بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Agricultural Studies

Department of Food Science and Technology

Food and Environment and Their Impact on Intelligence (Academic Performance)

الغذاء و البيئة و أثرهما على الذكاء (الأداء الأكاديمي)

A Dissertation Submitted in Partial Fulfillment of the Requirements for

The Degree of B.Sc. (Honor)

In the Department of Food Science and Technology

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قال تعالى :

(وَفِي الْأَرْضِ قِطَعٌ مُتَجَاوِرَاتٌ وَجَنَّاتٌ مِنْ أَعْنَابٍ وَزَرْعٌ وَنَخِيلٌ صِنْوَانٌ وَغَيْرُ صِنْوَانٍ يُسْقَىٰ بِمَاءٍ وَاحِدٍ وَنُفَضِّلُ بَعْضَهَا عَلَىٰ بَعْضٍ فِي الْأُكُلِ ۚ إِنَّ فِي ذَٰلِكَ لَآيَاتٍ لِقَوْمٍ يَعْقِلُونَ)

صدق الله العظيم

سورة الرعد الأية (4)

Exordium

Allah the Almighty says:

(And in the earth are tracts (diverse though) neighboring, and gardens of vines and fields sown with corn, and palm trees - growing out of single roots or otherwise: watered with the same water, yet some of them we make more excellent than others to eat. Behold, verily in these things there are signs for those who understand!)

Surah Al-Thunder Verse (4).

DEDICATION

To our Fathers and Mothers

To our Brothers and Sisters

To our teachers

To our friends.

ACKNOWLEDGEMENT

This dissertation was accomplished with the contribution and support of very valuable people. In turn, we would like to express our greatest appreciation for each of these people in order to endure their support and assistance.

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ABSTRACT

The aim of this study was to know the relationship between food and intelligence. The students from the eighth grade were questioned in four schools (ten students from each class as a random sample), two schools in a rural area (ALwadi al akhder schools "Boys and Girls"), and two schools in an urban area (Bahri) (Al Qabas schools " Boys and Girls").

Then the statistical analysis of the data obtained by means of the questionnaire was performed.

It's was found that the significant effect of nutritional behavior on the student was very clear in Al Qabas Boys School, and the data correlation is 99%.

In Al Qabas Girls School, the data correlation rate was 84%

As for ALwadi al Akhder School for Boys, the data correlation rate was 86%

The data correlation in girls' school is 40%. And there is a weak significant effect.

The food has a significant effect on rate of intelligence, but in a small percentage compared to other factors.

ملخص الدراسة

الهدف من هذه الدراسة هو معرفة العلاقة بين الغذاء والذكاء . أجرينا إستبيان للصف الثامن في أربع مدارس (عشرة طلاب من كل فصل كعينة عشوائية) ، ومدرستان في منطقة ريفية (مدرسة الوادي الأخضر "بنين وبنات") ، ومدرستين في منطقة حضرية (بحري) (مدارس القبس "بنين وبنات").

ثم تم إجراء التحليل الإحصائي للبيانات التي تم الحصول عليها عن طريق الاستبيان. وجدنا أن التأثير المعنوي للسلوك الغذائي على الطالب واضح جداً في مدرسة القبس للبنين ، وارتباط البيانات ٩٩٪ .

وفي مدرسة القبس للبنات بلغ معدل إرتباط البيانات ٨٤٪ . أما مدرسة الوادي الأخضر للبنين فقد بلغ معدل ارتباط البيانات ٨٦٪ .و إرتباط البيانات في مدرسة الوادي الأخضر للبنات هو ٤٠٪ . و لكن التأثير المعنوي ضعيف .

خلصنا إلى أن الغذاء له تأثير معنوي على معدل الذكاء ، ولكن بنسبة قليلة مقارنة بالعوامل الأخرى .

CHAPTER ONE

INTRODUCTION

Since God created man and gave him the ability to strive and spread, he worked diligently to obtain food that enables him to live and last and to maintain himself, and this matter is innate and instinctive since the beginning of life, and the evidence for that is the story of Adam and Eve, upon them be peace, when the instinct and the desire for food led them to forget the command of God and fall into sin: "We have made a commitment to Adam before So he forgot, and we found no determination for him "(Taha: 115).

Perhaps the association of food with the first incident in human history shows the importance of food in a person's life and in influencing his behavior. The Almighty said: (Say: Are those who know equal and those who do not know only remember those who have taken care) (Al-Zumar 9) .

And recent scientific research has indicated that the human brain is a vital organ that needs a set of nutrients in order to function well, and research has shown that the brain also feels hungry, and in order to function efficiently, it needs a complete and balanced diet of sugars, protons, fats, vitamins and salt, water and starches. when the brain lacks one of these elements, its electricity is cut off that is why scientists are working at the present time to study the types of food that ensure the best brain performance of its functions.

Intelligence is usually determined by the genetic factor in a ratio of (60 to 65%), especially with regard to children .

It is related to computational intelligence, which is the ability to solve problems and the ability to relate things together and elicit relationships that are measured by psychological tests and measures that determine capacity .

The child solves problems by thinking between himself and himself.

As for social intelligence, which is the ability to establish social relationships , and to act within the group spontaneously and successfully comes through socialization and the degree of mixing with the environment surrounding the child and the degree to which he is allowed to deal with environmental variables. To social contact and increasing influences that develop his mental abilities and talents . In addition to these factors there is the mother's health during pregnancy , child - birth and breastfeeding .

A theoretical study of some aspects related to intelligence and food from the point of view of developmental psychology works to raise the level of intelligence as well as the economic and social climate in the family. The possibility of providing entertainment, play and entertainment, all of this must be available within the family to raise the level of intelligence

Nutrition is an example of the connection between the external environment and the human body.

Nutrients contain the vital chemicals needed for human life effect on the functions of the central nervous system as well as its effective effect on the biological processes of the body. Dietetics is concerned with studying the components of what the human body requires of the necessary nutrients and the extent to which they are used according to the following variables: (age, gender، the atmosphere, function, biological condition, health, biological processes, chemical reactions, tissue building, and energy generation), and the mind is that mysterious, vibrant mine that manages the main functions of the body and controls feelings and emotions .

