds sparks conversation and implies solidarity and support for the campaign.

Social Media Platforms

The younger audience relies on their phones as the way to connect socially with their peers as well as the world around them, including news, celebrities, and organizations. They are heavily influenced by what they see through social media and what they research online. Therefore, to reach this audience at their level, an Instagram account (user name LearntobeatAD) is the primary platform for providing access to engaging content that is updated several times a week. The messaging is driven by school peer advocates and approved by the school program advisors. Content is sourced from the program curriculum, local activities related to the campaign, news stories about AD and/or education, recent information published by the Alzheimer’s Association, and other content designed by the peer advocates. The content varies to keep the audience engaged and encourage sharing. It includes personal stories (photos and short video clips) about people with AD, links to online brain games, promotion of educational opportunities/activities, a “riddle of the week” to encourage kids to keep up brain health, facts about education and your brain health, tips on how to spot AD, tips on how to act around someone who has AD, and suggestions for types of educational activities that

someone can do outside of school. Using social media to share information about AD and educational attainment will allow students to begin to change their behaviors together.

Website

The print materials and the Instagram posts reference the campaign website (domain name www.learntobeatAD.com) which serves as the central repository for information supporting the awareness campaign. The website is geared towards the primary target audience of pre-teens and teens, although there is a section for parents and grandparents. Therefore, it will be different from existing websites for Alzheimer's organizations which are typically geared towards the older audience in terms of content and graphics. For this campaign, the homepage content is more visual than text and includes photos, short video clips, and infographics that are presented in a simple manner to connect with the audience. There are linked pages that provide more substantial information related to AD and its connection to educational attainment. These are the sections of the website:

- Homepage – primary pane: includes the slogan and logo, and a general statement about the campaign along with general facts about AD and the connection between education and AD. It also has photos of younger people (teens through 20s) having fun and engaging in various educational activities.
- Homepage section pane – Educational Activities: Content divided by age range and lists suggestions for types of educational activities; the audience is encouraged to submit their ideas to be added to the list as well as photos of them participating in the activities.

- Homepage section pane - Local news: highlight events in the community and opportunities for education outside of school.
- Linked page – Research: provide summaries of the latest research on AD and educational attainment and AD; include links to TED talks, podcasts, PR clips, and AD organization websites.
- Linked page – Parents and Grandparents: provide content geared towards the middle to older age populations with summaries of recent research on AD and educational attainment and AD, information on the signs and symptoms of AD, where to go for help, and links to AD organizations.
- Linked page – I Need Help: provide a support contact for kids who need to talk with someone about AD.
- Linked page – I Want to Help: provide ways for people to help the campaign; this includes how to start an awareness program at your school, how to contribute to the content, request for informational brochures, and the online purchase of the campaign merchandise.

Information for Parents and Grandparents

An informational brochure helps to communicate the awareness message for parents and grandparents. It has basic information about AD, establishes the connection between educational attainment and AD, and encourages them to support their kids and grandkids in continuing with education throughout life. The content directs readers to the campaign website for more information. These brochures are provided for parents at the schools but

also at the public library, public health centers, and at doctor/pediatrician's offices. This is the layout of the brochure:

COVER FLAP

- Photo: Mixed age audience engaging in fun educational activity
- Message: Did you know education is the best medicine for protecting yourself against Alzheimer's disease (AD)?
- [logo, see Appendix - Figure 6]

INSIDE FLAP


- Message: AD is a degenerative brain disease that currently has no cure. It affects 5.7 million Americans, and this expected to rise to nearly 14 million in 30 years.
- [chart, see Appendix - Figure 1]

INSIDE

- Message: We don't know who will get AD in later life, but we can take measures now to help protect the ones we love. It turns out, education is the best medicine.
- Photo: Students engaging in campaign program at school
- Message: Your kids are learning about AD and the importance of continuing with educational activities throughout their life. Ask them what they are learning. Engage in educational activities as a family. You can help them make a difference.
- [across the bottom - graphic depiction of engaging in different examples learning activities throughout life's stages]

BACK PAGE

- Photo: Campaign celebrity spokesperson engaging with teens

- Message: Make lifelong learning a priority for your kids. It's easier than you think.
- Message: To understand how education helps your brain for life and for ways to keep the kids in your life engaged in learning, visit www.learntobeatAD.com today or follow us on  Instagram: LearntobeatAD.

