



## What is brain health?

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### ABSTRACT

The call to optimize brain health is now a local, regional and global priority. Organizations such as the World Health Organization, Centers for Disease Control and Prevention and Alzheimer's Association, American Academy of Neurology, World Federation of Neurology, and others have developed recommendations for the maintenance of brain health. Brain health definitions range from broad to narrow in scope and may focus on cognition or encompass broader core components such as cerebral, mental and social domains. In this manuscript we will explore various definitions of brain health and its core components, the importance of cognitive and functional domains, and briefly introduce the concept of cognitive medicine in the context of brain health.

### 1. Introduction

Optimal function of the brain is critical to individual health and well-being across the life course [1]. With an estimated 100 billion neurons connected together by a robust highway of myelinated axons, injury to key elements of the nervous system may leave behind a trail of loss—loss of independence in managing daily and instrumental activities of living resulting in financial and personal ruin. In a landmark action in 2022, the World Health Organization (WHO) released a position paper on the optimization of brain health [2]. The position paper was a technical complement to a global action plan on epilepsy and other neurological disorders titled *Intersectional Global Action Plan on Epilepsy and Other Neurological Disorders 2022–2031* (IGAP), making neurological disorders a policy priority with a call for the creation of national strategic plans to reduce the burden of neurological disorders and protect the brain [2,3]. These actions have established a forum by which to open further discussion defining and operationalizing definitions of brain health [3].

The definition of brain health has been a topic of considerable debate. Although the various definitions are linked by common threads, there has been considerable variation in the use of the term. For example, at its conception in 1948, WHO defined brain health in relation to physical, mental and social well-being and not merely the absence of disease [3]. In a broadening of the definition, WHO now defines brain health in terms of capacitance to function across cognitive, sensory, socio-emotional, behavioral and motor domains which allow an individual to actualize their full potential over life's course [2,3]. Furthermore, brain health is influenced by 5 determinants: physical health; the

environment; physical safety and financial security; opportunities for social convergence; and access to health and social services. Whereas brain health is an evolving concept, the WHO definitions of brain health have been criticized for 'medicalization' in that achievement of absolute physical and mental health and social well-being may be too ideal a construct and in addition, every individual is potentially turned into a patient (medicalization) [3]. In addition, by broadening the definition of brain health, it may make it difficult to practicably monitor it.

Given the aforementioned frame works, we launch into the debate about the definition of brain health and how it may be operationalized. Our anecdotal experience is that most primary healthcare providers do not discuss brain health with their patients although there are modifiable or preventable factors for brain injury, and one of the IGAP objectives is for countries to have intersectoral programs for brain health promotion and prevention [4]. In step with the latter IGAP objective, is a call for establishment of interventional brain health services for prevention of cognitive impairment in persons with intact cognition who are at high risk for progressive cognitive disorders [5]. Key components of such interventional programs may include assessment of genetic and potentially modifiable risks, risk stratification, risk communication, risk reduction, and cognitive enhancement through cognitive and physical training [5].

#### 1.1. Aims and search strategy

The primary aim of the paper is to discuss definitions of brain health and the context in which brain health is defined. As part of the review,

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we discuss the role of cognition and other domains in relation to the definition of brain health, and introduce a relatively new concept related to brain health, 'cognitive medicine' [6]. The authors reference recent, relevant, and readily available literature on the topics of interest.

## 2. Definition of brain health

### 2.1. American heart association/American stroke association definition of brain health

Although brain health has been variably defined, there are common threads that link together many of the definitions. At the core of the definition of brain health is the maintenance of optimal brain structure and function leading to a state of physical, mental and social well-being or functioning. However, brain health definitions range from the practical to the abstract. For example, in the American Heart Association/American Stroke Association (AHA/ASA) definition of optimal brain health in the adult, a practicable approach was taken whereby brain health was defined according to factors that were easy to *measure, monitor, and modify*, with the expectation that the definition of brain health would be modified and expanded over time taking into account not only adult risk factors but also, relevant factors from the earliest epochs of life [7].

