YOUNG ADULT BRAIN CAPITAL: A NEW OPPORTUNITY FOR DEMENTIA PREVENTION

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ABSTRACT

The potential for future prevention of Alzheimer's disease and related dementias (ADRD) through healthy lifestyle change is spurring a positive brain health movement. However, most ADRD research continues to focus on mid- and later life. We lack evidence regarding risk exposure and protective factors in young adulthood, i.e., 18-39 years. Brain capital is an emerging framework that represents the combination of education, knowledge, skills, and optimal brain health that people accumulate over their lives. Building on this framework, we present a new model that focuses on optimizing brain health in young adulthood; namely, young adult brain capital. Increasing focus on younger populations is critical for developing citizens who are emotionally intelligent, resilient and can anticipate and cope with rapid changes in the world. By understanding the values that are key drivers and motivators for young adults, we can empower the next generation to become active agents in optimizing their brain health and reducing their risk for future ADRD.

KEYWORDS: Brain health; Brain capital; Young adults; Alzheimer's disease; Prevention; Risk reduction

LIFE COURSE PREVENTION: THE YOUNG ADULT GAP

Growing evidence suggests that a large proportion of Alzheimer's disease and related dementias (ADRDs) are linked to lifestyle-related factors. Estimates generated using data predominately from Europe and North America indicate that 40% of all ADRD cases could be prevented (or at least delayed) by addressing 12 so-called modifiable factors, such as alcohol consumption, depression, and traumatic brain injury (TBI), among others [1]. The potential for prevention may be even higher in low- and middle-income countries; estimates generated using data from Latin America indicate that over half ADRD cases (56%) may be preventable [2]. Similar estimates have been reported among specific ethnic minority groups, such as Māori peoples in New Zealand [3].

The potential for risk reduction of poor brain health through healthy lifestyle change has spurred a positive brain health movement. Brain health is manifested through a state of brain functioning across mental health, cognitive, social, emotional and behavioral domains that allows a person to reach their full potential.[4] Proponents of brain health highlight the importance of early intervention [4-6]. Although ADRD is commonly associated with old age, there has been a shift in research towards prevention, starting in mid-life, i.e., 40 to 65 years of age [7, 8]. Building on this, we advocate for a more integrative life course perspective, and highlight the importance of focusing in an even younger adult population: specifically, young adults before mid-life, i.e., 18 to 39 years of age.

There is a stark knowledge gap around risk exposure and protective factors for brain health in young adulthood [9]. Most ADRD research continues to focus on either early childhood and adolescence or mid- and later life [1, 10, 11], with comparatively less research in-between these life stages. This is particularly limiting as exposure to many ADRD risk factors begins during young adulthood. For example, prevalence of heavy alcohol use peaks at age 20-24 years [12] and three-quarters of mental health conditions develop before the age of 25 [13]. Young people are also the most common age demographic to experience a TBI, resulting in long term disabilities [14]. Bridging knowledge gaps around how risk factors influence brain health in young adulthood will ideally allow us to characterize patterns of risk exposure across the life course, and thus, identify critical windows for intervention to reduce risk and optimize protective factors [15].

Progress towards addressing brain health knowledge gaps can be accelerated through cross-disciplinary collaboration. In particular, there is a wealth of research on young adults from psychology and neuroscience fields (e.g., cognitive and mental health outcomes, lifestyle exposures), which can be viewed through a brain health lens. Efforts to integrate brain health into other health domains (e.g., mental health) are already underway [16]. Such efforts will lead to broad health benefits, including prevention of ADRD and other chronic conditions in later life. Increased focus on young adult brain health may also facilitate the identification of new lifestyle-related risk factors. Sleep disturbance and anxiety are two examples of newer risk factors that may be particularly relevant for younger adults. Sleep problems in adolescence have been shown to predict sleep problems in later adulthood [17].

Excessive screen time has also been suggested as a potential risk factor for younger generations [18]. Specifically, more than 2 hours of exposure to electronic media per day has been shown to impact brain development (i.e., structure and function) and increase risk of cognitive, emotional, and behavioral disorders in young adults [18]. These effects are thought to be mediated by negative impacts on attention and concentration, learning and memory, emotional regulation, and social functioning, among others. Excessive social media use has also been associated with sleep problems, loneliness, and depression [18].