Also, intelligence is a general innate ability that a person is born with and continues with him throughout his life. Therefore, it is imperative to search for the best fuel for minds.

General objective:

Food and Environment and Their Impact on Intelligence (Academic Performance).

Specific objectives:

1. The effect of diet on student intelligence (academic performance).
2. The impact of economic aspects on students' intelligence (academic performance).
3. The effect of meal regularity on students' intelligence (academic performance).
4. The impact of the environment on students' intelligence (academic performance).
5. The effect of parent education on students' intelligence (academic performance)

CHAPTER TWO
LITERTURE REVIEW

2.1 Intelligence:

- Defining and classifying intelligence is extremely complicated. Theories of intelligence range from having one general intelligence (g), to certain primary mental abilities, and to multiple category-specific intelligences.

- Following the creation of the Binet-Simon scale in the early 1900s, intelligence tests, now referred to as intelligence quotient (IQ) tests, are the most widely-known and used measure for determining an individual's intelligence.

- Although these tests are generally reliable and valid tools, they do have their flaws as they lack cultural specificity and can evoke stereotype threat and self-fulfilling prophecies.

- IQ scores are typically normally distributed, meaning that 95% of the population has IQ scores between 70 and 130. However, there are some extreme examples of people with scores far exceeding 130 or far below 70.

2.1.1 What Is Intelligence?

It might seem useless to define such a simple word. After all, we have all heard this word hundreds of times and probably have a general understanding of its meaning. However, the concept of intelligence has been a widely debated topic among members of the psychology community for decades.

Intelligence has been defined in many ways: higher level abilities (such as abstract reasoning, mental representation, problem solving, and decision

making), the ability to learn, emotional knowledge, creativity, and adaptation to meet the demands of the environment effectively.

Psychologist Robert Sternberg defined intelligence as "the mental abilities necessary for adaptation to, as well as shaping and selection of, any environmental context (1997).

2.1.2 A Brief History of Intelligence:

The study of human intelligence dates back to the late 1800s when Sir Francis Galton (the cousin of Charles Darwin) became one of the first people to study intelligence.

Galton was interested in the concept of a gifted individual, so he created a lab to measure reaction times and other physical characteristics to test his hypothesis that intelligence is a general mental ability that is a produce of biological evolution (hello, Darwin).

Galton theorized that because quickness and other physical attributes were evolutionarily advantageous, they would also provide a good indication of general mental ability (Jensen, 1982). Thus, Galton operationalized intelligence as reaction time.

Operationalization is an important process in research that involves defining an unmeasurable phenomenon (such as intelligence) in measurable terms (such as reaction time), allowing the concept to be studied empirically (Crowthre-Heyck, 2005).

Galton's study of intelligence in the laboratory setting and his theorization of the heritability of intelligence paved the way for decades of future research and debate in this field.

2.1.3 Types of Intelligence:

Intelligence has three aspects: analytical, creative, and practical (Sternberg, 1985).

I. **Analytical intelligence**, also referred to as componential intelligence, refers to intelligence that is applied to analyze or evaluate problems and arrive at solutions. This is what a traditional IQ test measure.

II. **Creative intelligence** is the ability to go beyond what is given to create novel and interesting ideas. This type of intelligence involves imagination, innovation and problem-solving.

III. **Practical intelligence** is the ability that individuals use to solve problems faced in daily life, when a person finds the best fit between themselves and the demands of the environment. Adapting to the demands environment involves either utilizing knowledge gained from experience to purposefully change oneself to suit the environment (adaptation), changing the environment to suit oneself (shaping), or finding a new environment in which to work (selection).

2.1.4 Other Types of Intelligence

Spearman claims that intelligence is generalizable across many different areas of life, and on the other hand, psychologists such as Thurstone, Gardener, and Sternberg hold that intelligence is like a tree with many different branches, each representing a specific form of intelligence.

To make matters even more interesting, let's throw a few more types of intelligence into the mix!

Emotional Intelligence

Emotional Intelligence is the "ability to monitor one's own and other people's emotions, to discriminate between different emotions and label them appropriately, and to use emotional information to guide thinking and behaviour" (Salovey and Mayer, 1990).

Emotional intelligence is important in our everyday lives, seeing as we experience one emotion or another nearly every second of our lives. You may not associate emotions and intelligence with one another, but in reality, they are much related.

Emotional intelligence refers to the ability to recognize the meanings of emotions and to reason and problem-solve on the basis of them (Mayer, Caruso, & Salovey, 1999). The four key components of emotional Intelligence are (i) self-awareness, (ii) self-management, (iii) social awareness, and (iv) relationship management.

In other words, if you are high in emotional intelligence, you can accurately perceive emotions in yourself and others (such as reading facial expressions), use emotions to help facilitate thinking, understand the meaning behind your emotions (why are you feeling this way?), and know how to manage your emotions (Salovey & Mayer, 1990).

Fluid vs. Crystallized Intelligence

Raymond Cattell (1963) first proposed the concepts of fluid and crystallized intelligence and further developed the theory with John Horn..

Fluid intelligence is the ability to problem solve in novel situations without referencing prior knowledge, but rather through the use of logic and abstract thinking. Fluid intelligence can be applied to any novel problem because no

specific prior knowledge is required (Cattell, 1963). As you grow older fluid increases and then starts to decrease in the late 20s.

Crystallized intelligence

Refers to the use of previously-acquired knowledge, such as specific facts learned in school or specific motor skills or muscle memory (Cattell, 1963). As you grow older and accumulate knowledge, crystallized intelligence increases.

The Cattell-Horn (1966) theory of fluid and crystallized intelligence suggests that intelligence is composed of a number of different abilities that interact and work together to produce overall individual intelligence

For example, if you are taking a hard math test, you rely on your crystallized intelligence to process the numbers and meaning of the questions, but you may use fluid intelligence to work through the novel problem and arrive at the correct solution. It is also possible that fluid intelligence can become crystallized intelligence.

The novel solutions you create when relying on fluid intelligence can, over time, develop into crystallized intelligence after they are incorporated into long-term memory.