The AHA/ASA definition includes 4 *health-related behaviors and 3 health-related factors, respectively*, from AHA's Life's Simple 7: 1. Non-smoking status; 2. Physical activity at goal levels; 3. Body mass index (BMI) <25 kg/m<sup>2</sup>; and 4. Healthy diet consistent with current guidance; and 1. Untreated blood pressure <120/80 mmHg; 2. Untreated total cholesterol <200 mg/dL; and 3. Fasting blood glucose <100 mg/dL [7]. The evidence to support the definition largely emanates from epidemiologic observational studies, where healthy behaviors and related factors are associated with a lower risk of cognitive impairment [7]. Within the context of the AHA/ASA definition, one should consider brain health in terms of optimal capacity to function adaptively in the environment for most brain functions and thus, the definition goes beyond the mere absence of anatomic and physiologic disease.

Of note, the newly minted AHA's Life's Essential 8 base factors (the addition of healthy sleep pattern [7 to 9 h of sleep/night] to the original 7 factors) are now used as a replacement for Life's Simple 7 [8,9]. Historically, these factors have not only been associated with brain health, but were first recognized for their value in defining optimal cardiovascular health [10]. Therefore, the use of the 7 or 8 factor AHA systems provides not only a foundation for brain health but also for cardiovascular health, a main driver of brain health.

### 2.2. American heart association/American stroke association primary care agenda for brain health

In a complementary publication from AHA/ASA to the original AHA/ASA definition of brain health, a primary care agenda for brain health is discussed [11]. The primary care agenda refers to brain health at 3 levels (discussed below)—clinical, pathological, and pragmatic [11]. From a clinical perspective optimal brain health represents the absence of cognitive impairment or dementia, stroke and other brain diseases. Pathologically, the entity is characterized by the absence of neurodegenerative disease such as Alzheimer's disease, stroke and comorbid disorders that interfere with cognitive functioning. Finally, and from a practical perspective, brain health may be defined by preservation of neuronal function to allow the demands of life to be met successfully in relation to adapting to one's environment [11]. The importance of loss of cognition is emphasized as it may lead to helplessness and dependency.

## 3. Other definitions of brain health

Avan and Hachinski provide a contemporary review of definitions of

brain health as part of a brain health advocacy piece [12]. Select definitions of brain health are discussed below.

### 3.1. World health organization

The WHO provides a broad definition of brain health taking into account multiple levels in the global health ecosystem. The intent of the WHO definition is to capture ongoing interactions between genetics, environment and related circumstances, and interactions between the brain and all other systemic systems [2]. By capturing such interactions, one may track continuous adaptations of brain structure and function across life's continuum. Optimization of brain health is associated with improvements in mental and physical health, positive social and economic impacts, and overall, a generally greater well-being for individuals and a more productive society [2]. The aforementioned most recent *WHO definition of brain health* includes the following components: a state of brain functioning across cognitive, sensory, socio-emotional, behavioral, and motor domains that allows an individual to realize their full potential over the life span, irrespective of the presence or absence of disease states [2]. Furthermore, the WHO definition includes the continuum of life's stages; e.g., rapid growth of neuronal connections or neuroplasticity in utero and in early childhood, pruning or shedding of neuronal connectivity in later childhood and adolescence, and neuronal loss or senescence in adulthood. Finally, the WHO statement recommends taking advantage of protective strategies to assure brain health [2].

Opportunities for prevention exist within the determinants of brain health across the life span included in the domains of physical health (e.g., maternal health, nutrition, genetic and epigenetic factors, and others), healthy environments (e.g., safe work places, stable climate, air and water quality), safety and security (e.g., physical and financial), learning and social connections (e.g., education, social networks), and access to quality services (e.g., integrated healthcare, access to medications, carer support). Finally, whereas mental health is considered separate from brain health, the former is considered a closely related entity whereby brain health is an important determinant of mental health.

### 3.2. World federation of neurology

The World Federation of Neurology makes the points that the brain is critical to one's overall health and underlies the ability to communicate, make decisions, problem-solve, and make productive and useful contributions to society [13]. Because of the brain's central role in control of much of daily function, it may be the single most important organ in the human body. The World Federation of Neurology statement goes on to list categories of conditions that may impact brain health (e.g., stroke, neurodegenerative disease, inflammation, brain tissue injuries, malnutrition and vitamin deficiencies, and others), and 5 key conditions that may maintain brain health [13]. The latter circumstances include adequate exercise (both physical and mental), adequate and restful sleep, environmental factors (e.g., a clean environment, and one not prone to brain injuries), a balanced diet and one not rich in processed foods, salt and refined sugars, and access to care and preventive programs throughout life. Finally, the World Federation of Neurology statement lists barriers to brain health. These include but are not limited to poverty and trauma, poor access to healthcare, scarcity of public health resources such as educational programs, lack of access to neurologic specialists, and high costs of treatment. The World Federation of Neurology strongly advocates for the neurologist's vital role in the domains of research, patient care and policy in the global call for optimal brain health [13].

