GLOSSARY OF TERMS

There are several terms that are used in this article from the field of ageing, and the following definitions may be helpful.

Brain health is an approach that encompasses the multiple steps that individuals can take to strengthen their brain and to help protect it from the damage of ageing or disease (adapted from www.hellobrain.eu).

Cognition involves the processes of knowing, including attending, remembering, and reasoning, and also includes the content of those processes, such as concepts and memories (American Psychological Association).

Cognitive development is the development of processes of knowing, including imagining, perceiving, reasoning, and problem solving (American Psychological Association).

Cognitive reserve is the ability to maintain better brain function as you age, even if you develop the physical damage to your brain associated with dementia (adapted from www.hellobrain.eu).

Dementia is a term which describes a number of conditions that cause damage to brain cells. Alzheimer's disease is the most common cause of dementia, followed by Vascular dementia (Adapted from the Irish Alzheimer's Society).

Healthy ageing is the process of optimising opportunities for physical, social and mental health to enable older people to take an active part in society without discrimination and to enjoy and independent and good quality of life (Healthy Ageing Partnership, 2007).

Positive ageing is an approach to ageing that is underpinned by the premise that the years of older age are both viewed and experienced positively. This premise is established not just on the experience of older people, but also on the attitudes, expectations and actions towards ageing and older people, of younger generations (adapted from the New Zealand Positive Ageing Strategy, 2007).

PROMOTING BRAIN HEALTH

Dementia is not a single disease, but rather it describes a range of symptoms caused by diseases of the brain. These symptoms affect multiple brain functions including memory, behaviour and our ability to complete everyday tasks. Dementia is a progressive condition that largely affects older people and the course of the illness may be gradual, and sometimes subtle (Cahill et al). The impact of dementia goes beyond the medical realm, to have human, social and economic implications. In 2011 The Irish Longitudinal Study on Ageing (TILDA) found that 37% of the over 50s in Ireland show evidence of mild cognitive impairment (2), which is considered to be a transitional phase between normal ageing and the development of dementia. For this reason, cognitive impairment is a key indicator of 'Brain Health' within the National Positive Ageing Indicator Framework in 2016 (3).

According to the Health Service Executive (HSE) in 2016, there were 55,000 people in Ireland living with dementia. Furthermore, while the majority of adults in Ireland understand that dementia is a disease of the brain, fewer were aware of modifiable risk factors associated with dementia.

Both the National Dementia Strategy (2014) and the National Positive Health Strategy (2013) in Ireland highlight the importance of promoting public awareness and better understanding surrounding brain health and dementia. While not all forms of dementia are preventable, there are many things that people can do to reduce their risk of developing dementia. In 2016 the HSE launched the **Dementia Understand Together** campaign, to increase awareness of dementia to promote brain health among the Irish population, at all stages of the life course.

A major body of research has been concerned with a variety of factors that can promote brain health. Before looking at specific factors it is worth looking at the contrasting approaches in the studies and interventions that have been especially influential in recent times. Some have focused on **concurrent influences**, that is, intervening with older age-groups to improve brain health while others have taken a **developmental approach** and sought to identify experiences in earlier life that impact on later functioning. It is also noteworthy that some interventions seek to **directly impact** on brain functioning (e.g. exercise) while others are concerned with **less direct effects** like examining the impact of alcohol or cigarette smoking. Another distinction might be made between changes aimed directly at the **target group** including their attitudes and beliefs regarding ageing and interventions that have a social dimension and seek to change the **cultural context** of older people. Finally, some 'packages' include a number of approaches that combined, seek to address multiple risk factors for brain health including dementia.

Lifestyle

There is a major body of evidence from longitudinal studies on the health benefits of exercise, including lower risk of mortality and lower rates of cardiovascular disease. From the present perspective the beneficial effects on brain health are especially striking given that the demonstration of positive effects from middle age onwards (4).

The review by Colcombe & Kramer (5) consisted of a meta- analysis of 18 studies relating to benefit of exercise including both aerobic exercise and fitness training. There were positive effects on cognitive functions in older adults and these were most pronounced in relation to higher order processes. Also relevant are a complementary set of studies that have shown that exercise had beneficial effects on symptoms of depression among older people. The review by Depp et al., (4) of randomised control trials showed positive effects of different types of exercise including strength training, aerobics and resistance exercise. These positive outcomes are especially important given the demonstration that depression and cognitive impairment are linked; it is likely that the cultivation of a sense of efficacy around the causes of depression is likely to enhance cognitive performance.

