

Influence of fruit juice consumption before two years of age on the development of childhood obesity

Influência do consumo de suco de frutas antes dos dois anos de idade no desenvolvimento da obesidade infantil

Influencia del consumo de jugos de frutas antes de los dos años de edad en el desarrollo de la obesidad infantil

Received: 07/14/2023 | Revised: 07/28/2023 | Accepted: 07/29/2023 | Published: 08/02/2023

João Vítor Franco Flores

ORCID: <https://orcid.org/0009-0002-2510-5215>
Barão de Mauá University Center, Brazil
E-mail: jvff1@hotmail.com

Carolina Galvão Salioni

ORCID: <https://orcid.org/0000-0002-9860-0121>
Barão de Mauá University Center, Brazil
E-mail: carolinasalioni98@hotmail.com

Daniel Penteado Martins Dias

ORCID: <https://orcid.org/0000-0002-7509-1125>
Barão de Mauá University Center, Brazil
E-mail: danielpenteado@gmail.com

Abstract

Objectives: to describe the main data published in the literature, between the years 1990 and 2023, to better understand the influence of the consumption of fruit juices under two years of age on the development of childhood obesity. **Methodology:** the present study is a literature review where 55 articles on the subject were selected from the MEDLINE and Scielo databases from august 2020 to july 2023 and critically analyzed according to the relationship between the consumption of fruit juices in children under two years of age and obesity in adults. **Result:** studies have shown that the grinding step of the fruit for juice production removes fibers from its composition, negatively affecting gastrointestinal dynamics. In addition, fructose (i.e., found primarily in fruits) has a complex metabolism and accumulates adipose tissue if no associated fiber is consumed. It is also suggested that the balanced intake of juices throughout the first years of life prevents the accumulation of body fat in childhood and youth. **Conclusion:** excessive consumption of fruit juices should be avoided under two years of age, since their intake can contribute to the development of obesity and lead to important consequences from childhood to adulthood.

Keywords: Child; Fruit juice; Obesity; Carbohydrate metabolism.

Resumo

Objetivos: descrever os principais dados publicados na literatura, entre os anos de 1990 e 2023, para melhor compreender a influência do consumo de sucos de frutas menores de dois anos no desenvolvimento da obesidade infantil. **Metodologia:** o presente estudo é uma revisão de literatura onde 55 artigos sobre o tema foram selecionados das bases de dados MEDLINE e Scielo, no período de agosto de 2020 a julho de 2023, e analisados criticamente segundo a relação entre o consumo de sucos de frutas em crianças menores de dois anos e obesidade em adultos. **Resultado:** os estudos demonstraram que a etapa de moagem da fruta para produção de suco remove fibras de sua composição, afetando negativamente a dinâmica gastrointestinal. Além disso, a frutose (ou seja, encontrada principalmente em frutas) tem um metabolismo complexo e acumula tecido adiposo se nenhuma fibra associada for consumida. Sugere-se também que a ingestão balanceada de sucos ao longo dos primeiros anos de vida previne o acúmulo de gordura corporal na infância e juventude. **Conclusão:** o consumo excessivo de sucos de frutas deve ser evitado em menores de dois anos de idade, uma vez que sua ingestão pode contribuir para o desenvolvimento da obesidade e levar a consequências importantes desde a infância até a idade adulta.

Palavras-chave: Criança; Suco de fruta; Obesidade; Metabolismo dos carboidratos.

Resumen

Objetivos: describir los principales datos publicados en la literatura, entre los años 1990 y 2023, para comprender mejor la influencia del consumo de jugos de frutas menores de dos años en el desarrollo de la obesidad infantil. **Metodología:** el presente estudio es una revisión de la literatura donde se seleccionaron 55 artículos sobre el tema de las bases de datos MEDLINE y Scielo de agosto de 2020 a julio 2023 y se analizaron críticamente de acuerdo con la

relación entre el consumo de jugos de frutas en niños menores de dos años y la obesidad en adultos. Resultado: los estudios han demostrado que la etapa de molienda de la fruta para la producción de jugo elimina las fibras de su composición, afectando negativamente la dinámica gastrointestinal. Además, la fructosa (es decir, que se encuentra principalmente en las frutas) tiene un metabolismo complejo y acumula tejido adiposo si no se consume fibra asociada. También se sugiere que la ingesta equilibrada de jugos durante los primeros años de vida evita la acumulación de grasa corporal en la infancia y la juventud. Conclusión: el consumo excesivo de jugos de frutas debe evitarse antes de los dos años de edad, ya que su ingesta puede contribuir al desarrollo de la obesidad y llevar a consecuencias importantes desde la infancia hasta la edad adulta.

