Effect of quality nutrition on human brain development

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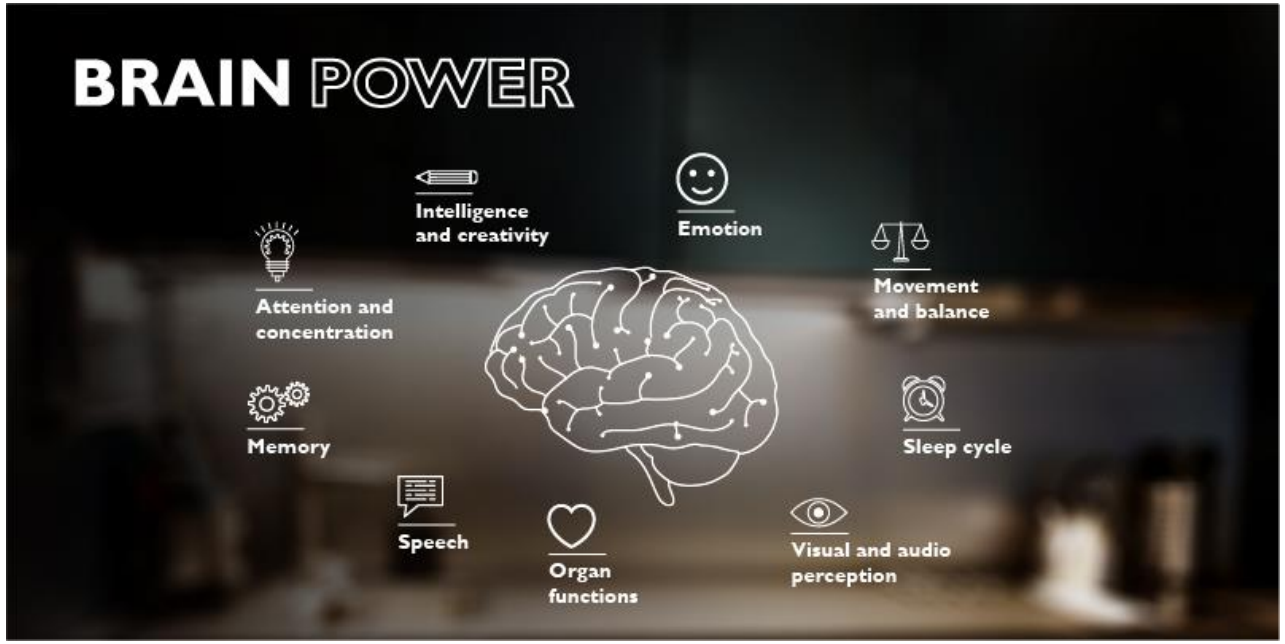
Outlines

- Brief introduction about formation and functions of the brain
- Important role of early nutrition
- Role of key nutrients especially in cognitive development.
- Burden of developmental delay
- Necessary interventions
- Conclusions

The brain and its functions

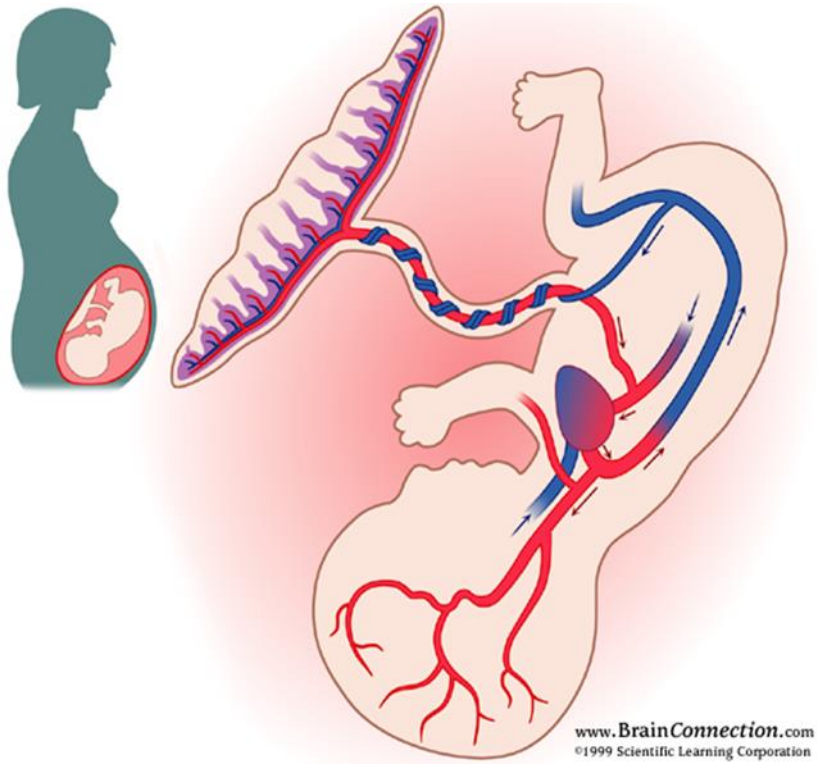


- Motor
- Social
- Cognitive/IQ
- Language

Maturation of the nervous system Underlies development and it progresses cephalo-caudally (head downward). It is also a smooth continuous process.