This illustrates some of the ways in which different forms of intelligence overlap and interact with one another, revealing its dynamic nature.

2.1.5 Extremes of Intelligence

IQ scores are generally normally distributed (Moore et al., 2013). That is, roughly 95% of the population has IQ scores between 70 and 130. But what about the other 5%?

Individuals who fall outside this range represent the extremes of intelligence.

Those who have an IQ above 130 are considered to be gifted (Lally & French, 2018), such as Christopher Langan, an American horse rancher, who has an IQ score around 200 (Gladwell, 2008).

Those individuals who have scores below 70 do so because of an intellectual disability, marked by substantial developmental delays, including motor, cognitive, and speech delays (De Light, 2012).

Some of the time, these disabilities are the product of genetic mutations.

Down syndrome, for example, resulting from extra genetic material from or a complete extra copy of the 21st chromosome, is a common genetic cause of an intellectual disability (Breslin, 2014). As such, many individuals with down syndrome have below average IQ scores (Breslin, 2014).

Savant syndrome is another example of an extreme of intelligence. Despite having significant mental disabilities, these individuals demonstrate certain abilities in some fields that are far above average, such as incredible memorization, rapid mathematical or calendar calculation ability, or advanced musical talent (Treffert, 2009).

The fact that these individuals who may be lacking in certain areas such as social interaction and communication make up for it in other remarkable areas, further illustrates the complexity of intelligence and what this concept means today, as well as how we must consider all individuals when determining how to perceive, measure, and recognize intelligence in our society.

2.2 What is Food?

Food is the third most important thing for living beings to provide energy and development, maintain life, or stimulate growth after air and water. In fact, it is one of the most complicated sets of chemicals. Food plays an important role in the promotion of health and disease prevention.

In general, it consists of essential nutrients, such as carbohydrates, proteins, fats, minerals and vitamins which are consumed to provide nutritional support for an organism and ingested by an organism and assimilated by the organism's cells to sustain health. These nutritious foods are in the form of grains, pulses, fruits, vegetables, oils, etc.

We must know that the terms 'food' and 'nutrition' are sometimes used synonymously, which is not correct completely. Food is a composite mixture of various ingredients that are consumed for nutrition. On the other hand, nutrition connotes a dynamic process in which swallowed food is utilized by the human body for nourishment. As much as we eat, our body gets nourished. When there is an insufficient intake of protein, energy or carbohydrate, there is often illness or infection.

2.3 Effects of feeding on cognition

Neural circuits that are involved in feeding behavior show precise coordination with brain centers that modulate energy homeostasis and cognitive function. The effects of food on cognition and emotions can start before the act of feeding itself, as the recollection of foods through olfactory and visual sensory inputs alters the emotional status of the brain. The ingestion of foods triggers the release of hormones or peptides, such as insulin and glucagon-like peptide, into the circulation; these substances can then reach centers such as the hypothalamus and the hippocampus and

activate signal-transduction pathways that promote synaptic activity and contribute to learning and memory. In turn, the lack of food that is signaled by an empty stomach can elicit the release of ghrelin, which can also support synaptic plasticity and cognitive function. Chemical messages derived from adipose tissue through leptin can activate specific receptors in the hippocampus and the hypothalamus, and influence learning and memory. The positive actions of leptin on hippocampus-dependent synaptic plasticity — that is, its actions on NMDA (*N*-methyl-_-aspartate) receptor function and long-term potentiation facilitation — are well characterized. Insulin-like growth factor 1 (IGF1) is produced by the liver and by skeletal muscle in response to signals derived from metabolism and exercise. IGF1 can signal to neurons in the hypothalamus and the hippocampus, with resulting effects on learning and memory performance. In addition to regulating appetite, the hypothalamus coordinates activity in the gut and integrates visceral function with limbic-system structures such as the hippocampus, the amyg-dala and the cerebral cortex. Visceral signals can also modulate cognition and body physiology through the hypothalamic–pituitary axis (HPA). The effects of the hypothalamus can also involve the immune system, as it heavily innervates the thymus and several immune-system molecules can affect synaptic plasticity and cognition. The parasympathetic innervation of the gut by the vague nerve provides sensory information to the brain, enabling gut activity to influence emotions. In turn, emotions can also influence the viscera through parasympathetic afferents in the vague nerve. Vagal nerve stimulation is being used therapeutically to treat chronic depression.

2.4 Effects of nutrients on cognition

Several dietary components have been identified as having effects on cognitive abilities (Table 2.1). Dietary factors can affect multiple brain processes by regulating neurotransmitter pathways, synaptic transmission,

membrane fluidity and signal-transduction pathways. This section focuses on recent evidence that shows the capacity of nutrients to affect neural pathways that are associated with synaptic plasticity.

Table (2.1): Select nutrients that affect cognitive function

Nutrient	effects on cognition and emotion	food sources
Omega-3 fatty acids (for example, docosahexaenoic acid)	Amelioration of cognitive decline in the elderly basis for treatment in patients with mood disorders ; improvement of cognition in traumatic brain injury in rodents ; amelioration of cognitive decay in mouse model of Alzheimer's disease	Fish (salmon), flax seeds, krill, chia, kiwi fruit, butternuts, walnuts
Curcumin	Amelioration of cognitive decay in mouse model of Alzheimer's disease ; amelioration of cognitive decay in traumatic brain injury in rodent	Turmeric (curry spice)
Flavonoids	Cognitive enhancement in combination with exercise in rodents ; improvement of cognitive function in the elderly	Cocoa, green tea, Ginkgo tree, citrus fruits, wine (higher in red wine), dark chocolate
Saturated fat	Promotion of cognitive decline in adult rodents−aggravation of cognitive impairment after brain trauma in rodents ; exacerbation of cognitive decline in aging humans	Butter, ghee, suet, lard, coconut oil, cottonseed oil, palm kernel oil, dairy products (cream, cheese), meat
B vitamins	Supplementation with vitamin B6, vitamin B12 or folate has positive effects on memory performance in women of various ages ; vitamin B12 improves cognitive impairment in rats fed a choline-deficient diet	Various natural sources. Vitamin B12 is not available from plant products
Vitamin D	Important for preserving cognition in the elderly	Fish liver, fatty fish, mushrooms, fortified products, milk, soy milk, cereal grains