Palabras clave: Niño; Jugo de frutas; Obesidad; Metabolismo de los hidratos de carbono.

1. Introduction

Obesity is a public health problem and it is a global epidemic that contributes substantially to morbidity and mortality and the consequences of the increase in its incidence and prevalence alert health organs (Silva et al., 2021). This epidemic, however, has an alarming impact on developed and developing countries, increasing the chance of the emergence of diseases that can lead to death, such as diabetes, cardiovascular disease and up to 13 types of cancer, according to the National Cancer Institute (“Posicionamento do Instituto Nacional de Câncer José Alencar Gomes da Silva acerca do Sobrepeso e Obesidade,” 2019). It is also concerning that a high body mass index (BMI) in childhood can lead to obesity in later life. However, childhood obesity depends on several factors, including the process of introducing food in solid form and subsequent food intake over the years (Andrade et al., 2016).

While there is preminent research on this topic, controversies are still seen, and decision-taken actions towards better recommendation standards regarding juice consumption in childhood are lacking. Several studies indicate that excessive consumption could lead to increased risk of childhood obesity (Dennison et al., 1997), while some evidence show that this association is not true (Crowe-White et al., 2016). Thus, this review aims to describe the main discoveries found in the literature about this field between the years 1990 and 2020 to better understand the relationship between childhood obesity and the consumption of natural fruit juice before two years of age.

2. Methodology

The present study is a bibliographic review of the narrative type. After defining the objective of better understanding the influence of the consumption of fruit juices under two years of age on the development of childhood obesity, the search in the literature began and, despite the large number of articles available in the literature, it is important to search for articles that provide the necessary subsidies to the central idea of the study (Pereira, 2018). Thus, 55 articles related to the theme addressed were selected, regardless of the type of scientific study, critically analyzed after observation of the similarities and differences and explained by the authors of the study (Pereira, 2018) and used in the composition of this review. For the aforementioned selection, the MEDLINE and Scielo databases were consulted, from august 2020 to july 2023. The keywords used to search for the articles were: child, fruit juice, obesity and carbohydrate metabolism. The keywords guided, but did not delimit the searches. The terms listed in Portuguese were used for research in Brazilian journals. Relevant references and articles of paramount importance in the context of the review were also analyzed, regardless of the date of publication. There was no maximum time for the inclusion of fonts. Table 1 shows the number of articles used by publication time range. Table 2, in turn, illustrates the main articles used and the fundamental findings listed.

Table 1 - Publishing time range and quantity of articles revised.

Time range	Quantity
1990 - 1995	2
1996 - 2000	7
2001 - 2005	6
2011 - 2015	16
2016 - 2020	21
2021-2023	3

Source: Authors.

Table 1 shows the growth in the number of important studies on the subject over the years, that is, selecting old articles on this topic is more difficult when compared to finding them in the most recent literature, which demonstrates the current ascendancy of research on fruit juice consumption by young children, in addition to the growing concern about childhood obesity and the factors related to it.

Table 2 - Summary points of ten notable articles revised.

First author	Summary points
Hallfrisch (1990)	The increased consumption of fructose among the general population and people with metabolic disorders has consequences due to its absorption and metabolism.
Perman (1996)	Absorption of fructose and sorbitol present in fruit juice has consequences in children.
Dennison et. al (1997)	Fruit juice consumption > or = 12 fl. oz/day during childhood is associated with short stature and obesity.
Kolotkin et al. (2001)	Obesity is a condition not caused solely by a single factor. Instead, obesity is multifactorial, including genetic, metabolic, sociobehavioral and cultural factors.
De Mello et. al (2004)	Childhood obesity is increasing, has serious metabolic consequences and several are the challenges to avoid it.
Barreiros et. al (2005)	Early diagnosis of inborn errors of metabolism and the consumption of an adequate amount of this sugar in the diet are important to avoid side effects.
Lacerda et. al (2014)	Obesity and overweight are public health problems caused by the sum of poor eating habits, inactive lifestyles, lack of information and awareness of family members, genetic predisposition and socioeconomic factors.
Andrade et. al (2016)	The first 1,000 days of life are an opportunity to influence the epigenetic programming of obesity factors and avoid future diseases.
Heyman et. al. (2017)	Fruit juice has no benefits for children under 1 year; it is necessary to give preference for the whole fruit; consuming fruit juice excessively can cause malnutrition or other health problems.
Mirtschink et. al (2018)	Excess sugar consumption promotes the development of type 2 diabetes, cardiometabolic problems and cardiovascular disease.

Source: Authors.

