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Importance of Nutrition in Brain Development and its Nexus with Socio-Economic Development

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Abstract

Zambia is counted among the least developed countries, with high poverty levels averaging 61.4% at national level. Further, the 2018 Global Hunger Report places Zambia in the "Alarming Hunger Situation" category. This is despite the fact that Zambia is endowed with abundant natural resources such as minerals, fertile land, water, forests and wild life. Human resource is the most important resource in the exploitation of all the other resources for enhancement of quality of life. The human capacity to achieve great things in one's life time largely depends on the brain. The brain, however, needs to grow and develop, and for this to happen, good nutrition is critical.

Nutrients regulate brain development during foetal and early postnatal life. In particular, the period between 24 and 44 weeks after conception is characterized by a rapid trajectory of several neurologic processes including synapse formation and myelination. The increase in complexity of the brain during this period largely reflects cortical neuronal growth, differentiation, and synaptic connections. Specific nutrients are required for these processes, and these include protein, iron, zinc, selenium, iodine, folate (vitamin B9), vitamin A, choline and long-chain polyunsaturated fatty acids.

It is well established that under-nutrition severely affects brain development, both before and during the first few years after birth. The developing brain between 24 and 44 weeks after conception is particularly vulnerable to nutritional insults. Synaptogenesis and myelinisation are particularly sensitive to nutritional insult. The ultimate of under-nourishing the brain is that it affects the cognitive and social behaviour functions of a person. Individuals suffering from severe acute malnutrition during early life show persistent behavioural and cognitive deficits throughout childhood and adolescence, which carry through into adulthood. Thus, under-nutrition in children under the age of 5 threatens the quality of not only their own life, but also the quality of the next generation as a cumulative society.

In order to address the problem of under-nutrition in Zambia, it is recommended that investment be done in awareness campaigns among the population about the nexus between nutrition and socio-economic development. In particular, focus of the campaign should be on the implications of undernutrition of the under-five children and how this affects their future performance to lead a quality life and contribute to socio-economic development of the country. Investment should also be done in the science and technology of agriculture and engineering for enhanced productivity and diversification of food production so that children can have access to nutritious food and balanced diet.

Keywords

Nutrition, brain development, socio-economic development, science and technology

INTRODUCTION

It is common knowledge that the poverty level in Zambia is excessively high. According to the 2015 Living Conditions and Monitoring Survey Report, the average national poverty level stands at 61.4%. The report shows that the lowest incidence of poverty is in Lusaka and Copperbelt provinces where it stands at 20.2% and 30.8%, respectively. In Central and Southern provinces, the incidence of poverty is 56.2% and 57.6%,

respectively. The incidence of poverty in the rest of the provinces ranges between 66% and 82%.

The Global Hunger Report (2018) places Zambia together with other four African countries in the "Alarming Hunger Situation" category. Of the 119 countries surveyed globally, Zambia took position number 5, with a score of 37.6.

Unemployment levels, particularly among the youths, are stubbornly high. The CSO Living Conditions Monitoring Survey Report (2015) reported the following unemployment rates for young people: 12–19 years (41.7%), 20–24 years (36.1%), 25–29 years (17.9%) and 30–34 years (8.7%). The report further showed that the rate of unemployment was much higher in urban areas compared to rural areas. The following figures were reported for urban areas: 12–19 years (73.5%), 20–24 years (58.0%), 25–29 years (30.4%) and 30–34 years (13.8%).

This is despite the fact that Zambia is endowed with abundant natural resources such as minerals that include copper, cobalt and many precious minerals (UNCTAD, 2011). The country also boasts of vast forests and numerous wildlife (UNCTAD, 2011). Further, Zambia is endowed with fertile land (58% arable land) and plenty of water (40% of fresh water in the SADC region), as reported by the Ministry of Agriculture and Livestock (2015).Despite the abundant natural resources, however, value addition is minimal. The processing industry has been developed only to a level of low-medium technologies (Dinh, 2013; ZDA, 2013; MCTI, 2014). Thus, application of science in the economy is conspicuously absent. The big question is why this situation?

