Health and Intelligence

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Health and intelligence research investigates the impact of health on intelligence and vice versa. This is one of the most important factors in understanding the origins of human group differences in IQ test scores and other measures of cognitive ability, and, conversely, differences in disease, mortality, and morbidity. Several factors can lead to significant cognitive impairment, particularly if they occur during pregnancy and childhood when the brain is growing and the blood-brain barrier is less effective. Such impairment may sometimes be permanent, sometimes be partially or wholly compensated for by later growth.

Developed nations have implemented several health policies regarding nutrients and toxins known to influence cognitive function. These include laws requiring fortification of certain food products and laws establishing safe levels of pollutants (e.g. lead, mercury, and organochlorides). Comprehensive policy recommendations targeting reduction of cognitive impairment in children have been proposed. Improvements in nutrition, and in public policy in general, have been implicated in worldwide IQ increases (the Flynn effect).

Nutrition

Malnutrition may occur during several different periods of growth, such as pregnancy, during breastfeeding, infancy, or childhood. It may also happen due to deficiencies of different nutrients, such as micronutrients, protein or energy. This may cause different effects.

Timing

Some observers have argued that malnutrition during the first six months of life harms cognitive development much more than malnutrition later in life. However, a study from the Philippines argues that malnutrition in the second year of life may have a larger negative impact than malnutrition in the first year of life.

Intrauterine growth retardation

Undernutrition during pregnancy, and other factors, may cause intrauterine growth retardation (IUGR), which is one cause of low birth weight. However, it has been suggested that in IUGR the brain may be selectively spared. Brain growth is usually less affected than whole body weight or length. Several studies from developed nations have found that with the exception of extreme intrauterine growth retardation also affecting brain growth, and hypoxic injury, IUGR seems to have little or no measurable effect on mental performance and behavior in adolescence or adulthood. For example, acute undernutrition for a few months during the Dutch famine of 1944 caused a decrease in mean birthweight in certain areas. This was later associated with a change in performance on IQ tests for 18-19 years old Dutch males draftees from these areas compared to

control areas. The subjects were exposed to famine prenatally but not after birth. During the famine, births decreased more among those with lower Socioeconomic status (SES), whereas after the famine, there was a compensatory increase in births among those with lower SES. Since SES correlates with IQ, this may have hidden an effect caused by the undernutrition.

Breastfeeding

Studies often find higher IQ in children and adults who were breastfed. It has also been proposed that the omega3 fatty acids that are found in high doses in breast milk, and that are known to be essential constituents of brain tissues, could at least partially account for an increase in IQ.

Recently, however, the longstanding belief that breastfeeding causes an increase in the IQ of offspring was challenged in a 2006 paper published in the British Medical Journal. The results indicated that mother's IQ, not breastfeeding, explained the differences in the IQ scores of offspring. The results of this study argued that prior studies had not allowed for the mother's IQ. Since mother's IQ was predictive of whether a child was breastfed, the study concluded that "breast feeding has little or no effect on intelligence in children." Instead, it was the mother's IQ that had a significant correlation with the IQ of her offspring, whether the offspring was breastfed or was not breastfed. The study has been subject to various criticisms. Another study found a positive effect of breastfeeding also after controlling for parental IQ.

A potential resolution to these different interpretations was proposed in a study showing that breastfeeding was linked to raised IQ (as much as 7 points when not controlling for maternal IQ) if the infants had a SNP coding for a C" rather than G base within the FADS2 gene. Those with the "G" version showed no IQ advantage, suggesting a biochemical interaction of child's genes on the effect of breast feeding. Other studies have failed to replicate any correlation between the FADS2 gene, breastfeeding and IQ, while others show a negative effect on IQ when combining bottledfeeding, and the "G" version of FADS2 .

Infancy

Two studies in Chile on 18 years old high-school graduates found that nutritional status during the first year of life affected IQ, scholastic achievement, and brain volume.

Micronutrients and vitamin deficiencies

Micronutrient deficiencies (e.g. in iodine and iron) influence the development of intelligence and remain a problem in the developing world. For example, iodine deficiency causes a fall, in average, of 12 IQ points.