Other factors such as hearing loss and drug use remain largely unexplored despite increasing relevance to young people [19-24]. Recent evidence suggests that unsafe listening practices (i.e., loud noise exposure) are highly prevalent and may leave over 1 billion young people worldwide at risk of hearing loss [23] This is concerning because hearing loss in older populations is associated with increased ADRD risk, likely due to a combination of factors (e.g., social isolation, exhaustion of cognitive reserve) [22].

YOUNG ADULT BRAIN CAPITAL: A RESOURCE UNDER THREAT

Brain capital is an emerging framework that can be defined as the combination of “education, knowledge, creative skills, and optimal brain health that people accumulate through their lives, enabling them to realize their potential as productive members of society and the modern economy” [25]. Brain capital is strengthened or impoverished through dynamics between people and their social environment [25, 26, 27]. The importance of building brain capital in older adults has recently been highlighted [26]. However, the opportunity to focus on young adult populations has yet to be explored [16]. Building on previous work,

Figure 1 presents a model for young adult brain capital comprising three components: brain health, brain skills, and the modern economy. Factors contributing to brain health (e.g., promotion of physical health, life-long learning, and social connection) and brain skills (e.g., increased value on design and systems thinking, and resilience) influence each other, and both are influenced by factors inherent in the modern economy (e.g., digitization, a drive towards sustainability, and increasing political polarization).

As much of the knowledge, skills and habits underlying healthy lifestyle behaviors are established in early adulthood, building brain capital in this generation is particularly important for future ADRD prevention. Unfortunately, however, young adult brain capital faces significant threats. Deteriorating mental health in young people over the past decade has been worsened by the COVID-19 pandemic, with racial, ethnic minority and LGBTQ+ groups being disproportionately affected [28, 29]. The closure of educational institutions and workplaces and reduced social interaction during the pandemic has also resulted in learning loss and widening of the learning gap among students, which are likely to have long-term negative effects [30]. Again, these effects will be unevenly distributed among groups already facing inequalities. For example, Black colleges and universities, Minority Serving Institutions, and Tribal Colleges and Universities in the United States experienced enrollment declines at higher rates compared to predominantly White peer institutions during the previous academic year [31].

Recessions and economic downturns, such as those currently being experienced in many parts of the world, also impact the developmental trajectories of young adults. Downturns take a toll not just on the individual, but also on family and intimate partner relationships, which can diminish emotional investment, and increase domestic violence and neglect [32]. Such adverse experiences early in life can have severe and long-term impacts on brain health, and in turn, brain capital. Finally, young adults live in an increasingly polluted world. The World Health Organization estimates that 99% of the global population live in areas where air quality guidelines are not met [33]. Rising air pollution has been associated with a range of negative effects, including poorer cognition and increased risk of late-life ADRD [34, 35].

LOOKING FORWARD THROUGH A BRAIN CAPITAL LENS

Global trends indicate that ADRD prevalence will continue to rise, with most new cases occurring in low- and middle-income countries (LMICs). Because ADRD occur mostly in older people, delaying the average

age of onset by even one or two years will lead to a reduction in age specific prevalence [15]. This can be achieved by working strategically and comprehensively to address brain capital development with targeted lifestyle interventions across the life course [36]. Young adults have great potential to achieve long-term benefits from such interventions. This will require targeted interventions and public health messaging, as those developed for older generations may not be suitable. Greater consideration of geographical location and gender, ethnic and cultural diversity is also required [15].

When it comes to brain capital, young adults, like all generations, will be motivated if strategies align with their established values and interests. For example, there is evidence that today's young adults may be more likely than previous generations to boycott businesses or products that do not align with their values, and to push organizations to adopt positive environmental, social, and governance frameworks [37]. Of course, this is more common in high income countries where basic needs are satisfied. Youth environmental activism is also proving to have a transformative effect on democratic politics in many countries around the world [38]. At the same time, there is growing evidence for the impact of our environment on brain health [35]. Connecting brain health and brain capital with issues like these will help to amplify their importance [9].