Nutrient	effects on cognition and emotion	food sources
Vitamin E	Amelioration of cognitive impairment after brain trauma in rodents reduces cognitive decay in the elderly	Asparagus, avocado, nuts, peanuts, olives, red palm oil, seeds, spinach, vegetable oils, wheatgerm
Choline	Reduction of seizure-induced memory impairment in rodents a review of the literature reveals evidence for a causal relationship between dietary choline and cognition in humans and rats	Egg yolks, soy beef, chicken, veal, turkey liver, lettuce
Combination of vitamins (C, E, carotene)	Antioxidant vitamin intake delays cognitive decline in the elderly	Vitamin C: citrus fruits, several plants and vegetables, calf and beef liver. Vitamin E: see above
Calcium, zinc, selenium	High serum calcium is associated with faster cognitive decline in the elderly ; reduction of zinc in diet helps to reduce cognitive decay in the elderly ; lifelong low selenium level associated with lower cognitive function in humans	Calcium: milk, coral. Zinc: oysters, a small amount in beans, nuts, almonds, whole grains, sunflower seeds. Selenium: nuts, cereals, meat, fish, eggs
Copper	Cognitive decline in patients with Alzheimer's disease correlates with low plasma concentrations of copper	Oysters, beef/lamb liver, Brazil nuts, blackstrap molasses, cocoa, black pepper
Iron	Iron treatment normalizes cognitive function in young women	Red meat, fish, poultry, lentils, beans

2.5 Best Foods to Boost Brain and Memory:

2.5.1 Fatty Fish

When people talk about brain foods, fatty fish is often at the top of the list.

This type of fish includes salmon, trout and sardines, which are all rich sources of omega-3 fatty acids .

About 60% of your brain is made of fat, and half of that fat is the omega-3 kind.

Your brain uses omega-3s to build brain and nerve cells, and these fats are essential for learning and memory.

Omega 3-s also has a couple additional benefits for your brain.

For one thing, they may slow age-related mental decline and help ward off Alzheimer's disease on the flip side, not getting enough omega-3s is linked to learning impairments, as well as depression.

In general, eating fish seems to have positive health benefits.

One study found that people who ate baked or broiled fish regularly had more gray matter in their brains. Gray matter contains most of the nerve cells that control decision making, memory and emotion. Overall, fatty fish is an excellent choice for brain health.

Summary:

Fatty fish is a rich source of omega-3s, a major building block of the brain. Omega-3s play a role in sharpening memory and improving mood, as well as protecting your brain against decline.

2.5.2 Coffee

If coffee is the highlight of your morning, you'll be glad to hear that it's good for you.

Two main components in coffee — caffeine and antioxidants — help your brain.

The caffeine in coffee has a number of positive effects on the brain, including:

- **Increased alertness:** Caffeine keeps your brain alert by blocking adenosine, a chemical messenger that makes you sleepy .**Improved mood:** Caffeine may also boost some of your "feel-good" neurotransmitters, such as serotonin.
- **Sharpened concentration:** One study found that when participants drank one large coffee in the morning or smaller amounts throughout the day, they were more effective at tasks that required concentration. Drinking coffee over the long term is also linked to a reduced risk of neurological diseases, such as Parkinson's and Alzheimer's.

This could at least be partly due to coffee's high concentration of antioxidants.

Summary:

Coffee can help boost alertness and mood. It may also offer some protection against Alzheimer's, thanks to its caffeine and antioxidants.

2.5.3 Blueberries

Blueberries provide numerous health benefits, including some that are specifically for your brain.

Blueberries and other deeply colored berries deliver anthocyanins, a group of plant compounds with anti-inflammatory and antioxidant effects. Antioxidants act against both oxidative stress and inflammation, conditions that may contribute to brain aging and neurodegenerative diseases.

Some of the antioxidants in blueberries have been found to accumulate in the brain and help improve communication between brain cells. Animal studies have shown that blueberries help improve memory and may even delay short-term memory loss.

Try sprinkling them on your breakfast cereal or adding them to a smoothie.

Summary:

Blueberries are packed with antioxidants that may delay brain aging and improve memory.

2.5.4 Turmeric

Turmeric has generated a lot of buzz recently.

This deep-yellow spice is a key ingredient in curry powder and has a number of benefits for the brain.

Curcumin, the active ingredient in turmeric, has been shown to cross the blood-brain barrier, meaning it can directly enter the brain and benefit the cells there.

It's a potent antioxidant and anti-inflammatory compound that has been linked to the following brain benefits:

- **May benefit memory:** Curcumin may help improve memory in people with Alzheimer's. It may also help clear the amyloid plaques that are a hallmark of this disease.
- **Eases depression:** It boosts serotonin and dopamine, which both improve mood. One study found curcumin improved depression symptoms just as much as an antidepressant over six weeks.
- **Helps new brain cells grow:** Curcumin boosts brain-derived neurotrophic factor, a type of growth hormone that helps brain cells grow. It may help delay age-related mental decline, but more research is needed

To reap the benefits of curcumin, try cooking with curry powder, adding turmeric to potato dishes to turn them golden or making turmeric tea.

Summary:

Turmeric and its active compound curcumin have strong anti-inflammatory and antioxidant benefits, which help the brain. In research, it has reduced symptoms of depression and Alzheimer's disease.

2.5.5. Broccoli

Broccoli is packed with powerful plant compounds, including antioxidants .

It's also very high in vitamin K, delivering more than 100% of the Recommended Daily Intake (RDI) in a 1-cup (91-gram) serving .

This fat-soluble vitamin is essential for forming sphingolipids, a type of fat that's densely packed into brain cells.

A few studies in older adults have linked a higher vitamin K intake to better memory.

Beyond vitamin K, broccoli contains a number of compounds that give it anti-inflammatory and antioxidant effects, which may help protect the brain against damage.

Summary:

Broccoli contains a number of compounds that have powerful antioxidant and anti-inflammatory effects, including vitamin K.

Take our free 3-question diet quiz

Our free assessment ranks the best diets for you based on your answers to 3 quick questions.

