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CHILDREN'S NUTRITION IMPACT ON COGNITIVE DEVELOPMENT

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ABSTRACT

Babies' brains are ready to absorb information when they are born. However, babies may comprehend some concepts about items and their connections to one another. They can touch, feel, watch, listen, and feels everything. This enables them to understand their older; they may discover that mixing yellow and blue paint produces green. Children learn through exploring and experimenting. This is the way they improve their cognitive abilities.

Human brain development is extremely fast between the ages of 20 and 36 weeks and proceeds until 20 months. The brain includes all the neurons required for life at birth. Of course, if the baby is brought to term, an infant's brain is 25% of its adult weight at birth. The brain would be 75 % of its body weight by age 2 (90 percent by age 6). Children will go through various phases of cognitive growth between birth and the age of two, such as sensory growth and learning ability.

Children naturally choose the meals they like the most, so the difficulty is to make healthy options enticing. Of course, no issue how excellent our motives are; convincing your eight-year-old that an apple is as sweet as a biscuit is going to be tough. Therefore, you might ensure that your child's food is as healthy and wholesome as possible while letting them enjoy a few of their preferred delights. Development.

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INTRODUCTION

This paper is based on current evidence on the Relationship between children's nutrition and cognitive development. This document is prepared based on literature and the articles which are reviewed. It is not a systematic review. This research report investigates the impact of diet, especially proper nutrition, on the cognitive capabilities of children.

In addition to the children themselves, my research will also be helpful to parents, teachers, and other professionals.

LITERATURE REVIEW

Cognitive capabilities must be described before examining the advantages of healthy eating on these abilities. Additionally, because this study is particular to the target age range, children under the age of ten, cognitive abilities, and dietary needs differ by age group. In this part, cognitive abilities will be defined along with how certain foods affect them. According to this definition, cognitive abilities include distinguishing between letters and thinking symbolically, affecting a student's reading ability. For people who do not read, it takes substantial focus and mental attentiveness to suddenly conceive of letters abstractly and integrate them into their schema. Distinguishing patterns and ordering are cognitive abilities that directly impact math abilities.

1. THE RELATIONSHIP BETWEEN CHILDREN'S NUTRITION AND COGNITIVE DEVELOPMENT

Malnutrition, which encompasses overnutrition and undernutrition, is defined as an imbalance between a person's nutritional needs and nutrient consumption. Undernutrition, a contemporary global issue that impedes young children's growth, is brought on by insufficient calories, protein, or vitamins and minerals. It can result in anorexia, retardation, wasting, or micronutrient deficits in early childhood. Improper protein and calorie consumption throughout childhood is strongly tied to stunted development and is a precursor to several psychological issues in adulthood. Underweight children also show developmental delays and reduced cognitive performance. Pediatric malnutrition is defined as an inability to gain enough weight, a low weight-to-height or weight-to-length ratio, and a major cause of diminished cognitive abilities.

The brain needs all vital nutrients, including lipids, proteins, carbohydrates, vitamins, minerals, and water, to build and maintain its structure. Consequently, proper nourishment is necessary for the growth and operation of the brain. Yet, it has been proven that some micronutrients, such as long-chain polyunsaturated fatty acids and iron, zinc, acetylcholine, iodine, folate, and B12, are vitally pertinent for cognitive growth. The formation of neurologic connections in the brain, which affect mental function, depends on iron.

2. DIETARY FACTORS THAT AFFECT COGNITIVE SKILLS

2.1 . Micronutrients and cognitive development

1. Omega 3 fatty acids

In neural tissue, the essential fatty acids serve a crucial physiological purpose. They not only serve as the fundamental elements of neuronal synapses but also regulate the membranes' liquidity and density, which affects the ion channel, enzymatic activity, and potential barriers. Additionally, essential fatty acids are building blocks for inflammatory messengers, which are crucial for immune system response and inflammation. They regulate neural transmission and signal processing by promoting the formation of synaptic membranes, dendrite spines, and neurons. Additionally, critical fatty acids control neural epigenetic modification. Furthermore, the body of available research strongly indicates that essential fatty acids remain important for the growth and operation of the brain.