Policy recommendations to increase availability of micronutrient supplements have been made and justified in part by the potential to counteract intelligence-related developmental problems. For example, the Copenhagen consensus, states that lack of both iodine and iron has been implicated in impaired brain development, and this can affect enormous numbers of people: it is estimated that 2 billion people (one-third of the total global population) are affected by iodine deficiency, including 285 million 6- to 12-year-old children. In developing countries, it is estimated that 40% of children aged four and under suffer from anaemia because of insufficient iron in their diets.

A joint statement on vitamin and mineral deficiencies says that the severity of such deficiencies "means the impairment of hundreds of millions of growing minds and the lowering of national IQs."

Overall, studies investigating whether cognitive function in already iron-deficient children can be improved with iron supplements have produced mixed results, possibly because deficiency in critical growth periods may cause irreversible damage. However, several studies with better design have shown substantial benefits. In order to prevent iron deficiency an option is giving specific supplementation, for example as tablets. However, this is costly, distribution mechanisms are often ineffective, and compliance is low. Fortification of staple foods (cereals, flour, sugar, salt) to deliver micronutrients to children on a large scale is probably the most sustainable and affordable option, even though commitment from governments and the food industry is needed. Developed nations fortify several foods with various micronutrients.

Additional vitamin-mineral supplementation may have an effect also in the developed world. A study giving such supplementation to "working class," primarily Hispanic, 6-12 years old children in the United States for 3 months found an average increase 2 to 3 IQ points. Most of this can be explained by the very large increase of a subgroup of the children, presumably because these were not adequately nourished unlike the majority. The study suggests that parents of schoolchildren whose academic performance is substandard would be well advised to seek a nutritionally oriented physician for assessment of their children's nutritional status as a possible etiology.

More speculatively, other nutrients may prove important in the future. Fish oil supplement to pregnant and lactating mothers has been linked to increased cognitive ability in one study. Vitamin B12 and folate may be important for cognitive function in old age.

Another study found that pregnant women who consumed 340 grams of low-mercury containing fish with fatty acids per week have benefits that outweigh the risks for mercury poisoning. They were less likely to have children with low verbal IQ, motor coordination and behavioral problems. However, foods containing high amounts of mercury, such as shark, swordfish, king mackerel and tilefish, might cause mental retardation.

Protein and energy malnutrition

One study from a developing country, Guatemala, found that poor growth during infancy, rather than low birth weight, was negatively related to adolescent performance on cognitive and achievement tests. A later related very long term study looked at the effect of giving 6-24 months old children in Guatemala a high protein-energy drink as a dietary supplement. A significantly positive and fairly substantial effects was found on increasing the probability of attending school and of passing the first grade, increasing the grade attained by age 13, increasing completed schooling attainment, and for adults aged 25-40 increasing IQ test scores.

Stunting

31% of children under the age of 5 in the developing world are moderately (height-for-age is below minus 2 standard deviations) or severely stunted (below minus 3 standard deviations). The prevalence was even higher previously since the worldwide prevalence of stunting is declining by about half of a percentage point each year. A study on stunted children aged 9-24 months in Jamaica found that when aged 17-18 years they had significantly poorer scores than a non-stunted group on cognitive and educational tests and psychosocial functioning. Giving a nutritional supplementation (1 kg milk based formula each week) to these already stunted children had no significant effect on later scores, but psychosocial stimulation (weekly play sessions with mother and child) had a positive effect.

Toxins

Industrial chemicals

Certain toxins, such as lead, mercury, arsenic, toluene, and PCB are well-known causes of neuro-developmental disorders. Recognition of these risks has led to evidence-based programmes of prevention, such as elimination of lead additives in petrol. Although these prevention campaigns are highly successful, most were initiated only after substantial delays.

Policies to manage lead differ between nations, particularly between the developed and developing world. Use of leaded gasoline has been reduced or eliminated in most developed nations, and lead levels in US children have been substantially reduced by policies relating to lead reduction. Even slightly elevated lead levels around the age of 24 months are associated with intellectual and academic performance deficits at age 10 years.

Certain, at least previously, widely used organochlorides, such as dioxins, DDT, and PCB, have been associated with cognitive deficits.