Campaign Spokespeople

The use of several well-known spokespeople would spark interest in the campaign and lend credibility. The ideal spokesperson can relate to both the younger audience as well as the parents; consider well-known celebrities such as Lady Gaga, Bradley Cooper, Sofia Vergara, Nick Jonas, and Rihanna with a connection to AD (<https://www.looktothestars.org/charity/alzheimers-association>, 2019) and the persona to positively influence the target market. The message they project is a confirmation of their belief in the correlation between educational attainment and AD, and a public commitment to engaging in educational activities throughout life while encouraging others to do the same. Furthermore, they vow to do what they can to give their kids a chance to avoid AD by supporting their lifelong educational activities. Either in person or through a video, these spokespeople can be a part of the school program, the website content, and the Instagram content, as well as other public relations activities to support the campaign.

Barriers to Success

This awareness campaign has many barriers to success, many of which may not be identified until a pilot version of this is activated. The primary barrier for implementing the campaign is finding the resources and funds to develop and maintain the content for the school program, the website, and the Instagram account. Furthermore, implementing this type of content in public schools will be a challenge. Teachers are required to teach specific curriculum, and there is little time to step outside those boundaries. Even if they are interested in including this type of content in their curriculum, they may not be permitted unless there is an educational policy change.

Assuming the school program can be achieved, there will be challenges in getting the traction needed to support the campaign long-term. There are many barriers to continuing with educational activities throughout one's lifetime, and although the kids may learn to understand the value, actually putting it into practice may be more difficult to do.

Finding spokespeople may be a challenge. These are people who need to come together as a family and be willing to overcome the current stigmatism in our society against AD. They will need to expose their personal experiences with AD in order to help others.

Assessment

The long-term success of an awareness campaign is difficult to assess. For this campaign, the behavior modification of younger people to embrace lifelong education will take decades to realize. With that being said, there are ways to assess this specific campaign during its implementation timeframe. The primary promotional delivery methods are a school educational program, an Instagram account, a website, and a brochure. It is possible to measure engagement for each of these.

For the school program, one metric of evaluation is the number of schools that incorporate the program over a given period of time. For example, the goal may be to implement the program in 500 middle schools and 500 high schools over the course of 3 years. Each year the team can track the progress and determine if changes need to be made. Also, another metric is the number of years the program continues to exist at each school where it was implemented. Furthermore, details can be collected at each school to measure the level of engagement by the students each year; for example, the number of students who are involved in a related club that supports the campaign initiatives. Also, specific questionnaires can be developed to assess the student's knowledge of AD and its association with educational attainment both prior to starting the program and after one year of involvement with the program. Results can be analyzed and used to influence content changes as well as ongoing program management.

The website and Instagram account have built in analytics that can be accessed at any time to evaluate the traffic and usage. The website tracks the user behavior such as repeat visits, click-throughs from links to other pages, and time spent on a particular webpage. Evaluating these trends can help identify where the content can be improved. Furthermore, the Instagram account has analytics to show the number of followers for the account, the number of likes a post gets, the number of times a post is shared, the number of times the post is saved, and more specifically, the comments that are posted. Similar to the program analysis, these trends can be monitored and used to guide content changes.

This program has the potential to generate a large group of test subjects for a longitudinal study on the impact of educational attainment and educational activities throughout life on the onset of AD. When the program is implemented at a school, students can become a part of this study. They can then be assessed via online survey on a regular basis, such as every 2 years, to

collect data about their health and educational activities that spans from their teens to old age, when possible. Along with MRI and other brain testing at predetermined intervals, these data can provide substantial insight into the types of educational activities and the effects of educational attainment on the onset of AD.

Section III: Campaign Summary

The purpose of this campaign is to spread awareness of the benefits of pursuing lifelong educational activities in a way that makes it fun for the younger population. Most current Alzheimer's informational campaigns are not geared towards the younger audience. By getting the pre-teens and teens engaged in learning about AD and the value of education in a way that makes sense to them – programs at school, online content, information on Instagram, celebrity stories – they will begin to make the behavioral shift in which lifelong learning is viewed as not only as something everyone does, but also as a way they can make a positive impact on their health and quality of life. Developing this campaign into a research study can provide long-term data that contribute to the scientific understand of the relationship between educational attainment and Alzheimer's disease.

Part IV: Research Limitations and Conclusion

Research indicates there are modifiable risk factors that play a role in delaying the onset of Alzheimer's disease. The evaluation of educational attainment is found in a great deal of research. However, there are some gaps in the existing research that should be addressed.

