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Effect of Serum Selenium on the Learning Outcomes of Young Girls Studying in Sokoto

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Abstract: *There is a need for proper nutrition for the growth and development of the human body, especially during the early years of education. Failure to have good nutrition elicits effects such as poor functioning of the body system or parts such as the brain (nervous system), which is responsible for the effect on learning and other cognitive activities. This study aimed to examine how the level of selenium in the body relates to the learning outcome of young girls in Sokoto, Nigeria. A cross-sectional semi-experimental design involving a sampling of 250 girls studying in Sokoto was carried out. The determination of selenium was done using standard methods of atomic absorption spectroscopy. The results ($p < 0.05$) indicate that, according to age, 10–12 years old participants had serum selenium within the range of 1.01–1.60 $\mu\text{mol/L}$ (56.0%); 13–15 years old girls had 0.76–1.0 $\mu\text{mol/L}$ serum selenium level (34.0%); while girls of more than 16 years had 0.40–0.75 serum selenium (of which 2.8% are deficient, and 7.2% are sufficient). Overall, 90.0% (225 girls) had normal selenium levels, while 10.0% (25 girls) had deficient selenium levels. An examination of the effect on learning outcome shows that normal girls scored a mean value of 52.90 ± 12.22 , while deficient girls had a score of 32.85 ± 11.84 . Therefore, to improve the learning and other activities of the girls, there should be efforts to help youngsters obtain a proper diet.*

Key Words: Selenium, Nutrition, Deficiency, Learning Outcomes, Learning, Girls School, Sokoto State

Introduction

Nowadays, education determines the development and growth of countries in the world. Education is significant in the development of human resources (Abubakar & Kwashabawa, 2021). Equally, girls' education is more significant as an indicator of development. Educated girls or mothers have more potential to give birth to children or daughters that would potentially benefit society. They are more prone to accept better health behaviors, eat balanced nutrition, and be economically buoyant than uneducated folks (Shabbir et al., 2019). There is utmost desire to ensure girls are educated at least at secondary school levels. Literate girls mostly take care of their children, encouraging them to be educated and wealthier, serving as role models to others, and encouraging mother and child healthcare (Abdulkadir et al., 2018). However, girls' education is affected by malnutrition among other factors. Malnutrition is a huge issue affecting developing nations, especially Africa. Nutrition and education are linked significantly; therefore, the same human rights are supposed to be accorded to all children, irrespective of their affiliations (Shabbir et al., 2019).

Selenium is a micronutrient naturally occurring that plays an essential role in the human body and is supposed to be within the shortest range of $<40 \mu\text{g/day}$ (level of deficiency) to $>400 \mu\text{g/day}$ (level of toxicity) as reported by Mehmood et al., (2019). Invariably, dietary selenium for human consumption depends on many occasions on plant-based foodstuffs that obtain selenium from soils (Kolawole et al.,

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2013; Mehmood et al., 2019). However, like other regions of the earth, Sokoto soil selenium concentration could easily be affected by rainfall levels, flooding, and irrigation, among many other things (Adeniyi & Agoreyo, 2018; Mehmood et al., 2019). Nevertheless, selenium determination and consumption in foods is a complex adventure. People who are vitamin E deficient could experience selenium toxicity. High selenium consumption is associated with cancer of the skin, pancreas, and type 2 diabetes (Mehmood et al., 2019). Even in some developed nations like the US, Japan, etc, specific populations experience high selenium intake. Therefore, whether there is high or low intake monitoring is crucial (Polanska et al., 2016).

Notably, the risk of nutrition or malnutrition in the human body cannot be overemphasized. Micronutrients, in parts or altogether, play vital roles in the development and functions of the human body (Giray et al., 2001). Parable, selenium micronutrient is an important nutrient needed for youngsters' growth and development, as well as proper body functioning. Young girls, due to their changing body system, require selenium. Among other reasons, because they are about to become mothers, their selenium supply should be sufficient (Ejezie et al., 2012; Khan et al., 2022). They also need selenium for better learning, considering the current impending issues surrounding learning outcomes and the state of education (especially in girl-child) in Sokoto and northern Nigeria at large.