An important finding is that active leisure pursuits can protect cognition among people in middle age. The study by Richards et al., (6) found that frequent involvement in physical exercise was positively associated with memory performance at age 43, even when controlling for relevant demographic and other variables including sex, education and socio-economic position, as well as IQ. However there are many different ways that physical activity can be measured and not all measures show the same level of association with cognition. Nevertheless, Wang et al. (7) examined the effects of exercise among a much older group. The participants' average age was 83 years activity was measured by counting the number of blocks walked each week. The result showed that even controlling education, cognition and depression, hypertension and smoking, lower level of mild cognitive impairment were associated with walking more frequently.

Interventions to sustain physical activity among older people have been difficult to implement for many reasons. Low levels of physical activity in early adulthood can track into later life and life-course factors such as low socio-economic position, difficulty understanding and evaluating health promotion messages and cost associated with e.g. gym and sports club membership all play a role (8). Fear of embarking on such activities in case of pain or falls or lack of support through companionship is also important. For this reason, planning such programmes requires care with regard to how implementation will be successful. However, the benefits for brain health as well as other positive outcomes are well established.

In public health, the benefits of exercise are often discussed in close relation to the role of healthy diet, however clarifying the role of nutrition in determining the risk of dementia is complex (9). The extent to which different types of diets and foods are associated with reduced dementia risk is not uniform, for example, current evidence does not support the theory that antioxidants have a protective role while there is a weak positive association between eating a Mediterranean diet and fish. Increasingly more predictive models for dementia risk include lifestyle elements such diet (e.g. fish intake, or folic acid) smoking, and alcohol intake, however there is no one model that is currently recommended for predicting dementia risk among populations, and it is unlikely that one model will fit all in terms of what factors are measured and how risk is calculated (10).

Challenging Intellectual Activities

A major body of research has been concerned with the extent to which cognitive stimulation and training can enhance brain health. While it is well established that there is a strong association between level of cognitive functioning and participation in intellectually challenging activities, the interpretation of such findings is difficult since it may be that older people with a high level of intellectual functioning are more likely to take up or remain involved in challenging activities rather than vice-versa. For this reason, experimental studies are crucial to unravel the outcomes.

A major experimental study cognitive stimulation (ACTIVE study) in the US with nearly 3,000 older participants involved random assignment to one of four groups; memory training, reasoning, speed of processing and control (11). The pattern of outcomes is especially interesting: at a two-year follow-up, the cognitive interventions had improved participants' in the areas in which they been trained but the beneficial effects did not extend to everyday cognitive challenges. However a follow-up study five years later than found that the cognitive training group had less problems in dealing with the challenges of daily living (12) thus showing the potentially general effects of such training.

A range of novel approach to cognitive stimulation includes computerised approaches as well interventions involving the arts. A study by Noice et al., (13) examined the effects of acting in a theatre setting in a sample of older adults. They based their rationale this context on the grounds that acting demands engagement of cognitive, emotional and physical domains and capacities. The results showed that compared to a control group the acting group showed a substantial improvement in various aspects of cognitive abilities as well as on measures of well-being – benefits that were sustained over time. The same authors tried a similar intervention with an older, less educated group who lived in retirement homes and similarly showed beneficial effects on cognitive capacity.

These findings have been welcomed by scholars who take the view that normal ageing influences cognitive functioning but within a wide zone, and that individuals themselves have a major impact on where they are within this zone through their involvement in various challenging activities (4). On the other hand other researchers have challenged this interpretation. For example, Salthouse (14) has argued that the results do not generally show benefits across the board that would justify the belief that brain changes are involved; rather the improvement are often confined to the kind of task which were central to the training. Given that several commercial products and games are now available, it is likely that this area will be researched even more thoroughly in the next decade.

Social Activities and Involvement

The substantial evidence that social activities helps to prevent brain deterioration is based on two lines of evidence. Firstly, the association between lifestyle featuring social activities and the prevention of cognitive decline emerges in studies. Secondly, experimental work in which older people participate in an active social

role show benefits compared to control conditions that do not feature such participation.