Currently, the majority of the dementia and Alzheimer's disease studies are based on subjects in the US and Europe, where education levels are higher than in poorer parts of the world. However, in 2010, 58% of all people with dementia lived in countries with low or middle incomes, and this is expected to rise to 63% in 2030 and 71% in 2050 (Herrmann et al., 2018). Furthermore, a review of 22 longitudinal studies that involve 21,456 subjects concludes that 19% of AD cases worldwide can be attributed to low educational attainment (Barnes & Yaffe, 2011). Ultimately, it will be critical to expand research to include populations in Asia and Africa, among other nations. Expanding the research may shed more light on factors that cause the disease as well as ways to manage the risks, including differences between race and cultural backgrounds. This would potentially help scientists discover the causes of the disease as well as ways to cure it, and it can help clinicians to improve diagnostic measures.

The AD research that involves educational attainment uses varied methods of data collection. Studies have different ways to categorize education levels, and there are also differing ways to group subjects by educational levels. Most studies create levels based on the number of years of education. For some older subjects without significant formal education, this is a number that is inaccurate because it can be difficult for them to remember their amount of education (Ko, et al., 2018). Furthermore, the number of years does not directly relate to the quality of education. However, it is difficult to qualify education in terms of quality because it is so varied by and within country. The Contador, et al. (2017) study found literacy to be a better predictor, but that was the only study to make such a claim, and the data was from a limited population in Spain. Furthermore, in current research, education levels are often grouped by low, medium, and high in terms of number of years, but they do not account for when the education was received. Because the connection between educational attainment and AD may be attributed

to cognitive reserve levels at old age, it would be interesting to study later-life education and its impact on the brain. Also, it would be valuable to know if there the mode of education and/or educational content has an effect on cognitive reserve levels and the onset of AD.

In terms of measuring cognition levels, there are different methods of testing and they are administered in different ways. These methods likely take into account their subject pool and the resources available to the study. However, this makes it difficult to translate various research studies that are measuring similar data from different subjects into a common conclusion. As a result, the outcomes vary based on age, ability to read/comprehend the tests, and cultural norms, and the results are impossible to compare.

Changes over time are critical in the understanding of the onset of AD and its rate of decline in different populations. However, perhaps due to cost and resources, there are fewer longitudinal studies. The non-longitudinal studies are a snapshot in time which are not as accurate as measuring the changes in each subject over time. Furthermore, the diagnostic criteria for dementia, MCI, and AD has changed over the decades, so it is difficult to translate studies over time to compare results.

With the aging population and the expected increase of people diagnosed with AD worldwide, it is critical for the public to become engaged in learning about the modifiable risk factors and the realities of the AD. Younger people are in a position to learn about AD and incorporate behaviors, such as lifelong educational attainment, that can put them at the best advantage to combat AD as they age. Furthermore, learning about AD early in life can help them to become empathetic and compassionate caregivers, thus de-stigmatizing the disease.

Appendix

Figure 1: The projected increase of Alzheimer's disease in the United States

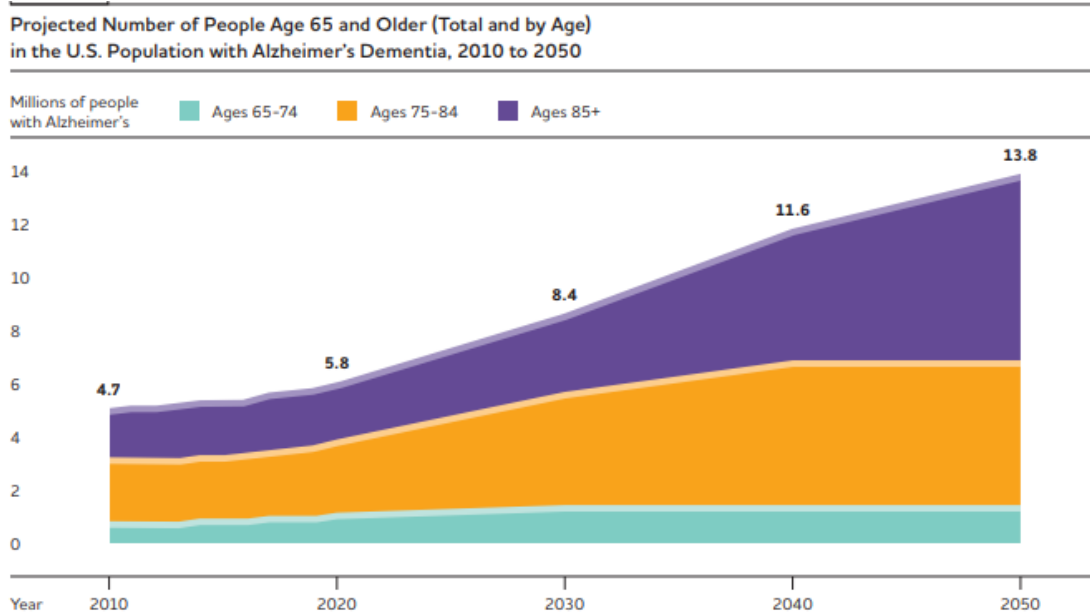
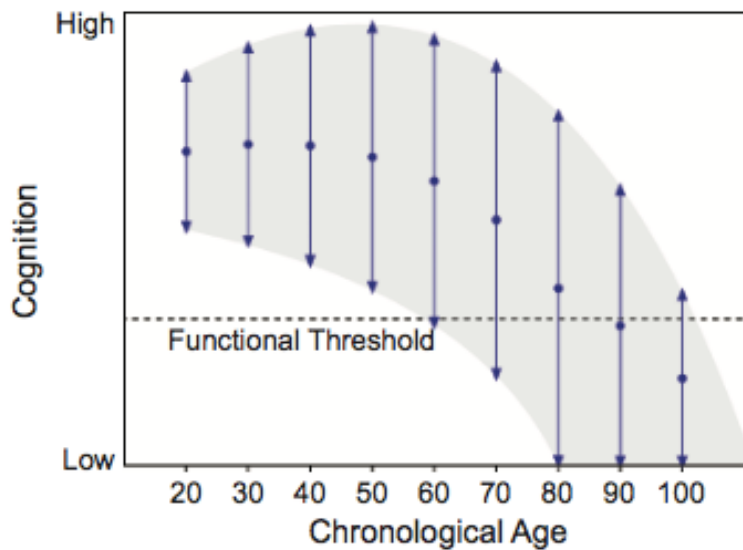