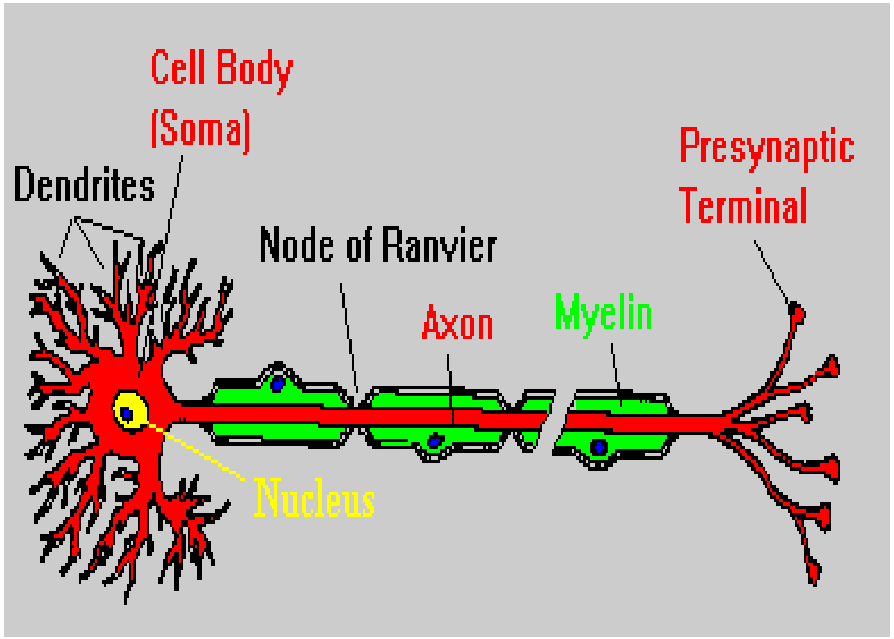
Brain development starts early……

- Brain cells (neurons) form in first months of fetal development
- Born with 100 billion brain cells
- Enough brain cells to learn just about anything – no more are developed after birth

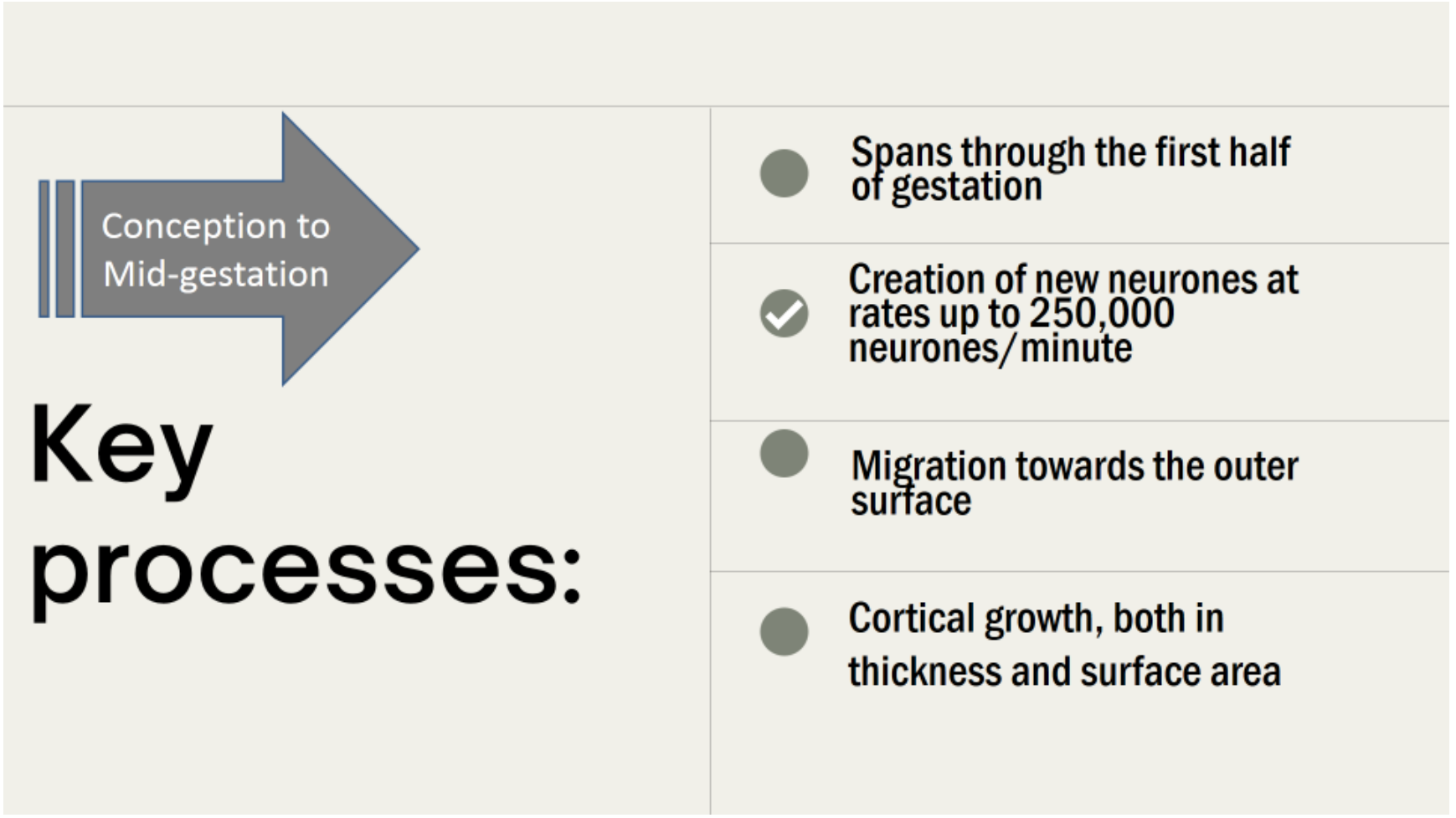


The developing brain

- Critical Periods of Brain growth
  - 1 month – neural tube
  - 4th month – All the lobes and major divisions complete
  - 1 year post-natal – 2/3 adult size
  - 2 years age – 75% adult size
  - 5 years – 90% adult size
- Potential for **Neurogenesis** (peaks in utero) and **Synaptogenesis** (peaks by 5 years) continues throughout life.