The brain needs selenium very well, which is why the body struggles to maintain selenium levels at the point of the brain whenever there is scarcity in the general circulation. Many enzymes in the brain, such as glutathione peroxidases and thioredoxin reductases, need selenium to proffer an antioxidant role by destroying hydrogen peroxide, as well as organic hydrogen peroxides (Polanska et al., 2016; Banna et al., 2022). Therewith, deiodinases that convert thyroid hormone thyroxine (T₄) to triiodothyronine (T₃) shall need the selenium micronutrient as well (Gray et al., 2001). Moreover, the significance of selenium in the brain was corroborated in animal studies, as reported by Polanska et al. (2016). This study aimed to examine how the level of selenium in the body relates to the learning outcome of young girls in Sokoto, Nigeria.

Objectives

The objectives of the study were to:

- determine the prevalence of serum selenium deficiency among girls studying in Sokoto, Nigeria
- determine the potential effect of low serum selenium levels on the learning outcome of girls studying in Sokoto, Nigeria

Research Questions

The following were the research questions for this study:

- How prevalent is serum selenium deficiency among girls studying in Sokoto, Nigeria?
- What is the potential effect of low serum selenium level on the learning outcome of girls studying in Sokoto, Nigeria?

Materials and Methods

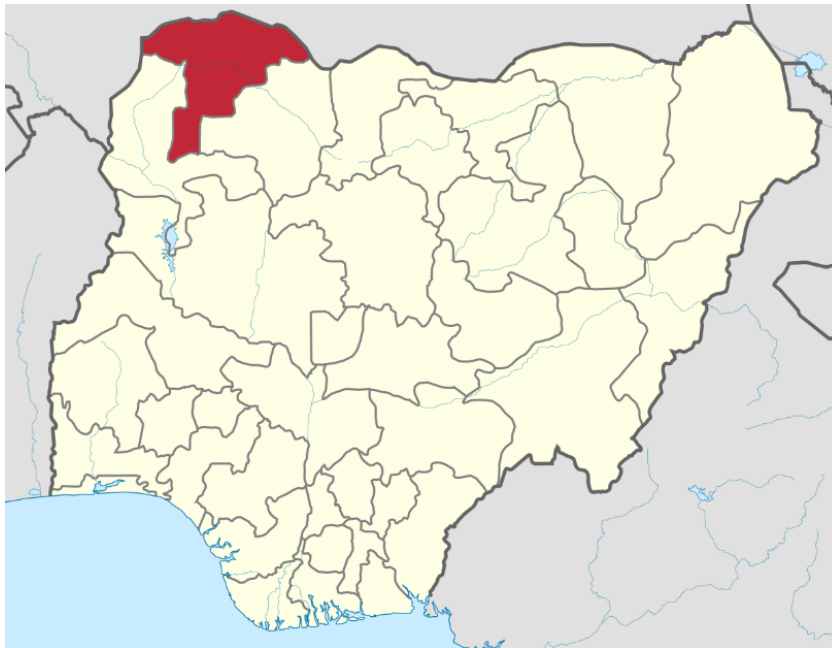
The study was conducted among female secondary school students in the three zones of Sokoto State, Nigeria. Sokoto is located on latitude 13° 04N and longitude 5°14E. The state covers an area of 25,973 square kilometers. It is bordered in the North by Niger Republic to the South and west by Kebbi State. In the east and south, it is bordered by Zamfara State. The state is located in the Sudan savannah geo-ecological zone. There are four major health institutions, namely, Usmanu Danfodiyo University Teaching Hospital, Specialist Hospital, Murtala Muhammed Hospital, and Wammako Orthopaedic Hospital (Umar, 2019). Sokoto State has a projected population of 4,393,689 by 2017. The state is made up of twenty-three local government areas. The climatic condition of Sokoto is tropically warm, with temperatures rising to 38°C and above between March to May. The rainy season starts in late June and ends in October, while the cold season starts in December and ends in February. The dominant Indigenous tribes are Hausa – Fulani and other tribes, including the Igbo, Yoruba, Kanuri, Nupe, and Tiv, as settlers. Agriculture is the most important occupation of people of the state; the major crops cultivated are rice, wheat, tomatoes, sorghum, millet, soybean, onions, garlic groundnut, beans, cassava, and maize. (Umar, 2019).



Study Area

Figure 1

Map of Nigeria showing study area (Sokoto State).