2. Vitamin B12, Folic acid, and choline.

Anemia caused by vitamin B12 and folate insufficiency is extremely uncommon worldwide. Nevertheless, it may happen in underdeveloped and industrialized countries, particularly in older persons, those with absorbent issues, and vegans.

The Relationship between vitamin folic acid, B12, choline metabolism, and intellectual abilities has recently drawn more attention. Folate influences DNA formation, apoptosis, homocysteine, S-adenosylmethionine production, neural stem cell development, and differentiation. Choline is thought to play comparable functions in brain growth to folate. Furthermore, the homocysteine-methionine-S-adenosylmethionine route links the metabolism of folate, choline, and vitamin B12. One of the primary methyl donors in several metabolic methylation processes, including DNA methylation, is S-adenosylmethionine. Therefore, a choline and folate shortage may cause DNA hypomethylation, which will change how genes are expressed.

Furthermore, choline functions as a precursor to the neurotransmitter acetylcholine and as a precursor of phospholipids in cell membranes. In addition to playing a part in axon myelination, which is crucial for the transmission of impulses from one cell to another, vitamin B12 also shields neurons against deterioration. Additionally, vitamin B12 may change how some cytokines, growth factors, and oxidative energy metabolites like lactic acid are produced.

3. Zinc

Impaired mental capabilities, negative academic output, poor cognitive performance, short attention span in class, and decreased cognitive ability are all consequences of zinc deficiency. More precisely, zinc functions as a component for more than 200 enzymes that control various cellular metabolic processes, along with the creation of protein, DNA, and RNA. Additionally, zinc aids in the development, growth, and motility of neurons as well as the creation of synapses.

Congenital abnormalities may be avoided, and the baby's immune health is improved by zinc supplementation. The connection between a mother's zinc status and her children's intellectual abilities hasn't been well studied.

4. Iron

Newborn anemia is linked to sensorimotor slowness, a prolonged period of intellectual development in which connection with things will be less strong. According to research, kids who got iron as a nutrient gained weight more quickly and developed cognitively at the predicted rate.

The effects of iron supplements on students of different ages and genders were investigated in four trials. The first research examined the effects of 60 days of iron-folic acid supplementation on memory in 94 boys and girls between the ages of 5 and 8. Compared to children lacking anemia, those aged 7 to 8 showed a much larger increase in their overall scores. The second research examined the effects of dietary supplements on memory in 14 pairs of anemic boys aged 5 to 6 and found definite improvements in cognitive function. The third research examined the impact of various elemental iron doses on 48 boys between the ages of 8 and 15 years, with diverse degrees of enhancement in brain performance. In the fourth research, 163 anemic girls between the ages of 8 and 15 were treated and evaluated at 4 and 8 months, with the results showing a substantial improvement in cognitive function.

Reduced IQ, motor slowness, neurological and mental impairment, and sociopathy are all symptoms of iodine deficiency illness. Fewer results on tests of mental and motor development were documented for iron-deficient participants in investigations of newborns and toddlers with an iron shortage. Additionally, these kids' timidness, distractibility, and social actions were all raised.

5. Iodine

During pregnancy and in newborns, iodine shortage affects thyroid function. Kids' and newborns' nervous - system progress is also impacted. The degree of shortage influences how much harm is done. Early-pregnancy maternal hypothyroxinemia is a major contributor to the emergence of neurological impairment. Iodine and selenium deprivation work together to avoid neurological damage, although mental retardation is accompanied by severe hypothyroidism.

The leading cause of avoidable brain injury and mental disability worldwide is iodine deficiency.

