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Nutrition:

Challenges, Opportunities, and Essential Strategies in the Prevention and Management of Chronic Diseases

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Abstract

Today, nutrition plays important roles on the encouraging incidences by the information that people find in different current media, harming their health in the absence of a consultation of experts in the area of health. This is where diseases such as obesity, type 2 diabetes mellitus and cancer have grown out of control regardless of gender and age. Each chapter explores a nutritional analysis on each of them. The recommendations of spirulina consumption, flavonoids, intermittent fasting, postpartum nutritional care, the importance of child and school health, and the critical role played by the gut microbiota are just one option that can be considered but if embraced will undoubtedly yield good results. This book provides evidence-based information to encourage more conscious and healthier dietary choices.
Keywords:
Nutrition; food; public health; chronic diseases; quality of life; quality of life

Resumen

Hoy, la nutrición juega roles importantes sobre las incidencias alentadoras por la información que las personas encuentran en diferentes medios de comunicación actuales, perjudicando su salud a falta de una consulta de expertos del área de la salud. Es así donde las enfermedades como la obesidad, diabetes mellitus tipo 2 y el cáncer han crecido descontroladamente sin mirar al género y a las edades. Cada capítulo explora un análisis nutricional en cada uno de ellas. La recomendaciones del consumo de espirulina, flavonoides, el ayuno intermitente, el cuidado nutricional postparto, la importancia de la salud infantil y escolar, y el papel fundamental que desempeña la microbiota intestinal son solo una opción que se puede tener en cuenta pero que si la aceptamos indudablemente dará buenos resultados. Este libro proporciona información basada en evidencia científica para fomentar decisiones alimentarias más conscientes y saludables.
Palabras clave:
Nutrición; alimentación; salud pública; enfermedades crónicas; calidad de vida.

Resumo

Hoje, a nutrição desempenha papéis importantes nas incidências alarmantes devido às informações que as pessoas encontram nos diferentes meios de comunicação atuais, prejudicando sua saúde pela falta de consulta a especialistas da área da saúde. É assim que doenças como obesidade, diabetes mellitus tipo 2 e câncer têm crescido descontroladamente, sem distinção de gênero ou idade. Cada capítulo explora uma análise nutricional relacionada a essas condições. As recomendações sobre o consumo de espirulina, flavonoides, o jejum intermitente, os cuidados nutricionais pós-parto, a importância da saúde infantil e escolar e o papel fundamental da microbiota intestinal são apenas algumas opções que podem ser consideradas – mas que, se adotadas, certamente trarão bons resultados. Este livro fornece informações baseadas em evidências científicas para promover escolhas alimentares mais conscientes e saudáveis.
Palavras-chave:
Nutrição; alimentação; saúde pública; doenças crônicas; qualidade de vida.

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Chapter 1

Comparison of nutritional aspects between breast milk versus artificial milk

Javier Alejandro Macías Lozano, Sarahí López Bustillos, Vetzaida Estela González Ponce, Crescencio Urías García

Abstract

Research related to exclusive breastfeeding has not been sufficiently clear or well disseminated, it has been left aside by the facilities provided by artificial milk for being practical and effective for today's fast-paced lifestyles, but breast milk is the perfect food, because it adapts to the nutritional needs at the beginning of his life, helping in its entirety to their physical, neurological and psychological development. Likewise, the infant arrives to receive care of all kinds for an indefinite period of time, and by giving it to him, it is only expected that he grows healthy and strong, but there are numerous variables that will lead us to achieve it, in the present investigation two options are proposed to satisfy the nutritional needs of the newborns and the benefits directed to the mother.

Keywords:
breastfeeding; infant development; nutrition; women's health; child welfare.

Introduction

Newborns represent one of the highest priorities for society, as they are at the most vulnerable stage of life in terms of morbidity and mortality, which are undoubtedly preventable and/or treatable. For this, it is essential to ensure their good development and growth from their early stages in providing them with adequate nutrients for good health in infancy and adulthood (Pereira et al., 2022). Breastfeeding is a potential nutritious food (rich in proteins, lipids, vitamins, minerals, oligosaccharides, immunoglobulins and even the presence of stem cells) that allows providing an ideal food for the healthy growth and development of infants enough and, given its easy absorption, it is used effectively for their proper brain and cognitive development, as well as the prevention of diseases prevalent in children, with which the rates of infant morbidity and mortality are considerably decreased (Sitelbanat-Osman et al., 2023). Although there are several factors involved in growth and development, breastfeeding is the cornerstone for a healthy future in all its dimensions (biological, cognitive and social) (Pereira et al., 2022).

On the other hand, there is currently a marked competition between artificial milks and breast milk, which offer the supply of nutrients, probiotics, essential fatty acids, nucleic acids and other nutrients that need to be good for the health of newborns (Martin et al., 2016). Formula milk is a modified cow's milk that tries to resemble breast milk as closely as possible, i.e., it tries to add all the nutrients present in breast milk so that the infant can obtain effects similar to those of a breastfed infant. Artificial lactation has several advantages and/or recommendations, however, there is a great difference between these formulas and breast milk, such as bioabsorption and bioavailability of nutrients, early stimulation of the microbiota, cellular response for the development of children, development of different tissues, strengthening of the immune system, among other aspects (Pereira et al., 2022). Therefore, in this chapter we propose to analyze the nutritional aspects and benefits between breast milk and formula milk, in order to understand the implementation of both milks in the infant's diet.

Differences and benefits of breast milk and formula milk

The breast milk is a very complete food, which is why there are various reasons that support this natural practice of feeding an infant within the first 6 months of life, requiring prebiotics, as well as prebiotics, transmission and reception of antibodies, living cells, as well as different psychological reasons that can create a bond between mother and child. During feeding there is direct skin-to-skin contact that helps foster attachment and a feeling of protection. Even a

benefit that breast milk has is that it can be adjusted to the needs of the baby, since as mentioned previously, breast milk has various stages that correspond and accompany each stage of the baby's development.

Artificial milk: One of the advantages offered by the use of infant formulas is the availability since they can be used in cases in which mothers cannot breastfeed due to different factors, whether health or work. The implementation and development of infant artificial milk has been carried out with the aim of being able to match the composition that exists in breast milk as closely as possible, although on the other hand artificial milk lacks natural antibodies that are found in breast milk (Martínez, 2020).

Table 1. Parameters of breast milk vs. artificial milk.

Parameter	Breast milk	Artificial milk
Body composition	Breast milk is a food that adapts to the needs of the infant at each stage of its development and its content is highly bioavailable, which means better uptake of nutrients.	Artificial milk, despite being developed with the aim of being as similar as possible to breast milk, does not have certain natural antibodies and cannot fully match the complexity of breast milk.
Emotional benefit	Carrying out the practice of breastfeeding promotes the creation of a mother-child bond which results in the release of satisfying/relaxing hormones.	The creation of a mother-child bond cannot be created in the same way through this method.
Immune protection	Within the components of breast milk it contains immunological compounds such as antibodies that generate protection against diseases and promote the strengthening of the baby's immune system.	Formula milk does not provide specific immunological protection.

Source: own elaboration

Breastfeeding as an aid to postpartum recovery

Postpartum symptoms can include a host of discomforts from the well-known postpartum depression, which encompasses intense sadness, asthenia or excessive tiredness, and the inability to feel pleasure in activities that were previously enjoyed. This can delay the return to the mother's activities, since she loses the notion of personal care, healthy sleep and feeding cycles, also having consequences for the newborn (Jordan, 2024).

Breastfeeding assists the movements of uterine contraction, this in turn helps eliminate lochia (which are the blood and placental waste left in the uterus), facilitating a successful recovery for the system, favoring the relationship between mother and child, a link that will help the patient secrete stress-regulating hormones such as oxytocins, and which in turn stabilizes blood pressure, reducing the chances of hemorrhage (Prieto, 2019).

The quality of sleep is also positively affected, remembering the hormone already mentioned and adding to it the effect that expelling prolactin has on the mother's body in the postpartum is to ensure mental well-being thanks to being able to feel that 90% of the needs they have in this period of life are being satisfied by simply providing a body fluid. Until just a few years ago, the psychological effect that motherhood has on women began to be mentioned. Self-esteem is generally deteriorated in the notable body change and other specific changes that depend on each woman, but one of the most frequent complexes is without a doubt the change in weight and the accumulation of fat; It is important to mention that the contribution of breast milk is mostly fats that are taken from the mother, the rest are carbohydrates and finally a low percentage of proteins. Having said this, it can be explained that, from the foods consumed, something is set aside for the baby and the caloric contribution of that food cannot be fully utilized, in addition to the fact that the energy expenditure required by breastfeeding on demand for a whole day is approximately equivalent to at least 40 minutes of intensive exercise, so yes, breastfeeding helps reduce the percentage of body fat and consequently to lose weight (Torres, 2019).

Finally, as a mention, we talk about breast and ovarian cancer as the most common causes of mortality in women around the world, but it has been shown that women who breastfeed from six months onwards reduce the probability of contracting them, but if the duration is greater than twelve months it can reduce its eventuality by up to 37% since the natural regulation of estrogen in pregnancy and breastfeeding has long-term effects. These results were observed in hormonal analyzes of premenopausal women who breastfed. during the mentioned time. Breastfeeding also helps to suppress possible diseased cells or the so-called free radicals of the mammary glands that also contribute to the formation of cancer; In this way we are sure that breastfeeding impacts mother and child in ways that we do not take into account every day, but from now on, we will (Cruz et al., 2024).

Benefits of exclusive breastfeeding for the baby's digestive development

According to Gigli (2020), Human milk is one of the only ones that adapts and changes according to the needs of the growing newborn, it has three stages:

colostrum, transitional milk and mature milk. For several years it was believed that colostrum (breast milk secreted in the first 3-5 days of breastfeeding) was a sterile substance, free of microorganisms that fed the unborn, it is not sterile at all, it has colonies of beneficial bacteria for the digestive system of the newborn, which will help it colonize its gastrointestinal tract and cover its intestine with immunoglobulins, that is, the first proteins for training its immune system.

Colostrum is mostly proteins, the first reserves of iron, sodium and other minerals as well as fat-soluble vitamins. Likewise, its consistency generates intestinal mucus and compensates for the inflammation generated by some microorganisms to which it was exposed during childbirth (Garcia, 2023). Transitional milk is that which, at a nutritional level, provides fewer immunoglobulins, but increases in percentage of fat, which will benefit even more, since fat-soluble vitamins continue to be administered, and a high intake of fat will help to metabolize the vitamins in a better way, at this point the chances of contracting common newborn diseases are lower and with this, mortality as well. And mature milk becomes more stable in terms of its structure, but not in its entirety because, as we remember, it is a living food that evolves according to the needs and requirements of the baby, starting with a greater contribution of water and calories to reach its demand due to greater activity, it still contains vitamins and minerals but now slightly reduced and with the flavors of everything that mother consumes (Medina, 2024).

Breastfeeding at least until 6 months is the technique that urgently needs to be implemented to avoid crib deaths and deaths from breast cancer. In newborns, all possibilities of food allergies and very strong diarrhea are practically eliminated, and their long-term health is improved due to the immunological and cognitive development benefits that it has compared to artificial milk (Franco, 2023).

Effects of breastfeeding on protecting the baby's health

During the first stage of any infant's life, breastfeeding is an essential process as this is a natural way of providing nutritional, immunological and emotional factors, the latter helping to create a bond between mother and child while at the same time receiving antibodies that will keep the child healthy. The first milk to be produced by the mother is called colostrum and it is characterized by being a creamy, yellowish liquid with high density. Substance that can be considered the perfect food for a newborn and is recommended to be consumed during the first hours of life. This substance called colostrum is mainly composed of white blood cells, protein and immuno agents that will serve to reinforce the infant's immune response. After colostrum, a milk called transitional milk is produced during the first 3 to 5 days after birth, which is responsible for and has the function of helping

to maintain the optimal pH of your excretions and maintain homeostasis in your intestinal flora, which means protection against possible bacterial diarrhea. From 7 to 14 days after childbirth, milk is produced called mature milk. This is the milk that is produced during most of breastfeeding. Given the protective effects that milk is shown to have, those babies who have been breastfed prove to be less likely to contract any disease compared to those who are fed by artificial feeding. Some breastfeeding compounds are shown in the breastfeeding composition table (Morales et al., 2022).

