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Maintenance of brain health: The role of social determinants of health and other non-traditional cardiovascular risks

Paul Olowoyo [a,b], Olaleye Adeniji [c,d], Rufus Akinyemi [d,e], Mayowa Owolabi [d,f,g,h,*]

[a] Department of Medicine, Afe Babalola University, Ado-Ekiti, Nigeria
[b] Federal Teaching Hospital, Ido-Ekiti, Nigeria
[c] Neurology Unit, Department of Internal Medicine, Federal Medical Center, Abeokuta, Ogun State, Nigeria
[d] Department of Medicine, University College Hospital, Ibadan, Nigeria
[e] Neuroscience and Ageing Research Unit, University of Ibadan, Nigeria
[f] Centre for Genomic and Precision Medicine, College of Medicine, University of Ibadan, Nigeria
[g] Lebanese American University of Beirut, Lebanon
[h] Blossom Specialist Medical Center, Ibadan, Nigeria

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ABSTRACT

Brain health is the complete functioning of the brain across the life course to support the full physical, mental, social, and spiritual well-being and quality of life of an individual towards attaining and maintaining the epitome of a meaningful, impactful, purposeful, and productive life. The determinants of brain health are complex and include at least in part, non-traditional risks such as interactions among social, economic, physical, and internal factors (e.g., emotions and adaptations to changing life experiences), and external factors such as environment, geography, and climate change. Thus, social determinants of health (e.g., where we work, live, and play) are those non-medical factors that influence health outcomes, and as non-traditional cardiovascular factors, may influence the development of traditional cardiovascular risks. Examples of the non-traditional cardiovascular factors include environmental stressors (e.g., climate change, air pollution), and psychological and physical abuse. In this article, we provide a discussion of social determinants of health and other non-traditional cardiovascular risks as they relate to brain health.

Introduction

'Brain health is the complete functioning of the brain across the life course to support the full physical, mental, social, and spiritual well-being and quality of life of an individual towards attaining and maintaining the epitome of a meaningful, impactful, purposeful, and productive life' [1]. Optimization of brain health allows us to cope with the demands of everyday life, learn, function adaptively in our environment, and successfully think, solve problems, remember, perceive, and communicate to allow a life of independence and hopefulness [2]. In this article, we provide a discussion of social determinants of health, other non-traditional cardiovascular risks as they relate to brain health, and prospects for prevention in relation to social determinants of health.

Articles published since 2000 were narratively examined. The articles included those with the following themes: "determinants of brain health", "social determinants", "risk factors", "traditional risk factors", "novel risk factors", "cardiovascular diseases", Cardiovascular Risk Prevention", "Primordial prevention", "Primary prevention", and "Secondary prevention".

Social determinants of brain health

Social determinants of health are those non-medical factors such as where we live, work, and play and that influence health outcomes [2]. Brain health may be determined by interactions among social, economic, physical, and internal factors such as emotions and adaptations to changing life experiences, and environment, geography, and climate change [3] As social determinants of health may be further influenced by the income and social status of individuals, they may influence health status at least in part as they relate to working conditions and perceived job security or status. Other related factors such as education, literacy, stress, self-esteem, and self-confidence may shape health status by

* Corresponding author: Prof. Mayowa Owolabi, DSc, Centre for Genomics and Precision Medicine, College of Medicine, University of Ibadan; University College Hospital, and Blossom Specialist Medical Center, Ibadan, Nigeria.
E-mail address: mayowaowolabi@yahoo.com (M. Owolabi).

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driving opportunities for employment and income [3]. Furthermore, access to safe water, clean air, a healthy work environment, safe accommodations, social interactions with families and friends in the community, networks of roads, and health services all contribute to good health [3]. The web of causation is far more complex as individual differences in behavior and coping mechanisms to the stresses and challenges of life are determined by the genomic expression under the influence of environmental interactions [4,5]. An example are genetic differences between men and women which may make them vulnerable to different types of diseases at different ages [6].

