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The Cognitive Effects of Malnutrition

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Introduction

Malnutrition is associated with both structural and functional pathology of the brain. Structurally malnutrition results in tissue damage, growth retardation, disorderly differentiation, reduction in synapses and synaptic neurotransmitters, delayed myelination and reduced overall development of dendritic arborization of the developing brain. There are deviations in the temporal sequences of brain maturation, which in turn disturb the formation of neuronal circuits. The brain is vulnerable to the effects of insults during critical periods of brain development from the second trimester of pregnancy until 2 years of age. Indeed, malnutrition experienced at these ages will have lifelong consequences that are not reversed by adequate nutrition. Long term effects of prenatal, postnatal and childhood malnutrition have been reported even after a long period of recovery from the illness itself. In addition, malnutrition, a consequence of various factors, is often related to poor quality of food, insufficient food intake, and severe and repeated infectious diseases, or, frequently, combinations of the three. The major outcomes of malnutrition during childhood may be classified in terms of morbidity, mortality and psychological and intellectual development with important consequences in adult life [1-7].

Malnutrition and Brain Function

Chronic malnutrition affects the growth and maturation of the brain. The stages of development are numerous and complex: neural cells must proliferate, migrate to the right place, establish the right connections, form the right receptors for neurotransmitters and be well covered with myelin, a protective substance essential to the proper transfer of nerve messages. This meticulous assembly of neural cells is vulnerable to environmental stressors, including of course, malnutrition [8]. Later, between early childhood and adolescence, an acute episode of famine can affect cognition and behavior, but these are more likely to recover once the child is well fed. It must be remembered, however, that it is not only a matter of weight and head circumference. You can have a child with normal measurements who also has neurocognitive deficits. Evidences from human and animal studies indicate that neurocognitive development is influenced by various environmental factors including nutrition. It has been established that nutrition affects the brain throughout life. However, the mechanisms through which nutrition modulates mental health are still not well understood. It has been suggested that the deficiencies of both vitamin B12 and omega-3 fatty acids can have adverse effects on cognition and synaptic plasticity. Studies indicate a need for supplementation of vitamin B12 and omega-3 fatty acids to reduce the risk of cognitive decline, although the results of intervention trials using these nutrients in isolation are inconclusive [9].

Brain development continues after birth, where migration and cellular proliferation takes place. It has been observed that protein deficiency reduces the thickness of the visual cortex, parietal neocortex, dentate gyrus, CA3 and cerebellum [10-12]. Moreover, Plagemann et al.

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determined that the Ventromedial Hypothalamic Nucleus of hypothalamus increased its size while the Paraventricular Hypothalamic Nucleus is reduced after malnutrition, demonstrating that perturbations during development may change the brain organization [13]. The consequence of malnutrition on brain anatomy, through changes on brain connectivity, might be the cause of behavioral deficits observed in malnourished people.

Malnutrition and Neuropsychological Performance

Cognitive deficits caused by malnutrition are manifested by memory difficulties, intellectual slowness or specific learning disabilities in reading, writing or mathematics. The child may have behavioral problems such as attention deficit hyperactivity disorder, emotional regulation or socialization difficulties [14]. In extreme cases, there will be mental retardation. It is estimated that the "survivors" of malnutrition have on average a deficit of 5-15 points in standard intelligence tests compared to well-nourished children living in the same environment [15]. The degree of cognitive impairment is proportional to the severity of malnutrition.

In a study of children in the Kenitra city of Morocco who suffered from moderate to severe malnutrition in their first year, attention deficit disorder with or without hyperactivity, lower intelligence quotients, more disorders were observed of learning, which ultimately led to more failures in national school exams [14] . These effects persisted over time, at least until adolescence. In a study about children in the Cleveland, demonstrates that children with signs of poor nutrition as measured by growth also have associated high rates of developmental delays. In addition, these children have early signs of cognitive deficits. Longitudinally, these children were able to show motor and cognitive gains toward the normal range with improvements in their nutritional status. While maximizing nutrition after periods of under-nutrition is crucial to support cognitive recovery, ensuring adequate and consistent nutrition for vulnerable children with developing minds to prevent cognitive injury is paramount [16]. The neuropsychological interpretation of the cognitive processes more severely affected in malnourished children suggests a diffuse cortical involvement. This is with reference to deficits pertaining to functions mediated by dorsolateral prefrontal cortex (poor performance on tests of attention, fluency and working memory), right parietal (poor performance on tests of visuospatial functions) and bilateral temporal cortex (poor performance on tests of comprehension, verbal learning, and memory for verbal and visual material). The prefrontal cortex may be particularly vulnerable to malnutrition [17].

Conclusion

This review of the literature shows that malnutrition remains important to local and regional worldwide. Malnutrition results in cognitive impairments as well as slowing in the rate of the development of cognitive processes. The biochemical and physiological mechanisms underlying often malnutrition connecting a neuron-impaired cognitive function are clear.

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