It is generally agreed that human capital is the most important resource in the exploitation of all the other resources for enhancement of quality of life. Cognition, which is a function of the brain is, however, important in the exploitation of other resources. Thus the brain must grow and develop within the specified time and space for proper cognitive function. In order for the brain to physically develop and function properly, good nutrition is critical (Prado and Dewey, 2014). Both quantity and quality of food are important.

For several decades now, Zambia has mainly depended on maize as the only major food on which millions of people survive. It is public knowledge that consumption of a variety of foods in adequate amounts among many Zambians is absent. This consumption pattern could have impact on the cognitive function of many people due to impairment in the brain development. Further, this may affect the quality of life as well as the country's economic performance.

The objective of this study was therefore to explain the importance of nutrition on brain development and its connection with socio-economic development.

METHODOLOGY

The study utilized secondary data that was collected through reviewing various studies conducted within and outside Zambia. The information was synthesized and descriptive analysis done.

RESEARCH FINDINGS

Nutrition and Human Development

The normal growth and development of an individual from conception through the neonatal phase, adolescence and adulthood is dependent on nutrition (Nyaradi et al., 2013). Nutrients regulate brain development during foetal and early postnatal life (Pollitt et al., 1996). In particular, the period between 24 and 40 weeks after conception is characterized by a rapid trajectory of several neurologic processes including synapse formation and myelination (Keunen et al., 2015). Specific nutrients are required for these processes.

Critical Period of Human Growth and Development

It has been shown that the first 1,000 days of human life are the most critical (Levitt, 2003). This period begins at conception and continues through foetal life, birth, infancy up to the second year of life. While there is rapid growth of the physical body during this time, there is also significant brain formation and development.

During the period between 24 and 44 weeks after conception, the human brain undergoes remarkable structural and functional changes, progressing at the beginning of the third trimester from a smooth bilobedstructure to a complex one at term that morphologically resembles the adult brain (Georgieff, 2007). The increase in complexity largely reflects cortical neuronal growth, differentiation, and synaptic connections. The development of synapses occurs at an astounding rate during the first 1,000 days of life. More than one million synapses are formed every second during this period (Lake, 2017). By the time the children reach the age of 3, their brains have approximately 1,000 trillion synapses (Georgieff, 2007). Synapses organize the brain by forming neuronal pathways that connect the parts of the brain governing everything that a human being does – from breathing and sleeping to thinking and feeling (Child Welfare Information Gateway, 2001). Depending on the usage of the neuronal pathways, some

of them will be strengthened and remain intact while others will be discarded.

It has been established that a normal child with adequate nutrient intake will achieve 80% of his adult brain weight in their first 2 years, and achieve 90% in their first 5 years (Lenroot and Giedd, 2006; Palupi *et al*., 2013). It is to be appreciated that just like the rest of the body, the brain is built from all nutrients including protein, carbohydrates, fat, vitamins and minerals which are essentially supplied by the diet. While all nutrients are important for neuronal cell growth and development, some appear to have greater effects during the late foetal and neonatal periods. Those with greater effects include protein, iron, zinc, selenium, iodine, folate, vitamin A, choline and long-chain polyunsaturated fatty acids (PUFA). It can be seen from this list of nutrients that trace elements are critically important in the process of neuronal cell growth and development.

Under-Nutrition and its Effects

Under-nutrition or nutritional insult refers to a state where the body does not receive adequate quantity and/or quality of food. According to the United Nations International Children's Emergency Fund (UNICEF, u.d.), some immediate causes of under-nutrition include lack of knowledge of those who take care of the children, household food insecurity, poverty, unsanitary health environment, illiteracy, and social norms. Palupi *et al*. (2013) observed that people who suffer from hunger, either chronically or acutely malnourished, are mainly located in Sub-Saharan Africa and some parts of Asia. Zambia falls within the brackets of the Sub-Saharan Africa region. Sanchez and Swaminathan (2005) gave the following reasons why people of Sub-Saharan Africa and some areas of Asia suffer from hunger: Limited access to sufficient quantity and quality of food, starvation due to famine, low agricultural productivity, unemployment, and micronutrient deficiencies. The authors further observed that approximately half of the hungry people are smallholder farmers – the very people that many Sub-Saharan governments are trying to protect through subsidies and provision of inputs.