Table 2 presents a summary with the main points about the main articles used in the narrative review. Thus, it is clear how researchers demonstrate the importance of understanding fructose metabolism, the consequences of excess sugar consumption and childhood and adult obesity, the benefits of a quality food introduction and the harms of offering fruit juice to children. However, it is evident that this availability of articles influences the recommendations on this theme by health professionals who follow the literature.

3. Results and Discussion

3.1 Childhood obesity overview

Obesity is listed as a disease in the Group of Chronic Non-Communicable Diseases (Pinheiro et al., 2004) and is multifactorial, including genetic, metabolic, sociobehavioral and cultural factors (Kolotkin et al., 2001). It is known that chronic-degenerative diseases are directly associated with excess fat levels in the abdominal or trunk region, excess visceral fat and total amount of fat (de Mello et al., 2004), being a public health problem that increases morbidity and mortality worldwide (de Mello et al., 2004). In addition, obesity has been increasing markedly and has presented several complications for the affected population, both in childhood and adulthood (de Mello et al., 2004; Hasnain et al., 2014).

There are different ways to assume that an individual is actually obese. The World Health Organization (WHO) uses the BMI criterion, which considers the height and weight of the individual. In the case of children, it is necessary to analyze them according to their ages. Thus, two forms of classification according to BMI by the WHO were created, one for children from 0 to 5 years old and another for children from 5 to 13 years old. Despite the existence of other tables and other age groups, the weight/age table for children aged 0 to 5 years classifies children as obese only if they are above p97 or have a z score of +3 (Camarinha et al., 2016).

In Brazil, recent data state that 1 in 10 children up to 9 years and 11 months of age are obese, being 10% in girls and 13% in boys, according to the criteria determined by the WHO (Castro et al., 2019). In addition, in Japan, in 10 years, the mean BMI by age increased by 0.32 kg/m² in boys and 0.24 kg/m² in girls and, as a consequence, the prevalence of obesity increased from 6.1% in boys and 7.1% in girls to 11.1% and 10.2%, respectively (Matsushita et al., 2004). In the United States, childhood obesity is also increasing, with 25% of the child population overweight and 11% obese (Lacerda et al., 2014). The explanation would be the change in eating habits and/or lifestyle changes over the years, including early weaning, the introduction of formulated and processed foods, prolonged screen time, reducing energy expenditure from outdoor activities, among others (Lacerda et al., 2014).

Childhood obesity is closely linked to comorbidities in adulthood, such as obesity, hypertension and cardiovascular diseases – three aspects that correlate with mortality today. Thus, preventing childhood obesity effectively reduces chronic-degenerative diseases (de Mello et al., 2004).

3.2 Fruit juice consumption in childhood

Recommendations of juice intake

WHO recommends that breastfeeding be exclusive in the first six months of life, without water, tea, or juice, since breast milk has the nutrients responsible for immunomodulation, protection against allergies and infections, neurological maturation, and infant digestion. Breastfeeding should be stimulated until 24 months or more (*Manual de Orientação - Departamento de Nutrologia*, 2012).

Traditionally, fruit juice intake was on pediatricians' recommendations as an additional source of water and vitamin C to children (Heyman et al., 2017). However, both industrialized and artificial juices contain a large amount of dyes, sugars and monosodium glutamate, a highly harmful component to the central nervous system (Ferreira, 2015). Since children under two years of age have cognitive immaturity, this consumption can generate mental disorders such as hyperactivity, developmental and attention deficit, autism and depression, in addition to other metabolic disorders such as obesity and diabetes (Ferreira, 2015). Therefore, some aspects such as the age and the amount of natural fruit juice ingested by the child are also relevant.

The Brazilian Society of Endocrinology and Metabology, in its guide to feeding children up to two years of age, highlights the importance of the consumption of fruit juice rich in vitamin C (from 50 to 100 mL per day) for children who have already undergone food introduction, when it is not possible to eat meat, favoring the absorption of inorganic iron (*Dez*

passos para uma alimentação saudável: guia alimentar para crianças menores de dois anos: um guia para o profissional da saúde na atenção básica - 2ª Edição, 2015). In addition, the vitamins that the juice provides are also found in the whole fruit (Ferris et al., 2017). However, the same guide clarifies that liquid diets do not have the same energy density (calorie per gram of food) as solid diets and should not be unique components of a meal (Ministério da Saúde, 2019).