Table 2. Composition of breastfeeding

Antimicrobial compounds	**Tolerance compounds**	**Immune system development compounds**	**Anti-inflammatory compounds**
Immunoglobulins (IgA, IgG, IgM) Lactoferrin Lactoferricin B and H Lysozyme Lactoperoxidase Haptocorrin Mucins Fatty acids	Cytokines (IL-10 and TGF-beta) Anti-idiotypic antibodies	Macrophages Neutrophils Lymphocytes Cytokines Growth factors Hormones Dairy peptides	Cytokines (IL-10 and TGF-beta) IL-1 antagonist receptors Adhesion molecules Long chain fatty acids Hormones and growth factors Lactoferrin

Source: Rodríguez et al. (2022).

It is recommended that within the first hour of life the infant receives breast milk from its mother, that this be at the baby's free demand and that the use of milk or artificial breastfeeding (formula) be avoided since breast milk is a food rich in nutritional content, since it contains essential vitamins and minerals for the baby (micronutrients). Likewise, it is recommended that the infant receive complementary breastfeeding until around two years of age. Those neonates who have been breast-fed are less likely to die within their first year of life, compared to those infants who have been fed with artificial milk (formula). In the same way, neonates who have been breast-fed demonstrate a higher IQ and a lower probability of suffering from diabetes, asthma or leukemia (Rodríguez et al., 2022).

Obesity: It has been shown that breastfeeding reduces the chances of developing overweight and obesity by up to 13%. Since through breastfeeding the infant ingests only the amount he needs without overdoing it, which is the opposite of what happens in those infants who ingest their food through the use of a bottle, in which often the person in charge of preparing it for intake usually forces the infant to have the entire prepared portion of food be ingested, which is why it becomes a factor that prevents the baby from developing its ability to recognize its signals of satiety and its signals of appetite. in which the hormones ghrelin and leptin are responsible and if it is not corrected it can become a habit that accompanies it through the years.

Diabetes: There is little evidence that there is a relationship between breastfeeding consumption and a decrease in the prevalence of diabetes.

Leukemia: There is some evidence that indicates a reduction in developing leukemia or lymphoma, although for other types of cancer the evidence is still limited.

Neurodevelopment: There are studies that have reported greater academic performance and in logistics and intelligence tests in infants who have been breastfed, including some adolescents.

Attention and hyperactivity disorders: There are some studies that have shown a lower level of attention deficit and hyperactivity in children who show that they have been breastfed.

Otitis media: There is a lower prevalence of otitis media in infants who have been breastfed by the mother, extending their protection from 2 to 4 years of life even if they no longer receive breastfeeding during these ages (Rodríguez et al., 2022).

Conclusions

The findings of the present study show that despite the efforts made by the industry to have products similar to breast milk, the majority of artificial formulas are very far from having a similarity to it, however, this does not mean abandoning research in this regard, improving the quality of said formulas, assessing the true dimension of the differences and advantages of breast milk and artificial formula. a valid option. On the other hand, the research values a constant relationship between the mother/child, an aspect that must be considered in the management of children in general and in particular those under six months.

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Comparación de los aspectos nutricionales entre la leche materna y la leche artificial

Comparação dos aspectos nutricionais entre o leite materno e o leite artificial

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Resumen

Las investigaciones relacionadas a la lactancia materna exclusiva, no han sido lo suficiente claros ni bien difundidos, se ha dejado de lado por las facilidades que brinda la leche artificial por ser práctica y efectiva para los estilos de vida actuales tan acelerados, pero la leche materna es el alimento perfecto, pues se adapta a las necesidades nutricionales en el inicio de su vida, ayudando en la totalidad a su desarrollo físico, neurológico, y psicológico. Así mismo, el lactante llega para recibir cuidados de todo tipo durante tiempo indefinido, y al dárselos sólo se espera que crezca saludable y fuerte, pero hay numerosas variables que nos llevarán a lograrlo, en la presente investigación se proponen dos opciones para satisfacer las necesidades alimentarias de los neonatos y los beneficios dirigidos a la progenitora.
Palabras clave: lactancia maternal; desarrollo del niño; nutrición; salud de la mujer; bienestar de la infancia.

Resumo

As pesquisas relacionadas ao aleitamento materno exclusivo não têm sido suficientemente claras ou bem divulgadas, ele tem sido deixado de lado pelas facilidades proporcionadas pelo leite artificial por ser prático e eficaz para o estilo de vida acelerado dos dias de hoje, mas o leite materno é o alimento perfeito, pois se adapta às necessidades nutricionais no início de sua vida, ajudando em sua totalidade no seu desenvolvimento físico, neurológico e psicológico. Da mesma forma, o bebê chega para receber cuidados de todos os tipos por um período indefinido de tempo e, ao dar isso a ele, espera-se que ele cresça saudável e forte, mas existem inúmeras variáveis que nos levarão a alcançá-lo. Na presente investigação, duas opções são propostas para satisfazer as necessidades nutricionais dos recém-nascidos e os benefícios direcionados à mãe.
Palavras-chave: amamentação; desenvolvimento do bebê; nutrição; saúde da mulher; bem-estar da criança.

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Chapter 2
Flavonoids: Dietary Interveners as Cancer Chemoprotectants

Edgar Abraham Andrade Gómez, Gilberto Mercado Mercado

Abstract

Cancer are cells with altered morphologies and functions that cause an unstoppable growth and proliferation of the same. Therefore, these changes lead to the existence of different types of cancer that reproduce in different organs or tissues in people, with specific genotypes that originate a growing and uncontrollable aggressive mechanisms until they cause programmed cell death. Thus, cancer mortality is growing at an alarming rate despite the drugs currently available. In this context, phytochemicals, specifically flavonoids, which have served as mediators of inflammatory responses, expression of protogenes and inhibit the secretion of adhesion molecules, constitute a promising and effective opportunity that could provide an alternative approach to treat cancers and overcome the challenges faced by current therapies.
Keywords:
Flavonoids; cancer; genes; chemopreventive; proto-oncogenes

Introduction

Cancer cells are those that alter intracellular functions and mechanisms causing uncontrollable growth and proliferation (Ahmed et al., 2019). According to the area and processes that are generated, several types of cancer with different characteristics have been identified. Thus, there is a range of cancer cell genotypes with self-sufficiency in growth, immeasurable replicative potential, assisted ontogenesis, tissue aggression, insensitivity to growth inhibitory signals, and programmed cell death and metastasis (Sun et al., 2023). Thus, cancer mortality is increasing at an alarming rate despite currently available drugs. In this context, phytochemicals, specifically flavonoids, constitute a promising and effective opportunity that could provide an alternative approach to treat cancers and overcome the challenges faced by current therapies (Welborn, 2004).

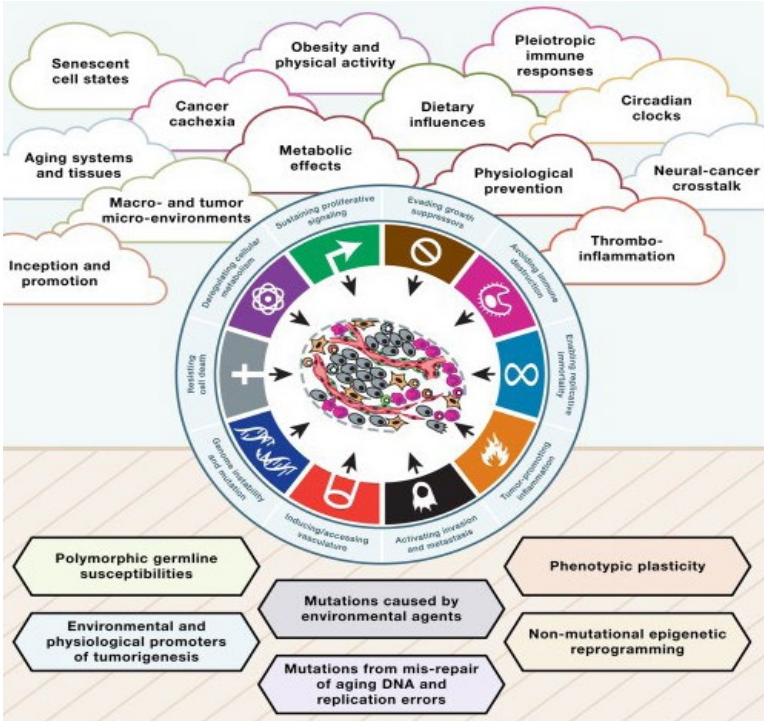
Most research has shown that these compounds reduce the risk of cancer mortality through their anti-inflammatory, antioxidant and anticancer activities (Ahmed et al., 2019). Flavonoids act through different pathways, such as inhibiting several protein kinases like cyclin-dependent kinases (CDK), glycogen synthase kinase 3 (GSK3), dual specificity tyrosine phosphorylation-regulated kinase 1A (DYRK-1A), which are involved in cancer development (Alsawaf et al., 2022; Ponte et al., 2021). They have also shown great potential in the initiation of apoptotic and autophagic cell death and in the inhibition of cancer metastasis by modulating different signaling pathways. These studies suggest that a diet rich in flavonoids is associated with a decreased risk of certain types of cancer, thus arousing interest in using them as chemoprotectants (Zhou et al., 2016). However, human studies remain insufficient and assays are often inconclusive or discordant, so far concerning are the imprecise optimal concentration of flavonoids for cellular function, the poor knowledge of their kinetics and the actual contribution of individual compounds to their effect. This chapter includes an investigation of the pathways of action and cancer chemopreventive effects of flavonoids.

Cancer

Cancer is a cellular disease that is produced by the alteration of the regulatory mechanisms of cell division, causing damage to cellular DNA in a chain reaction, and as a consequence, generates an uncontrolled proliferation of cells. Consequently, cells continue to mutate and perpetuate themselves by secreting their own growth and angiogenic factors (Welborn, 2004). Cancer is induced by multifactorial processes (Figure 1) such as tumor promoters, modulating transcription factors (NFκB, AP-1, STAT 3), anti-apoptotic proteins (AKt, BcL2, Bcl-XL), apoptotic proteins (Caspases, PARP), protein kinases (Cyclins and Cyclin-

dependent kinase), adhesion molecules, cyclooxygenases (COX) and growth factor signaling pathways (Swietach et al., 2014; Aggarwal, 2006). Aberrant gene expression leads to a number of important biological process changes in cancer cells, which are called hallmarks and molecular features of cancer, comprising six biological capabilities acquired during the development of human tumors. The hallmarks constitute an organizing principle for understanding the complexity of the disease (Swietach et al., 2014; Hanahan and Weinberg, 2011).