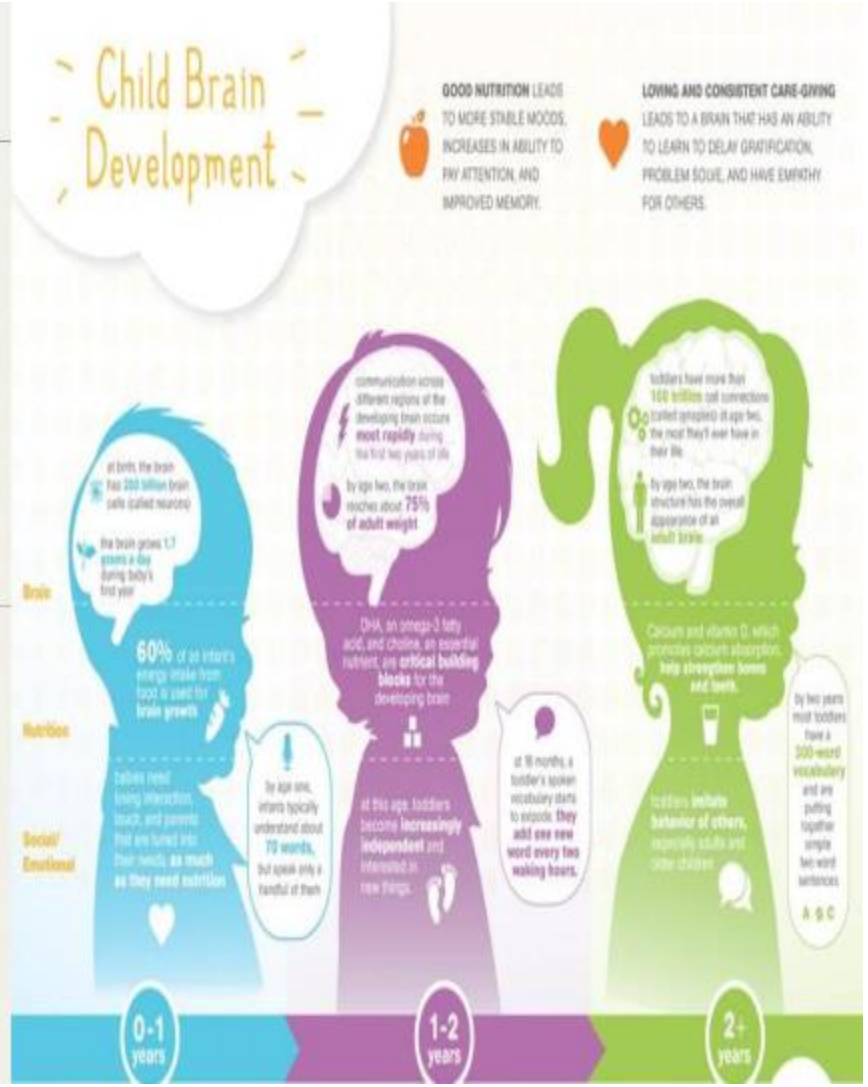


Stages of brain development



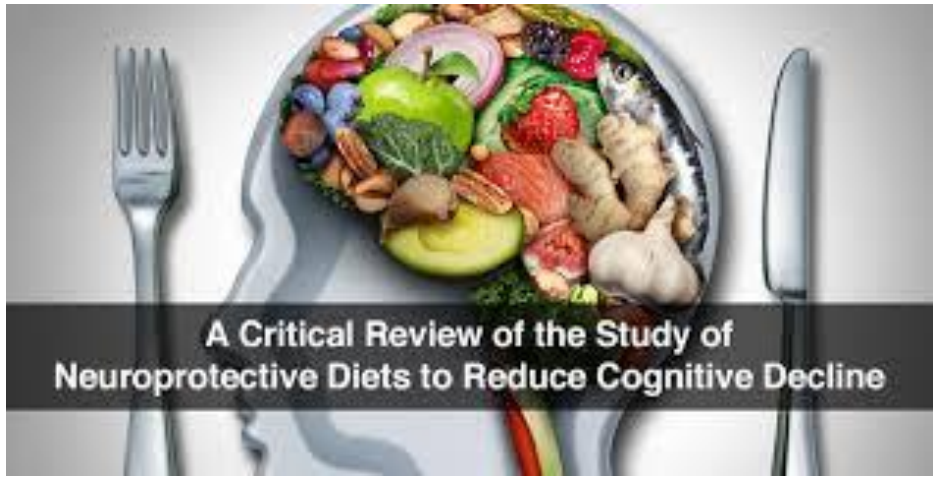
Mid-gestation to age 2 years

- Neuronal migration
- Neuronal connectivity



Factors affecting brain function

- Intrinsic
  - **Genetics**
  - Age
  - Neurotransmitters (brain chemicals)
  - Gender
- Extrinsic
  - Exposure to drugs (cocaine, phenytoin, alcohol)
  - Stress
  - Hypoxia/ischemia,
  - Viral infection
  - Gonadal steroids
  - **Nutrition**



Optimal nutrition

- OPTIMAL NUTRITION is the provision of macro- and micronutrients adequate for the age and needs of the individual

- It is a pre-requisite of Effective Early Childhood Education

- Quality Childhood Nutrition is critical for enhancing optimally, growth and intellectual capacity. IT IS THE FOUNDATION OF HUMAN CAPITAL DEVELOPMENT OF ANY PROGRESSIVE SOCIETY.