2.5.6 Pumpkin Seeds

Pumpkin seeds contain powerful antioxidants that protect the body and brain from free radical damage.

They're also an excellent source of magnesium, iron, zinc and copper.

Each of these nutrients is important for brain health:

- **Zinc:** This element is crucial for nerve signaling. Zinc deficiency has been linked to many neurological conditions, including Alzheimer's disease, depression and Parkinson's disease.
- **Magnesium:** Magnesium is essential for learning and memory. Low magnesium levels are linked to many neurological diseases, including migraines, depression and epilepsy
- **Copper:** Your brain uses copper to help control nerve signals. And when copper levels are out of whack, there's a higher risk of neurodegenerative disorders, such as Alzheimer's.

Iron:

- Iron deficiency is often characterized by brain fog and impaired brain function.

The research focuses mostly on these micronutrients, rather than pumpkin seeds themselves. However, since pumpkin seeds are high in these micronutrients, you can likely reap their benefits by adding pumpkin seeds to your diet.

Summary:

Pumpkin seeds are rich in many micronutrients that are important for brain function, including copper, iron, magnesium and zinc.

2.5.7 Dark Chocolate

Dark chocolate and cocoa powder are packed with a few brain-boosting compounds, including flavonoids, caffeine and antioxidants.

Flavonoids are a group of antioxidant plant compounds.

The flavonoids in chocolate gather in the areas of the brain that deal with learning and memory. Researchers say these compounds may enhance memory and also help slow down age-related mental decline. In fact, a number of studies back this up.

In one study including over 900 people, those who ate chocolate more frequently performed better in a series of mental tasks, including some involving memory, than those who rarely ate it. Chocolate is also a legitimate mood booster, according to research.

One study found that participants who ate chocolate experienced increased positive feelings, compared to participants who ate crackers. However, it's still not clear whether that's because of compounds in the chocolate, or simply because the yummy flavor makes people happy.

Summary:

The flavonoids in chocolate may help protect the brain. Studies have suggested that eating chocolate could boost both memory and mood.

2.5.8 Nuts

Research has shown that eating nuts can improve markers of heart health, and having a healthy heart is linked to having a healthy brain. A 2014 review showed that nuts can improve cognition and even help prevent neurodegenerative diseases.

Also, another large study found that women who ate nuts regularly over the course of several years had a sharper memory, compared to those who didn't eat nuts. Several nutrients in nuts, such as healthy fats, antioxidants and vitamin E, may explain their brain-health benefits.

Vitamin E shields cell membranes from free radical damage, helping slow mental decline.

While all nuts are good for your brain, walnuts may have an extra edge, since they also deliver omega-3 fatty acids.

Summary:

Nuts contain a host of brain-boosting nutrients, including vitamin E, healthy fats and plant compounds.

2.5.9 Oranges

You can get all the vitamin C you need in a day by eating one medium orange.

Doing so is important for brain health, since vitamin C is a key factor in preventing mental decline.

Eating sufficient amounts of vitamin C-rich foods can protect against age-related mental decline and Alzheimer's disease, according to a 2014 review article.

Vitamin C is a powerful antioxidant that helps fight off the free radicals that can damage brain cells. Plus, vitamin C supports brain health as you.

You can also get excellent amounts of vitamin C from bell peppers, guava, kiwi, tomatoes and strawberries.

Summary:

Oranges and other foods that are high in vitamin C can help defend your brain against damage from free radicals.

2.5.10 Eggs

Eggs are a good source of several nutrients tied to brain health, including vitamins B6 and B12, folate and choline.

Choline is an important micronutrient that your body uses to create acetylcholine, a neurotransmitter that helps regulate mood and memory.

Two studies found that higher intakes of choline were linked to better memory and mental function.

Nevertheless, many people don't get enough choline in their diet.

Eating eggs is an easy way to get choline, given that egg yolks are among the most concentrated sources of this nutrient.

Adequate intake of choline is 425 mg per day for most women and 550 mg per day for men, with just a single egg yolk containing 112 mg .

Furthermore, the B vitamins have several roles in brain health.

To start, they may help slow the progression of mental decline in the elderly .

Also, being deficient in two types of B vitamins — folate and B12 — has been linked to depression .

Folate deficiency is common in elderly people with dementia, and studies show that folic acid supplements can help minimize age-related mental decline .

B12 is also involved in synthesizing brain chemicals and regulating sugar levels in the brain .

It's worth noting that there's very little direct research on the link between eating eggs and brain health. However, there is research to support the brain-boosting benefits of the nutrients found in eggs.

Summary:

Eggs are a rich source of several B vitamins and choline, which are important for proper brain functioning and development, as well as regulating mood.

2.5.11 Green Tea

As is the case with coffee, the caffeine in green tea boosts brain function.

In fact, it has been found to improve alertness, performance, memory and focus .

But green tea also has other components that make it a brain-healthy beverage.

One of them is L-theanine, an amino acid that can cross the blood-brain barrier and increase the activity of the neurotransmitter GABA, which helps reduce anxiety and makes you feel more relaxed.

L-theanine also increases the frequency of alpha waves in the brain, which helps you relax without making you feel tired.

One review found that the L-theanine in green tea can help you relax by counteracting the stimulating effects of caffeine ,

It's also rich in polyphenols and antioxidants that may protect the brain from mental decline and reduce the risk of Alzheimer's and Parkinson's.

Plus, green tea has been found to improve memory.

Summary:

Green tea is an excellent beverage to support your brain. Its caffeine content boosts alertness, while its antioxidants protect the brain and L-theanine helps you relax**.**

CHAPTER THREE

METHODOLOGY

3.1 Methodology:

The current is cross-sectional and data was conducted in public and private basic school students in Sudan , Khartoum(Bahri) , Forty students , their ages range from 13-16, randomly selected including (20)males and(20)females in 2019-2020 school year . We could response in the data collection from male and female schools under supervisor. Face to face specific questionnaires were distributed for the students to collect information from them about, demographic and socio-economic, personal data (name, school, gender and age). Anthropometric data (weight ,height).Eating Habits(appetite, number of meals/day, main meal, skipping meals, food likes and dislikes, snacking, number of meals eaten outside/week , worrying about weight, dieting and food habits).