Why brain health and social determinants of brain health are important

The importance of brain health cannot be underestimated as a healthy population is necessary to assure successful social and economic growth. Contemporary economies have been referred to as a "brain economy" as most new jobs demand cognitive, emotional, and social skills, and not just manual application [7]. With increased automation, our global economy increasingly places a premium on cerebral, brain-based skills such as self-control, emotional intelligence, creativity, compassion, altruism, systems thinking, collective intelligence, and cognitive flexibility which are characteristic of humans [8]. Investments in brain health and brain skills underlie the economic renewal, reimagination, and economic resilience in times of crisis in an attempt to maintain a healthy ecosystem [9].

In addition, social determinants of health are forerunners to the development of traditional cardiovascular risk factors which in turn are drivers of cognitive and motor dysfunction [12,13]. For example, lack of or low education, lower occupational and income status, as well as social isolation, living alone, and being unemployed or retired may be associated with poorer lifestyle and thus, increased risk for cognitive decline and dementia [10]. Individuals with lower educational attainment may have reduced brain reserve to tolerate pathological changes in brain structure and reduced cognitive reserve which can lead to early clinical manifestations of dementia [11].

Other non-traditional cardiovascular risks for brain health

Novel biological markers

Whereas social determinants of health are factors relating to social circumstances such as where we live, work and play, other non-traditional cardiovascular risks may be defined as including biological, physical, and psychological factors that may influence cardiovascular and brain health though are often not recognized or remain hidden. For example, our environment may contain factors that influence our genetics through epigenetic mechanisms that adversely influence endothelial function [17] When the cerebral blood vessels are affected in this manner, there is an increased risk of brain infarcts and attendant cognitive decline. Endothelial dysfunction may be predicted by elevation in serum levels of markers of hemostatic activation, fibrinogen, factor VIII coagulant activity, C-reactive protein, intercellular adhesion molecule-1, homocysteine levels, N-terminal pro-brain Natriuretic Peptide (NT-proBNP) and high sensitivity cardiac troponin T (hs-cTnT) [12,13]. Detection of these markers is also a manifestation of underlying inflammatory processes resulting from infectious, connective tissue, cancerous, immunological and stress-related disorders. Thus, adverse social and environmental conditions may be responsible for the development of endothelial dysfunction. Such social and environmental risks may be reversed leading to opportunities for better brain health.

Physical factors

Brain health is considered across life's continuum and each of life's epochs may pose unique physical threats. For example, in some cultures, early life brain trauma is observed in association with corporal punishment, which may have implications for the manifestation of psychopathology later in life [14]. This may be observed and go undetected and untreated in women who have experienced brain trauma under circumstances of domestic violence, making them more susceptible to future cognitive, mood and behavioral disorders.

The continuum of traumatic brain injuries includes concussions in the absence of loss of consciousness whereby damage may only be detected by neuroimaging study such as brain computerized tomography (CT) or magnetic resonance imaging (MRI) [15]. The delayed development of symptoms in these cases makes it difficult, sometimes, to link them with previous abuse such as in the case of the development of subdural hematoma in the elderly or persons who suffer from heavy alcohol use. Repeated blows to the head have been linked to a degenerative brain disease called chronic traumatic encephalopathy (CTE) which may manifest as memory loss, confusion, mood changes including depression, and eventually dementia [16]. This form of encephalopathy first made headlines several years ago when it was found in the brains of retired National Football League players in the United States, who committed suicide [17]. Domestic violence survivors might be at risk for this condition. Studies on the relationship between domestic violence with suicide are limited. However, several small studies have suggested that there are more suicide attempts among battered women than among those who have not experienced domestic violence [18].

Mental (psychological) factors

Verbal abuse during the stages of brain development can be just as harmful as other forms of mistreatment such as brain trauma [19]. There can be lasting effects on the structure of the brain and clinical manifestations such as anxiety, depression, hostility, learning deficits, other behavioral issues, and drug abuse [19]. Verbal abuse-induced stress during childhood can be observed in association with hippocampal atrophy and dysregulation of emotional events [20]. Therefore, the social environment in which a child lives may determine, at least in part, their brain development, behavioral tendencies, and ability to adapt to the environment. The effect of verbal abuse may inflict emotional pain, and when it becomes repetitive, the child may develop maladaptive coping mechanisms giving rise to an inferiority complex.