- Quality childhood nutrition is fundamental in any country aspiring towards stability, economic and social development.

Cognition

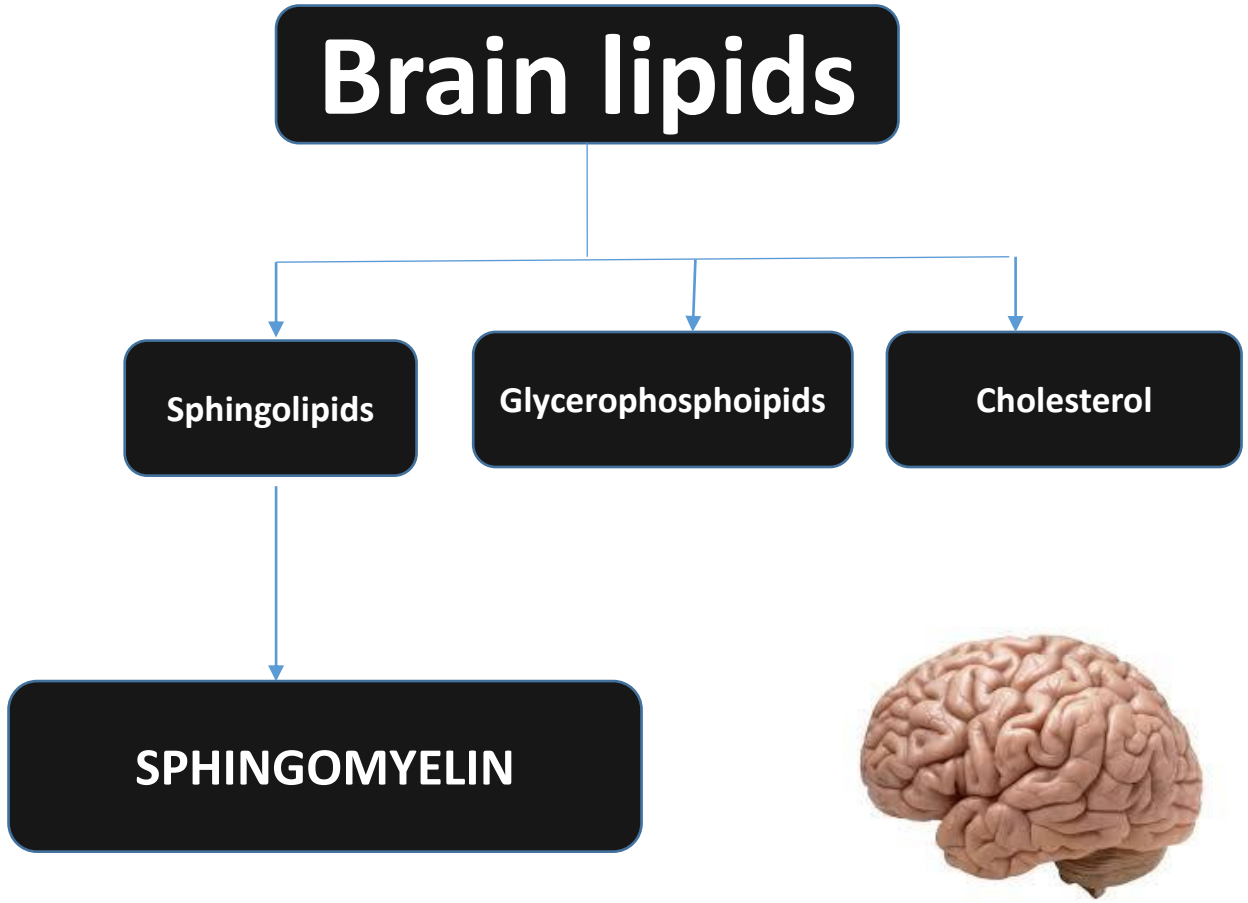
- This is a higher brain function or processes of acquiring knowledge and understanding through thought, experience and the senses.

- Nutrition is greatly needed for this function of the brain.

- What is the link?

Nutritional perspective of the brain

- Human brain is 60% lipids.
- Lipids found in the brain are grouped as sphingolipids, glycerophospholipids, and cholesterol and are considered to be present in almost equal ratios.



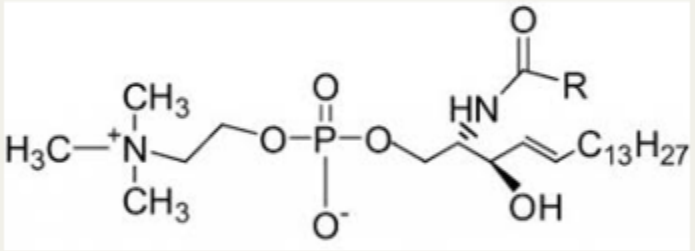
What the brain lipids do

These lipids are involved in:

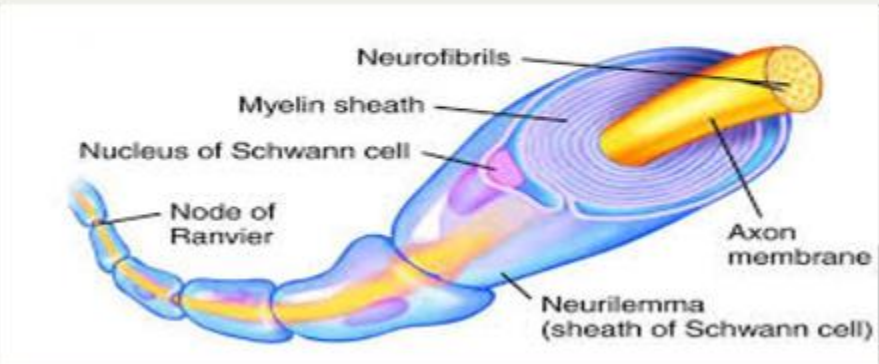
- Developmental, maintenance and many other cellular processes of the brain.
- The lipids act as signaling molecules.
- source of energy
- for contributing to synaptogenesis, neurogenesis, impulse conduction and many others.