Figure 1. Factors influencing carinogenesis

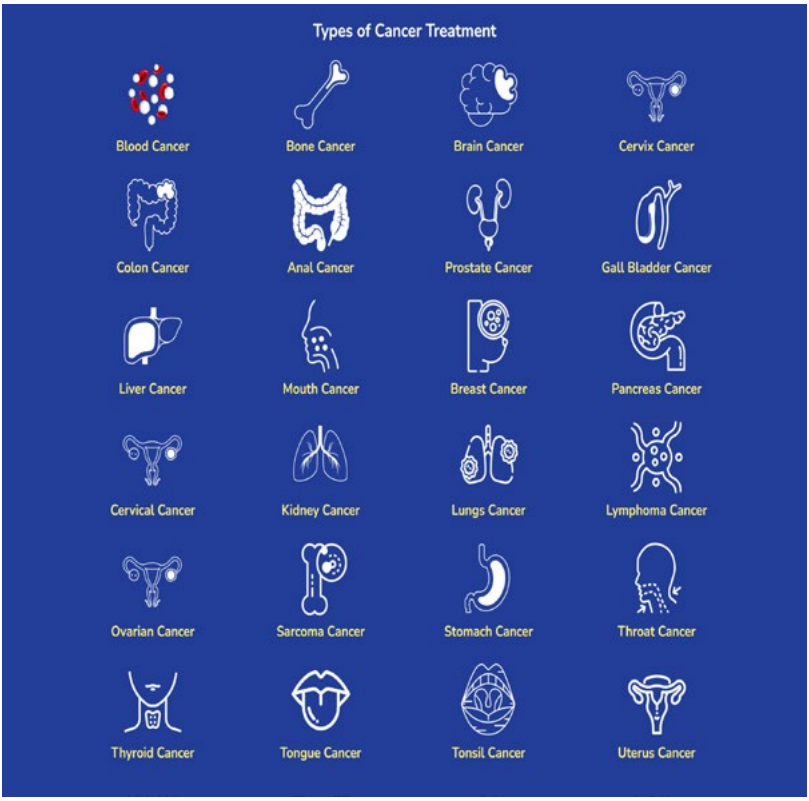


Source: Palacios-Castrillo (2024).

Cancer is derived from two classes of genes (oncogenes and tumor suppressor genes), the former are derived from mutated versions of genes called proto-oncogenes, which control cell proliferation, survival and spread (Kontomanolis et al., 2020). They are also described as phenotypically dominant and are not associated with inherited cancer syndromes, whereby their activation is responsible for uncontrolled cell division, enhancing survival and spread. On the other hand, tumor suppressor genes (TSGs) have the function of inhibiting cell proliferation and survival, i.e., they are involved in the control of cell cycle progression and apoptosis. Also, TSGs are phenotypically recessive and are

responsible for inherited cancer syndromes (Honoki et al., 2024; Hanahan and Weinberg, 2011). When the cell has mutations in its DNA, it may have altered specific genes that predispose the cells to more aggressive cancers (Kontomanolis et al., 2020; Swietach et al., 2014). At present, the organs and tissues of the human body are prone to generating cancer (Figure 2), which can be formed due to both genetic and external factors (lack of nutritional care, stress, sedentary lifestyles).

Figure 2. Cancer developed in different organs of the human body.



Source:

Relationship between flavonoids and cancer

Foods of plant origin contain bioactive compounds that have beneficial health effects. These dietary agents suppress inflammatory processes that allow transformation, hyperproliferation and initiation of carcinogenesis (Concettina et al., 2016). Flavonoids are one of the major components of the human diet,

with an average intake of 1 g/day. The compounds can be obtained from foods of plant origin, primarily for their antioxidant, anti-inflammatory, antiviral, antineoplastic and anticarcinogenic properties (Suhail et al., 2024).

In the structures of flavonoids, there is a relationship of C-ring substitution that distinguishes the different classes of flavonoids. Typically, these compounds are hydroxylated at the 3, 5, 7, 3', 4' and/or 5' positions, and may be additionally methylated, acetylated, prenylated or sulfated. In their natural sources they are found as free aglycones, glycosylated or acylated derivatives and in the form of oligomeric or polymeric structures (proanthocyanidins), the latter being constituted by the union of a variable number of flavan-3-ol units. Most flavonoids are in the form of *O*-glycosides or, less frequently, as C-glycosides, except for the flavanols (Huang, Cai and Zhang, 2010; Ahmed et al., 2019). Glycosyls can be attached to hydroxyl groups 3, 7 or 4', and directly linked to C-6 or C-8 carbons (Dias et al., 2021). Sugars can be esterified with aliphatic or aromatic acids (Suhail et al., 2024; Kopustinskiene et al., 2020). The differences in the substitutions in their structures (the substituent functional group, number, distribution and orientation in space) determine the molecular mechanism of action, electron delocalization, molecule rearrangement, reactive oxygen species (ROS) scavenging capacity, ability to generate intra- or inter-molecular hydrogen bonds, metal ion chelation, steric effects and electronic properties, which confer different properties depending on their structure (Yadav et al. 2023; Osman et al., 2015).

For example, the presence of hydroxyl groups at carbon 3 (3-OH), flavonols and flavan-3-ols have planar structure, whereas flavones and dihydroflavones are slightly folded. The structural planarity generates conjugation and electron dislocation, which acts by increasing the stability of the flavonoid phenoxyl radical. Removal of the 3-OH group eliminates planarity and conjugation, decreasing the desired antioxidant properties. Likewise, glycosylation at the 3-OH group also decreases this property compared to its aglycones due to steric effect (Drețcanu et al., 2022).

The bioavailability and effectiveness of flavonoids depend on their structure and their aforementioned substituents (Kopustinskiene et al., 2020). It is for this reason that the consumption of these compounds is proposed as a good option for the containment of various diseases caused by oxidative damage, such as cancer (Huang et al., 2022). Likewise, they have been given importance in cancer chemoprevention as preventive dietary interventions; as they can act on all three pathways in the carcinogenesis process (Table 1) (Suhail et al., 2024; Zhou et al., 2016). In this sense, these compounds facilitate the donation of hydrogens or electrons from the hydroxyl groups that make possible the neutralization of free radicals (Dias et al., 2021).

Table 1. Flavonoids with anticancer activity.

Flavonoids	**Type of cancer**	**Reference**
Artemisinin	Breast cancer, Liver, and pancreatic	Efferth 2017
EGCG, Epigallocatechin	Breast, skin, lung, prostate and bladder	Iqbal et al. 2017
Doxorubicin, rutin and quercetin	Breast cancer, and lung	Jaradat et al. 2016
Psoralidin	Prostate and stomach	Pahari et al. 2016
Luteolin	Colorectal cancer, Glioblastoma	Rocchetti et al. 2023; Osman et al. 2015
Crocetin	Lung and Hippocampal	Bakshi et al., 2009
Procyanidins	Colon	Cheah et al. 2014
Apigenin	Prostate, lung, osteosarcoma &prostate	Yadav et al. 2023
Curcumin	Melanoma	Chacko and Jacob 2022
Cardamonin	Breast	Arzi et al. 2022
Baicalein	Breast	Sun et al. 2023
Hesperidin	Breast	Ávila-Gálvez et al., 2019
Daidzein	Prostate	Ponte et al. 2021
Genistein	Prostate, Bladder, Colon and Rectal, Non-small Cell Lung	Ponte et al. 2021; Pintova et al., 2019 ; Citrin et al., 2016; Messing et al., 2012
Cyanidin	Oral	Ponte et al. 2021

Source: own elaboration

Another of its benefits is to inhibit certain mediators that are activated under inflammatory conditions, as well as other mediators of inflammatory processes such as proinflammatory cytokines (i.e. NF-κB), chemokines, iNOS expression or activity, inhibit gene expression and secretion of TNF-α, IL-1β or IL-6 and adhesion molecules (Suhail et al., 2024; Khan et al., 2021). It should be emphasized that each flavonoid has its own mechanisms and effects for different situations in the stages of carcinogenesis. Furthermore, it has been observed that the effect of flavonoids shows different dose-dependent behavior in each cell type (Huang et al., 2022).

Flavonoids act at early stages of tumor initiation or by intervening in tumor proliferation pathways, in which they have been shown to inhibit the enzymatic

activity of phase 1 enzymes, whose metabolic products can activate various procarcinogens, such as cytochrome P450 isoenzymes (CYPA1 and CYP1A2) (Huang et al., 2022; Selvakumar et al., 2020; Huang, Cai and Zhang, 2010). Thus, they help to decrease the occurrence of tumors in this initiation phase by modifying GSH levels and modulating the activity of cytochrome P450 enzymes, GPx, SOD and catalase, which are responsible for metabolically activating many compounds that can interact with cellular neutrophils and trigger carcinogenesis (Hasin et al., 2024; Alsawaf et al., 2022).

During phase 2, flavonoids also induce enzymes that promote the modulation of gene expression of detoxifying enzymes detoxification and elimination of carcinogens from glucuronidation, sulfation, acetylation or methylation reactions (Gardeazabal et al., 2019; Concettina et al., 2016). Also, it has been described that they can modulate PI3K/AKT signal transduction pathways, MAPKs (ERKs, JNKs, p38 MAPKs), PKCs, AP-1 and NF-kB for the regulation of cell survival, cell proliferation and programmed cell death (Yahfoufi et al., 2018). Thus, some authors have shown that flavonoids are able to inhibit the enzyme xanthine oxidase (Rahaman et al., 2022) and COX (Kopustinskiene et al., 2020). Los flavonoides son eficaces en la inhibición de la xantina oxidasa, la COX o LOX55 (de Luna, et al., 2023; Zhou et al., 2016). On the other hand, different types of cancer are related to hyper-activation of cyclin-dependent kinases (CDK), due to mutations or repressions in the coding genes of these cyclins. Several studies found that flavopiridol was able to induce cell cycle disruption in G1 or G2/M by inhibiting CDK (Arzi et al., 2022; Ponte et al., 2021). Esterification with acetyl or malonyl groups at the 6' sugar position of certain isoflavones (genistein and diadzein), is thought to be key to their anti-inflammatory activity (Pintova et al., 2019; Citrin et al., 2016; Messing et al., 2012). tudies in breast cancer suggest that some flavonoids act in inhibiting the enzyme DNA dimethyltransferase, i.e., cause inactivation of tumor suppressors (Yahfoufi et al., 2018; Paluszczak y col, 2010). Therefore, these have attracted attention for their potential effects on cancer prevention. Specific studies of the chemopreventive activities of flavonoids are shown in Table 2.

Table 2. Flavonoids and their anticarcinogenic activities.

Flavonoids	**Mechanism of action for biological activity**	**Reference**
Apigenin	It has shown to increase anticancer activity via JAK-STAT and Wnt/Catenin signalling pathway	Ozbey et al. 2019
Luteolin	It induces autophagy and initiates apoptosis in MCF-7, ANA-1 and ACS gastric cells via akt, JNK and p38 signalling cascade.	Liao et al., 2018

Flavonoids	Mechanism of action for biological activity	Reference
Tangeritin	It cases cell cycle arrest via Cyp1A1 and Cyp1B1 mediated metabolism as seen in MCF-7 and MDA-MB-468 breast cancer cell lines.	Surichan et al. 2018
Quercetin	It decreases cancer mortality via cell cycle inhibition and initiation of apoptosis.	Hirpara et al. 2009
kaempferol	Help in initiation of apoptosis and induction of autophagy via increase in expression of miR-340 micro RNA in (Colon) HCT-116, HCT15, SW480 and A549 human lung cancer cell lines.	Han et al. 2018
Myricetin	Inhibits metastasis via inhibition of cell migration as seen in prostate cancer.	Ye et al. 2018; Kumar et al. 2023
Hesperetin	Initiated apoptosis in H522 lung cancer cells	Elango et al. 2018
Naringenin	Decreased cancer metastasis via voltage gated sodium channels and initiated both early and late apoptosis in prostate cancer	Gumushan Aktas and Akgun 2018
Taxifolin	Decreased carcinogenesis through mTOR/PTEN axis and CYP1B1 mediated cancer	Haque et al. 2018
Epigallocatechingallate (EGCG)	Increased chemoprevention and apoptosis through Abl/Bcrmediated p38-JAK2/STAT3/Akt and MAPK/JNK pathways in chronic myeloid leukemia and Glioblastoma cancer cells respectively	Grube et al. 2018
EGCG, catechin	Decreased cancer growth through programmed cell death	Xiao et al. 2019
Cyanidin	Decreased angiogenesis in MCF-7 cells through STAT3/VEGF signalling pathway	Ma and Ning 2019
Delphinidin	Increased initiation of apoptosis and induction of autophagy in HER2 positive MDA-MB-453 cancer cells	Chen et al. 2018
Genistein	Increased apoptosis and decreased cellular proliferation in human laryngeal Mcl-1 and EP3 expressing melanoma cancer cells respectively	Ma et al. 2018
Isoliquiritigenin	Reduce the incidence of colitis-associated colorectal cance. Increase the abundance of Bacteroidetes, Butyricicoccus, Clostridium, Lachnospiraceae, Rikenellaceae and Ruminococcus; reduce the abundance of Enterococcus, Escherichia, Firmicutes and Helicobacteraceae	Wang et al., 2016
Epigallocatechin gallate	Suppress the growth of colorectal cancer. Increase the abundance of Bifidobacterium and Lactobacillus	Wang et al., 2017
Baicalin	Repress the growth of colorectal cancer and block gut inflammation. Produce the bioactive metabolite, baicalein, by gut microbiota Exhibit cytotoxicity toward gastric cancer cells. Attenuate the virulence of Helicobacter pylori	Chen et al., 2018