The recommendation of the American Academy of Pediatrics (AAP) in the United States is that the daily intake of fruit juice be limited to 4 to 6 oz (i.e., approximately 118 to 177 mL) for children up to six years of age and 8 to 12 oz (i.e., approximately 236 to 354 mL) for children older than seven years (Zolot, 2017). In addition, the recommendation of the 2017 AAP guideline suggested that fruit juice should be avoided in the diet of children under one year of age, and should be consumed only as part of a meal and not throughout the day (Heyman et al., 2017). In addition, the daily vitamin C requirements for children one to three years of age could be met after eating 1/4 of an orange, 1/4 of a cup of broccoli, or 1/4 of a cup of strawberry, reinforcing that vitamin C needs are met even without fruit intake (Ferris et al., 2017).

Excessive natural or industrialized fruit juice intake in childhood

In childhood, there is an innate preference for sweet taste, but offering sweet foods to children increases the chance of rejection of natural foods (Giesta et al., 2019; Louzada et al., 2015; Tandoi et al., 2017). In addition, food introduction is essential for the formation of eating habits (Marques et al., 2013).

The consumption of ultra-processed products already in the first six months of age is typical in Brazil (Saldiva et al., 2014). In addition, a study with North American children from the last trimester of pregnancy to the 6th year of life showed a 92% chance of the child will be obese in the future when the introduction of sugary fruit juice occurs before 6 months of life (Pan et al., 2014). Juices produced by the industry go through several stages and take many ingredients, such as salt, fats, oils, food additives and sugar (Ministério da Saúde, 2019), being sources of sodium, preservatives and food additives (de Alcântara & de Almeida, 2020). Regarding the consumption of overall (i.e., other than juice) ultra-processed products, there was an important growth between 2000 and 2013, being 43% worldwide (114% in Asia and the Pacific, 73% in Eastern Europe and 48% in Latin America) at all ages (Bortolini et al., 2019).

Some industrialized juices also lack fiber, an important component for intestinal health (Ferris et al., 2017), increase satiety (Wojcicki & Heyman, 2012), improve cholesterol profile and decrease low-density lipoproteins (LDL) (Brown et al., 1999), in addition to improving glycemic control in patients with diabetes mellitus (Riccardi & Rivellese, 2000) and helping to reduce body weight (Birketvedt et al., 2005). The consumption of at least 30 g/day added to the variety of fiber sources can be significant (Bernaud & Rodrigues, 2013).

Of note, when the juice is indicated to supply some individual need of a child older than six months, it is suggested offered it in a glass to prevent also dental caries, which is another problem caused by the consumption of juice (König & Navia, 1995), avoiding prolonged exposure of teeth to sugars (Heyman et al., 2017).

3.3 Fructose metabolism increases lipids production

Fructose is a monosaccharide obtained by the ingestion of fruits or glucose and may be involved in the development of childhood obesity associated with the ingestion of fruit juices, since its metabolism results in increased blood lipids (Barreiros et al., 2005; Campbell et al., 2014).

Its absorption may be by a transport that does not depend on glucose, but has less influence, or by a glucose-dependent pathway, which has greater influence (Perman, 1996; Shi et al., 1997). Thus, absorption is potentiated when ingested together with glucose. After the absorption of fructose in the intestine, it is taken to the liver, leaving the enterocyte through the

basolateral membrane and reaching the blood of the portal vein, ending its transport in the liver (that is, responsible for its metabolism) (Buchs et al., 1998).

Studies show a higher production of triglycerides in the human body associated with fructose intake compared to more complex carbohydrates such as glucose (Hallfrisch, 1990). In addition, excessive fructose consumption can lead to metabolic syndrome, since there is an association with ectopic fat accumulation, especially in the liver (Lim et al., 2019; Mirtschink et al., 2018; Santos et al., 2019; Stahl et al., 2019; Stanhope et al., 2018).

Fructose is widely used to sweeten industrialized beverages and fruit juices, because it is more soluble in aqueous solutions and about 1.5 times sweeter than sucrose (Gaino & Silva, 2011). Each gram of fructose offers 16kJ of energy (Barreiros et al., 2005) compared to glucose which offers 14kJ of energy per gram (Spolidoro, 2000).

3.4 1000-day theory

The 270 days of gestation and the 730 days of the first two years of life add up to 1000 days of great relevance for the development of the child, which include adequate feeding of the pregnant woman, exclusive breastfeeding of the newborn up to 6 months and subsequent introduction of balanced feeding (Andrade et al., 2016).

In addition, the beginning of life is an essential period for development, including eating, sleeping, the first exertive physical activities of the human body (Taylor et al., 2016) and even the development and increase in the size of fat cells (Hauner et al., 2013). Soon after birth, body fat that represents about 14% of total weight grows to 20% in 1 year (Hauner et al., 2012).