Figure 2: Depiction of the zone of possible cognitive development across adult life for a given individual.



The blue dots indicate a general developmental trend for the individual under typical circumstances. The upper and lower curves indicate optimal and suboptimal boundaries that define the zone of possibility (shaded grey area). Upward and downward movements at a given age (arrows) are influenced by biological, behavioral, and environmental influences. The functional threshold indicates a point at which goal-directed cognition in the ecology will be compromised. (Hertzog et al., 2009)

Figure 3: Summary of websites include in analysis (Lawless et al., 2018)

Organization	Country	Website
Alzheimer's Australia	Australia	www.fightdementia.org.au
Alzheimer's Society of Canada	Canada	www.alzheimer.ca
Alzheimer's Society of Ireland	Ireland	www.alzheimer.ie
Alzheimer's New Zealand	New Zealand	www.alzheimers.org.nz
Alzheimer's Scotland	The United Kingdom	www.alzscot.org
Alzheimer's Society	The United Kingdom (except Scotland)	www.alzheimers.org.uk
Alzheimer's Research	The United Kingdom	www.alzheimersresearchuk.org
Alzheimer's Association	The United States	www.alz.org

Figure 4: Experimental ad manipulation (Gorp et al., 2012)



Figure 5: The SMOG Conversion Table* (McKenzie et al., 2017)

Total Polysyllabic Word Counts	Approximate Grade Level (± 1.5 Grades)
0-2	4
3-6	5
7-12	6
13-20	7
21-30	8
31-42	9
43-56	10
57-72	11
73-90	12
91-110	13
111-132	14
133-156	15
157-182	16
183-210	17
211-240	18

*Developed by Harold C. McGraw, Office of Educational Research, Baltimore County Schools, Towson, Maryland.

Figure 6: Lifelong Learning to beat AD logo (created by Halle Boroski, March 2019)