Flavonoids	Mechanism of action for biological activity	Reference
Rutin	Block colonic carcinogénesis. Reduce the fecal concentration of lithocholic acid and hyodeoxycholic acid	Han et al., 2009
Flavonoid glycosides (apigenin, kaempferol, luteolin, quercetin)	Exert antiproliferative effects on colorectal cancer cells. Increase the growth of beneficial bacteria including Bifidobacterium and Bacteroides; enhance the concentration of SCFAs	Eid et al., 2013
Protocatechuic acid	Prevent esophageal carcinogénesis. Lower the expression of inflammation markers (sEH, COX-2 and iNOS	Peiffer et al., 2014

Source: own elaboration

Another mechanism responsible for the antineoplastic effect is at the level of apoptosis, whose deregulation plays an important role in oncogenesis. Flavonoids have been shown to induce apoptosis in some neoplastic cell lines, while excluding healthy cells from this effect. Therefore, finding inhibitors or modulators of CDK activity represents a new challenge in cancer treatment. Cell apoptosis is another effect in which flavonoids could be involved, in which they have been shown to induce apoptosis only in cancer cells by altering the expression of heat shock proteins (HSP; Khan et al., 2021), with the decrease of ROS (de Luna et al., 2023) and with the modification of molecular signaling pathways (Zhou et al., 2016).

On the other hand, flavonoids can act as pro-oxidants derived from their high reactivity of their metabolisms and depending on the cell treated, as well as the dose and time of exposure, leading to cell apoptosis, so that it can avoid and prevent the development of tumors (Khan et al., 2021; Zhou et al., 2016). It is important to keep in mind that the chemoprotective activity of flavonoids may be effective for one type of cancer cell and show no effect on another type of tissue. Studies in this regard should take into account the trade-off between the cytotoxic effect of flavonoids against tumor cells and the cytoprotective effect on healthy cells. In addition, it has been observed that the effect of flavonoids shows a different dose-dependent behavior in each type of cell (de Luna, et al., 2023; Selvakumar et al., 2020; Huang, Cai and Zhang, 2010).

Conclusion

Numerous studies suggest that a diet rich in flavonoids may reduce the incidence of certain types of cancer. The attributed effects of flavonoids on cancer cells are many related to their antioxidant and anti-inflammatory properties; however, the multiple mechanisms involved include modulation of molecular events and signaling pathways associated with cell survival, proliferation, differentiation, migration, angiogenesis, hormonal activities, detoxification enzymes and immune responses.

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Flavonoides: Intervenciones dietéticas como quimioprotectores contra el cancer

Flavonoides: Intervenientes dietéticos como quimioprotetores do câncer

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Resumen

El cáncer son células con morfologías y funciones alteradas que provoca un crecimiento y proliferación imparable de las mismas. Por lo anterior, estos cambios conllevar a que existan diferentes tipos de cáncer que se reproducen en diferentes órganos o tejidos en las personas, con genotipos específicos que originan un creciente e incontrolable de mecanismos agresivos hasta ocasionar muerte celular programada. Así, la mortalidad por cáncer crece a un ritmo alarmante a pesar de los fármacos disponibles en la actualidad. En este contexto, los fitoquímicos, concretamente los flavonoides, que han servido como mediadores de respuestas inflamatorios, la expresión de protogenes e inhibir la secreción de moléculas de adhesión, por lo que constituyen una oportunidad prometedora y eficaz que podría proporcionar un enfoque alternativo para tratar los cánceres y superar los retos a los que se enfrentan las terapias actuales.
Palabras clave: flavonoids; cancer; genes; quimiopreventivo; proto-oncogenes.

Resumo

O câncer são células com morfologias e funções alteradas que causam um crescimento e uma proliferação imparáveis das mesmas. Portanto, essas alterações levam à existência de diferentes tipos de câncer que se reproduzem em diferentes órgãos ou tecidos das pessoas, com genótipos específicos que originam mecanismos agressivos crescentes e incontroláveis até causarem a morte celular programada. Assim, a mortalidade por câncer está crescendo em um ritmo alarmante, apesar dos medicamentos disponíveis atualmente. Nesse contexto, os fitoquímicos, especificamente os flavonoides, que têm atuado como mediadores de respostas inflamatórias, expressão de protogenes e inibem a secreção de moléculas de adesão, constituem uma oportunidade promissora e eficaz que poderia fornecer uma abordagem alternativa para tratar cânceres e superar os desafios enfrentados pelas terapias atuais.
Palavras-chave: Flavonoides; câncer; genes; quimiopreventivo; proto-oncogenes.

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Chapter 3
The role of diet in health, wellbeing and achievement

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Abstract

Food plays a fundamental role in people's health, well-being and achievements. This article will seek to show the relationship that diet has with chronic diseases, mental health, cognitive performance, physical performance and productivity. A balanced and healthy diet provides the fuel necessary for the body to function optimally. Speaking first of its relationship with health, a good diet can control or even prevent diseases such as obesity, diabetes, cardiovascular diseases, among others. On the well-being side, a good diet influences our energy and vitality, improves body composition and reduces stress and anxiety. With respect to achievements, a balanced diet influences cognitive performance, which leads to concentration, memory and learning. It also helps in physical performance which influences our motivation and productivity. We must take into account the importance that eating a good diet deserves, since it is closely related to positive aspects that human beings seek for their development and provide optimal results in their daily lives.
Keywords:
Nutrition; well-being; achievements; health: diet.

Introduction

Chronic diseases can be prevented with a healthy diet, since the fundamental basis is the balance of plant foods with foods of animal origin. Eating habits and physical activity favor the reduction of morbidity profiles in people (Cena and Calder, 2020). Diet plays a fundamental role in people's health, because when it is not adequate, chronic degenerative diseases and metabolic risks are presented, such as high blood pressure, high blood glucose, high cholesterol, overweight, cancer, cardiovascular diseases, diabetes mellitus, obesity and obesity (Moreira et al., 2014). Hence, diet and nutrition are coming to the forefront and the scientific evidence on counteracting diseases throughout life is growing. More importantly, dietary plans and regimens can determine whether or not a person suffers from the aforementioned diseases (Løvhaug et al., 2022). In addition, dietary strategies should not only aim to ensure health for all but should also promote the consumption of adequate amounts of foods that make up a healthy diet as a whole. This chapter presents an analysis of the most important aspects of diet and the health status of the population.

Nutrition and chronic diseases

The relationship between diet and the prevention of diseases such as obesity, diabetes, cardiovascular diseases and some types of cancer. Chronic diseases, also called non-communicable diseases, require a long-term diet plan. They are currently a global problem that, according to the WHO, cause 40 million deaths (Torres, 2022). There are multiple diseases related to or caused by poor nutrition, whether in quantity, excess or defect, or poor quality: anemia and atherosclerosis, some types of cancer, diabetes mellitus, obesity, high blood pressure, vitamin deficiency, malnutrition, endemic goiter, bulimia nervosa, anorexia nervosa and/or vigorexia. Certain diseases that affect the small intestine can cause improper absorption of nutrients, such as undiagnosed and untreated celiac disease and Crohn's disease (Pfeiffer, 2017).

The role of essential nutrients in disease prevention. Many common diseases and their symptoms can often be prevented or alleviated with a certain diet; For this reason, nutrition science tries to understand what are the specific dietary aspects that influence health (Rizzo et al., 2016). In all food groups, especially fruits and vegetables, we can find essential nutrients such as vitamins and minerals. Low consumption of these can cause deficiencies that can alter our system and cause diseases. For example, a good consumption of fruits provides us with antioxidant vitamins such as vitamin C, which promotes high blood pressure. Vegetables

are of great importance due to the contribution of many vitamins, minerals and dietary fiber that help prevent colorectal cancer (Angulo and Mendez, 2024).

Nutrition and mental health

The relationship between diet and mental health, including depression, anxiety and stress. It has been shown that our eating habits can reduce or increase the risk of having disorders such as depression, anxiety and stress. For example, processed foods and drinks have colorings that impact our psychological well-being, for example, tartrazine, carmoisine, allura red, sodium benzoate and sunset yellow in high doses cause changes in mood, they can also cause hyperactivity and attention deficit in children which can cause them to have a delay in learning (Sasaki, 2017). Also, weathering foods that cause inflammation also have an impact on mood, due to systemic interaction and brain functioning.

The role of essential nutrients in mood regulation.

There are more and more studies that show that diet is essential for better control of mental health diseases, all foods contain nutrients with functions that help us in our mood, for example, it has been shown that vitamin B12 in low concentrations affects the neurotransmitters of the brain, so our moods can be low, it has been shown that in patients with depression, anxiety and stress a deficiency of vitamin B12 was found and an improvement was seen when including it as a supplement, however, this does not mean May this be the replacement for the treatment of any disorder (Pastor, 2023).

Nutrition and cognitive performance

It has been shown that adolescents with obesity problems have had poor cognitive performance in subjects such as mathematics and language. Also the lack of the first meal of the day, which is breakfast, affects the correct functioning of the central nervous system due to the synthesis of neurotransmitters. (González, 2021) People who live in the Mediterranean normally follow the Mediterranean diet since it is rich in fruits, vegetables, cereals, legumes, dairy products and fish, generates satiety with a low calorie intake and accompanied by physical activity. This diet will help with better memory, academically we will be able to have better retention of information and it will not deteriorate over the years (Vasquez et al., 2022).

The role of essential nutrients in regulating brain function

Our body mainly needs carbohydrates, lipids and proteins. If we want to regulate our brain functions, we must have a balanced diet. If we do not have it, we will have nutrient deficiencies that can affect us. That is why we must highlight the importance of carbohydrates, since it is the main reserve source of our body, 50% of what we consume goes to our brain mainly for energy purposes. Proteins are made up of amino acids that are important to consume through the diet since the body cannot synthesize them on its own. An example is serotonin, which is a neurotransmitter that is synthesized from the amino acid tryptophan. Low levels of this are related to a decrease in learning, reasoning and memory. With lipids we have the example of Omega-3, which stands out in cognitive development, visual memory learning and auditory function (González, 2021).

The relationship between diet and physical performance

Through a correct eating plan we can obtain significant improvements in our performance, as well as in our recovery. Greater intensities and duration can be obtained during training. If we obtain the necessary nutrients in our diet we will obtain an optimal state of health, both performance and recovery are more effective and the body responds better to unexpected loads (Diller and Thompson, 2019).