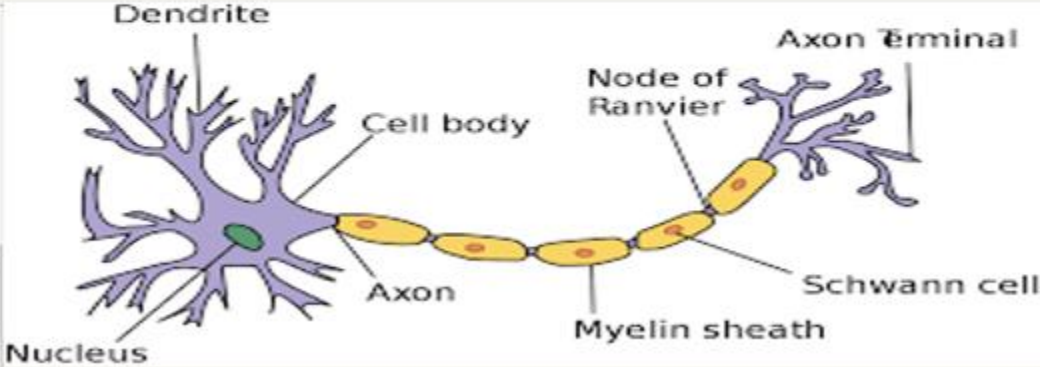
SM is naturally present in breastmilk

Sphingomyelin

Sphingomyelin (SM): a structural building block of the brain	The most abundant phospholipid in human milk
	
	By the age of 4 weeks, SM accounts for 35% of phospholipids in human milk

SM: a key nutrient for myelination





SM is a key component of the myelin sheath

- Myelin protects the neurones
- Helps to conduct signals more efficiently
- Prevents erratic activation of neighbouring axons

Sphingomyelin: a structural building block of the brain

- SM levels in the brain increase from 2% at birth to 15% at 3 years
- The increase is consistent with a progressive increase in neuronal myelination after birth

- Other phospholipids decline or show a modest increase during postnatal development

Other nutrients of importance.

- Other nutrients
  - Amino acid: important source of different neurotransmitter.
  - Carbohydrate: Energy from lactose is important for brain growth.
  - Glycogen: reported to be importation for communication and memory.
  - Folic acid and choline : affect neuronal stem cell proliferation.
  - Vitamin B12 : axonal myelination
  - Zinc: neurogenesis, maturation and migration of neurons.
  - Iodine: myelination, neurotransmission
  - Iron: a co-factor for different enzymes in the brain, psychomotor retardation

Sensitive period of brain growth

- In utero
- First 2 years of life

Newborn Brain
Average Weight

333 grams

2 Year Old's Brain
Average Weight

999 grams

Very rapid brain growth in last trimester of pregnancy and first 2 years of life.

Diet provides the building blocks and fuel for the brain

Impact of nutrition on cognition

- Nutrients are structural and functional components of cognitive system.
- Therefore, it is important to provide adequate and appropriate diet early in life.
- Neither insufficiency or excess is preferred.