Source: Umar (2019)

Study Participants

The multi-stage sampling procedure was used, followed by systematic sampling of schools and study subjects from identified schools in the following stages according to:

Stage 1: Three zones were all selected

Stage 2: Selection of two local governments from each zone with the female secondary school using simple random sampling”

Stage 3: Random selection of girls' schools after line listing (Total number of schools in LGA)”

Stage 4: Proportionate allocation of students in each school”

Stage 5: Convenient sampling of students” (Umar, 2019).

Meanwhile, 250 girls going to school in Sokoto State, Nigeria were enrolled for this research. The selection of the girls was made based on simple random sampling according to the three zones (Sokoto East, Central, and Western parts) of the state, provided the girls were in secondary schools or primary six class (at primary school). All duly required ethics were followed, while other recruitment protocols were based on the methods of Umar et al. (2018). The study was a semi-experimental design that involved girls with normal selenium and girls with poor selenium levels. An investigation of learning outcomes was done based on assessment methods utilized by Umar et al. (2018). A cross-sectional study was done involving a sample of 250 girls. The sample size was obtained using a formula as follows as reported by Umar (2019):

$$N = \frac{(Z)^2 (p)(1- p)}{d^2}$$

Where

N = Minimum sample size

Z = 95% confidence level (= 1.96)

P = Prevalence in the target population = 18%

d = Margin of Error set at 5% (= 0.05)

Substituting the values in the equation above

$$N = \frac{(1.96)^2 (0.18) (1-0.18)}{(0.05)^2}$$

$$N = \frac{3.8416 \times 0.18 \times 0.82}{0.0025} = 226$$

Plus 10% Attrition rate (24)

N= 248

Therefore, the sample size utilized for the study was 226; albeit, 250 were involved to take care of the attrition rate.

Students Assessment

The participants were instructed (in the area of biology for a good four weeks), and later they were assessed by the teachers (researchers) using 50 multiple-choice objectives attracting 100 marks. The grading included prepared grades (fail, less than 40 marks; and 40 above, as pass marks). The means were statistically analyzed using the Chi-square test.

Blood Samples Collection

4mm blood samples were collected from Venus using a test tube (without anticoagulant), blood allowed to stay for clotting to occur at room temperature, centrifuged, and the serum stored at -20°C for further analysis. Blood samples that were used to identify the levels of selenium among adolescent girls in Sokoto were collected according to the methods of Bilbis et al. (2002).

Reagents and Equipment Utilized and Conducted Assay

The entire reagents were of analytical grade, and an atomic absorption spectroscopic machine was utilized. However, an assay of the serum was conducted as reported in Bilbis et al., (2002). The results obtained during this work were analyzed using Chi-square and one-way ANOVA (p<0.05).

Ethical Issues

Ethical approval was obtained from authorities in the state, consent forms were filled by the students across the three zones in the state.

Results

The results of this study are revealed in Tables 1, 2 and 3.

Table 1

Demographic characteristics of girls in Sokoto, Nigeria

	Frequency	Percentage
Age group		
10 to 12 years	162	140(56.0%)
13 to 15 years old	40	7(2.8%)
More than 16 years	48	7(2.8%) 18(7.2%)
Religion		
Islam	240	90.0
Christianity	10	10.0
Tribe		
Hausa	100	40.0
Igbo	8	3.2
Fulani	40	16.0
Yoruba	20	8.0
Gobirawa	82	32.8

**Table 2**

Concentrations of serum selenium among girls in Sokoto, Nigeria

Age group	Mean selenium+ standard deviation	Frequency (percentage)	Sex
10 to 12 years	1.01-1.60	14(56.0%)	Female
13 to 15 years old	0.40-0.70	7(2.8%)	Female
	0.71-0.75	18(7.2%)	Female
More than 16 years	0.40-0.70	7(2.8%)	Female
	0.71-0.75	18(7.2%)	

Table 3

Effects of serum selenium status on the leaning outcome among girls in Sokoto, Nigeria

Serum selenium status	Mean score	Standard deviation	Chi-square	Remarks
Deficient (Less than 0.76umol/L) N=20	52.90	12.22	56.57	Significant
Normal(0.76-1.91 umol/L) N=20	32.85	11.84	18.32	Significant