### 3.3. United states centers for disease control and prevention and Alzheimer's association

The United States Centers for Disease Control and Prevention and Alzheimer's Association have jointly developed the 3rd in a series of roadmaps to advance cognitive health as a component of public health for 2018–2023 [14]. This brain initiative outlines how state and local public health agencies and their partners can promote cognitive health, address cognitive impairment in the community, and meet the needs of caretakers. The document includes 25 specific actions across 4 public health domains (education and empowerment, development of policies and mobilization of partnerships, assurance of a competent workforce, and monitoring and evaluation) [14]. The agenda identifies central issues such as risk identification and reduction, diagnosis, education and training, caregiver challenges, and impact of disease states.

Whereas the United States Centers for Disease Control and Prevention and Alzheimer's Association brain health initiative is largely an action agenda for maintenance of cognition, the glossary provides a simple yet practical definition of brain health that includes making the most of the brain's capacity, reducing risk as one ages, and utilizing the ability to draw on the strengths of the brain to, for example, remember, learn, concentrate, interact with others and maintain a clear and active mind [14]. As with other definitions and position statements about brain health, a lifelong approach to brain health is recommended as there are stages of vulnerability throughout life's epochs.

### 3.4. Brain health learn and act group

The Brain Health Learn and Act Group argues for the need for an agreed upon overarching definition of brain health and objective metrics to quantify it [15–17]. Current definitions of brain health focus on absence of disease, and omit other important factors such as mental health, quality of life and overall happiness. The group further argues that a gap has been created between those who deal with mental health and social well-being and those who deal with ailing brains [15]. Without such convergent efforts, it will be difficult to manage and prevent brain disease with a life-course approach in mind. What is lacking is the intersection or convergence of experts for the understanding of brain health.

The authors propose a definition of brain health that encompasses a state of complete physical, mental and social well-being accomplished through a fully balanced, continuous development and use of the brain [15–17]. Consequently, the most promising strategy to protect and promote brain health is a holistic life-course approach beginning before conception and going forward through transgenerational, biological, and social effects. The approach requires global governmental support given the movement of people, capital, goods and services, and knowledge of factors beneficial to brain health (e.g., new treatments, preventative) and those that are deleterious (e.g., environment contaminants, cardiovascular risks) [15]. The approach requires synergy between governmental leads, health-care systems, public health systems, scientific communities, and other non-governmental organizations who may influence brain health, and cooperation of other countries to govern health and the determinants of brain health in their region [15]. Health systems and resources could then be deployed to provide surveillance of risks and services at national levels via community-based surveys and electronic databases; prevention efforts could be deployed through population approaches utilizing mobile technology; acute care established through shared capacitance building; and rehabilitation accomplished via interdisciplinary care and education and training [15].

Promotion of neuroplasticity through physical and cognitive exercises and other measures is advocated [15]. On behalf of the Dementia Prevention Initiative, Hachinski suggests that savings of scale could be accomplished by concurrent prevention of stroke, heart disease and progressive cognitive disorders, as they pose risks for one another [18].

Central to the prevention effort are neurologists who are “keepers” of the brain.

In a follow-up publication to the Brain Health Learn and Act Group piece [15], Hachinski expands on and further operationalizes the definition of cerebral or brain health [19]. To promote a more holistic approach he introduces the term “integral” brain health as an underpinning of relevant facts and takes into account cerebral, mental and social health domains in 3 versions of the definition to appeal to and provide an understandable definition to a lay, scientific and other audiences through a potentially customized version of the definition, respectively [19]. Furthermore, the definition may be updated as needed based on creation of a repository system. Hachinski outlines steps to take to achieve the definition and portions of the definition in need of clarification as science advances. Finally, the importance of working toward a common agenda in this area and the prospects for a global integrated brain health questionnaire are emphasized [19].