To optimize health and well-being for the societies of tomorrow, we must invest in young adult brain health and brain skills. While our focus is on young adults here, earlier intervention (i.e., in childhood) should also be prioritized as part of a whole-of-life approach. Expanding focus to younger populations is essential not only for to training future leaders who can tackle society's greatest challenges, but also for developing citizens who are emotionally and ecologically intelligent, resilient and can anticipate and cope with rapid changes in the world. Understanding the values that are key drivers and motivators for young adults is imperative to empowering young people to become active agents in optimizing their brain health and preventing future ADRD. To this end, we propose a novel framework for investing in young adult brain capital (Table 1). Our framework for young adult brain capital outlines objectives, barriers to change, and required investments. A key component of the model is the need for more data on prevalence and impact of ADRD risk and protective factors young adult populations. Building this evidence base will require harmonized action across disciplines and sectors [39]. In addition, we must push for greater commitment to diversifying study populations. This will involve addressing current barriers to participation, which are

numerous and varying, ranging from financial constraints (e.g., distance to travel) and language barriers to medical distrust (e.g., due to historical and contemporary racism) [39, 40]. Greater commitment to engaging with local and community enterprises is one strategy to address these issues. For example, a growing number of researchers are adopting a co-production approach, where members of the public are involved in all steps of the research cycle [41]. While this approach can be costly and time-consuming, it is arguably essential to understanding upstream social determinants of health, and thus, health equity.

Enhancing young adults' knowledge of the factors that can affect brain health at the population level (e.g., through educational programs) should also be prioritized. This will serve to embed a positive brain health culture that will not only benefit young adult generations, but also society as a whole. One strategy to build interest among young adults is to link brain health with issues they are already actively motivated to address [9]. For example, air pollution as a potential ADRD risk factor could be linked to youth activism around the climate crisis [42]. Similarly, excessive social media use as a risk factor for poor brain health could be linked to youth movements against online sexual harassment, violence, and data privacy concerns [43].

The development of innovative methods, tools, and protocols also presents new opportunities for research. Digital applications (e.g., mobile apps and wearable devices) are now being used for health monitoring and promotion with some success [44]. However, their potential utility for promoting brain health in young adults remains unexplored. In addition to generating large datasets, use of mobile apps can serve to build capacity among young adults as brain health advocates, as individuals can actively monitor their own data. Virtual and augmented reality technologies represent another new frontier for brain health research. Developing and implementing these technologies can be facilitated through cross-sectoral collaboration with industry (e.g., technology corporations and start-ups).

Reaching participants through these platforms will require innovative recruitment strategies, especially for those groups who are traditionally under-represented. For example, the increasing popularity of brief (e.g., 60 second) video-based content through applications like TikTok represents an entirely different type of engagement. To effectively engage young adults about brain health using these platforms, research must therefore embrace new strategies; for example, community-building through hashtag challenges and 'duetting' or 'stitching' (i.e., pairing a new video with existing content into a single post) [45].

Finally, there is the potential to leverage existing databases to recruit well characterized young adults. One example is the electronic health record (EHR) in the United States, which has seen an increase in usage in recent years [46].

CONCLUSION

The United Nations (UN) has called this the “Decade of Healthy Ageing” [47]. The UN Decade of Healthy Ageing calls for a fundamental shift in how our societies work, think, and feel about aging. Young adults are poised to become part of this movement. Around the world, young activists are powerfully condemning injustices, such as greenwashing, and calling for global change [38]. We believe that when young adult brain capital literacy is enhanced, similar positive social change movements will take place for brain health and life course ADRD prevention. To achieve this, future research must fill gaps in the evidence base of young adult brain health, understanding awareness and attitudes towards ADRD risk and resiliency among diverse populations, and crucially, values that will motivate healthy lifestyle change across the lifespan.

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CONFLICT OF INTEREST

HAE receives consulting fees from Kooth LLC and has received support for the Brain Capital Dashboard from The Lundbeck Foundation. The authors have no other conflict of interest to report.

DATA AVAILABILIYY

Data sharing is not applicable to this article as no datasets were generated or analyzed during this study.