Discussion

There is universal acceptance that every nation progresses due to education, especially that of the girl child. Education boosts the political, social, economic, health, and technology of a nation and its citizens (Abdulkadir et al., 2018). Especially for the girl child, education is a committed human right, vital to developing well-being and personal and societal aspects of development (Abdulkadir et al., 2018). Educated girls are more confident in confidence, health, wealth, self-esteem, skills, and other indices of development and benefits (Andrew & Etumabo, 2016). However, among other issues, girls' education is heavily affected in Northern Nigeria (Abubakar & Kwashabawa, 2021). One major issue that affects children in the region (including Sokoto) is malnutrition. Malnourished children are unhealthy and have devastating challenges educationally. They are often sick and, therefore, have to be absent from school for healthcare. Often, malnutrition leads to poor cognition and, in turn, affects learning and education as well (Shabbir et al., 2019). Girls are growing and, therefore, need nutrients for growth and development; therein, malnutrition (lack of nutrient consumption or utilization) elicits health and educational problems (Shabbir et al., 2019).

Micronutrients such as selenium are vital for human body growth and functions (Kolawole & Ebueh, 2013). Selenium is taken from food materials that could be plant-based materials depending on soil for their nutrients. Various soils in the Sokoto region could affect the nutritional contents of plant-based foods because of semi-desert areas in eastern Sokoto and generally low rainfall patterns, as well as the presence of causes of flooding and relations (Garba et al., 2023). Likewise, the animal-based foods serving as selenium sources could be affected due to their dependence on plants. Nevertheless, girls are youngsters who need micronutrients to ensure the full efficiency of the growing body system and for other reasons such as menstruation and preparation for childbearing (Gudmundadottir et al., 2012; Ohaka et al., 2023). Nevertheless, young girls need selenium generally for health and to give them the ability to learn properly and become productive for the benefit of the entire society (Zhang et al., 2023). Selenium has about 18 known selenoproteins dedicated to various functions, such as acting as antioxidants in diverse capacities, protecting against cancer, and T₄ to T₃ conversion (Adeniyi & Agoreyo, 2018; Banna et al., 2022). Sokoto State is ravaged by poverty in some quotas, malnutrition, poor health care, burden of diseases (Garba et al., 2023).

Considering the role of selenium in physiological enzymes that ensure the body (or brain) is being protected against oxidative stress; and ensuring the thyroid hormone (T₃) is well assembled for its diverse purposes; these are portends showing that selenium is needed by the brain, the higher learning center of

the body (Celik et al., 2014; Banna et al., 2022). Thus, it is important to keep an eye on the levels of selenium in young girls, the potential mothers, and the building blocks of girl-child education and its benefits (Ejezie et al., 2012). Early detection of the selenium problem accounts for room to make needed amendments at early stages and restore efficiency or prevent impending catastrophe (Adame et al., 2011). The results from this work show that the younger ones among the girls involved in the study (10 to 15 years old) had normal selenium levels, whereas the girls in the age range of more than 16 years were deficient (25.0%). This finding was in line with the study of Kolawole & Ebueh (2013), which shows a general deficiency of selenium in adults in Akwa Ibom state, Nigeria. In a similar work, Zhang et al. (2023) in their work found that men consume excess selenium more than women in the United States. However, this work was also somehow relevant to another work (revealing a prevalence of selenium deficiency of just 10% among young girls) from Iceland that found that adolescent girls consume acceptable levels of selenium (Gudmundadottir et al., 2012). Specifically, the 10% prevalence of selenium deficiency found by this work could be due to poverty, insufficient selenium in diet, poor nutrition education, and overall general malnutrition in the area (Garba et al., 2023; Ohaka et al., 2023).

Additionally, examination of the relationship between selenium level and level of learning outcome among girls involved in this study indicates that girls earned a mean mark of 52.90 ± 12.22 (mean, standard deviation), a pass mark; that is higher than the score of selenium deficient girls (32.83 ± 11.84). Therefore, the selenium could be related to the learning outcome. This could be due to the role of selenium in the body, specifically the brain. Micronutrient deficiencies affect the brain or central nervous system due to oxidative stress and affect fuel metabolism, among other tactics (Stenesh, 1993). Therefore, selenium prevents oxidative stress through activating enzymes responsible for abating oxidative stress and helps in converting T₄ to T₃ to make active iodine, a well-known micronutrient that affects brain function (Polanska et al., 2016; Ohaka et al., 2023).