Adults can also experience the devastating consequences of psychological and narcissistic abuse. Repeated emotional trauma in an environment in which the victim believes there is no possibility of escape, may lead to complex post-traumatic stress disorder [21]. This may be associated with hippocampal atrophy(memory and learning impairment), and an enlarged amygdala associated with primitive emotions such as fear, grief, guilt, envy, and shame [22]. The longer the exposure to emotionally abusive language, the greater the deterioration in the hippocampus and enhanced feelings of confusion, cognitive dysfunction, and amnesia.

Social determinants of health and preventive strategies for the maintenance of brain health: from primordial to secondary prevention

We now discuss prospects for prevention in relation to social determinants of brain health. According to the Leavell and Clark prevention framework, disease prevention interventions range from primary prevention to secondary prevention to tertiary prevention levels [23]. We will focus on primary and secondary prevention. Primary prevention captures the sum of all activities and strategies to reduce the occurrence of a disease within a population at risk of the disease before the disease occurs. Secondary prevention refers to those activities and interventions that ensure prompt treatment of the disease once it has occurred to prevent recurrence and mitigate complications. This includes acute care of neurological disorders and their comorbidities.

Further refinements have been made to the original Leavell and Clark

prevention framework notably the addition of primordial prevention [24]. The term refers to the sum of all activities and interventions to reduce the occurrence or onset of risk for a particular disease within a population including population-approaches to risk factor avoidance. With this background in mind, maintaining optimal brain health throughout the life course in relation to social determinants of health will require a holistic approach at a number of societal levels.

The linkage between social determinants of health and major neurological diseases affecting the brain

In 2016, the top five global neurological causes of Disability Adjusted Life-Years (DALYs) lost were stroke (42.2%), headaches (migraine, 16.3%), dementias (10.4%), meningitis (7.9%) and epilepsy (4.9%) [25]. The World Health Organization (WHO) Non-Communicable Diseases (NCDs) Countdown 2030 report concluded that the risk of dying from these neurological disorders from birth to 80 years of age increased in more than half of all countries from 2000 to 2016, making them the fastest-growing cause of death among NCDs [26]. Many of these disorders share common risk factors; for example, increasing age and certain cardiovascular factors are risks for dementia and stroke, and these risks often interact in complex, stochastic ways to undermine optimal brain health. As an example, neuro-infectious diseases may be complicated by epilepsy and cognitive impairment.

According to Diderichsen, social determinants of health may exert quasi-deterministic effects on lifetime disease-specific risks and health-related outcomes [27]. As an example, low socioeconomic status (SES) increases the risk of stroke [28], dementia [29], epilepsy [30], and neuro-infectious diseases [31]. Parental low SES is also associated with lower levels of educational attainment [32] and lower cognitive scores in adulthood [33]. Lower levels of educational attainment may undermine access to economic opportunities and have subsequent downstream effects on lifestyle, behavioral, and dietary choices which may increase disease risks.

Furthermore, the structural determinants of health such as political governance, and economic and social and economic policies may act on the intermediate determinants of health such as the living conditions, dietary choices, opportunities for physical activity, and available social support to increase disease risk and determine both physical and financial access to health services [34]. In other words, social determinants of health create the 'milieu' in which populations 'interact' with disease risks and seek treatments for already established illnesses.

Table 1 shows examples of strategies and interventions for the prevention of the major neurological disorders of public health importance, and Fig. 1 shows the interplay between the traditional risk factors, non-traditional risk factors and the other social determinants of health, genetics, and brain health.

Table 1
Examples of primordial, primary, and secondary prevention strategies for the five neurological leading causes of death according to the NCD 2030 Countdown.