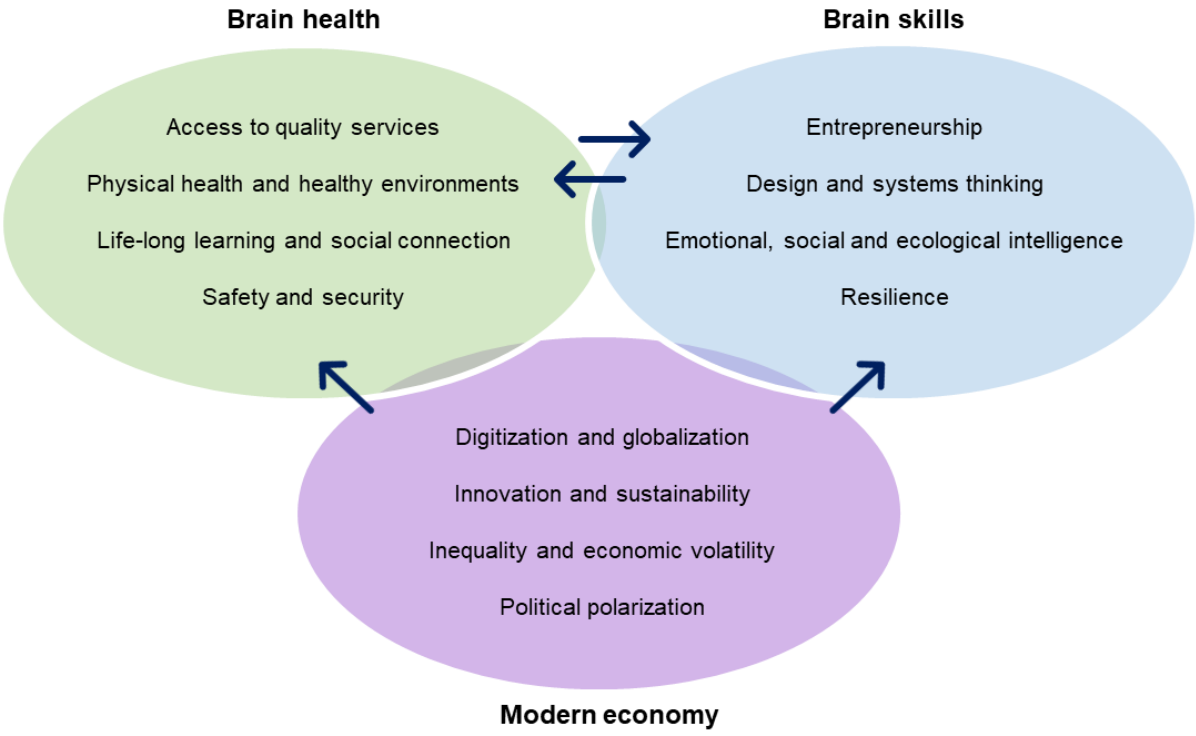

FIGURE 1: Young adult brain capital incorporates brain health and brain skills in the modern economy. Brain health and brain skills have a bidirectional interaction. Brain health and skills are ultimately majorly influenced by the modern economy. Adapted from Smith *et al.* [25] with brain health factors from the World Health Organization [4].

TABLE 1: Framework for optimizing young adult brain capital.

Goal	Reduce the impact of brain health risk factors on brain capital and increase brain health resilience in young people			
Problem	Young adult brain capital is threatened by multiple brain health risk factors that individuals are exposed to early in life			
Barriers to change	Lack of evidence around prevalence and impact of risk factors young adults; siloed academic approaches	Lack of public-private collaboration	Lack of community engagement and involvement in priority setting	Modern economic challenges such as climate extremes, rising inequality, stress from societal polarization, technology accelerations
Objectives	Tackle social and structural determinants of health	Enhance education around brain health, mental health services and social supports for young adults	Scale up research: (a) neuroscience to socio-economic, e.g., inequities (b) socio-political, e.g., climate change (c) socio-technological, e.g., role of social media	Increase implementation and development of innovative solutions, e.g., startups and technology investment
Investments	Systems reengineering	(a) Explore 'in all policies' approaches and engaging with non-clinical stakeholders such as schools, universities, and volunteer and community sector enterprises (b) Embed a positive brain health culture; build capacity to involve community engagement into established frameworks, breaking down the divide between academic, clinical, and community-based systems		

		(c) Explore and refine the field of mental wealth
	Priority setting	(a) Work with volunteer and community sector enterprises to develop locally focused, sustainable, practical areas of support (b) Scale up already established young adult brain health focused health promotion, prevention and intervention programs, regulations, and legislations
	Resource mobilization	(a) Champion tailored young adult brain health focused programs, regulations and legislations that address cost and outcomes relevant to non-traditional sources of funding for young adult brain health capital (e.g., non-health sectors) (b) Build capacity among young adult brain health advocates to become active agents in the positive brain health movement

Adapted from the World Economic Forum's Investment Framework for Building Mental Capacity in Young People [48].

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