All micronutrients are important for growth, health and development

Zinc

Vitamin D

Cobalt

Iodine

Thiamin

Riboflavin

Vitamin B_6

Vitamin E

Magnesium

Manganese

Iron

Selenium

Folate

Vitamin B_{12}

Niacin

Vitamin A

Phosphorus

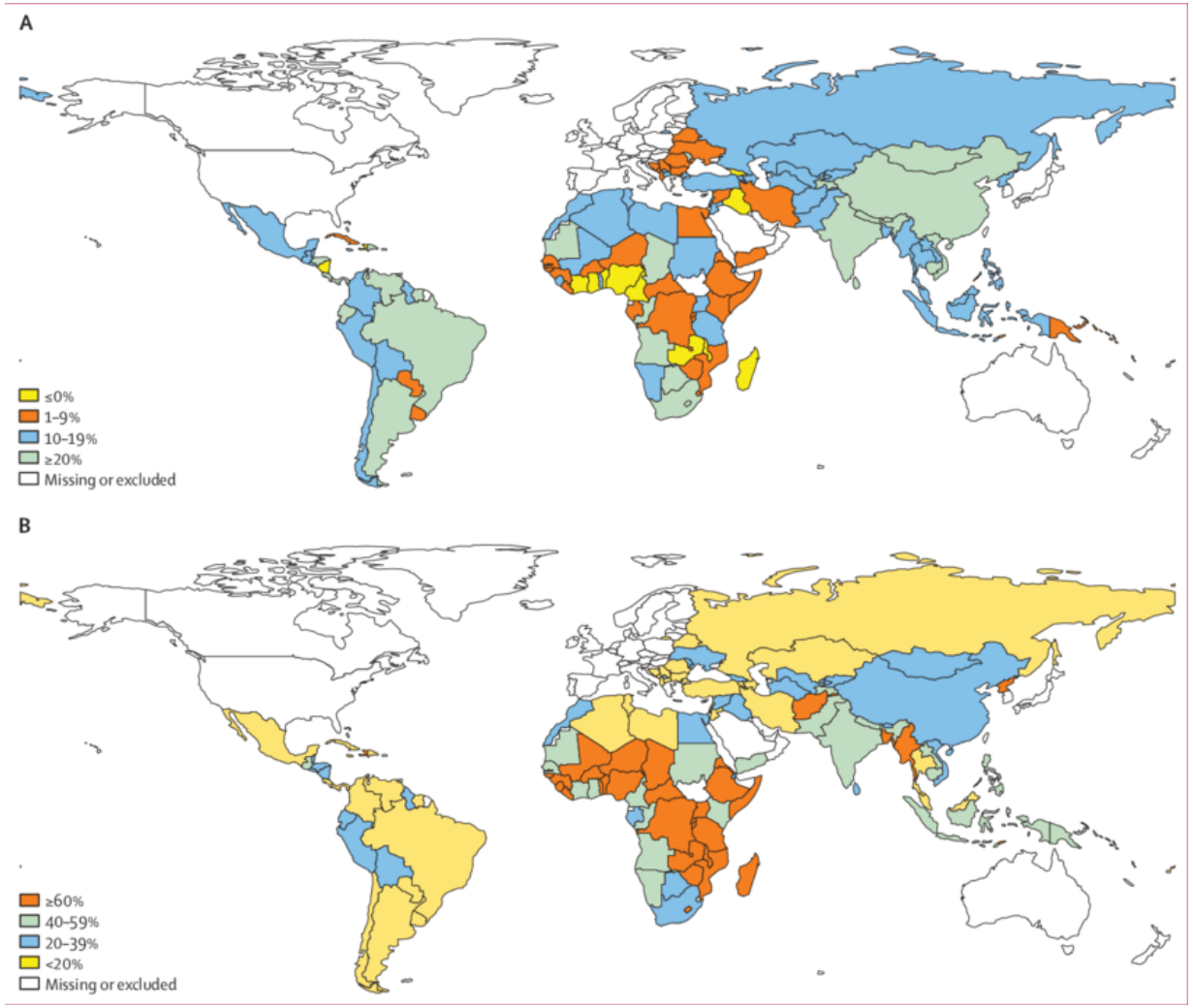
Vitamin K

Vitamin C

Cobalamin

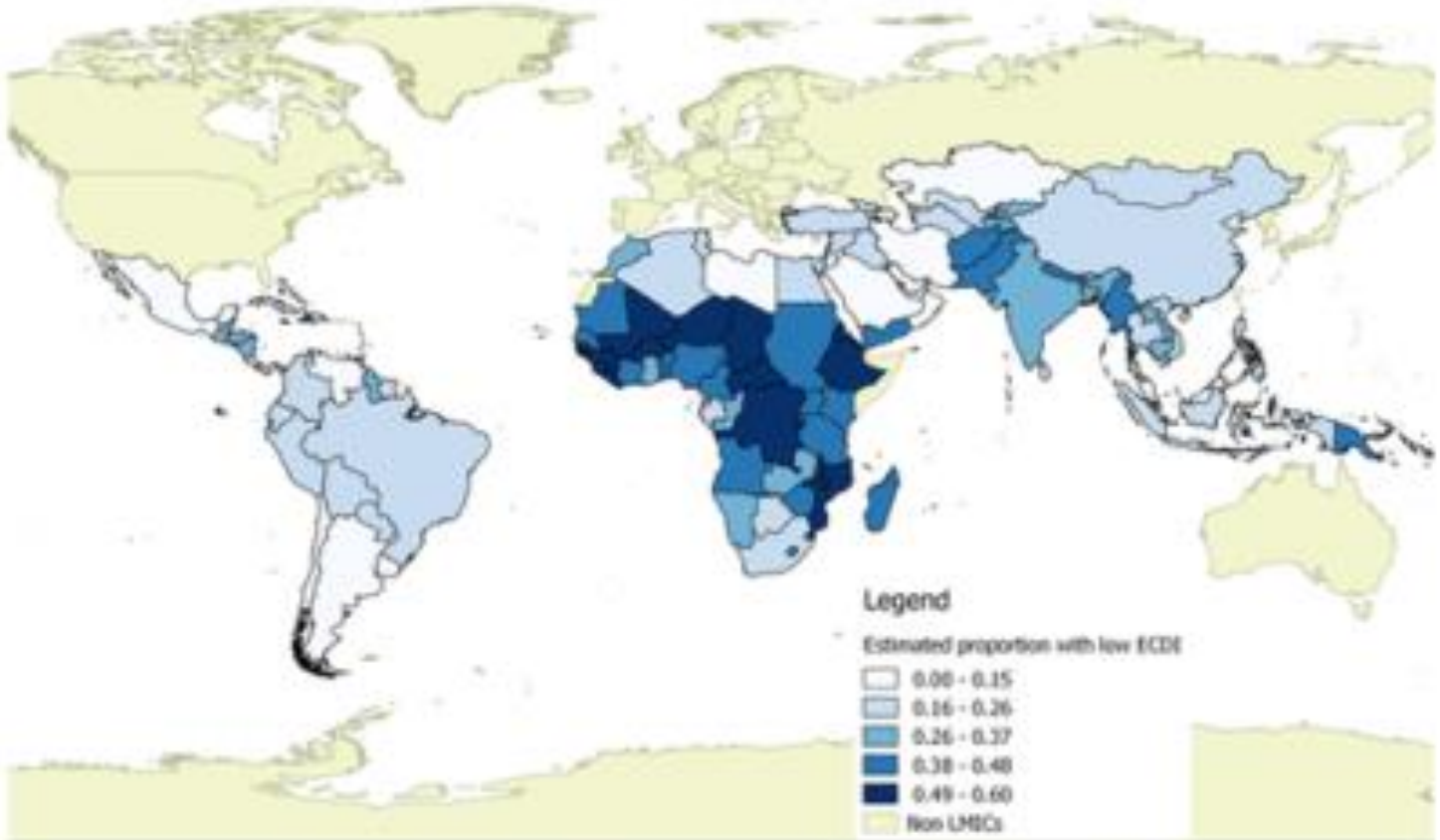
Chromium

Risk of poor development in young children in low-income and middle-income countries: an estimation and analysis at the global, regional, and country level



Country-level percentage of children younger than 5 years at risk of poor development in 141 countries (A) Reduction between 2004 and 2010. (B) Prevalence in 2010.