The study by James et al. (15) is illustrative of the first strand of research and is especially valuable since estimates of precise improvement are provided. The sample consisted of 1138 persons without dementia with a mean age of 79.6 years who were followed for up to 12 years. The results showed that even after controls for sex, education, race, depression, and chronic conditions, more social activity was associated with less cognitive decline. The rate of cognitive decline was reduced by an average of 70% in older people who were frequently socially active compared to persons who were infrequently socially involved. Two other features of the results are of interest. Firstly, there was evidence of an impact on all features of cognition and secondly the beneficial outcomes were found for all groups in the study including those scoring high or low initially.

The research by Cherry et al. (16) was concerned with the impact of social behaviours in a study that included an older age-group (90-97 years) as well as younger group (21-59) and people aged 60-89 years. The research looked at a range of health outcomes including behaviours known to enhance brain health. The results indicated a relationship between social engagement and positive health behaviours. For example, the number of clubs visited and hours spent outside the home were significantly associated with a variety of self-reported health indicators even into very late adulthood.

A related matter concerns the role of relationships in older people's lives as they age. A review by Soulsby & Bennett (17) examined evidence on changing features and the implications for brain health. They note that there is an age-related reduction in the older people social network, especially in the case of older men. This is particularly unfortunate since the research suggests that a larger social network tends to be associated with enhanced health. The evidence shows that the experience of widowhood can be especially challenging for both men and women; the bereaved persons suffer a major loss of support and as a result report lower levels of health (psychological and physical) across a range of variables. For this reason a supportive network and involvement in social activities is especially important for people who have experience bereavement and the indications are that recovery is hastened among those who build such a network.

Experimental studies featuring older people involved in challenging social/intellectual activities have shown very positive results. The study by Studenski et al. (18) involved older adults who helped at-risk students with challenging aspects of school subjects (especially maths and reading). The outcomes showed positive effects on cognitive performance of the participating older adults and in addition, they spent less time watching television and more time involved in cognitively demanding activities. The implication of this kind of intervention is that it benefited the brain health of the older people who helped as well making a major contribution to the school success of disadvantaged students.

Benefits of Volunteering

A substantial research literature has built up around the positive effects of volunteering among older people, partly on the grounds that volunteering involves social and cognitive engagement, similar to other activities that have been shown to be beneficial for brain health. There is also a recognition that such volunteer contributions can make a major economic difference and one estimate from 2011 is that world-wide volunteering contributes $400 billion to the global economy (19).

The personal benefits of volunteering to older people are substantial. A meta-analysis of 73 studies by Anderson et al. (20) showed that volunteering was associated with a range of beneficial outcomes including fewer limitations in what they could do, reduced symptoms of depression, better self-reported health, and lower mortality. They concluded that volunteering increases cognitive, social and physical activity - which can vary depending on the nature of the involvement that is central. Three other features emerge from the review. Firstly, there are indications multiple volunteer roles are more beneficial, specifically older people who have a variety of challenges benefit to a greater extent than those in more limited involvement. Secondly, older volunteers who are in management positions benefit to a relatively greater extent than others possibly because of the greater variety and the extent of challenges. Thirdly, the authors suggest that their results provide optimism for the hypothesis that volunteering will also be associated with reduced dementia risk. However, they admit that the evidence on this point is meagre.

One interesting point that emerges from the study of the involvement of volunteers and also from other lines of research is that the benefits in one domain are frequently associated with well-being in an apparently unrelated domain. Thus cognitive strengths are found to be accompanied by an enhancement of social and emotional measures including lower levels of anxiety and depression. This pattern is not exclusively associated with interventions targeting older adults but is also found in childhood as evidenced from the finding of the national longitudinal study 'Growing up in Ireland'. A major question arises for aging research concerning which feature is dominant and most likely to benefit other domains. It may be that brain health has a holistic dimension resulting in the interactions emerging. To date, the precise biological or psychological mediating factors have not been isolated with any certainty.

DISCUSSION

A number of important implications follow from this overview of factors that can enhance brain health. What is perhaps most striking is the evidence of the success of interventions and while relatively few studies have sought to quantify the impact, the consistency of the findings together with evidence of effects in several domains testifies to the potential of the various approaches to enhance positive aging. Another striking feature is the evidence that improvement in one area has benefits for others as in the case of the **interaction** of cognitive and social-emotional outcomes.