Thus, knowing that there is a relationship between food introduction (AI) and childhood obesity, some factors should be taken into account, such as the fact that, in addition to the fact that AI should not precede 4 months or extend after 6, it should not be based on hypercaloric foods, but rather low energy density, such as fruits and vegetables. Salt, sugar, fruit juices, sugary drinks, sweets, soft drinks, pasta and industrialized should not be offered (Lellis & Coelho, 2023). However, the reality is different, as shown by a cross-sectional Brazilian study that observed that more than a third of children aged 12 to 23 months (1,216 children out of a total of 4,863 studied) consume artificial juices (Flores et al., 2021).

The theory of epigenetics and the concepts of neurobiology show that a phenotype is formed with changes in gene expression and can even be transmitted to future generations (Noro & Gon, 2015). Thus, the first 1000 days of life are an opportunity to generate an excellent metabolic scheme and avoid future damage such as obesity and chronic diseases (Andrade et al., 2016), since fat deposition in babies is associated with excessive weight gain in adulthood (Rudolph et al., 2017).

4. Conclusion

Although the topic is challenging and not yet fully understood, several studies between 1990 and 2023 have shed light on the relationship between fruit juice consumption by individuals under two years of age and overweight or obesity in adulthood. It was found that exclusive breastfeeding in the first 6 months of life, the phase in which adipose tissue cells develop, is essential to avoid overweight or obesity in adulthood. In addition, even small amounts of fruit juice taken by children under 2 years of age play a role in childhood and adult obesity. The unfavorable effects of fruit juice on children affect both developed and underdeveloped countries, also relying on cultural aspects of child nutrition. Thus, more research is needed for applicability to the clinical scenario, allowing the establishment of standards and integrated information to health professionals, aiming to provide the correct and necessary guidance to parents and caregivers, so that the children they assist have the opportunity to develop a healthy metabolic profile and a better body composition in adult life. In addition, future research should aim at the creation of nutrition protocols applicable to daycare centers and schools, seeking to reduce the consumption of sugary drinks and fruit juice by children under 2 years of age in their living scenarios.

Conflict of interest

Authors declare no conflict of interest.

Author contributions

Study concept and methodology design: CGS, JVFF; data curation: CGS, JVFF and DPMD; drafting of the manuscript: CGS, JVFF and DPMD; critical revision of the manuscript: CGS, JVFF and DPMD; and study supervision: DPMD.