Fig 8. Estimated proportion of children with low development per the ECDI by country.



McCoy DC, Peet ED, Ezzati M, Danaei G, Black MM, et al. (2016) Early Childhood Developmental Status in Low- and Middle-Income Countries: National, Regional, and Global Prevalence Estimates Using Predictive Modeling. PLOS Medicine 13(6): e1002034. https://doi.org/10.1371/journal.pmed.1002034
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ORIGINAL ARTICLE

Early-onset developmental impairments among infants attending the routine immunization clinic at the University College Hospital, Ibadan, Nigeria

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Developmental disorders are frequently overlooked in the developing countries, particularly in sub-Saharan Africa. Early identification of developmental delays (DDs) is critical to optimal outcomes. This study set out to determine the proportion of children who are at risk of DDs among infants attending immunization clinics at the University College Hospital, Ibadan, Nigeria. Infants 6 weeks to 12 months of age (median age 6 months) who presented for routine immunization were screened for DDs using the Ages and Stages Questionnaire. A total of 587 infants [312 (53.2%) males] were enrolled. A total of 198 (33.7%) children showed signs of DDs. For the domains of communication skills, fine motor skills, gross motor skills, problem solving/cognition skills and personal/social skills, the prevalences of DDs were 7.5%, 15.0%, 10.7%, 14.1% and 14.8%, respectively, and 14.3% had global DDs. Factors that significantly predicted DDs included prematurity (odds ratio [OR] 2.64 [95% confidence interval (CI) 1.45 to 2.05]) and a history of perinatal asphyxia (OR 1.74 [95% CI 1.77 to 2.49]). There is a

Necessary interventions

Education of women's groups about exclusive breastfeeding and complementary feeding.

Education on the use of locally available sources of quality nutrition (*less dependence on imported food items*

Use of media, workshops, conference

Role of dietitians, nutritionists, paediatricians

Food industries

Iron supplementation in key periods to prevent later impairment.

Pregnancy: iron and folic acid SUPPLEMENTATION

4. Interventions targeted at pregnant women

4.1 Daily supplementation with iron and folic acid for women during pregnancy

WHO RECOMMENDATION

Daily oral iron and folic acid supplementation is recommended as part of antenatal care to reduce the risk of low birth weight, maternal anaemia and iron deficiency (*176*).

A suggested scheme for daily iron and folic acid supplementation in pregnant women is presented in Table I-9.

Table I-9 Suggested scheme for daily iron and folic acid supplementation in pregnant women

Supplement composition	Iron: 30–60 mg of elemental iron[a]
	Folic acid: 400 µg (0.4 mg)
Frequency	One supplement daily
Duration	Throughout pregnancy. Iron and folic acid supplementation should begin as early as possible
Target group	All pregnant adolescents and adult women
Settings	All settings

[a] 30 mg of elemental iron equals 150 mg of ferrous sulfate heptahydrate, 90 mg of ferrous fumarate or 250 mg of ferrous gluconate.

Conclusion

- Adequate nutrition during pregnancy and the first two years especially is necessary for normal brain development, laying the foundation for future cognitive and social ability, school success, and productivity.

- Diversified nutritious diet is key to provide required micronutrients – when difficult to obtain, food fortification should be used.

- Preventing these conditions should be a health priority of any serious nation.

Fig 6. Percentage of children scoring low in cognitive and/or socioemotional development on the ECDI by cognitive stimulation (r = 0.06, p < 0.01).