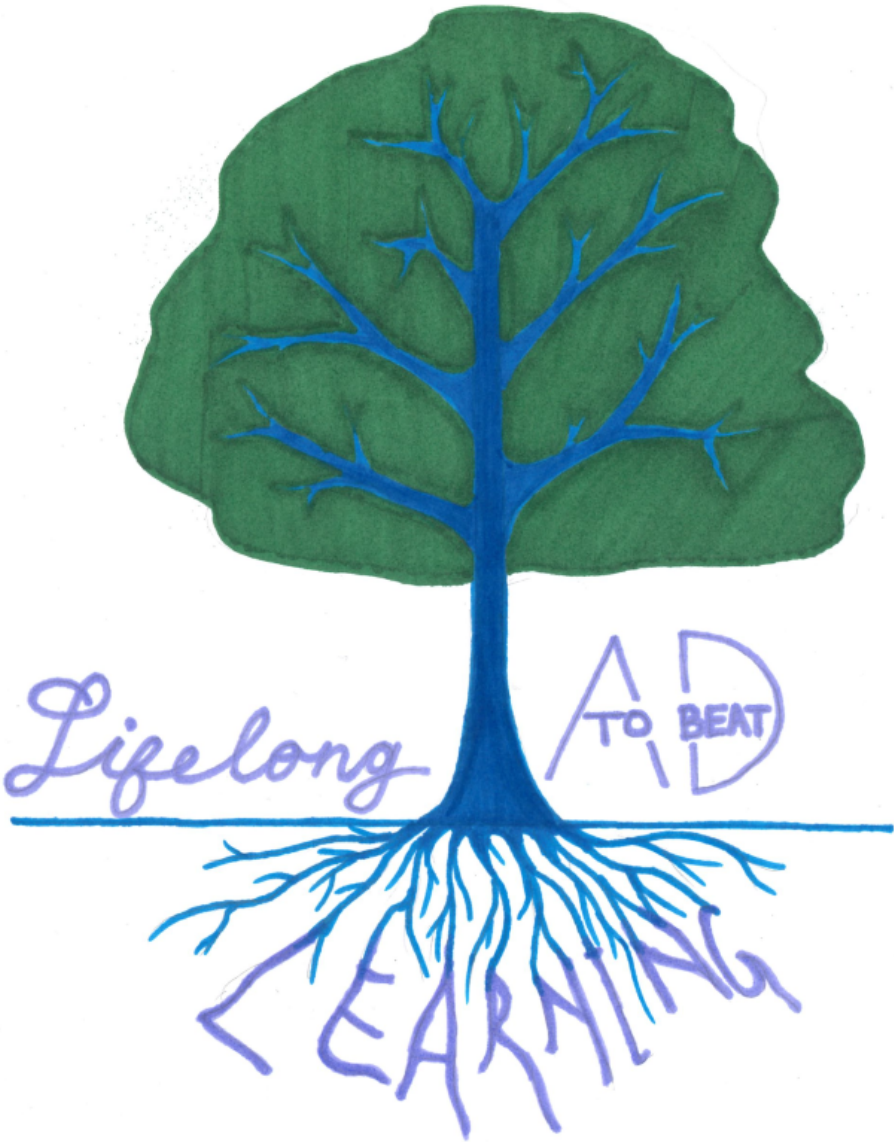


Figure 7: Homepage of the Alzheimer’s Association Website (www.alz.org)

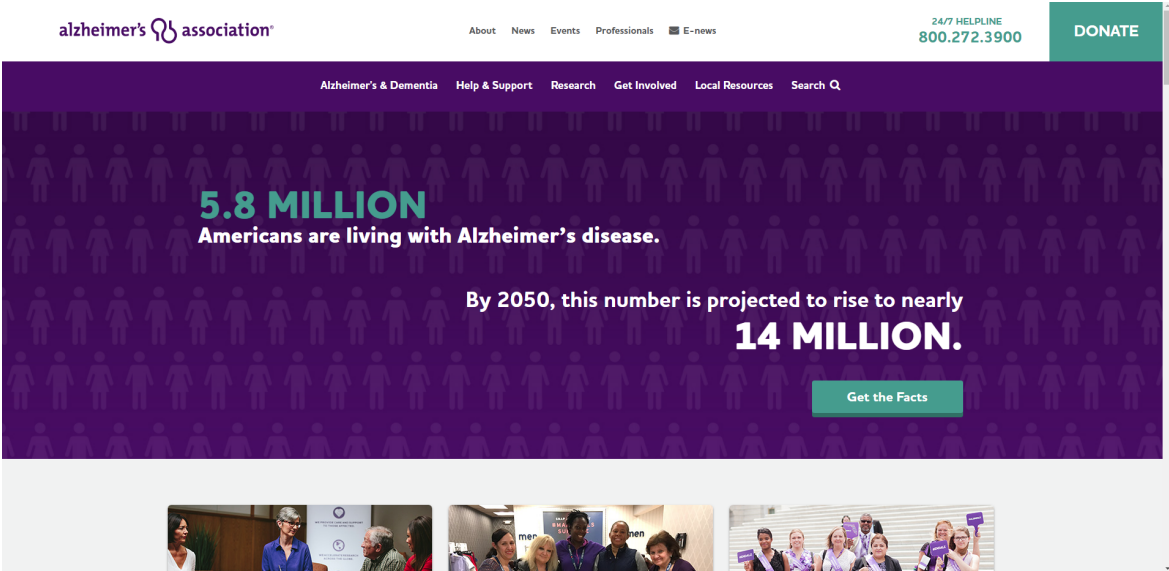


Figure 8: Pura Vida Charity Bracelet (<https://www.puravidabraccets.com/collections/charity>)



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