References

- Andrade, B. C. P., Lage, B. A., Borges, C. D. S., Falci, D. A. R., Neto, O. L. O., & Gaspar, L. R. (2016). 1000 dias: uma janela de oportunidades. *Revista uningá review*, 25(2), <http://34.233.57.254/index.php/uningareviews/article/view/1754>
- Barreiros, R. C., Bossolan, G., & Trindade, C. E. P. (2005). Frutose em humanos: Efeitos metabólicos, utilização clínica e erros inatos associados. *Revista de Nutrição*, 18, 377–389. <https://doi.org/10.1590/S1415-52732005000300010>
- Bernaudo, F. S. R., & Rodrigues, T. C. (2013). Fibra alimentar: Ingestão adequada e efeitos sobre a saúde do metabolismo. *Arquivos Brasileiros de Endocrinologia & Metabologia*, 57, 397–405. <https://doi.org/10.1590/S0004-27302013000600001>
- Birketvedt, G. S., Shimshi, M., Erling, T., & Florholmen, J. (2005). Experiences with three different fiber supplements in weight reduction. *Medical Science Monitor: International Medical Journal of Experimental and Clinical Research*, 11(1), P15-8.
- Bortolini, G. A., Moura, A. L. de P., de Lima, A. M. C., Moreira, H. de O. M., Medeiros, O., Diefenthaler, I. C. M., & de Oliveira, M. L. (2019). Guias alimentares: Estratégia para redução do consumo de alimentos ultraprocessados e prevenção da obesidade. *Revista Panamericana de Salud Pública*, 43, e59. <https://doi.org/10.26633/RPSP.2019.59>
- Brown, L., Rosner, B., Willett, W. W., & Sacks, F. M. (1999). Cholesterol-lowering effects of dietary fiber: A meta-analysis. *The American Journal of Clinical Nutrition*, 69(1), 30–42. <https://doi.org/10.1093/ajcn/69.1.30>
- Buchs, A. E., Sasson, S., Joost, H. G., & Cerasi, E. (1998). Characterization of GLUT5 domains responsible for fructose transport. *Endocrinology*, 139(3), 827–831. <https://doi.org/10.1210/endo.139.3.5780>
- Camarinha, B., Graça, P., & Nogueira, P. J. (2016). A Prevalência de Pré-Obesidade/Obesidade nas Crianças do Ensino Pré-Escolar e Escolar na Autarquia de Vila Nova de Gaia, Portugal. *Acta Med Port*, 10.
- Campbell, E., Schlappal, A., Geller, E., & Castonguay, T. W. (2014). Chapter 19 - Fructose-Induced Hypertriglyceridemia: A Review. In R. R. Watson (Ed.), *Nutrition in the Prevention and Treatment of Abdominal Obesity* (pp. 197–205). <https://doi.org/10.1016/B978-0-12-407869-7.00019-2>
- Castro, A., Galvao, T., Ferreira, C., Reis, N. dos, & Gusmão, R. (2019). Prevalência da obesidade infantil no Brasil: Revisão sistemática e meta-análise. *Revista dos Trabalhos de Iniciação Científica da UNICAMP*, 27, <https://doi.org/10.20396/revpibic2720192440>
- Crowe-White, K., O'Neil, C. E., Parrott, J. S., Benson-Davies, S., Droke, E., Gutschall, M., Stote, K. S., Wolfram, T., & Ziegler, P. (2016). Impact of 100% Fruit Juice Consumption on Diet and Weight Status of Children: An Evidence-based Review. *Critical Reviews in Food Science and Nutrition*, 56(5), 871–884. <https://doi.org/10.1080/10408398.2015.1061475>
- de Alcântara, K. R., & de Almeida, S. G. (2020). *Centro Universitário de Brasília – UniCEUB Faculdade de Ciências da Educação e Saúde Curso de Nutrição*. 24.
- de Mello, E. D., Luft, V. C., & Meyer, F. (2004). Childhood obesity—Towards effectiveness. *Childhood Obesity*, 10.
- Dennison, B. A., Rockwell, H. L., & Baker, S. L. (1997). Excess fruit juice consumption by preschool-aged children is associated with short stature and obesity. *Pediatrics*, 99(1), 15–22.
- Dez passos para uma alimentação saudável: Guia alimentar para crianças menores de dois anos: Um guia para o profissional da saúde na atenção básica—2ª Edição*. (2015). 76.
- Ferreira, F. de S. (2015). *Consumo de alimentos impróprios por crianças menores de dois anos e suas possíveis consequências DOI: <http://dx.doi.org/10.5892/rivr.v13i1.1843>*. Universidade Vale do Rio Verde.
- Ferris, H. A., Isganaitis, E., & Brown, F. (2017). Time for an End to Juice in the Special Supplemental Nutrition Program for Women, Infants, and Children. *JAMA Pediatrics*, 171(6), 509–510. <https://doi.org/10.1001/jamapediatrics.2017.0134>
- Flores, T. R., Neves, R. G., Wendt, A., Costa, C. D. S., Bertoldi, A. D., & Nunes, B. P. (2021). Padrões de consumo alimentar em crianças menores de dois anos no Brasil: Pesquisa Nacional de Saúde, 2013. *Ciência & Saúde Coletiva*, 26(2), 625–636. <https://doi.org/10.1590/1413-81232021262.13152020>
- Gaino, N. M., & Silva, M. V. da. (2011). Consumo de frutose e impacto na saúde humana. *Segurança Alimentar e Nutricional*, 18(2), <https://doi.org/10.20396/san.v18i2.8634681>