The role of essential nutrients in regulating muscle function and endurance. Essential nutrients include proteins, carbohydrates, fats, vitamins and minerals. Proteins are essential for the growth and repair of muscles, carbohydrates provide energy and fats are also important since they provide us with satiety and help us with muscle health. Consuming sufficient amounts of these nutrients before and after exercise helps repair and strengthen muscles, resulting in a reduced risk of injury (Madden et al., 2021).

Food and productivity

The relationship between diet and productivity.

In our daily diet, it is essential to have all the food groups in adequate and sufficient proportions during the day for our body to function correctly. By not following this healthy lifestyle, we run the risk of facing cardiovascular diseases, such as diabetes, obesity and hypertension, and normally people who suffer from any of these conditions have complications and problems that prevent them from

having better productivity (Martínez, 2021). The World Health Organization (WHO) assures that by having a healthy lifestyle, which involves having a balanced diet and exercising regularly, a person can increase their productivity by 20%, performance, physical and mental well-being, as well as reduce the risk of cardiovascular diseases (Aucapiña and Becerra, 2023).

The role of essential nutrients in regulating energy and motivation.

As mentioned previously, the amino acids that we obtain through proteins are essential for the correct functioning of the neurotransmitters in our body. Some examples of neurotransmitters are: Dopamine, mainly participates in our memory, motivation, attention and cognition and Histamine also helps us with motivation and to have a state of alert (Segura, 2021). The energy we obtain is thanks to macronutrients (carbohydrates, lipids and proteins) since the body is not capable of synthesizing it on its own, that is why we must consume adequate quantities to obtain better energy. Furthermore, if we do not have a good supply of these macronutrients we can have deficiencies that will cause us diseases and, most importantly, lack of energy and motivation, this will prevent us from continuing with our daily activities. We must not forget micronutrients (vitamins and minerals) are also a fundamental role for our metabolism, for example, B complex vitamins help the conversion of nutrients to energy, magnesium helps produce cellular energy, a poor diet causes deficiencies of these micronutrients and as a consequence can cause lack of energy that appears as fatigue and lack of concentration (Reyes, 2023).

The relationship between diet and the immune system

The immune system is made up of cells, tissues and organs that together have the function of protecting the body from diseases and infections. All of this is made up of immune cells, and for these to function they require energy from all the micro and macronutrients that we obtain from our diet. A dietary deficiency leads to alterations in our immune system and an increase in contracting infections, which is why it is extremely important to include all varieties of groups in our daily diet, 45-55% should be made up of carbohydrates, 15-25% foods of animal origin and 25-35% and it is also important to maintain good hydration, our body will reserve the nutrients obtained from these groups in the adipose tissue which secretes hormones and cytokines. that participate in immunological activity (Sunardi, 2021).

However, following these nutritional indications does not ensure that we are completely immune to a disease because no food alone can prevent or cure diseases. However, it must be emphasized that a healthy and balanced diet is of great help to promote the functioning of the immune system (Trucco, 2021).

Table 1. Nutrients and compounds that help the immune system

Nutrient	Function	Reference
Vitamin A	Helps white blood cells identify pathogens.	Barker, 2023
Vitamin C	Helps treat respiratory infections	Alberts et al., 2025
Vitamin E	Protects body tissue from free radicals (unstable molecules that damage cells, tissues and organs)	Barker, 2023
Vitamin D	It proliferates cells with the purpose of protecting against foreign agents.	Rebelos, Tentolouris, and Jude, 2023
Vitamin B12 / Folic acid	Helps in the production of immune cells	Barker, 2023
Vitamin B6	It helps in the production and communication of immune cells, as well as metabolizing antibodies	Barker, 2023
Prebiotics	Maintain the integrity of the intestinal lining (villi)	Trucco, 2021
Zinc	Helps produce new immune cells	Razzaque & Wimalawansa, 2025
Copper	Participates in the development, growth and maintenance of the immune system	Razzaque & Wimalawansa, 2025
Selenium	Participates in the production of red blood cells	Razzaque & Wimalawansa, 2025
Iron	Maintains healthy immune cells	Razzaque & Wimalawansa, 2025
Glutamin	It has a function in various immune cells such as macrophages and neutrophils	Trucco, 2021
Omega-3	Regulates inflammatory processes and acts on immune cells.	Trucco, 2021

Source: own elaboration

Conclusion

This chapter provides an overview of good nutrition and its beneficial effects on health. A balanced diet helps to significantly reduce chronic diseases. Minerals are vital to health because they play essential roles in maintaining the functions of most body systems, so excessive supplementation should be avoided to prevent toxicity or adverse health effects. Vitamins will be important therapeutic considerations for various physiological functions.

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El papel de la dieta en la salud, el bienestar y los logros

O papel da dieta na saúde, no bem-estar e nas conquistas

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Resumen

La alimentación desempeña un papel fundamental en la salud, el bienestar y los logros de las personas. Este artículo tratará de mostrar la relación que la dieta tiene con las enfermedades crónicas, la salud mental, el rendimiento cognitivo, el rendimiento físico y la productividad. Una dieta equilibrada y saludable proporciona el combustible necesario para que el organismo funcione de forma óptima. Hablando en primer lugar de su relación con la salud, una buena dieta puede controlar o incluso prevenir enfermedades como la obesidad, la diabetes, las enfermedades cardiovasculares, entre otras. En cuanto al bienestar, una buena dieta influye en nuestra energía y vitalidad, mejora la composición corporal y reduce el estrés y la ansiedad. En cuanto a los logros, una dieta equilibrada influye en el rendimiento cognitivo, que se traduce en concentración, memoria y aprendizaje. También ayuda en el rendimiento físico, que influye en nuestra motivación y productividad. Debemos tener en cuenta la importancia que merece llevar una buena alimentación, ya que está estrechamente relacionada con aspectos positivos que el ser humano busca para su desarrollo y proporcionarle resultados óptimos en su vida diaria.
Palabras clave: Nutrición; bienestar; logros; salud; dieta.

Resumo

A alimentação desempenha um papel fundamental na saúde, no bem-estar e nas realizações das pessoas. Este artigo procurará mostrar a relação que a alimentação

tem com doenças crônicas, saúde mental, desempenho cognitivo, desempenho físico e produtividade. Uma dieta equilibrada e saudável fornece o combustível necessário para que o corpo funcione de maneira ideal. Falando primeiramente de sua relação com a saúde, uma boa dieta pode controlar ou até mesmo prevenir doenças como obesidade, diabetes, doenças cardiovasculares, entre outras. No que diz respeito ao bem-estar, uma boa dieta influencia nossa energia e vitalidade, melhora a composição corporal e reduz o estresse e a ansiedade. Com relação às conquistas, uma dieta equilibrada influencia o desempenho cognitivo, o que leva à concentração, à memória e ao aprendizado. Ela também ajuda no desempenho físico, o que influencia nossa motivação e produtividade. Devemos levar em conta a importância que uma boa alimentação merece, pois está intimamente relacionada aos aspectos positivos que o ser humano busca para seu desenvolvimento e proporciona ótimos resultados em sua vida diária.
Palavras-chave: Nutrição; bem-estar; realizações; saúde: dieta.

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Chapter 4

Intermittent fasting: a precautionary alternative remedy for people with obesity

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Abstract

Intermittent fasting (IF) has become popular due to the ease of reducing body weight by alternating periods of fasting with unrestricted eating; however, its frequent practice may have consequences unknown to most users. The IF diet triggers adaptive cellular responses that cause a decrease in inflammatory markers that go hand in hand with alterations in metabolic and physiological processes that could help treat and prevent obesity and associated diseases. This chapter narrates, focuses and analyzes the different types of IF and their contributions to health improvement. Thus, the hypothesized intermittent fasting regimens offer promising approaches to improve population health.

Keywords:
Intermittent fasting; calorie restriction; health; obesity; metabolism.

Introduction

Currently in Mexico, 70% of Mexicans are overweight and almost a third suffer from obesity, which is why these have been identified as a problem and the challenge of the coming decades (Llamas et al., 2024). Both pathologies are considered as chronic diseases, among their main characteristics we can find an excessive accumulation of fat mass as a consequence of the excessive consumption of calories, representing an energetic imbalance as they are stored and not expended (Templeman et al., 2018).

One of the alternatives that have been put into practice is the restriction of energy and comprehensive intervention on lifestyle to generate a moderate weight loss (Canicoba, 2020), however, since obesity is a precursor of multiple chronic diseases such as diabetes mellitus, hypertension and heart disease, it has been required to implement an effective diet for weight loss with good metabolic results, which is why intermittent fasting is an alternative option to regulate obesity (Ederra Unzu, 2021).

The subject of weight loss is a very current topic, we can see that there is a global trend to consume healthy foods because of the interest and awareness of consumers, although this is not the only reason. That is why every day there are more diets and different techniques to lose weight, however, we are going to focus on the effectiveness of intermittent fasting for weight loss. Most diets focus on what to eat, while intermittent fasting revolves around when to eat (Fung, 2016). As discussed above, with fasting, food intake is only allowed for a certain period of time, either for hours or days, depending on the type of fasting being performed.

Intermittent fasting (IF)

IF is a practice that has been performed throughout the history of human beings, dating back to the time of the cavemen, who unconsciously practiced it due to the lack of food that could not be found to subsist, therefore, they could spend long periods fasting between meals (Song and Kim, 2023). This practice has been recommended since the 5th century, where Hippocrates recognized the healing aspects of a diet based on IF, as well as Socrates, Plato and Aristotle who considered it as a good practice to maintain and improve their healthy body (Brogi et al., 2024). Likewise, IF is also used from the spiritual, medicinal, therapeutic, nutritional and even as a way of life point of view; but nowadays this temporary food restriction is focused on an improvement in the health of the body (Nye et al., 2024).

IF is a process of caloric restriction, daily by a voluntary act of refraining from ingesting calorie-dense foods, beverages and/or supplements during specific and recurrent periods (Ke et al., 2024; Elsworth et al., 2023). It should be emphasized that AI is not generic and should not be confused with starvation, i.e., a state of chronic uncontrolled non-voluntary nutritional deficiency that can result in death. Therefore, it is important to determine that this restriction can occur during one or more days per week, continuous (12, 16, 24 and 48 h) or alternated, generating changes in eating habits in a conscious manner; where healthy foods (fruits and vegetables), hydrating liquids and non-caloric stimulants (water, tea, coffee, infusions) are included, as well as physical activity, provoking adaptive cellular responses during the fasting period so that the cells participate in specific tissue processes of growth and plasticity, with important metabolic effects, resistance to stress and suppression of inflammation (Brogi et al., 2024). Also, it is important to highlight that while sleeping, the body is fasting, which eliminates toxins and undesirable metabolites inducing an increase in the amount of urine (Benjamin et al., 2015).

Metabolism in intermittent fasting

Previously mentioned, IA induces the coordinated alteration of metabolic and transcriptional mechanisms after 12 to 36 h (Mattson et al., 2017). The organism, when it senses the need for glucose and fatty acids, the cell produces molecular mechanisms causing the body to enter a physiological state of adipose tissue lipolysis, whereby triglycerides are hydrolyzed to increase the production of free fatty acids (FFA), glycerol, and ketone bodies (KB; acetoacetate and β-hydroxybutyrate (βHB)). These metabolites are produced in the liver and are transported to the brain and many tissues to be used for their energy needs (Brogi et al., 2024; Ke et al., 2024). In the liver FFA are oxidized to βHB and acetoacetate to become energy through β-oxidation, involving an increase in circulating FFA and other changes related to glucose and FFA metabolism (Benjamin et al., 2015; Morselli, et al., 2010). Also, KB function as receptor coactivators and activators by peroxisome proliferator 1a (PGC-1a), fibroblast growth factor (Gälman et al., 2008), nicotinamide adenine dinucleotide (NAD+) with energy production and sirtuins (Brito et al., 2019). In addition, IF regulates mitochondria functions, whereby peroxisome proliferator-activated receptor alpha (PPAR-α) induces the expression of genes that regulate AG oxidation in muscle cells and suppresses the expression of proinflammatory cytokines (IL-6 and Tumor Necrosis Factor α (TNFα) (Longo & Mattson, 2014). During IF, autophagy of body tissues is also promoted, which has been considered an optimal intervention to improve health and increase longevity, which in turn influences lipid metabolism by altering the activities of some anorexigenic and oroxigenic hormones, involved in the

regulation of appetite and satiety mechanisms, such as ghrelin, leptin, insulin, amylin, peptide YY (PPY), cholecystokinin (CCK) and glucagon-like peptide (GLP-1) (Table 1) (Benjamin et al., 2015).