A Lancet review identified 201 chemicals with the ability to cause clinical neurotoxic effects in

human adults, as described in the peer-reviewed scientific literature. Most of them are commonly used. Many additional chemicals have been shown to be neurotoxic in laboratory models. The article notes that children are more vulnerable and argues that new, precautionary approaches that recognise the unique vulnerability of the developing brain are needed for testing and control of chemicals in order to avoid the previous substantial before starting restrictions on usage. An appendix listed further industrial chemicals considered to be neurotoxic.

Recreational drugs

Current cannabis use was found to be significantly correlated in a dose-dependent manner with a decline in IQ scores, during the effect of the use. However, no such decline was seen in subjects who had formerly been heavy cannabis users and had stopped taking the drug. The authors concluded that cannabis does not have a long-term effect on intelligence. Effects on fetal development are minimal when compared with the well-documented adverse effects of tobacco or alcohol use.

Fetal alcohol exposure, causing Fetal alcohol syndrome, is one of the leading known causes of mental retardation in the Western world.

Maternal tobacco smoking during pregnancy is associated with increased activity, decreased attention, and diminished intellectual abilities. However, a recent study finds that maternal tobacco smoking has no direct causal effect on the child's IQ. Adjusting for maternal cognitive ability as measured by IQ and education eliminated the association between lower IQ and tobacco smoking. But another study instead looking at the relationship between environmental tobacco smoke exposure, measured with a blood biomarker, and cognitive abilities among U.S. children and adolescents 6-16 years of age, found an inverse association between exposure and cognitive deficits among children even at extremely low levels of exposure. The study controlled for sex, race, region, poverty, parent education and marital status, ferritin, and blood lead concentration.

Healthcare during pregnancy and childbirth

Healthcare during pregnancy and childbirth, access to which is often governed by policy, also influences cognitive development. Preventable causes of low intelligence in children include infectious diseases such as meningitis, parasites, and cerebral malaria, prenatal drug and alcohol exposure, newborn asphyxia, low birth weight, head injuries, and endocrine disorders. A direct policy focus on determinants of childhood cognitive ability has been urged.

Stress

A recent theory suggests that early childhood stress may affect the developing brain and cause

negative effects. Exposure to violence in childhood has been associated with lower school grades and lower IQ in children of all races. A group of largely African American urban first-grade children and their caregivers were evaluated using self-report, interview, and standardized tests, including IQ tests. The study reported that exposure to violence and trauma-related distress in young children were associated with substantial decrements in IQ and reading achievement. Exposure to Violence or Trauma lead to a 7.5-point (SD, 0.5) decrement in IQ and a 9.8-point (SD, 0.66) decrement in reading achievement.

Violence may have a negative impact on IQ, or IQ may be protective against violence. The causal mechanism and direction of causation is unknown. Neighborhood risk has been related to lower school grades for African-American adolescents in another study from 2006. Violence may also be more prevalent in the homes of parents with lower IQ's. These parents could have genetically produced children with lower IQ's.

Infectious diseases

A 2010 study by Eppig, Fincher and Thornhill found a close correlation between the infectious disease burden in a country and the average IQ of its population. The researchers found that when disease was controlled for, IQ showed no correlation with other variables such as educational and nutritional levels. Since brain development requires a very high proportion of all the body's energy in newborns and children, the researchers argue that fighting infection reduces children's IQ potential. The Eppig research may help to explain the Flynn effect, the rise in intelligence noted in rich countries. Scientific American noted that the study did not show that parasite load caused low IQ, and Geraint Rees pointed out that a third factor linked to both IQ scores and infectious disease prevalence could explain the correlation.

Tropical infectious diseases

Malaria affects 300-500 million persons each year, mostly children under age five in Africa, causing widespread anemia during a period of rapid brain development and also direct brain damage from cerebral malaria to which children are more vulnerable. A 2006 systematic review found that Plasmodium falciparum infection causes cognitive deficits in both the short- and long-term. Policies aimed at malaria reduction may have cognitive benefits. It has been suggested that the future economic and educational development of Africa critically depends on the eradication of malaria.

Roundworms infect hundreds of millions of people. There is evidence that high intensities of worms in the intestines can affect mental performance, but a systematic review in 2000 and a 2009 update found that there was insufficient evidence to show that deworming treatments improve cognitive performance or school performance in children.