### 3.5. Additional definitions of brain health

Several other definitions of brain health have been offered and are reviewed elsewhere [15]. Central to these definitions are the capacity to use one's abilities in an unimpeded manner or preservation of optimal brain structure and function. Over time, it is anticipated that new initiatives will surface to better quantify brain health and identify cognitively impairing disorders. One such study provides brain health risk factors in combined indexes for brain resilience, vulnerability, and brain performance in hopes of the eventual development of a personalized, precision medicine-like intervention [20].

## 4. Discussion

### 4.1. What is brain health?

In the above sections we reviewed select definitions of brain health proposed by various international organizations, work groups and workers. The brain is central to our everyday function, creativity, productivity, and success. Acknowledgement of the importance of the brain has led to a growing movement to establish brain health and its related initiatives across the globe [21–36]. Such initiatives focus on clinical, research, and public health aspects of brain health and are designed to facilitate communication, exchange of ideas and information, identify common goals and synergies, and create action plans around the preservation and maintenance of brain health [21]. A central feature of brain health initiatives is a definition of brain health to answer the question: what is brain health? And, to establish a definition of brain health that is accessible and actionable, not only for the layperson but for the clinician, scientist, and policy maker.

Our review suggests that there are several core features of a definition of brain health:

- (1) Although brain health may be focused on a specific epoch of life, brain health includes and is continuous across all of the life span;
- (2) Preservation of brain structure and function is a primary component;
- (3) Brain health is influenced by environment, genes, and interactions of these factors that may be taken for granted (e.g., food security, social isolation, happiness and mental health, climate, and political upheaval);
- (4) Many of the threats to brain health are modifiable; and
- (5) A broad convergence of the sciences, public health policies, and government priorities is required to prevent brain injury and maintain brain health on a global scale.

### 4.2. A cognitive-centric definition of brain health or not?

As has been shown, the definitions of brain health may be practical or

abstract, broad or narrow, or brain function cognitive-centric or less so. For example, some definitions heavily emphasize the role of cognitive function, whereas others take into account a broader viewpoint and go beyond cognitive and the traditional cognitive domains and acknowledge the importance of preservation of motor, sensory, gait, emotional-motivational aspects, and other brain functions related to cognitive function. Other definitions integrate factors such as mental health, quality of life and overall happiness. Yet, others focus mainly on risks to brain dysfunction. Whereas all of the approaches have inherent advantages and disadvantages, an appropriate definition of brain health may best be fitted to the scientific or public health policy question at hand. Because brain health is multi-faceted and cuts across the continuum of life, there are nuances and complexities that must be taken into consideration when constructing a definition.

For brain health to occur, we emphasize the importance of maintenance of optimal brain structure and function. Functionally, cognition is an important component of brain health and aging, and as such cognition remains a core component of brain health as do other important functions such as social and motor skills [37]. Mechanistically, the underlying forces driving brain health include the extent of brain injury (e.g., through exposure to risks) and inherent functional resilience (i.e., ability to adapt successfully to adverse circumstances despite the presence of brain injury) [37]. It is when allostasis (the biological balance between stress and repair) is tipped in favor of stressors and repair mechanisms are inadequate or fail that we become susceptible to adverse structural and functional consequences to the brain [37].

#### 4.3. Cognitive medicine and brain health

As we take into account a number of different approaches to defining brain health, one considers a refreshing approach to the field—cognitive medicine [6]. Cognitive medicine may be defined as a discipline and research-focused area dealing with the study, identification, prevention, and treatment of cognitive impairment and decline [6]. Research in this field is designed to determine the cellular and molecular mechanisms underlying cognitive function and decline, frequency of cognitively impairing conditions, health-economic evaluations, and interventions to preserve brain function amongst the 6 main cognitive functions (perceptual-motor function, attention, learning and memory, executive function, and social cognition or the ability to understand others' wishes and needs) [6]. Cognitive medicine may serve as an umbrella term that includes aspects of cognition across the life span and different health conditions and diseases, to increase knowledge about how to prevent, diagnose, cope and treat cognitive disorders. Furthermore, cognitive medicine provides an upstream approach whereby we can preserve and maintain brain health. By being upstream, before the ravages of significant cognitive function loss take hold of the brain, one's focus can be on prevention rather than the late stages of brain injury when it may be too late to salvage the brain. Therefore, cognitive medicine provides a complementary pathway to help understand and maintain brain health, a continuous state of attainment and maintenance of optimal neurologic function to best support physical, mental and social well-being through every epoch of life (American Academy of Neurology's recently released 2023 definition of brain health) [38].

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