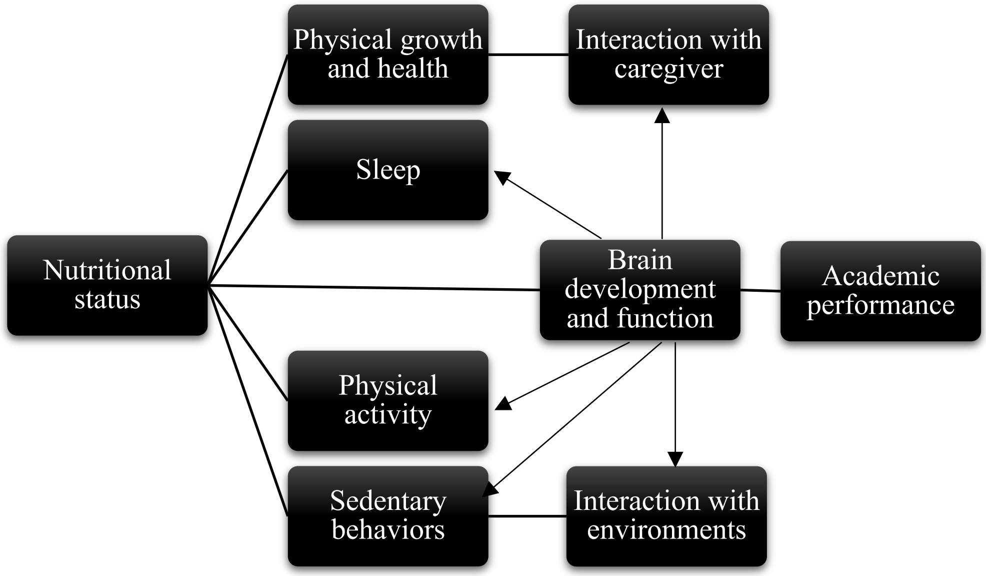

Figure 1 nutrients and academic performance

3. RESEARCH IMPLEMENTATION

3.1 Study methods and data collections

The Follow - up action Elements for Systematic Reviews and Meta-Analyses standards were followed in conducting this systematic review of the published research in May 2021. The Demographic, Involvement, Inputs, Result (PICO) model and a forest and agricultural resources librarian worked together to establish the search strategy. Figure 1 shows the Reporting items for the systematic flow diagram, which depicts the outflow of findings at various stages of this evaluation.