It is also worth mentioning another relevant area of research; **cognitive reserve**, within a life course approach to healthy and positive ageing. Given the evidence that earlier developmental factors in childhood and early adulthood impact on brain health in later life, the concept of **cognitive reserve** helps to explain why people who have a higher level of education, or similar positive experiences show less deterioration of skills that are reliant on brain function as they get older (21). The basic ideas guiding explanations of cognitive reserve is that positive experiences including education provide a shield against brain pathology. It seems that cognitive reserve facilitates more flexible use of learning strategies and the ability to compensate for features of brain damage by involving additional brain regions. There are also indications that cognitive reserve can be enhanced even in old age and thus lesson the likelihood of cognitive impairment as well as dementia (22).

It should also be considered that there have been major advances in understanding **the risk factors of dementia** in recent times. The review of risk factors by Cleary & McAvoy (9) identifies several factors that can reduce the risk and delay the onset of dementia; furthermore many of these factors are susceptible to being modified. As well as those influences that are examined above, they note the findings that cigarette smoking as well as heavy alcohol consumption is associated with both dementia and cognitive deterioration. Furthermore a number of medical conditions are found to be significant predictors of these conditions including cardiovascular risk factor as well as obesity and hypertension. As might be expected on the basis of the evidence reviewed here, depression and sleep disturbance are significant risk factors. The review also notes that dietary patterns and especially a Mediterranean diet have been found to be beneficial.

The findings regarding multiple risk factors raise an important issue not only with regard to dementia but more generally with regard to brain health. This concerns the need for multi-domain interventions since any one influence is by its nature limited in what benefits will accrue. An example of a **multi-domain intervention** is the FINGER study in Finland which examined the joint effects of diet, exercise, cognitive training as well as vascular risk monitoring in a controlled trial over two years with individuals aged 60-77 years (23). On the basis of a neuropsychological test battery, the evaluation indicated a major difference favouring the experimental group over controls. The authors concluded that a multi-domain intervention could improve cognitive functioning of elderly people. Based on the current international evidence suggesting that a significant proportion of cases of age-related cognitive decline and dementia may be preventable through the modification of risk factors including education, depressive symptomology, physical activity, social engagement and participation in cognitively stimulating activities, in Ireland the NEIL Memory Research Unit cohort study was established to investigate factors related to brain health and the maintenance of cognitive function (24). Results from this study may have the potential to inform the development of public health interventions aimed at preventing cognitive decline and promoting active and healthy ageing.

FINAL REMARKS

A critically important question concerns the number affected by deteriorating brain health and the related matter of projections regarding the likely number in the future. Estimates of current prevalence rates vary considerably depending on the indicator of brain health as well as the population targeted and the year of the study. Thus, the Positive Ageing Indicators report provides a percentage for mild cognitive impairment while the study of risk (9) seeks to estimate the number of people with dementia as well the percentage that could be prevented. Also relevant are the statistics in Positive Ageing Indicators report on positive mental health including prevalence of depression and anxiety. The important point emerging is that no single percentage can be regarded as definitive given the different measures that can reasonably be justified as indicative of brain deterioration.

The predictions regarding future rates raise an important issue. These are partly dependent on population aging, assumptions surrounding fertility and migration which affect population growth, as well as on the extent to which new approaches address risk factors. Also relevant is the finding that cognitive capacity among older people has been shown to have improved very significantly over the last decades (25). However, while precise numbers are not justified, the research provides valuable guidelines for policy. In planning the promotion of brain health in the future the following considerations are especially important in **guiding strategies:**

- There is a need for higher level of **awareness of the specific factors** that promote brain health including physical activity, meditation and intellectual challenges;
- In planning for Age-Friendly communities, particular attention should be given to opportunities for **meaningful social contact** and supports that address the problem of loneliness;
- There is a need for policies that take into account the **multiple determinants** of brain health. A major feature should be multi-domain interventions that are guided by the multiple risk factors as in the case of dementia;
- Schools and higher education institutions can make a significant contribution to providing facilities to enable life-learning to facilitate brain health;
- There is a need to evaluate the implementation and outcomes of programmes promoting brain health. This is especially the case for interventions targeting dementia;
- Pre-retirement courses should focus on maintenance of brain health as well as on other concerns of participants;
- Strategies regarding brain health should take into account societal beliefs regarding aging with particular regard to age-stereotyping; and
- Interventions to enhance brain health are more likely to be successful when there is a widely shared belief in the efficacy of approaches that will enhance the lives of older people, family members, and carers.

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