Prevention Strategies	Primordial	Primary	Secondary
Stroke	• Dietary control of salt and sugar intake. • Reduce smoking and alcohol use. • Reduce trans-fats. • Increase physical activity. • Taxes on alcohol and tobacco products. • Maintain a healthy weight.	• Optimal blood pressure treatment. • Optimal diabetes treatment. • Optimal dyslipidemia treatment. • Stop alcohol and tobacco use.	• Thrombolysis and mechanical thrombectomy in acute ischemic large vessel stroke. • Antiplatelets and statins for acute ischemic stroke. • Optimization of blood pressure and blood glucose. • Care of stroke in multidisciplinary stroke units. • Decompressive craniectomy for cerebral edema in stroke. • Swallow assessments. • Prevent infections and aspirations. • Begin neuro-rehabilitation. • Offer caregiver support and education
Dementia	• Increase physical activity. • Improve education opportunities across the life course. • Socially engaging workplaces. • Healthy diet. • Increase physical activity. • Primordial prevention for stroke (above). • Maintain a healthy weight.	• Optimize the control of vascular risk factors such as hypertension, and diabetes.	• Neuropsychological assessments. • Cognitive stimulation therapy. • Treat with Donepezil, memantine or galantamine. • Manage Behavioral and psychiatric symptoms. • Caregiver education and support.
Epilepsy	• Reduce the occurrence of road traffic accident-related head injuries: use seatbelts and helmets. • Prevent hypoglycemia. • Safe and effective maternal and child health services to prevent cerebral palsy. • Reduce drug abuse. • Improve socioeconomic conditions of the population. • Treat stroke risk factors. • Hand washing clean water availability and sanitary food preparation to reduce infection with Taeniasis.	• All actions and strategies in primordial prevention for epilepsy	• Safe and effective epilepsy treatment clinics. • Treat co-morbidities such as depression. • Avoid stigma. • Antiepileptic drugs availability and accessibility.
Neuro-infections	• Improve socioeconomic status. • Good housing and clean drinking water. • Avoid overcrowding. • Immunization for meningitis. • Safe and effective HIV services and clinics.	• All actions and strategies in primordial prevention	• Prompt diagnosis and treatment of neuro-infections. • Use IV dexamethasone before antibiotics in meningitis. • Treat complications such as hypoglycemia, seizures, cognitive impairment, and hearing loss.
Headaches and Migraines	• Adequate housing. • Improve socioeconomic status	• All primordial prevention strategies for headaches.	• Prompt diagnosis and treatments. • Migraine medications such as sumatriptan, non-steroidal anti-inflammatory drugs. • Manage comorbidities-depression.