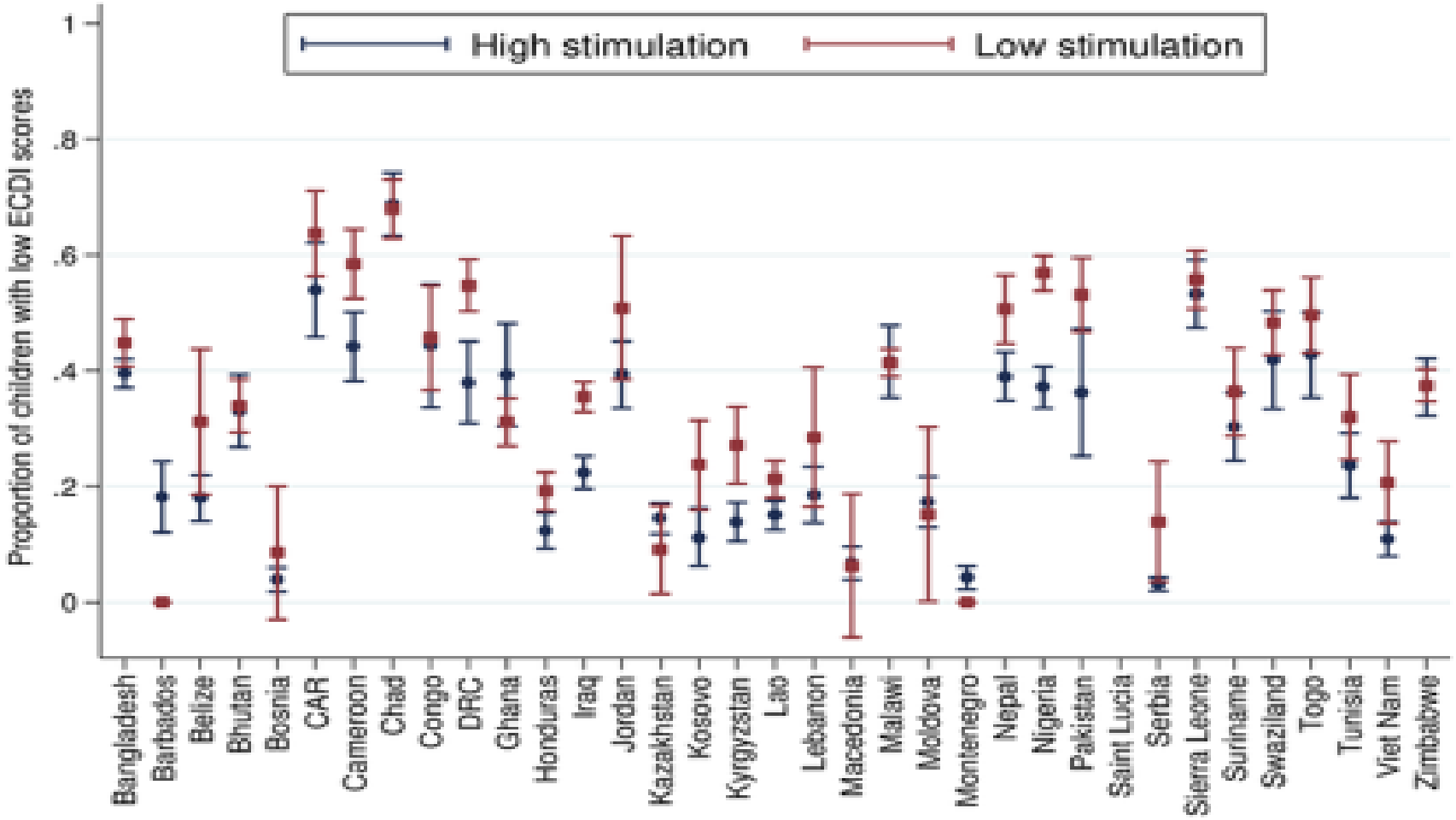

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Table 2. Prevalence of children with low ECDI scores.

Country	Sample Size	Low Cognitive and/or Sociaemotional ECDI Score		Low Cognitive ECDI Score		Low Sociaemotional ECDI Score	
		n	Percent	n	Percent	n	Percent
Bangladesh	7,713	2,958	38.3%	908	11.8%	2,319	30.1%
Barbados	171	31	18.2%	1	0.4%	30	17.8%
Belize	719	156	21.6%	9	1.2%	153	20.9%
Bhutan	2,209	749	34.1%	145	6.6%	656	29.8%
Bosnia	903	40	4.4%	5	0.6%	37	3.8%
Cameroon	1,587	840	53.1%	247	15.6%	715	45.0%
Central African Republic	3,358	1,817	54.1%	918	28.4%	1,337	39.8%
Chad	4,161	2,982	67.0%	2,347	52.7%	1,388	29.4%
Congo	1,486	729	48.0%	216	14.5%	622	41.9%
Democratic Republic of the Congo	3,726	1,788	47.9%	1,053	28.2%	1,072	28.8%
Ghana	2,909	865	30.6%	309	10.9%	778	26.8%
Honduras	2,666	477	17.0%	34	1.2%	464	16.5%
Iraq	15,119	3,714	28.3%	1,391	10.6%	2,834	21.6%
Jordan	2,587	983	37.6%	257	9.8%	798	30.7%
Kazakhstan	1,686	230	13.6%	80	4.8%	158	9.3%
Kosovo	696	93	16.4%	12	2.1%	85	14.2%
Kyrgyzstan	1,980	321	16.1%	135	6.8%	239	14.0%
Lao People's Democratic Republic	4,052	719	17.7%	245	6.2%	502	12.4%
Lebanon	866	189	20.9%	48	7.0%	133	17.7%
Macedonia	503	47	8.9%	6	1.2%	42	8.3%
Malawi	7,030	2,938	46.0%	1,359	19.2%	1,980	27.1%
Montenegro	1,208	51	4.3%	9	0.8%	42	3.5%
Nepal	3,140	900	42.0%	378	17.7%	655	30.9%
Nigeria	8,582	4,059	45.7%	1,991	21.2%	3,115	33.2%
Pakistan	1,483	704	48.1%	481	31.9%	396	26.1%
Republic of Moldova	620	124	20.0%	3	0.5%	121	19.5%
Saint Lucia	113	12	11.0%	2	1.5%	12	10.6%
Serbia	3,193	155	4.9%	13	0.4%	148	4.8%
Sierra Leone	3,232	1,759	54.3%	713	22.1%	1,281	39.9%
Suriname	907	319	32.0%	13	1.3%	309	31.0%
Swaziland	1,011	430	42.5%	68	6.8%	388	38.4%
Togo	1,668	769	47.3%	318	19.1%	548	32.8%
Tunisia	1,024	286	27.9%	73	6.9%	249	24.3%
Viet Nam	1,388	209	15.8%	112	8.2%	104	6.8%
Zimbabwe	7,403	2,766	37.5%	759	10.2%	2,339	31.5%
Total	90,202	35,547	35.6%	14,492	14.6%	25,967	26.2%

Children were classified as "low development" in an ECDI domain if they received a score of zero on more than one item within the domain.

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Thank you for listening