Conclusion

The human body requires a proper diet at certain amounts to live and perform functionally. Particularly, the nervous system or the brain that is responsible for learning and related intelligence-based activities has to be provided with certain nutrients, such as selenium, to act properly. This work undertook an analysis of the possible influence of serum selenium levels on the learning of girls in Sokoto, Nigeria, considering the role of selenium in body and brain physiology. This work shows that girls with normal selenium levels score more than those with poor selenium levels. This could have been associated with the role of selenium in brain functions. Critically, youngsters need micronutrients most at the age of youngness for better outcomes.

Recommendations

The following recommendations are stated:

- There should be moves to continuously encourage the consumption of selenium, especially among youngsters in the state
- There should be educative approaches aimed at making people aware on the importance of nutrition in health, well-being and progress of society as a whole.

References

- Abdulkadir, A., Maryam Lawal, A., & Muhammad, T. I. (2018). Climate Change and Its Implications on Human Existence in Nigeria: A Review. *Bayero Journal of Pure and Applied Sciences*, 10, 152–158. <https://doi.org/10.4314/bajopas.v10i2.26>
- Abubakar, I., & Kwashabawa, B. B. (2021). Securing girl-child education for sustainable national security: Focus on North-Western Nigeria. *British Journal of Education*, 5, 34–64.
- Adame, E. M., Florea, D., Perez, L. S., De La Cruz, A., & Del Pozo, E. (2012). Deficient selenium status of a healthy adult Spanish population. *Nutrition Hospitalaria*, 27(2), 524–528. <https://doi.org/10.3305/nh.2012.27.2.5529>
- Adeniyi, M. J. (2018). Nigeria and the selenium micronutrient: A review. *Current Trends in Biomedical Engineering & Biosciences*, 14(1), 555876. <https://doi.org/10.19080/ctbeb.2018.14.555876>