Table 1. Effect of IF on hormones involved in appetite and satiety.

Hormona	IF	Reference
Ghrelin	Low	Coultihno et al., 2018; Sutton et al., 2018
Leptin	Low	Shabkhizan et al., 2023; Parr et al., 2020
Insulin	Low	Cienfuegos et al., 2020; Trepanowski et al., 2018
Amylin	Sin cambios	Shabkhizan et al., 2023; Hutchison et al., 2019
PPY	Low	Shabkhizan et al., 2023
CCK	Sin cambios	Zouhal et al., 2020; Coultihno et al., 2018
GLP-1	Low	Shabkhizan et al., 2023; Sutton et al., 2018

AI: intermittent fasting; PPY peptide YY; CCK: cholecystokinin; GLP-1: glucagon-like peptide.

Source: own elaboration

Leptin is associated with proinflammatory processes, so in the IF this protein decreases inducing increased insulin sensitivity, in this sense, in the IF its production and secretion decreases due to low triglyceride reserves; while ghrelin can stimulate neurogenesis (neuronal regeneration and development) (Table 1) (Brogi et al., 2024; Longo and Mattson, 2014). Ghrelin is secreted before meals and peaks at the onset of meals, which its concentrations are elevated in IF (Ke et al., 2024; Elsworth et al., 2023).

On the other hand, insulin secretion is reduced in IFs (Benjamin et al., 2015), due to caloric reduction of up to 75 % (Longo & Mattson, 2014). Some studies report that in 12-week IF postprandial insulin decreases (Brogi et al., 2024; Sutton et al., 2018); while amylin is secreted to reduce food intake and favor energy balance (Nye et al., 2024). Similarly, PPY is secreted in small amounts in both pancreatic islet F cells and the large intestine by significantly reducing caloric reserve intake over periods of more than 12 weeks (Liu et al., 2020). Other proteins that are reduced by low caloric content are CCK and GLP-1, which, because they are not synthesized by duodenal cells, cause weight loss by reducing glucagon secretion and inducing insulin secretion (Morselli et al., 2010).

Types of Intermittent Fasting

Currently, there are different modalities of IF depending on the duration of caloric restriction, which can be classified into short-duration IF, long-duration IF and extended IF for long periods of time. Short-duration AIs are performed more frequently and on a daily basis for the ease of a weight loss or to treat their diseases such as type II diabetes mellitus or other metabolic diseases but with relevant care (Nye et al., 2024; Fung, 2016). Table 2 shows the classification of the different types of IF fasting according to the duration time.

Table 2. Relationship of schedule in short-term intermittent fasting.

IF	Funtion	References
Fasting on alternate days		
5:2	Normal food intake for 5 days a week and limit for 2 days to an intake of 500-600 Kcal in a single meal or spread out over a day	Warchalowski, 2020
Alternating fasts		
12:12	12 h window to eat and undergo another 12 h without ingestion. Works as prevention against obesity	Hall, 2020
16:8	Ingesta durante 8 h/d, sin consumir en el periodo de 16 h. Coloquialmente conocido como “saltarse la cena”	Ramírez-Harris, 2018
12:12	Combination with a low-carbohydrate diet for a greater effect on weight loss	Nye, Cherrin, Meires, 2024
20:4	Ayuno estricta que tienen la opción de comer durante cuatro h/d y mantener en ayunas durante 24 h	Hall, 2020
Extended IF		
2–3 days	Avoidance of food intake for 2–3 days	Ramírez-Harris, 2018
7–14 days	Avoidance of total food intake for 7 to 14 days. Allows the body to adapt quickly to the fasting conditions, allowing an easy and gradual transition	Elsworth et al., 2023
>14 days	Prolonged fasting longer than 14 days. It is advisable to follow up with a doctor	Elsworth et al., 2023

*IF: Intermittent fasting.

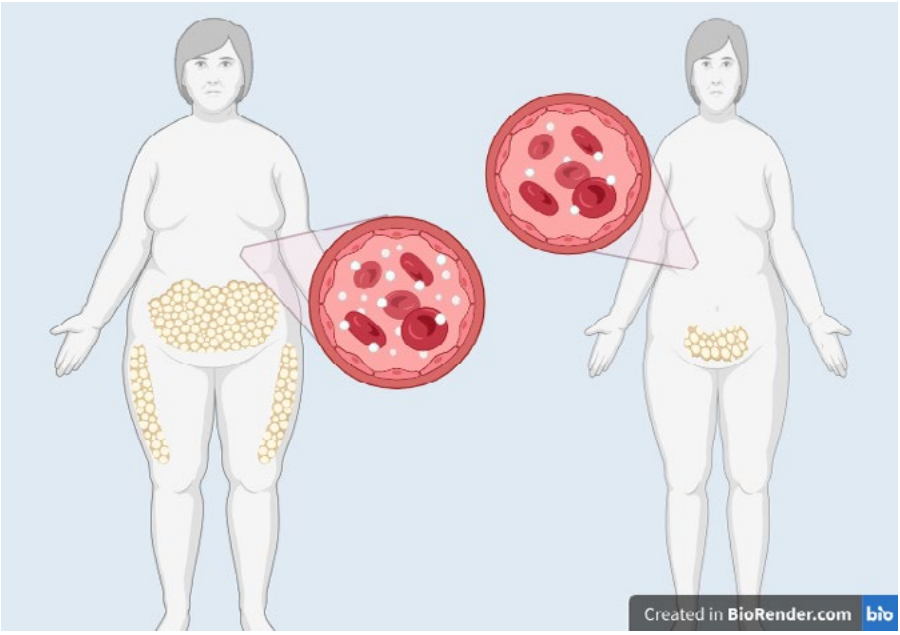
Source: own elaboration

In the table above you can see that depending on the time of fasting are the effects it generates in the body. Therefore, when fasting is considered to be used over long periods of time or in a more persistent way, it is important to constantly consult a doctor to avoid the consequences of this type of diet, which is very often performed by people without the supervision of medical personnel.

Benefits of IF in obesity

IF has a number of benefits to the body, including improved cognition, mitochondrial biogenesis and resistance to injury and disease, increased parasympathetic system, reduced blood pressure and resting heart rate (Varady et al., 2022). It also decreases the amount of glycogen, lipid accumulation, leptin production and inflammation. At the same time, it increases insulin sensitivity and improves muscular endurance and efficiency, improves the central nervous system and the metabolic system (Nye et al., 2024; Morselli et al., 2010). Taking the last point, it decreases the suffering of overweight and/or obesity and does not lead to malnutrition if controlled within 6 months (Song and Kim, 2023; de Cabo & Mattson, 2019). Studies have found that by increasing leptin levels and decreasing ghrelin levels, IF helps control appetite and reduce caloric intake (Hannaford et al., 2013), whereby, by limiting feeding windows, it facilitates the mobilization of stored fat since, during periods of fasting (Figure 1), the body consumes its glycogen stores and eventually begins to use fat as a source of energy, which can result in a significant reduction in adipose tissue (Anton et al., 2018; Duncan et al., 2020; Longo & Panda, 2016). IF may also positively influence the composition of the gut microbiome, favoring species that promote better metabolic health (Clemente et al., 2012).

Figure 1. Effect of blood glucose and decrease in abdominal fat.



Source:

Table 3 shows the results of the implementation of the FI. IF helps to increase thermogenesis and norepinephrine activity, favoring lipolysis (Varady & Hellerstein, 2009) and reducing LDL and triglyceride levels (Harvie & Howell, 2017; Harvie et al., 2013; Tinsley & La Bounty, 2015).

Table 3. Some studies conducted with IF.

IF regimen	Duration	Results	Reference
15 days: alternate-day fasting	20-hour fasting intervals	↓ glucose ↑ adiponectin ↓ leptin	Halberg et al., 2005
22 days: no caloric intake every other day	(36-hour fasting intervals)	↓ insulin ↓ weight change	Heilbronn 2005
1 day: water only	28-hour fasting interval	↓ glucose ↓ weight change ↓ insulin ↑ LDL ↑ HDL ↓ TG	Horne 2013

IF regimen	Duration	Results	Reference
12 weeks: weight-loss diet with alternate-day modified fasting	25% of energy needs	↓ TG ↓ CRP ↑ adiponectin ↓ weight change	Varady 2013
weight-loss diet with alternate-day modified fasting, 25% of energy needs	8 weeks	↓ weight change ↓ glucose ↓ insulin ↓ leptin	Hoddy 2016
1 meal per day	8 weeks	↓ weight change ↓ glucose ↓ LDL ↑ HDL ↑ TG	Carlson 2007; Stote 2007
3 day fast (25% to 30% of caloric needs), 3 day usual diet, and 1 day ad libitum intake	3 days fast, 3 days usual diet, and 1 day ad libitum intake	Viable weight loss strategy in obesity	Eshghinia and Mohammadzadeh, 2013
2 days fast and 5 days usual diet	2 days fast (25% of usual calorie intake) and 5 days usual diet	Effective for weight loss and insulin sensitivity	Harvie et al, 2011
12 wk	16 h daily fast	Effective for weight loss and glycemic control in Type2 Diabetes Mellitus	Kahleova et al., 2014

↓ decrease; ↑ increase; Abbreviations: CRP, C-reactive protein; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TG, triglyceride; TNF-α, tumor necrosis factor-α; h: hours; wk: week.

Source: own elaboration

An alarming fact, currently children and adolescents under eighteen years of age, suffer from overweight or obesity, a fact that leads us to think that the new generations do not have a correct healthy eating habits style (Song and Kim, 2023). The above, generates a reflection that society lives in an environment where a large amount of hypercaloric and ultra-processed foods are ingested, and the realization of physical activity every day is less due to the existence of numerous means of transport and entertainment devices that are present 24 hours a day and make unnecessary the use of their own feet (Stockman et al., 2018; Varady et al., 2022).

Considerations to take into account when practicing IF

Adopting the IF as a diet style to achieve weight loss should take into consideration possible risks if it is not monitored by physicians and nutritionists, because in excess it can cause dehydration, hypoglycemia, fatigue, dizziness, migraines and in extreme cases malnutrition (Garegnani et al., 2023). To understand the role of IF it is important to mention that this practice does not generate the same result with people with obesity, since there are factors that influence the results, among them are age, nutritional status of the person, gender, period with the disease, circadian rhythm, implementation of drugs for the control of obesity, to mention some of them (Stockman et al., 2018). Likewise, the type of IF influences the outcome, as was the case in a study conducted by the Faculty of Medicine, Chiang Mai University Hospital, Chiang Mai, Thailand, where 108 participants with obesity and type 2 diabetes mellitus of both sexes were grouped into three AI groups: 16:8 and 14:10, and a control group. Anthropometric measurements (weight, height, waist and hip circumference) were measured at week zero, six and twelve. The weight change in both groups was significant compared to the control group where the percentage weight change was -0.55%. The 16:8 group had -4.02% weight change while the 14:10 group obtained -3.15% (Sukkriang & Buranapin, 2024; Varady et al., 2022). Another study with 131 patients with obesity, three groups were divided, the first group performed IF 5:2, the second group applied daily caloric restriction (70% of energy needs every day) and the third group with daily caloric restriction with meal replacement (70% of energy needs every day, partially with protein-rich meal replacement); with this, it was demonstrated that IF 5:2 was superior to caloric restriction for weight loss (Kang et al., 2022).