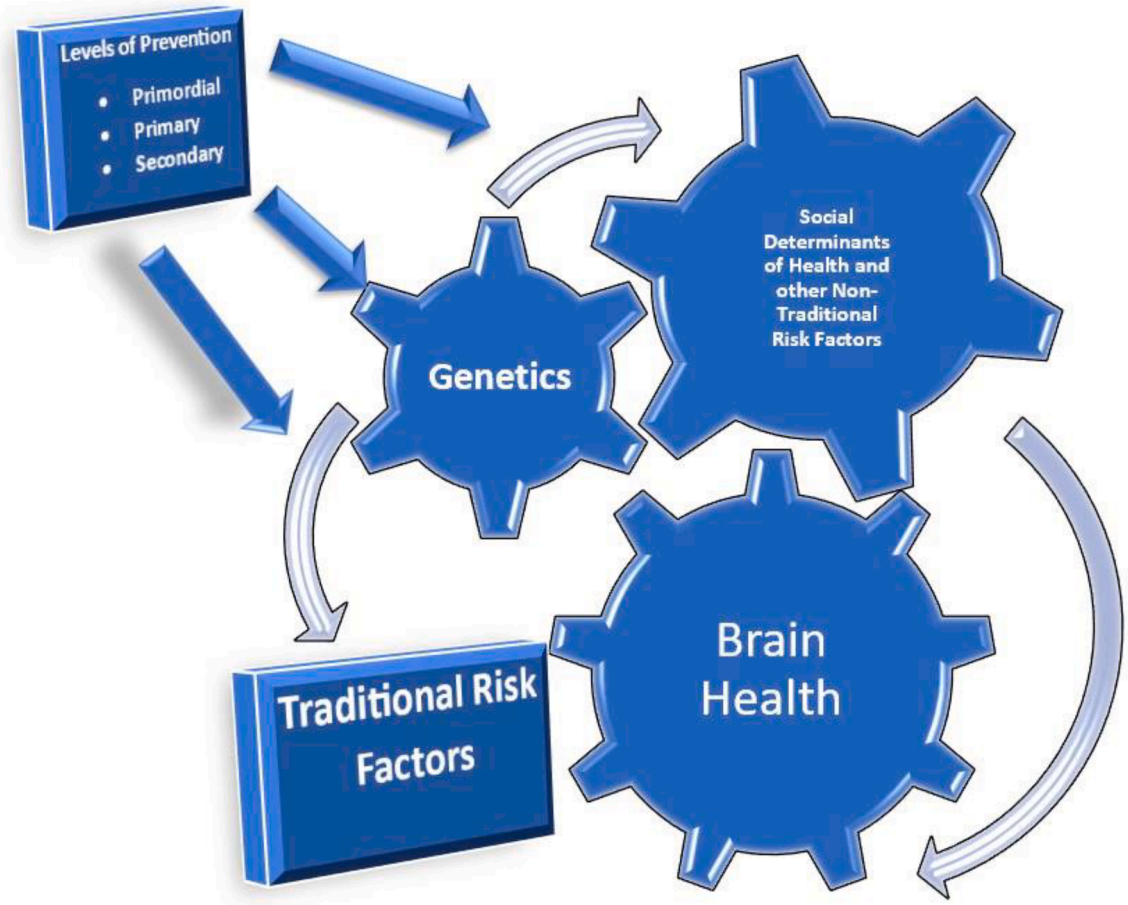

Fig. 1. The interplay between social determinants of health, traditional and non-traditional risk factors, genetics, and brain health.

Are the barriers to social determinants of health surmountable?

Primordial and primary prevention strategies represent the interventions with the greatest potential for population prevention of neurological disease risk. These interventions may require significant financial investment to improve economic and social circumstances in a population, and thus, may be a "stretch" goal. For example, in some regions of the world it will require collaboration with governmental authorities and policy makers from non-health sectors of the society such as housing, security, road safety, and agriculture, and such efforts may be perceived as being too costly to apply or too difficult to achieve based on a lack of political will or a need to balance competing non-health interests such as those related to traditional, cultural, religious or economic needs and beliefs. Furthermore, although government obligations to help provide adequate services such as housing, food security, clean water, safe roads, and emergency medical services to its constituents are considered to be fundamental services by some, such may not be the case in many countries [35].

Social determinants of health also influence the nature and organization of acute care and rehabilitation services in many societies. In many low to middle income countries (LMICs), for example, health services compete with other hierarchical needs which undermine the timely and safe delivery of acute care for diseases such as strokes [36]. In many of these health systems, low levels of general health financing, poor working conditions, and low wages for health workers force many highly skilled health workers to emigrate to other countries where there are better wages and conditions, further reinforcing the barrier to effective delivery of health services.

To overcome the barriers to provision of services to improve population level social determinants of health, a multifaceted, multi-stakeholder action is required. For example, in 2021 the WHO commissioned the World Report on the Social Determinants of Health for Advancing Health Equity (SDHE) [37] and the WHO Multi-Country Special Initiative for Action on the Social Determinants of Health for Advancing Health Equity (SDHE) [38]. These actions were designed to improve social determinants of health for at least 20 million disadvantaged people in at least 12 countries by 2028. These initiatives build on previous works by the WHO Commission on the social determinants of health 2008 [39] and the WHO 2010 conceptual framework for action on social determinants of health [37] and are designed to demonstrate the potential effectiveness of strategies, policies, models, and practices for improving social determinants of health by ensuring the integration of health equity into the development of social and economic policies. This and other initiatives such as the WHO Global Plan on Epilepsy and Other Neurological disorders (IGAP) 2022–2031 initiative [40] have placed the need to improve social determinants of health at the forefront of global policy discourse.

Conclusions

Social determinants of health and other non-traditional cardiovascular risks play an important role in brain health across life's continuum. Whereas traditional cardiovascular risks are generally well known to practitioners, health professionals must become familiar with these less well known and acknowledged factors and consider serving as advocates for health policy to improve these and related factors in the population at-large. As these non-traditional cardiovascular risk factors are now being integrated into prevention guidelines, those that are potentially

modifiable (e.g., air pollution, psychological and physical abuse) can be more frequently addressed within the framework of prevention strategies to achieve better patient and population outcomes, as has occurred for traditional risk factors. The burgeoning field of brain health initiatives and programs is well-positioned to include social determinants of health and the related factors as part of their platform for maintenance of brain health.

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Paul Olowoyo: Writing – review & editing, Writing – original draft, Conceptualization. **Olaleye Adeniji:** Writing – original draft, Conceptualization. **Rufus Akinyemi:** Supervision. **Mayowa Owolabi:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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