HIV infection in children in sub-Saharan Africa affects their motor development, but there is insufficient evidence to show a slowing of language development.

Association with other diseases

There are numerous diseases affecting the central nervous system which can cause cognitive impairment. Many of these are associated with aging. Some common examples include Alzheimer's disease and Multi-infarct dementia. Many diseases may be neurological or psychiatric and may primarily affect the brain. Others may affect many other organs, like HIV, Hashimoto's thyroiditis causing hypothyroidism, or cancer.

Persons with a higher IQ have generally lower adult morbidity and mortality. This may be because they better avoid injury and take better care of their own health, or alternatively may be due to a slight increased propensity for material wealth. Post-Traumatic Stress Disorder, severe depression, and schizophrenia are less prevalent in higher IQ bands. On the other hand, higher IQ persons show a higher prevalence of Obsessive Compulsive Disorder.

The Archive of General Psychiatry published a longitudinal study of a randomly selected sample of 713 study participants (336 boys and 377 girls), from both urban and suburban settings. Of that group, nearly 76 percent had suffered through at least one traumatic event. Those participants were assessed at age 6 years and followed up to age 17 years. In that group of children, those with an IQ above 115 were significantly less likely to have Post-Traumatic Stress Disorder as a result of the trauma, less likely to display behavioral problems, and less likely to experience a trauma. The low incidence of Post-Traumatic Stress Disorder among children with higher IQs was true even if the child grew up in an urban environment (where trauma averaged three times the rate of the suburb), or had behavioral problems.

Major depression, affecting about 16% of the population on at least one occasion in their lives and the leading cause of disability in North America, may give symptoms similar to dementia. Patients treated for depression score higher on IQ tests than before treatment.

Research in Scotland has shown that a 15-point lower IQ meant people had a fifth less chance of seeing their 76th birthday, while those with a 30-point disadvantage were 37% less likely than those with a higher IQ to live that long. In addition, a study of 11,282 individuals in Scotland who took intelligence tests at ages 7, 9 and 11 in the 1950s and 1960s, found an "inverse linear association" between childhood intelligence and hospital admissions for injuries in adulthood. The association between childhood IQ and the risk of later injury remained even after accounting for factors such as the child's socioeconomic background.

Dementia

A decrease in IQ has also been shown as an early predictor of late-onset Alzheimer's Disease and other forms of dementia. In a 2004 study, Cervilla and colleagues showed that tests of cognitive ability provide useful predictive information up to a decade before the onset of dementia.

However, when diagnosing individuals with a higher level of cognitive ability, a study of those with IQ's of 120 or more, patients should not be diagnosed from the standard norm but from an adjusted high-IQ norm that measured changes against the individual's higher ability level.

In 2000, Whalley and colleagues published a paper in the journal Neurology, which examined links between childhood mental ability and late-onset dementia. The study showed that mental ability scores were significantly lower in children who eventually developed late-onset dementia when compared with other children tested.

Myopia and hyperopia

A 2008 literature review writes that studies in several nations have found a relationship between myopia and higher IQ and between myopia and school achievement. Several, but not all, studies have found hyperopia to be associated with lower IQ and school achievements. A common explanation for myopia is near-work. Regarding the relationship to IQ, several explanations have been proposed. One is that the myopic child is better adapted at reading, and reads and studies more, which increases intelligence. The reverse explanation is that the intelligent and studious child reads more which causes myopia. Another is that the myopic child have an advantage at IQ testing which is near work because of less eye strain. Still another explanation is that pleiotropic gene(s) affect the size of both brain and eyes simultaneously. A study of Chinese schoolchildren found that after controlling for age, gender, school, parental myopia, father's education, and books read per week, myopia was still associated with high nonverbal IQ. Nonverbal IQ was a more important explanation than books read per week.

Other associations

Long working hours (55 vs. 40) was associated with reduced scores on cognitive tests in a 5 year study on midlife British civil servants.

In terms of the effect of one's intelligence on health, in one British study, high childhood IQ was shown to correlate with one's chance of becoming a vegetarian in adulthood. In another British study, high childhood IQ was shown to inversely correlate with the chances of smoking.