- Andrew, O., & Etumabo, A. G. (2016). The implications of girl-child education for nation-building in the 21st century in Nigeria. *Global Journal of Human Social Science: G Linguistics and Education*, 16(3), 1–5. https://globaljournals.org/GJHSS_Volume16/1-The-Implications-of-Girl-Child.pdf
- Banna, H. M. E., Elsayed, Z. A. H., Hamed, A. I. & Faheim, R. M. (2022). Serum selenium levels among Ain shams university medical students with family history of cancer, a pilot study. *Ain Shams Medical Journal*, 73(1), 77–84. <https://doi.org/10.21608/asmj.2022.233531>
- Bilbis, L. S., Saidu, Y. & Aliyu, R. U. (2002). Serum vitamin A and zinc levels of some preschool children in Sokoto Metropolis of Nigeria. *Biokemistri*, 14, 82–87. <https://www.ajol.info/index.php/biokem/article/view/136417>
- Çelik, T., Savaş, N., Kurtoğlu, S., Sangün, Ö., Aydın, Z., Mustafa, D., Öztürk, O. H., Mısırlıoğlu, S., & Öktem, M. (2014). Iodine, copper, zinc, selenium and molybdenum levels in children aged between 6 and 12 years in the rural area with iodine deficiency and in the city center without iodine deficiency in Hatay. *Turk Pediatri Arsivi*, 49(2), 111–116. <https://doi.org/10.5152/tpa.2014.1209>
- Ejezie, F. E., Okaka, A. C., & Nwagha, U. I. (2012). Reduced maternal selenium levels in pregnant and lactating Nigerian women: should routine selenium supplementation be advocated? *Nigerian Journal of Medicine: Journal of the National Association of Resident Doctors of Nigeria*, 21(1), 98–102. <https://pubmed.ncbi.nlm.nih.gov/23301458/>
- Garba, S., Dikko, M., Bala, B. I., Malami, Z., Sarkingobir, Y., & Muhammad, S. (2023). Rotavirus disease (gastroenteritis) in children with diarrhea (0–5 years): Determined prevalence in selected hospitals of Sokoto city, Nigeria. *Journal of Community Service in Science and Engineering (JoCSE)*, 2(2), 35. <https://doi.org/10.36055/jocse.v2i2.22174>
- Giray, B., Hincal, F., Teziç, T., Ökten, A., & Gedik, Y. (2001). Status of selenium and antioxidant enzymes of goitrous children is lower than healthy controls and nongoitrous children with high iodine deficiency. *Biological Trace Element Research*, 82(1–3), 035–052. <https://doi.org/10.1385/bter:82:1-3:035>
- Gray, R., Javad, M., Power, D. M., & Sinclair, C. D. (2001). Social and environmental disclosure and corporate characteristics: A research note and extension. *Journal of Business Finance & Accounting*, 28(3–4), 327–356. <https://doi.org/10.1111/1468-5957.00376>
- Gudmundsdottir, E., Gunnarsdottir, I., Thorlacius, A., Reykdal, O., Gunnlaugsdottir, H., Thorsdottir, I., & Steingrimsdottir, L. (2012). Blood selenium levels and contribution of food groups to selenium intake in adolescent girls in Iceland. *Food & Nutrition Research*, 56(1), 18476. <https://doi.org/10.3402/fnr.v56i0.18476>
- Khan, U. A., Farooq, S., & Zafar, M. (2022). A study of evolved gender differences in mate selection preferences among students and their parents. *Archives of Educational Studies (ARES)*, 2(2), 97–120. <https://ares.pk/ojs/index.php/ares/article/view/30>
- Kolawole, S. E., & Obueh, H. O. (2013). Relationship between soil contents and plasma levels of selenium, chromium and manganese in healthy adults Nigerians. *African Journal of Biotechnology*, 13(34), 5339–5346. <https://doi.org/10.5897/AJB12.107>
- Mehmood, S., Velumani, A., Iyer, S., & Sinkar, P. (2019). Micronutrient selenium: A pan-India report on borderline high. *Asian Journal of Biological and Life Sciences*, 8(1), 41–44. <https://doi.org/10.5530/ajbls.2019.8.7>
- Ohaka, C., Uzoigwe, S. A., Nonye-Enyidah, E. I., Awoyesuku, P. A., Ngeri, B., Jumbo, A. I., & Amadi, S. C. (2023). Relationship between serum selenium deficiency and preeclampsia among pregnant women at the Rivers State university teaching hospital, Port Harcourt, Nigeria. *World Journal of Advanced Research and Reviews*, 17(1), 162–172. <https://doi.org/10.30574/wjarr.2023.17.1.1470>
- Polanska, K., Krol, A., Sobala, W., Gromadzinska, J., Brodzka, R., Calamandrei, G., Chiarotti, F., Wasowicz, W., & Hanke, W. (2016). Selenium status during pregnancy and child psychomotor development–Polish Mother and Child Cohort study. *Pediatric Research*, 79(6), 863–869. <https://doi.org/10.1038/pr.2016.32>
- Shabbir, M., Qamar-uz-Zaman, & Atif, M. (2019). Effects of malnutrition on the academic performance: A case study of grade 6–8 learners in Punjab, Pakistan. *Review of Economics and Development Studies*, 5(4), 713–719. <https://doi.org/10.26710/reads.v5i4.882>
- Stenesh, J. (1998). Biochemistry. *Biochemistry*. <https://doi.org/10.1007/978-1-4757-9427-4>

- Umar, A. I. (2019). *Iodine status, bioenvironmental components and students performance among female secondary school students in Sokoto State* [PhD Thesis]. Postgraduate School Usmanu Danfodiyo University Sokoto, Nigeria.
- Umar, A., Umar, R., Wasagu, R., & Oche, M. (2018). Effect of inadequate iodine status on academic performance of secondary school girls in Sokoto state, Nigeria. *Greener Journal of Epidemiology and Public Health*, 6(1), 029–033. <https://doi.org/10.15580/gjeph.2018.1.122117184>
- Zhang, J.-W., Lin, Y., Liu, Y.-M., Wang, M.-M., Gong, J.-G., Shen, X.-G., Shen, Q.-Q., Lin, B., Su, W.-E., Gao, Y.-C., Yuan, C.-Y., Pan, Z.-H., & Zhu, B. (2023). Excess selenium intake is associated with microalbuminuria in female but not in male among adults with obesity: Results from NHANES 2009–2018. *Frontiers in Nutrition*, 10, 1043395. <https://doi.org/10.3389/fnut.2023.1043395>