- Giesta, J. M., Zoche, E., Corrêa, R. da S., & Bosa, V. L. (2019). Fatores associados à introdução precoce de alimentos ultraprocessados na alimentação de crianças menores de dois anos. *Ciência & Saúde Coletiva*, 24, 2387–2397. <https://doi.org/10.1590/1413-81232018247.24162017>
- Hallfrisch, J. (1990). Metabolic effects of dietary fructose. *FASEB Journal: Official Publication of the Federation of American Societies for Experimental Biology*, 4(9), 2652–2660. <https://doi.org/10.1096/fasebj.4.9.2189777>
- Hauner, H., Brunner, S., & Amann-Gassner, U. (2013). The role of dietary fatty acids for early human adipose tissue growth. *The American Journal of Clinical Nutrition*, 98(2), 549S-555S. <https://doi.org/10.3945/ajcn.112.040733>
- Hauner, H., Much, D., Vollhardt, C., Brunner, S., Schmid, D., Sedlmeier, E.-M., Heimberg, E., Schuster, T., Zimmermann, A., Schneider, K.-T. M., Bader, B. L., & Amann-Gassner, U. (2012). Effect of reducing the n-6:n-3 long-chain PUFA ratio during pregnancy and lactation on infant adipose tissue growth within the first year of life: An open-label randomized controlled trial. *The American Journal of Clinical Nutrition*, 95(2), 383–394. <https://doi.org/10.3945/ajcn.111.022590>
- Heyman, M. B., Abrams, S. A. (2017) section on gastroenterology, hepatology, and nutrition, & committee on nutrition. Fruit Juice in Infants, Children, and Adolescents: Current Recommendations. *Pediatrics*, 139(6), e20170967. <https://doi.org/10.1542/peds.2017-0967>
- König, K. G., & Navia, J. M. (1995). Nutritional role of sugars in oral health. *The American Journal of Clinical Nutrition*, 62(1 Suppl), 275S-282S; discussion 282S-283S. <https://doi.org/10.1093/ajcn/62.1.275S>
- Lacerda, L. R. F. de, Rodrigues, A. Y. F., Rocha, M. R. da S., & Lopes, S. V. M. U. (2014). Prevalência de obesidade infantil e sobrepeso em escolares. *Revista Interfaces: Saúde, Humanas e Tecnologia*, 2(5). <https://doi.org/10.16891/89>
- Lellis, A. C., & Coelho, C. G. G. (n.d.). *Alessandra Nogueira de Carvalho*.
- Lim, S., Taskinen, M.-R., & Borén, J. (2019). Crosstalk between nonalcoholic fatty liver disease and cardiometabolic syndrome. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, 20(4), 599–611. <https://doi.org/10.1111/obr.12820>
- Louzada, M. L. da C., Martins, A. P. B., Canella, D. S., Baraldi, L. G., Levy, R. B., Claro, R. M., Moubarac, J.-C., Cannon, G., & Monteiro, C. A. (2015). Ultra-processed foods and the nutritional dietary profile in Brazil. *Revista de Saúde Pública*, 49(0). <https://doi.org/10.1590/S0034-8910.2015049006132>
- Manual de Orientação—Departamento de Nutrologia*. (2012). 152.
- Marques, R. de F. da S. V., Sarni, R. O. S., Santos, F. P. C. dos, & Brito, D. M. P. de. (2013). Práticas inadequadas da alimentação complementar em lactentes, residentes em Belém-PA. *Rev. para. med.*, 27(2). <http://bases.bireme.br/cgi-bin/wxislind.exe/iah/online/?IsisScript=iah/iah.xis&src=google&base=LILACS&lang=p&nextAction=lnk&exprSearch=681362&indexSearch=ID>
- Matsushita, Y., Yoshiike, N., Kaneda, F., Yoshita, K., & Takimoto, H. (2004). Trends in childhood obesity in Japan over the last 25 years from the national nutrition survey. *Obesity Research*, 12(2), 205–214. <https://doi.org/10.1038/oby.2004.27>
- Ministério da Saúde. (2019). *Guia alimentar para crianças brasileiras menores de 2 anos*. Ministério da Saúde, Secretaria de Atenção Primária à Saúde, Departamento de Promoção da Saúde.
- Mirtschink, P., Jang, C., Arany, Z., & Krek, W. (2018). Fructose metabolism, cardiometabolic risk, and the epidemic of coronary artery disease. *European Heart Journal*, 39(26), 2497–2505. <https://doi.org/10.1093/eurheartj/ehx518>
- Noro, G., & Gon, M. C. C. (2015). Epigenética, Cuidados Maternais e Vulnerabilidade ao Estresse: Conceitos Básicos e Aplicabilidade. *Psicologia: Reflexão e Crítica*, 28, 829–839. <https://doi.org/10.1590/1678-7153.201528422>
- Pan, L., Li, R., Park, S., Galuska, D. A., Sherry, B., & Freedman, D. S. (2014). A Longitudinal Analysis of Sugar-Sweetened Beverage Intake in Infancy and Obesity at 6 Years. *Pediatrics*, 134(Suppl 1), S29–S35. <https://doi.org/10.1542/peds.2014-0646F>
- Pereira AS, Shitsuka DM, Parreira FJ, Shitsuka R. (2018). Metodologia da pesquisa científica. Brasil. <http://repositorio.ufsm.br/handle/1/15824>.
- Perman, J. A. (1996). Digestion and absorption of fruit juice carbohydrates. *Journal of the American College of Nutrition*, 15(5 Suppl), 12S-17S. <https://doi.org/10.1080/07315724.1996.10720469>
- Posicionamento do Instituto Nacional de Câncer José Alencar Gomes da Silva acerca do Sobrepeso e Obesidade. (2019). *Revista Brasileira de Cancerologia*, 63(1), 7–12. <https://doi.org/10.32635/2176-9745.RBC.2017v63n1.186>
- Riccardi, G., & Rivellese, A. A. (2000). Dietary treatment of the metabolic syndrome—The optimal diet. *British Journal of Nutrition*, 83(S1), S143–S148. <https://doi.org/10.1017/S0007114500001082>
- Rudolph, M. C., Young, B. E., Lemas, D. J., Palmer, C. E., Hernandez, T. L., Barbour, L. A., Friedman, J. E., Krebs, N. F., & MacLean, P. S. (2017). Early infant adipose deposition is positively associated with the n-6 to n-3 fatty acid ratio in human milk independent of maternal BMI. *International Journal of Obesity (2005)*, 41(4), 510–517. <https://doi.org/10.1038/ijo.2016.211>
- Saldiva, S. R. D. M., Venancio, S. I., de Santana, A. C., da Silva Castro, A. L., Escuder, M. M. L., & Giugliani, E. R. J. (2014). The consumption of unhealthy foods by Brazilian children is influenced by their mother's educational level. *Nutrition Journal*, 13(1), 33. <https://doi.org/10.1186/1475-2891-13-33>
- Santos, R. D., Valenti, L., & Romeo, S. (2019). Does nonalcoholic fatty liver disease cause cardiovascular disease? Current knowledge and gaps. *Atherosclerosis*, 282, 110–120. <https://doi.org/10.1016/j.atherosclerosis.2019.01.029>
- Shi, X., Schedl, H. P., Summers, R. M., Lambert, G. P., Chang, R. T., Xia, T., & Gisolfi, C. V. (1997). Fructose transport mechanisms in humans. *Gastroenterology*, 113(4), 1171–1179. <https://doi.org/10.1053/gast.1997.v113.pm9322512>