3.2 Methods

3.2.1 Socio-demographic data:

This includes question on basic including information about number of members in the family, the rank of the student in siblings.it also collects data on participant's characteristics as: the age, educational status of the fathers and mothers, occupational and employment status, income source, average of household income, place of residence, and type of dwelling. Social status of the family was done according to (park and park, 1979).

3.2.2 Anthropometric data:

The weight and height of the students in the two groups (boy and girl) were assessed. Height was measured by a meter. The students were standing without shoes on a flat surface with feet parallel and heel together, and the head, back and heels in contact with the vertical board. The height was recorded to the nearest 0.1 cm (WHO, 1995). Weight of students was determined by using a common balance.

Anthropometric indices are combination measurements. They are essential for the interpretation of measurements. In adolescents, the four most commonly used indices are weight-for-height, height for-age, weight-for-age and BMI-for-age.

3.2.2.1 Weight (w t):

The plate from scale was used to measure weight for participating adolescents. The scale should be placed on a flat, hard surface. We should make sure that the scale is at zero before measuring the weight. The student should stand in the middle of the scale's platform without touching anything and with the body weight equally distributed on both feet .The weight should be read to the nearest 100g (0.1 kg) and should be recorded. The subject asked to be wearing light clothes as possible (Robert, et al., 2003).

3.2.2.2 Height (H t):

Height was measured using vertical measuring board for adults. The student stood bare footed on a flat platform, with feet parallel and with heels, buttocks, shoulders and back of head touching the upright surface. The head was held comfortable erect, with the over border of the orbit in the same horizontal plane and measuring neared to 0.1cm.

In the same day of interview, the students were asked to recall type and quantity of all foods and beverages that consumed during the school day, and

they were also asked to record the food intake during the lifestyle in their homes and the amount in units or parts then collect the questioners from them when they could write. The students whom could not write were interviewed again, or by telephone (day by day).

3.2.3 Statistical Analysis:

The statistical analysis included:

Descriptive Statistics: arithmetic mean or average, median and standard deviation.

The results were analyzed by SPSS statistical package version and the results were tabulated.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Al Qabas Boys School:

The level of significance value at 5% indicates that these factors are highly significant, except for the mother's education level .There is a good positive relationship between intelligence and variable "x2" .

There is an inverse relationship between intelligence and variables "x1,x3,x4,x5,x6 " .

Table (4.1): shows the significant effect of the factors (x1 - x6) on the student's academic achievement:

Factors	Degree of correlation	Standard Error	P-value
X1	-3.0	0.229334	0.000902
X2	0.93	0.114573	0.003894
X3	-22.0	2.610061	0.003488
X4	-66.3	4.104559	0.000516
X5	-23.0	2.720928	0.003475
X6	-1.6	2.779141	0.586268

whereas :

X1 = Weight

X2 = Height

X3 = Father's work

X4 = Average income

X5 = Father's education

X6 = Mother's education

the relationship between intelligence and food behavior was :

1. There is a good positive relationship between intelligence and variable "4"

2. There is no correlation between intelligence and variables " 3, 8, 17, 23 "

3. There is an inverse relationship between intelligence and variables " 7, 5, 11,9,10,13,14,20,21 " .

4. There is a weak positive relationship between intelligence and the variables " 1,2,6,12,15,16,18,19,22" .

Table (4.2): shows the relationship between intelligence (academic performance) and food behavior

The degree of correlation	Factors
0.07	Eat the main meals regularly '1'
0.51	I have an appetite for timely meals 2
0	Eat fast food during the day '3'
0.73	I prefer eating meals out '4'
-0.39	Do you follow a regular diet?'5'
0.11	I hate some types of food '6'
-0.27	I keep meals on time '7'
0	the breakfast '8'
-0.1	the lunch '9'
-0.29	the Dinner '10'
-0.46	I care about the type of food during the meal '11'
0.31	Pay attention to the amount of food only '12'
-0.05	Better eat canned food '13'
-0.31	I prefer eating food at home '14'
0.44	I prefer eating food at school '15'
0.44	Do you replace the main meal with meals or something else? '16'
0	The mother supervises the preparation of food for us '17'
0.39	Do you prefer eating breakfast early in the morning '18'
0.18	Do you prefer to have lunch in the evening '19'
-0.39	Do you prefer to have milk only for dinner? '20'
-0.39	Do some meals have an effect on your ability to absorb? Select the meal '21'
0.25	Do you eat fruits and vegetables? '22'
0	The mother is concerned with the type and shape of the food ' 23'

4.2 Al Qabas Girls School :

The significance value of these factors are lowly .

There is a good positive relationship between intelligence and variable "x4,x5,x6" .

There is strong an inverse relationship between intelligence and variables

 "x1,x3 " .

There is a weak positive relationship between intelligence and variable"x2"

Table (4.3): shows the significant effect of the factors (x1 - x6) on the student's academic achievement :

Factors	Degree of correlation	Standard Error	P-value
X1	-0.8	0.761377	0.333976
X2	0.2	0.818786	0.7406
X3	-37.7	17.86897	0.125209
X4	27.4	26.45595	0.375943
X5	19.4	34.22518	0.610274
X6	1.4	12.55151	0.914503

whereas :

X1 = Weight

X2 = Height

X3 = Father's work

X4 = Average income

X5 = Father's education

X6 = Mother's education

The relationship between academic performance (intelligence) and food behavior was:

1. There is no good positive relationship between intelligence and this variables .

2. There is no relationship between intelligence and variables "12, 23 " .

3. There is an inverse relationship between intelligence and variables " 1,3.4.6,9,10,11,18,19,20,21 " .

4. There is a weak positive relationship between intelligence and the variables " 2,5,7,8,13,14,15,16,17, 22 " .

Table (4.4): shows the relationship between intelligence (academic performance) and food behavior