Conclusions

Based on scientific evidence related to this work, it is concluded that the present benefits of IF are optimal for the treatment of obesity as a dietary intervention, however, possible risks should be taken into consideration if they are not controlled and supervised. Performing IF can provide flexibility that allows the public to choose the one they consider convenient for their lifestyle or healthy goals.

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Ayuno interminente: remedio alternativo precautivo en las personas con obesidad

Jejum intermitente: um remédio alternativo preventivo para pessoas com obesidade

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Resumen

El ayuno intermitente (IF) se ha popularizado debido a las facilidades de reducir el peso corporal a partir de alternar periodos de ayuno con alimentación sin restricciones; sin embargo, su práctica frecuente puede contraer consecuencias aun desconocidas para la mayoría de los usuarios. La dieta de IF desencadena respuestas celulares adaptativas que provocan una disminución de los marcadores inflamatorios que van de la mano de la alteración en procesos metabólicos, y fisiológicos que podría ayudar a tratar y prevenir

la obesidad y las enfermedades asociadas. Este capítulo narra, centra y analiza los diferentes tipos de IF y sus contribuciones a la mejora de la salud. Así, la hipótesis de los regímenes de ayuno intermitente ofrece enfoques prometedores para mejorar la salud de la población.
Palabras clave: Ayuno intermitente, restricción calórica, salud, obesidad, metabolismo.

Resumo

O jejum intermitente (IF) tornou-se popular devido à facilidade de reduzir o peso corporal alternando períodos de jejum com alimentação irrestrita; no entanto, sua prática frequente pode ter consequências desconhecidas pela maioria dos usuários. A dieta IF desencadeia respostas celulares adaptativas que causam uma diminuição nos marcadores inflamatórios que acompanham as alterações nos processos metabólicos e fisiológicos que poderiam ajudar a tratar e prevenir a obesidade e as doenças associadas. Este capítulo narra, enfoca e analisa os diferentes tipos de IF e suas contribuições para a melhoria da saúde. Assim, os regimes hipotéticos de jejum intermitente oferecem abordagens promissoras para melhorar a saúde da população.
Palavras-chave: Jejum intermitente; restrição calórica; saúde; obesidade; metabolismo.

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Chapter 5
Gut Microbiota and Its Relationship with Nutritional Health

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Abstract

The intestinal microbiota plays a crucial role in health and in the development of various diseases, therefore, the health of a person is influenced by various factors such as biology, lifestyle and environment. Because of this, microbial colonization plays a crucial role in many of these variables, which, if altered, would have a considerable impact on the health of the host. Therefore, appropriate nutritional intervention can have a significant impact on the optimal state of the intestinal microbiota, since diet directly influences the composition and diversity of bacteria and other microorganisms that inhabit the intestine. Through various mechanisms, nutrition can help balance and improve the health of microbiota.

Keywords:
Physiology; Metabolism; Gut microbiota; Nutrition; Health.

Introduction

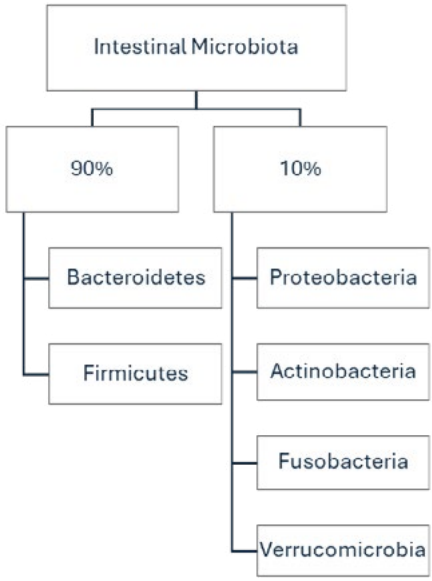
The gut microbiota is a vast community of living microorganisms residing in the digestive tract, which has a direct impact on nutritional health. This is because the gut microbiota performs important functions for health, including vitamin production, food digestion and metabolism, immune system stimulation, as well as preventing pathogen entry into the body and degrading foodborne toxins that could harm the host. Maintaining an optimal state of the gut microbiota may help reduce the risk of developing chronic diseases such as type 2 diabetes mellitus, obesity, inflammatory bowel diseases, and certain types of cancer, as alterations in the gut microbiota have been linked to the onset of these conditions.

In this chapter, we will explore in-depth how gut microbiota influences individual nutritional and general health, the dietary and environmental factors that modify it, and the dietary interventions that can contribute to improving its composition and function. Additionally, we will review the specific mechanisms of the gut microbiota, its interaction with the host, potential applications in disease treatment, and health promotion through diet.

Intestinal Microbiota

The intestinal microbiota is a complex entity that is considered an external organ of the body. It is composed of trillions of microorganisms, including hundreds of different bacterial species. Its composition varies depending on factors such as age and dietary habits (Garza-Velazco et al., 2021). The intestinal microbiota consists of a vast diversity of microorganisms; however, this ecosystem includes approximately 100 trillion microbial cells with around 9.9 million genes in total (Merino et al., 2021). Upon reaching adulthood, the intestinal microbiota is composed as shown in Figure 1. Although each individual has a unique composition of intestinal microbiota, there are patterns that are defined as enterotypes (Álvarez, et al., 2021).

Figure 1. Types of microbiota present in the intestine



Source: Álvarez et al. (2021).

Factors Influencing Microbial Diversity

Diet is directly related to the microbial diversity of the host. From birth, the type of feeding—whether exclusive breastfeeding or formula—affects the composition of the intestinal microbiota. The microbial population in newborns is crucial, as breast milk facilitates the transfer of beneficial microbiota to the infant's intestine (Senchukova, 2023). Microbial diversity (Table 1) at any stage of life is influenced by the consumption of different types of sugars or sweeteners. It has also been shown that sugar and sweetener intake impact the intestinal microbial population, leading to genetic changes. When sugars and sweeteners are incorporated into the diet, intestinal microorganisms may begin modifying their transcriptional profiles, causing metabolic alterations and changes in microbiome composition (Di Rienzi & Britton, 2020).

Table 1. presents some effects of consuming different types of sugar on intestinal bacteria and their physiological impact.

Bacteria	Physiological Alterations	Related Pathologies	Effects of Sugar Consumption
Lactobacillus spp.	SCFA production; anti-inflammatory and anticancer activities	Decreases IBD	Increases its population with lactose and decreases with artificial sweeteners.
Bifidobacterium spp.	SCFA production; improves intestinal mucosal barrier	Reduced abundance in obesity	Increases its population with lactose, fructose, glucose, and decreases with artificial sweeteners.
Bacteroides spp.	Activates CD4 + T lymphocytes	Increased abundance in IBD	Its population decreases with glucose, lactose, and fructose, and increases with artificial sweeteners.
Clostridium spp.	Promotes TH17 cell generation	Some species are pathogenic, causing botulism or Pseudomembranous colitis	Decreases with lactose and artificial sweeteners.
Faecalibacterium prausnitzii	SCFA production; anti-inflammatory effects	Reduced abundance in IBD and obesity	—

Source: Singh et al. (2017).

On the other hand, not only does diet impact microbial diversity, but moderate- and high-intensity exercise also has positive effects on the intestinal microbiota. However, if the intestinal microbiota is not in a healthy state, it can negatively influence physical performance. High-performance athletes exhibit greater microbial diversity, which translates into increased production of short-chain fatty acids (SCFAs), such as butyrate and propionate (Clauss et al., 2021).

Functions, digestion and metabolism of the Gut Microbiota

The gut microbiota plays a fundamental role not only in nutrient digestion and absorption but also in immune system regulation and protection against pathogens that can cause infections and intoxications. Additionally, it is key to the body's overall metabolism. Therefore, maintaining microbiota balance is essential for host well-being, as its disruption can lead to various diseases (Rowland et al., 2017).

The gut microbiota plays a crucial role in host metabolism, possessing enzymes capable of transforming dietary carbohydrates that cannot be fully digested or absorbed in the small intestine. These carbohydrates reach the colon, where microorganisms ferment them to produce short-chain fatty acids (SCFAs), which can be used as an energy source by intestinal epithelial cells or transported through the circulatory system to distant organs, where they play important metabolic roles (Álvarez et al., 2021). Another metabolic process regulated by the gut microbiota is bile acid transformation. These acids act as signaling molecules that regulate both lipid absorption and cholesterol homeostasis (Jaillier-Ramírez et al., 2021).

Immune system modulation

The gut microbiota is acquired rapidly from birth and, despite some variability, tends to remain relatively stable throughout life, being essential for proper human homeostasis. At birth, the newborn has a fully developed but immature immune system. In the first hours of life, intestinal colonization begins, influenced by factors such as gestational age, mode of delivery, neonatal nutrition, and individual genetics (Alarcón et al., 2016). These microorganisms play a crucial role in forming intestinal barriers and producing immune cells such as lymphocytes, as well as in antibody formation. Although a healthy person's microbiome is relatively stable, its dynamics can be affected by lifestyle and dietary choices (Singh et al., 2017). Gut microbiota health directly influences inflammatory responses, with implications for inflammatory bowel diseases, skin conditions such as psoriasis and atopic dermatitis, and chronic metabolic diseases, including obesity, type 2 diabetes, and cardiovascular diseases (Gentile & Weir, 2016). Singh et al. (2017), mention that immune cells located in the intestine, such as dendritic cells and T lymphocytes, directly interact with gut microorganisms. These cells can recognize specific microbial patterns and activate appropriate immune responses or, alternatively, promote immune tolerance to avoid inappropriate responses. In this context, gut microbiota helps maintain a balance between immune tolerance and immune responses to pathogens (Garza-Velasco et al., 2021). Additionally, gut microorganisms produce bioactive signals that educate the immune system to differentiate between beneficial microbes and nutrients versus harmful pathogens or substances that could disrupt homeostasis. Nutrients in the diet are essential not only for human health but also for the well-being and survival of the trillions of microorganisms inhabiting the gut (Garza-Velasco et al., 2021).

Production of vitamins and essential nutrients

The gut microbiota facilitates nutrient extraction from food and plays a role in the production of vitamins such as vitamin K and folic acid. It also contributes to the synthesis of amino acids (Rowland et al., 2017).

Function of intestinal barrier integrity

The gastrointestinal tract mucosa is lined with epithelial cells that create an effective barrier through intercellular junctions, separating the internal environment from the external one and preventing the entry of toxins, microorganisms, and other agents that could cause harm to the body. However, as previously mentioned, epithelial cells also play a fundamental role in the absorption of nutrients and electrolytes. To fulfill this function, the intestinal barrier must be semi-permeable, allowing the selective passage of beneficial substances while blocking the entry of harmful compounds. To achieve this, the intestine has developed a defensive system (intestinal barrier), which is essential for protection against antigens, toxins, and microbial products (Salvo-Romero et al., 2015).

At the same time, the intestinal barrier plays a crucial role in regulating the immune system, helping maintain tolerance toward non-pathogenic components present in the intestine, such as those derived from food and gut microbiota, while activating an immune response against invading pathogens. When this barrier is in good condition, it prevents chronic inflammation and avoids uncontrolled immune responses that could lead to inflammatory bowel diseases, such as Crohn's disease or ulcerative colitis (Salvo-Romero et al., 2015).