Silva, E. N. da, Almeida, G. D. de, & Skrivan, A. G. (2021). A influência da publicidade da indústria alimentícia nos hábitos alimentares infantis: Uma revisão bibliográfica. *Research, Society and Development*, 10(14), Article 14. <https://doi.org/10.33448/rsd-v10i14.22668>

Spolidoro, J. V. N. (2000). Parenteral Nutrition in pediatrics. *Jornal de Pediatria*, 76(8), 339–348. <https://doi.org/10.2223/JPED.173>

Stahl, E. P., Dhindsa, D. S., Lee, S. K., Sandesara, P. B., Chalasani, N. P., & Sperling, L. S. (2019). Nonalcoholic Fatty Liver Disease and the Heart: JACC State-of-the-Art Review. *Journal of the American College of Cardiology*, 73(8), 948–963. <https://doi.org/10.1016/j.jacc.2018.11.050>

Stanhope, K. L., Goran, M. I., Bosy-Westphal, A., King, J. C., Schmidt, L. A., Schwarz, J.-M., Stice, E., Sylvetsky, A. C., Tumbaugh, P. J., Bray, G. A., Gardner, C. D., Havel, P. J., Malik, V., Mason, A. E., Ravussin, E., Rosenbaum, M., Welsh, J. A., Allister-Price, C., Sigala, D. M., & Krauss, R. M. (2018). Pathways and mechanisms linking dietary components to cardiometabolic disease: Thinking beyond calories. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, 19(9), 1205–1235. <https://doi.org/10.1111/obr.12699>

Tandoi, F., Morlacchi, L., Bossi, A., & Agosti, M. (2017). Introducing complementary foods in the first year of life. *La Pediatria Medica E Chirurgica: Medical and Surgical Pediatrics*, 39(4), 186. <https://doi.org/10.4081/pmc.2017.186>

Taylor, R. W., Heath, A.-L. M., Galland, B. C., Cameron, S. L., Lawrence, J. A., Gray, A. R., Tannock, G. W., Lawley, B., Healey, D., Sayers, R. M., Hanna, M., Meredith-Jones, K., Hatch, B., & Taylor, B. J. (2016). Three-year follow-up of a randomised controlled trial to reduce excessive weight gain in the first two years of life: Protocol for the POI follow-up study. *BMC Public Health*, 16, 771. <https://doi.org/10.1186/s12889-016-3383-4>

Wojcicki, J. M., & Heyman, M. B. (2012). Reducing Childhood Obesity by Eliminating 100% Fruit Juice. *American Journal of Public Health*, 102(9), 1630–1633. <https://doi.org/10.2105/AJPH.2012.300719>

Zolot, J. (2017). Daily Consumption of Fruit Juice is Associated with Slight Weight Gain in Young Children. *The American Journal of Nursing*, 117(8), 56. <https://doi.org/10.1097/01.NAJ.0000521975.84459.73>