The degree of correlation	Factors
-0.34	Eat the main meals regularly '1'
0.28	I have an appetite for timely meals 2
-0.11	Eat fast food during the day '3'
-0.03	I prefer eating meals out '4'
0.11	Do you follow a regular diet?'5'
-0.45	I hate some types of food '6'
0.30	I keep meals on time '7'
0.05	the breakfast '8'
-0.49	the lunch '9'
-0.15	the Dinner '10'
-0.20	I care about the type of food during the meal '11'
0.00	Pay attention to the amount of food only '12'
0.30	Better eat canned food '13'
0.30	I prefer eating food at home '14'
0.18	I prefer eating food at school '15'
0.45	Do you replace the main meal with meals or something else? '16'
0.30	The mother supervises the preparation of food for us '17'
-0.23	Do you prefer eating breakfast early in the morning '18'
-0.43	Do you prefer to have lunch in the evening '19'
-0.10	Do you prefer to have milk only for dinner? '20'
-0.20	Do some meals have an effect on your ability to absorb? Select the meal '21'
0.26	Do you eat fruits and vegetables? '22'
0.00	The mother is concerned with the type and shape of the food ' 23'

.

4.3 Al Wadi al akhdar Boys School :

The significance value of these factors are lowly .

There is a good positive relationship between intelligence and variable "x1,x2,x4,x5" .

There is strong an inverse relationship between intelligence and variables

 " x3,x6 " .

Table (4.5): shows the significant effect of the factors (x1 - x6) on the student's academic achievement:

Factors	Degree of correlation	Standard Error	p- value
X1	26.8	9.661336	0.068798
X2	16.2	11.10019	0.240476
X3	-72.3	57.68672	0.298726
X4	113.3	56.78865	0.139976
X5	117.3	69.90312	0.191753
X6	-239.6	125.2052	0.151476

 Whereas:

X1 = Weight

X2 = Height

X3 = Father's work

X4 = Average income

X5 = Father's education

X6 = Mother's education

The relationship between intelligence and food behavior:

1. There is no a good extreme relationship between intelligence and variables .
2. There is no relationship between intelligence and variables " 12, 23 "
3. There is an inverse relationship between intelligence and variables " 1,3,6,9,10,11,18,20,21"
4. There is a weak extreme relationship between intelligence and the variables " 2,5,7,8,13,14.15,16,17,22 " .

Table (4.6): shows the relationship between intelligence (academic performance) and food behavior

The degree of correlation	Factors
-0.34	Eat the main meals regularly '1'
0.28	I have an appetite for timely meals 2
-0.11	Eat fast food during the day '3'
-0.03	I prefer eating meals out '4'
0.11	Do you follow a regular diet?'5'
-0.45	I hate some types of food '6'
0.30	I keep meals on time '7'
0.05	the breakfast '8'
-0.49	the lunch '9'
-0.15	the Dinner '10'
-0.20	I care about the type of food during the meal '11'
0.00	Pay attention to the amount of food only '12'
0.30	Better eat canned food '13'
0.30	I prefer eating food at home '14'
0.18	I prefer eating food at school '15'
0.45	Do you replace the main meal with meals or something else? '16'
0.30	The mother supervises the preparation of food for us '17'
-0.23	Do you prefer eating breakfast early in the morning '18'
-0.43	Do you prefer to have lunch in the evening '19'
-0.10	Do you prefer to have milk only for dinner? '20'
-0.20	Do some meals have an effect on your ability to absorb? Select the meal '21'
0.26	Do you eat fruits and vegetables? '22'
0.00	The mother is concerned with the type and shape of the food ' 23'

4.4 Al Wadi al akhdar Girls School :

The significance value of these factors are lowly .

There is a good positive relationship between intelligence and variable "x1,x2,x3,x6" .

There is strong an inverse relationship between intelligence and variables

 " x4,x5 " **.**

Table (4.7): shows the significant effect of the factors (x1 - x6) on the student's academic achievement :

Factors	Degree of correlation	Standard Error	P-value
X1	0.84	4.412694	0.860842
X2	4.82	14.80711	0.766082
X3	21.43	72.80943	0.787633
X4	-15.1	129.7976	0.914661
X5	-73.9	86.86211	0.457182
X6	7.05	89.48565	0.942134

whereas :

X1 = Weight

X2 = Height

X3 = Parent's work

X4 = Average income

X5 = Father's education

X6 = Mother's education

The relationship between intelligence and food behavior **:**

1. There is no a good extreme relationship between intelligence and variables .

2. There is no relationship between intelligence and variables "14,17,21" .

3. There is an inverse relationship between intelligence and variables "6,4,3,15,16,12,13,18,19,22,23"

4. There is a weak extreme relationship between intelligence and the variables " 1,2,5,5,7,4,10,9,8" .

Table (4.8): shows the relationship between intelligence (academic performance) and food behavior

The degree of correlation	Factors
0.47	Eat the main meals regularly '1'
0.40	I have an appetite for timely meals 2
-0.34	Eat fast food during the day '3'
-0.14	I prefer eating meals out '4'
0.47	Do you follow a regular diet?'5'
-0.47	I hate some types of food '6'
0.47	I keep meals on time '7'
0.49	the breakfast '8'
0.47	the lunch '9'
0.33	the Dinner '10'
0.47	I care about the type of food during the meal '11'
-0.62	Pay attention to the amount of food only '12'
-0.43	Better eat canned food '13'
0.0.	I prefer eating food at home '14'
-0.16	I prefer eating food at school '15'
-0.49	Do you replace the main meal with meals or something else? '16'
0.00	The mother supervises the preparation of food for us '17'
-0.06	Do you prefer eating breakfast early in the morning '18'
-0.24	Do you prefer to have lunch in the evening '19'
-0.49	Do you prefer to have milk only for dinner? '20'
0.00	Do some meals have an effect on your ability to absorb? Select the meal '21'
-0.47	Do you eat fruits and vegetables? '22'
-0.34	The mother is concerned with the type and shape of the food ' 23'

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion:

God Almighty has created many foods that have important benefits in building the brain and its growth and development by containing important and necessary nutrients, so the human brain needs to eat food in sufficient quantities to obtain energy and work efficiently.

Sufficient nutrient intake is very important during adolescent cognitive development. There was a significant association between adolescent dietary intake and adolescent's rate of academic performance (intelligent) level.