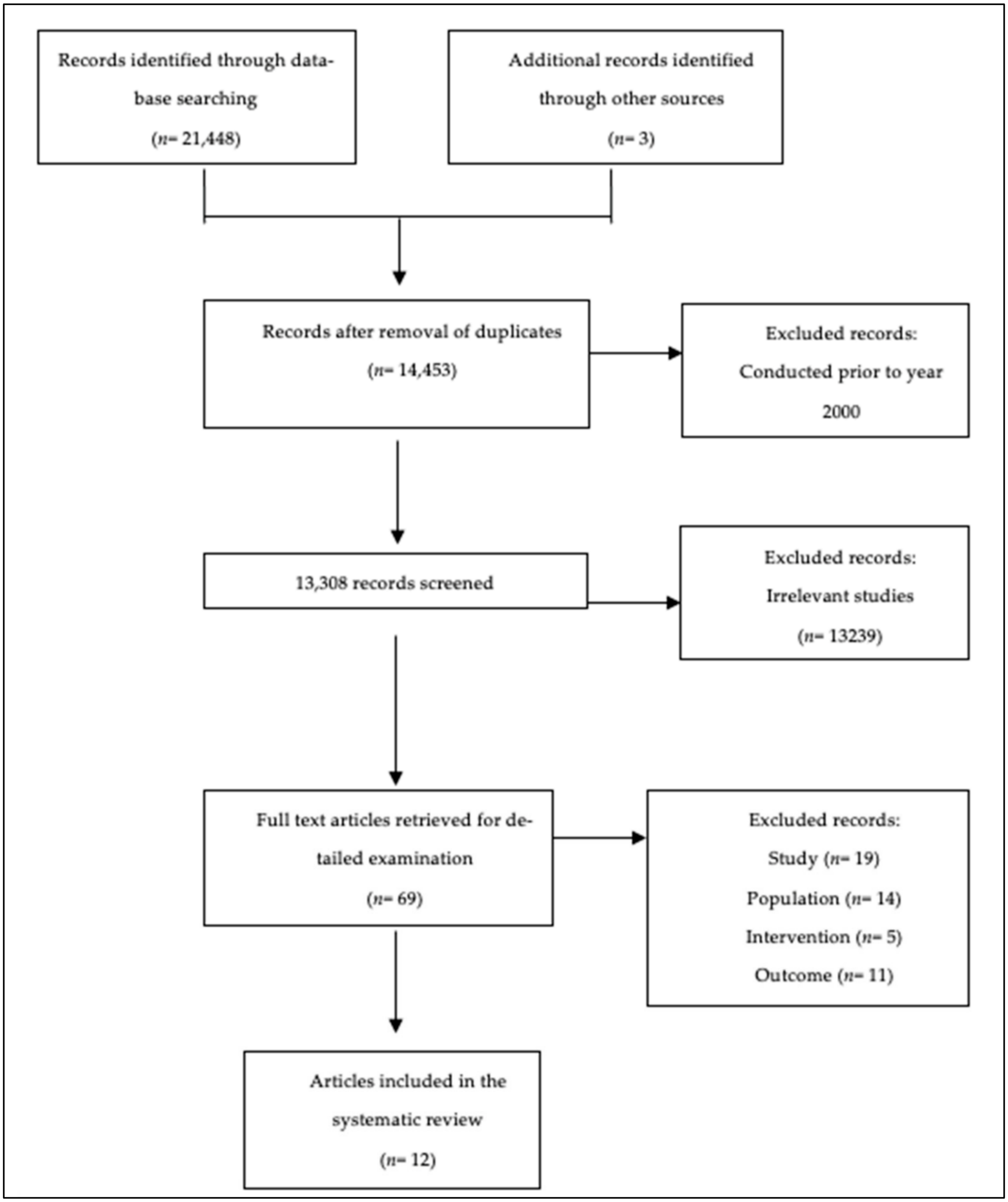

Figure 2 An image of a PRISMA flowchart showing the information flow at various stages of this review.

3.2 Research strategies.

Electronic databases used by the scholars included PsycInfo, PubMed, Academic Search Complete, and Cochrane Library. We obtained RCTs (Randomized clinical trials) between 2000 and 2021.

Database	Searched Terms
PubMed	(nutrient OR nutrition OR micronutrient OR macronutrient OR diet OR dietary OR "food intake" OR "meal diversity") AND ("child development" OR cognition OR focus OR brain OR attentiveness OR attention OR memory OR verbal OR vocabulary OR learning OR literacy OR neuro* OR problem-solving OR reasoning OR "school performance" OR "school achievement" OR "academic achievement" OR "educational measurement" OR "academic success" OR "academic performance") AND (randomized controlled trial [pt] OR controlled clinical trial [pt] OR randomized [tiab] OR placebo [tiab] OR clinical trials OR randomly [tiab] OR trial [ti]) AND (child OR children OR preschool OR "pre-school")
CENTRAL	(nutrient* OR nutrition* OR micronutrient* OR macronutrient* OR diet* OR "food intake" OR "meal diversity") AND ("child development" OR cognition OR focus OR brain OR attentiveness OR attention OR memory OR verbal OR vocabulary OR learning OR literacy OR neuro* OR problem-solving OR reasoning OR "school performance" OR "school achievement" OR "academic achievement" OR "educational measurement") AND (child OR children OR preschool OR "pre-school")
PsycInfo and Academic Search Complete	(nutrient* OR nutrition* OR micronutrient* OR macronutrient* OR diet* OR "food intake" OR "meal diversity") AND ("child development" OR cognition OR focus OR brain OR attentiveness OR attention OR memory OR verbal OR vocabulary OR learning OR literacy OR neuro* OR problem-solving OR reasoning OR "school performance" OR "school achievement" OR "academic achievement" OR "educational measurement") AND (random* OR control* OR trial* OR placebo* OR "double-blind") AND (child OR children OR preschool OR "pre-school")