Children born from poor families are the most affected in this whole scenario. UNICEF (u.d.) has provided some statistics about Zambia, which statistics have persisted over more than two decades: About 45% of the children below the age of 5 years are stunted due to malnutrition; prevalence of underweight stands at 15%; prevalence of wasting is at 5%; prevalence of vitamins A deficiency and prevalence of anaemia stand at 54% and 53%, respectively. Undoubtedly, these statistics underscore the reasons why Zambia is in the "alarming hunger situation" category.

It is scientifically established that under-nutrition severely affects brain development, both before and during the first few years after birth. The developing brain between 24 and 44 weeks after conception is particularly vulnerable to nutritional insults. Pollitt *et al*. (1996) noted that synaptogenesis and myelinisation were very sensitive to nutritional insult. In particular, protein-energy malnutrition in foetal and early neonatal phases has been reported to reduce neuronal DNA and RNA content and also alters the fatty acid profile. Neuropathologically, this results in lower neuronal number, reduced protein synthesis and hypomyelination. Overall, under-nutrition results in stunted brain growth. According to Benton (2010), since the brain develops faster than the rest of the body, a dietary deficiency during the critical stage of development may result in lasting changes in the brain structure and function. Thus, under-nutrition in children under the age of 5 threatens the quality of not only for their own life, but also the quality of the next generation as a cumulative society (WHO, 2012). And this can be catastrophic on the economy of the affected country.

The ultimate of under-nourishing the brain is that it affects the cognitive and social behaviour functions of a person. Individuals suffering from severe acute malnutrition during early life show persistent behavioural and cognitive deficits throughout childhood and adolescence, which carry through into adulthood when economic underperformance and psychiatric morbidities are added to the disease burden (Sheppard *et al*., 2017). Palupi *et al*. (2013) who conducted research in Indonesia reported that children with severe acute malnutrition had significantly lower memory ability score compared to well-nourished children. Specific nutrient deficiencies are associated with specific cognitive and social behaviour anomalies. For example, iron deficiency results in cognitive and motor delays, anxiety, depression, social problems, and problems with attention Shonkoff and Phillips (2000). Similarly, protein deficiency results in motor and cognitive delays and impulse behaviour (Pollitt and Gorman, 1994). Pollitt *et al*. (1996) noted that severely under-nourished children were apathetic, not very responsive to their environment and inclined to stay close to their mother. Shonkoff and Phillips (2000) concluded that the cognitive, social and behavioural deficits were linked to the slower passage of electrical signals in the brain of an under-nourished individual.

CONCLUSION

Under-nutrition during the critical period of brain growth and development has long-term effects which are difficult to correct. According to UNICEF Zambia,

under-nutrition is associated with poor school performance leading to reduced productivity and income earning capacity in adult life. The implication is that such minds have less ability to innovate and consequently wealth creation is exceedingly limited. As this is passed on from generation to generation, the entire society loses confidence in itself regardless of how far in education some individuals may go, and the country's economymay suffer significantly. With high levels of poverty in Zambia, it may be concluded that the low economic performance could be related to under-nutrition.

WAY FORWARD

In order to address the problem of under-nutrition in Zambia, it is recommended that:

- Awareness be created among the Zambian population about the nexus between nutrition and economic performance. In particular, focus of the campaign should be on the teachers and learners from pre-school through primary, secondary to college and university level.
- Investment be done in educating expectant mothers attending antenatal clinics and mothers attending under-5 clinics so that they understand the implications of not feeding a child a balanced diet, particularly how this affects future performance of an individual.
- Investment be done in high technology agriculture for enhanced productivity and diversification. This means investing in high level scientific training of young people to develop skills to achieve high level agricultural productivity. Agriculture is a complex science and is knowledge-based, and therefore its practice must be approached from a scientific perspective.
- Invest in science educationand produce highly trained science teachers who can contribute to the cognitive development of children, particularly at the foundation levels. Further, build science laboratories and other facilities to help children learn by doing.

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