5.2 Recommendations:

Based on this study, it's recommend the following:

1. Taking care of students' meals in schools.

2. Paying attention to education and awareness of the importance of proper nutrition for children during childhood.

3. Further studies are needed intelligence quotient (IQ) tests and blood test.

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APPENDICES

Images of questionnaire

بسم الله الرحمن الرحيم

جامعة السودان للعلوم والتكنولوجيا

كلية الدراسات الزراعية - قسم علوم وتكنولوجيا الأغذية

إستبانة بحث

عنوان الدراسة

العلاقة بين الغذاء والذكاء

تنويه :

١) هذه المعلومات في غاية السرية

٢) الأسئلة الوارده لاغراض البحث فقط

٣) الرجاء الاجابة على هذه الاسئلة بقدر من الصدق

٤) شكرا لحسن تعاونكم معنا

اولا : البيانات الشخصية :-

الاسم : سحر أحمد ....

العمر : ١٦ ....

الجنس : ذكر ⬤   أنثى ☑

الوزن : ⬤ ٥٣

محيط الخصر ⬤   محيط العضد ⬤   محيط الفخذ ⬤

الطول : ١٦ ....

الصف الدراسي : ثامن ....

ثانيا: البيانات الإجتماعية :

عدد افراد الأسرة : ٨

ترتيبك بين أفراد الاسره ، الاول ☑   وسط ⬤   الاخير ⬤

طبيعة عمل الوالد : عامل ☑   موظف ⬤   عمل خاص ⬤

طبيعة عمل الوالدة : عاملة ⬤   ربة منزل ☑   اعمال خاصة ⬤

مصدر دخل الاسرة : من عمل الوالد .... وقدره ....

من عمل الوالده .... وقدره ....

متوسط دخل الاسره في الشهر : ٥٠٠ - ١٠٠٠ ⬤   ١٠٠٠ - ٢٠٠٠ ☑

اكثر من ٢٠٠٠ ⬤

السكن : حضر ⬤   ريف ☑

المستوى التعليمي للوالد : اساس ☑   ثانوي ⬤

جامعي ⬤   فوق الجامعي ⬤

المستوى التعليمي للوالده : اساس ☑   ثانوي ⬤

جامعي ⬤   فوق الجامعي ⬤

الوالدان متزوجان ....

لا	نعم	البيان	الرقم
		أتناول الوجبات الرئيسية بصورة منتظمة	١
✓		لدي شهية لتناول الوجبات في أوقاتها	٢
	✓	أتناول بعض الوجبات السريعة خلال اليوم	٣
	✓	أفضل تناول الوجبات خارج المنزل	٤
✓		هل تقوم بإتباع نظام غذائي منتظم	٥
✓			
	✓	لدي كراهية لبعض انواع الأغذية حددها: ١- الرجله ٢- ١ لخذره ٣- القرع ٤- العرس	٦
✓		أحافظ على تناول الوجبات في موعدها	٧
✓		الافطار	٨
✓		الغداء	٩
✓		العشاء	١٠
✓		إهتم بنوع الغذاء خلال الوجبة	١١
	✓	إهتم بكمية الغذاء فقط	١٢
✓		أفضل تناول الاغذية المعلبة	١٣
	✓	أفضل تناول الطعام بالمنزل	١٤
	✓	أفضل تناول الطعام بالمدرسة	١٥
	✓	هل تقوم بإستبدال الوجبة الرئيسية بوجبات او غيرها	١٦
	✓	تشرف الوالده على إعداد الطعام لنا	١٧
	✓	هل تفضل تناول الافطار في الصباح الباكر لماذا؟ ١ حساس ا لجوع	١٨
صح	✓	هل تفضل تناول الغداء في فترة المساء لماذا؟ عند ١٣ حساسيا لجوع	١٩
✓		هل تفضل تناول الحليب فقط في العشاء لماذا؟ لا أحب الحليب	٢٠
	✓	هل تعتقد أن لبعض الوجبات أثر على قدرتك على الإستيعاب ؟ حدد الوجبة : الافطار ✓ الغداء العشاء	٢١
	✓	هل تتناول الفواكه والخضروات في الوجبات التالية الافطار الغداء العشاء	٢٢
	✓	تهتم الوالده بنوع وشكل الغذاء	٢٣

حدد نوع الغذاء الذي تتناوله حسب الوجبة:

الإفطار: د ـــــــ بيضة، ٢ سلطة ـــــ، ٣ فول ـــــ، ٤ استشوية

الغداء: د ـــــ صمون، ٢ ـــــ، ٣ ـــــ، ٤ ـــــ

العشاء: د ـــــ لحمة، ٢ فول ـــــ، ٣ ـــــ، ٤ حليب

الرقم	البيانات	أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشدة
١	أتناول الاغذية التالية بصورة شبه دائمة:		✓			
	الخضروات					
	الفواكه			✓		
	الوجبات السريعة		✓			
	المحفقات			✓		

معلومات خاصة بمستوى الطالب الاكاديمي:

الرقم	البيانات	نعم	لا
١	هل أنت بصحة جيدة	✓	
٢	أعاني من بعض حالات الارق والتعب	✓	
٣	اهتم بممارسة الرياضة		✓
٤	استطيع النوم بصورة جيدة	✓	
٥	اشارك في البرامج الثقافية بالمدرسة		✓
	لماذا		
٦	هل تقوم بحل الواجبات المدرسية بانتظام	✓	
٧	هل تقوم بعملية الحل في الفصل	✓	

الرقم	البيانات	وسط	جيد	ممتاز
١	مستوى التحصيل الدراسي	✓		
٢	مستوى التحصيل الدراسي خلال الفصول الدراسية السابقة		✓	
٣	المستوى الاكاديمي لافراد الاسرة			
٤	الام	✓		
٥	الاب	✓		
٦	الاخوان	✓		
٧	الاخوات			✓

أي المواد الدراسية تفضل: مواد الحفظ ⚪   مواد الفهم ✓

ايهما تفضل: الرياضيات ⊗
لماذا: .... ؟؟؟

اللغة العربية ✓
لماذا: ....

اللغة الانجليزية ⊗