Figure 3In accordance with the Cochrane highly sensitive search algorithms for finding randomized clinical trials, query phrases were modified for each source to improve document collection.

3.3 Data Extraction

One researcher worked independently to evaluate the qualification of the abstracts and titles returned by the initial computerized search. Two other writers separately evaluated the qualifying full-text entries. Discussions and a fourth author's help were used to clarify qualifying disputes by authors. To make sure that no important research was overlooked in this review, a backward search was conducted, during which the source pages of relevant papers were examined.

RCTs completed following the year 2000, and that evaluated the cognitive effects of food enrichment, fortification, or diet therapies on individuals between the ages of 2 and 6 were included in the study. Cross-sectional studies, non-randomized managed trials, small sample size RCTs (60 subjects), trials conducted in disorder populations, studies focusing on kids older than 6 or younger than 2, trials offering dietary habits targeted to the first 1000 days of life, and trials that only offered family proper nutrition as the nutritional involvement were all excluded.

Criteria	Study Design	Population	Intervention	Outcome
Include	RCTs conducted after the year 2000	Preschool Children (2–6 years of age)	Nutritional intervention including food-based, single, and multiple micronutrient supplementation intervention/s	Cognitive outcomes measured using cognitive assessment tests
		Healthy children and children suffering from undernutrition, anemia, parasitic infections, or HIV	Nutritional intervention/s provided after the first 1000days and in children <6 years of age	Cognition was measured after the first 1000 days or in children <6 years of age
	All other study designs and animal studies RCTs with a sample size <60 subjects	Newborns, infants, primary school-aged children, adolescents, adults, elderly	Nutritional intervention/s not provided to preschool-aged children	Cognitive outcomes not measured in preschool-aged children
Exclude		Children with specific diseases, such as cystic fibrosis, attention deficit hyperactivity disorder (ADHD), epilepsy, phenylketonuria, autism, and gluten-related neurological disorders		

Figure 4inclusion and exclusion criteria.

4. RESULTS

4.1 Selection of Studies

After filtering the data, the extensive database produced 14,453 entries. Thirteen thousand two hundred thirty-nine papers were discarded after abstracts and titles were examined. 69 full-text publications overall were evaluated further. Through a reverse review of the list of references of all those publications, three papers were found out of the 12 RCTs that this meta-analysis found that matched the inclusion criteria.

The significant degree of study variability made a meta-analysis inappropriate for this evaluation. Particularly, there were significant interpretation difficulties due to heterogeneity in the definition and measurement of developmental function and the kind and duration of dietary treatments.

4.2 Summary of Studies

In conclusion, 50 percent of studies were carried out in wealthy nations and 50 percent in low- to middle-income (LMIC) nations. Six experiments were carried out in urban regions with high-income status, and four experimental research in rural areas with low economic factors.

YEAR, COUNTRY	AGE	SUBJECT CHARACTERISTICS AT BASELINE	DURATION	MAJOR COGNITIVE OUTCOMES
2014, Germany	4-6 years	High socioeconomic class, urban setting, and youngsters in good health with modest but adequate total folate catabolite concentrations (34 nmol/mmol creatinine)	3 months	short-term memory, cognitive speed, and verbal intelligence
2017, Ethiopia	4-6 years	Two control and four intervention districts were in rural areas with poor socioeconomic status and had high baseline UIC levels.	10 months	School preparedness, both verbal and nonverbal thinking
2019, Germany	4-6 years	Higher socioeconomic status, urban setting, and healthy children	4 months	abilities in coding, signal research, word and structure thinking, word and verbal reasoning, vocabulary, a form of expression, and fine motor capabilities.
2021, India	3-5 years	Rural areas, poor economic standing, ICDS recipients alone, and kids with hemoglobin levels over 7 g/dL	8 months	receiving visual information, developing speech patterns, and fine motor skills
2018, Norway	4- 6 years	Higher socio-economic status, urban setting, and healthy children	4 months	abilities in coding, symbol research, word and matrix thinking, word and verbal ability, literacy, and visual concepts, including fine motor capabilities.
2018, Indonesia	3-5 years	Children living in urban areas in the middle to upper nations with below-average levels of domestic stimulation, adequate brain development, and weight for height within two standard	6 months	Remembering, vocabulary, intellectual abilities, challenge, attention, and learning ability

	deviations of the average z-score	

Table 1 Survey of Randomized trials, examines how dietary treatments affect young children's cognitive growth.

4.3 study participants

Most of the research participants were healthier preschoolers. Yet, kids with low folate levels, kids at risk for malnutrition and micronutrient inadequacies, kids with anemia, and kids using anthelmintics were also taken into account.

5. DISCUSSIONS

According to this analysis, nutrient treatments dramatically enhance the cognitive performance of undernourished preschoolers. Studies carried out in LMICs indicated that the cognitive abilities of nutrient-deprived kids who obtained dietary treatments regularly improved. However, given the clinical variance of the qualifying studies, care should be exercised when analyzing the results. Iron-supplemented preschoolers with anemia may learn things more quickly and make fewer errors. These results concur with those of other systematic studies. Children who received goal enrichment showed greater data processing, interpretation, and challenge capabilities.

Micronutrient intake is a useful approach to re-establish nutrient balance and boost the potential of malnourished preschool-aged children, given the adverse consequences of poor nutrition on child literacy and social and emotional abilities. Although it is commonly known that a child's first 1000 days of life are most important for brain formation and growth, this analysis contends that the next 1000 days are just as important for cognitive development. Thus, nutritional interventions that are given to preschool-aged children who are at risk for inadequate intake can help them further improve their cognitive skills. Although nutritional replenishment treatments can have positive results, operational, financial, and durability issues may make it difficult to plan and carry out trials based on supplements. Furthermore, the multiple-micronutrient enrichment controlled trials covered in this review had good short-term impacts on cognition, but there is no information on the long-term effectiveness of such treatments.

We are unaware of any studies investigating the advantages of a higher fruit and vegetable diet on preschoolers' cognitive development. Additionally, no study assessed how better nutritional diversity affected toddlers' cognitive skills. When a child consumes five or more of the eight food groups that are advised, such as breastfeeding, cereals, roots, and root vegetables, legumes and nuts, milk and cheese products (milk, yogurt, cheese), meat foods (meat, fish, poultry, liver, or other organs), eggs, and other vegetables and fruits that are high in vitamin A, dietary supplementation is considered to be sufficient.

6. CONCLUSION

Our study showed that cognitive deficits are very common, notably in the manual and ocular domains. Additionally, it showed that poor nutrition was uncommon in this semi-urban area, whereas overnutrition was present. It validated the link between nutritional intake and neurodevelopmental quotient, showing that underweight children are more likely to experience delays in the socially interactive sector, vocabulary, and auditory.

Macro- and micronutrient supplementation has been identified as a viable therapeutic option to overcome developmental deficits in children. Nevertheless, future research must be planned to determine the date of this comeback after food fortification and the magnitude of this restoration in terms of changes in the developmental factor. It will be easier to comprehend how diet affects infant development when combined with other risk variables (such as primary caregivers, societal practices, parental education, etc.

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