Dietary factors that modulate the gut microbiota

The dietary factors that modulate the gut microbiota include: dietary fiber is an indigestible carbohydrate that is not enzymatically degraded in the small intestine. Instead, it moves to the large intestine, where it is fermented by resident microorganisms. Consequently, dietary fiber serves as a good source of "microbiota-accessible carbohydrates," which microbes can utilize to provide the host with energy and a carbon source (Pistollato et al., 2016). Through this process, dietary fiber can modify the intestinal environment. This property justifies its additional designation as a prebiotic—non-digestible dietary components that benefit host health by selectively stimulating the growth and/or activity of certain microorganisms. Sources of prebiotics include soy, inulins, unrefined wheat and

barley, raw oats, and non-digestible oligosaccharides (Pandey et al., 2015). A diet low in these substances has been shown to reduce total bacterial abundance (Halmos et al., 2015).

Use of probiotics and prebiotics

Probiotics (Table 2) and prebiotics (Table 3) are valuable tools for improving gut microbiota health.

Table 2. Functions and examples of Probiotics.

Functions	**Examples**
Improve gut microbiota composition	Lactobacillus acidophilus
Increase the production of short-chain fatty acids.	Bifidobacterium bifidum
Improve intestinal barrier function.	Streptococcus thermophilus
Reduce inflammation and oxidative stress.	Saccharomyces boulardii
Enhance immune response.	

Source: own elaboration

Fermented foods containing lactic acid bacteria, such as cultured dairy products and yogurt, serve as a source of ingestible microorganisms that can beneficially regulate gut health and even help treat or prevent inflammatory bowel disease (Shen et al., 2014). Based on these properties, foods enriched with these modulating microorganisms are referred to as probiotics. Several studies have observed an increase in total bacterial load following regular consumption of fermented milk or yogurt (Matsumoto et al., 2010). Notable increases in beneficial intestinal Bifidobacteria and/or Lactobacilli have also been observed with various types of probiotics (Carnicer et al., 2006).

Table 3. Functions and examples of Prebiotics

Functions	Examples
1. Increase the population of beneficial bacteria.	Inulin
2. Improve the production of short-chain fatty acids.	Fructooligosaccharides (FOS)
3. Improve intestinal barrier function.	Galactooligosaccharides (GOS)
4. Reduce inflammation and oxidative stress.	-glucans

Source: own elaboration

According to Floch et al. (2006), before using probiotics or prebiotics, it is important to consider the following contraindications and precautions:

- Patients with compromised immune systems
- Patients with chronic diseases, such as diabetes or cardiovascular diseases.
- Patients taking medications that may interact with probiotics or prebiotics
- Patients with allergies or intolerances to certain ingredients.

It is essential to consult a healthcare professional before using probiotics or prebiotics, especially if there are underlying health conditions or if medications are being taken. Increasing fiber intake is an effective strategy for improving gut microbiota health. Below are some benefits and recommendations for increasing fiber consumption (Table 4)

Table 4. Benefits and Recommendations Related to Fiber Intake

Benefits	Recommendations
Increases gut microbiota diversity.	Consume at least 25-30 grams of fiber per day.
Promotes the growth of beneficial bacteria.	Include a variety of fiber-rich foods in the diet, such as: - Fruits: apples, bananas, strawberries. - Vegetables: broccoli, carrots, spinach. - Whole grains: oats, quinoa, brown rice. - Legumes: lentils, chickpeas, beans. - Nuts and seeds: almonds, chia seeds.
Improves the production of short-chain fatty acids.	

Benefits	Recommendations
Helps regulate intestinal transit.	Gradually increase fiber intake to avoid digestive issues.
May reduce the risk of chronic diseases such as obesity, diabetes, and cardiovascular diseases.	Drink enough water to help fiber move through the digestive tract.

It is important to consult a healthcare professional before making significant changes to your diet.

Source: own elaboration

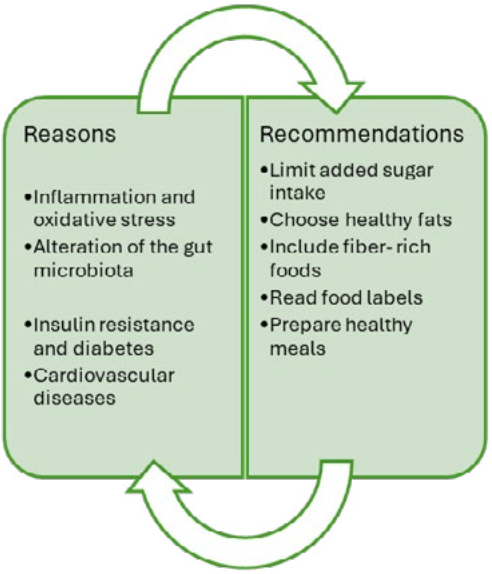
Proteins and fats

According to Singh et al. (2017), an experiment administered different protein sources to participants: animal-based (meat, eggs, and cheese), whey protein, and plant-based protein (such as pea protein). Most studies indicated that protein consumption correlates positively with gut microbiota diversity. However, some results showed that plant-based proteins are associated with lower mortality compared to animal-based proteins. It is important to highlight that diets rich in animal products provide not only proteins but also fats, which could influence microbial composition. In fact, several human studies suggest that a high-fat diet increases total anaerobic microflora and Bacteroides counts.

Reducing the consumption of refined sugars and saturated fats

Reducing the consumption of sugars and saturated fats is essential for improving gut microbiota health (Sonnenburg & Sonnenburg, 2014).

Figure 2. Description of reasons and recommendations for reducing sugar and saturated fat consumption.



Source:

Refined sugars and processed foods

Processed foods are industrially manufactured, often pre-packaged, convenient, energy-dense, and nutrient-poor. Processed foods are widespread in the modern Western diet, and numerous studies support their potential contribution to non-communicable diseases such as obesity and cardiovascular diseases. It is believed that processed foods affect the body in multiple ways, including inducing changes in the gut microbiome (Brichacek et al., 2024). Additionally, long-term dietary habits characterized by high intake of refined sugars or fats have been linked to a pro-inflammatory intestinal environment and the depletion of beneficial bacteria, along with an enrichment of pathogenic and pro-inflammatory microbes (Antonini et al., 2019). These changes can impair butyrate production and induce inflammatory responses, damaging intestinal barrier permeability and causing uncomfortable gastrointestinal symptoms such as bloating or flatulence (Dahl & Stewart, 2015). Other dietary factors that modulate the gut microbiota include carbohydrates, fermented foods, artificial sweeteners, antioxidants, polyphenols, water, hydration levels, vitamins, and minerals (Singh et al., 2017). It is important to highlight that each person has a unique gut microbiota, and responses to dietary factors may vary from one

individual to another. A balanced and varied diet rich in fruits, vegetables, whole grains, and fermented foods can help maintain a healthy gut microbiota.

Impact of the microbiota on intestinal health and diseases

The intestinal microbiota and the microorganisms that inhabit it have revealed a significant role in human health, as they are directly related to dietary patterns and the host's lifestyle, being a key factor in the modulation of chronic diseases, affecting the immune system and metabolism (Chávez, 2013).

Obesity is a metabolic pathology characterized by excessive accumulation of body fat. However, the relationship between the intestinal microbiota (IM) and obesity-related issues emerged from a study conducted with germ-free mice and normal mice. This study showed that germ-free mice began to develop increased leptin levels, insulin resistance, and had a higher percentage of adipose tissue compared to normal mice. (Farías et al., 2011). This type of phenotype is transmissible and could be caused by intestinal dysbiosis, where the introduction of high-fat diets promotes the ability to collect energy. An increase in Firmicutes-type bacteria has been associated with disorders such as Metabolic Syndrome (MS) and obesity (Salinas, 2013). According to Khan et al. (2014), "Obesity is currently at the intersection of inflammatory and metabolic disorders, causing an alteration in immune activity that increases the risk of developing diabetes, atherosclerosis, fatty liver disease, and lung inflammation".

Type 2 Diabetes Mellitus

Type 2 Diabetes Mellitus (T2DM) is a public health issue. Individuals suffering from this disease are often characterized by leading a sedentary lifestyle, having a high intake of simple carbohydrates, suffering from obesity, and presenting genetic factors. (Awad et al., 2020). Research on the pathogenesis of T2DM has demonstrated an increase in the proportion of Firmicutes and Bacteroides bacteria in patients with this condition. This microbial imbalance contributes to systemic inflammation, insulin resistance, and the development of diabetes. This is partly due to the fact that the cell membranes of gram-negative bacteria are primarily composed of lipopolysaccharides (LPS), which are potent stimulants of inflammation. (Farías et al., 2011). Additionally, the development of T2DM is linked to metabolites produced by the intestinal microbiota, which can affect the function of pancreatic β-cells and alter glucose and lipid metabolism. One of these metabolites, Trimethylamine-N-oxide (TMAO), impairs glucose tolerance by blocking the hepatic insulin signaling pathway (Wu J. Yang et al., 2023).

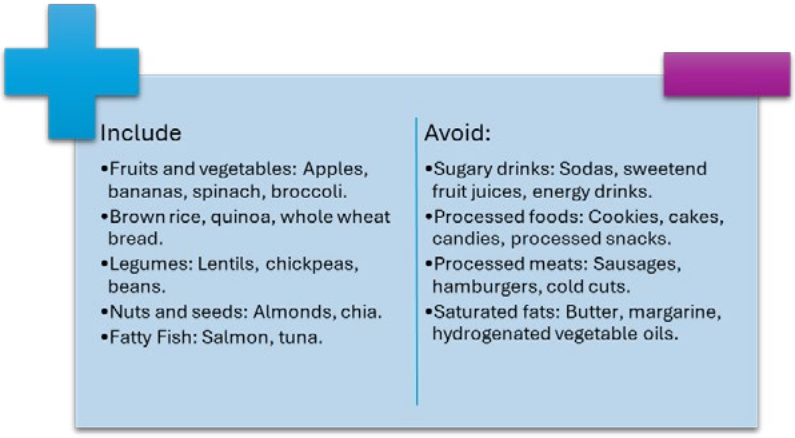
Cardiovascular diseases

Cardiovascular Diseases (CVD) have had a significant impact worldwide, and the primary cause of these pathologies is attributed to dietary habits. A high intake of lipids, saturated fatty acids, and proteins activates metabolic processes that interact with bacteria involved in lipid absorption through the activation of receptors, secretin, and cholecystokinin. (Senchukova, 2023). Excessive consumption of red meat promotes an increase in the metabolite Trimethylamine-N-oxide (TMAO), accelerating the metabolism of choline and phosphatidylcholine, creating a significant risk of atherosclerosis (Singh et al., 2017).

Gastrointestinal and inflammatory disorders

Irritable Bowel Syndrome is associated with a low diversity of bacteria from the genera Bacteroides and Firmicutes, leading to a decrease in the production of butyrate and other short-chain fatty acids (SCFAs), compounds known for their anti-inflammatory functions (Singh et al., 2017). On the other hand, in Inflammatory Bowel Disease, lesions occur in the intestinal tract, and patients present a microbiota significantly different from that of healthy individuals. The main cause of this alteration is dysbiosis, characterized by poor diversification of the intestinal microbiota. In these cases, bacteria such as Clostridium, Bacteroides, and Bifidobacteria predominate (Polanco, 2015).

Figure 3. Displays foods to avoid and include to improve gut microbiota health, increasing fiber intake and healthy fats.



Source:

Conclusion

The gut microbiota is essential for maintaining health. Various alterations in its composition contribute to the development of inflammatory, metabolic, and cardiovascular diseases. It is crucial to maintain microbial homeostasis through a varied and balanced diet that includes dietary fiber and probiotics, while regulating protein, fat, and sugar intake, alongside regular physical activity. Despite extensive research on gut microbiota, it remains an active area of study due to its significant role in human physiology and pathophysiology.

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La microbiota intestinal y su relación con la salud nutricional

Microbiota intestinal e sua relação com a saúde nutricional

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Resumen

La microbiota intestinal desempeña un papel crucial en la salud y en el desarrollo de diversas enfermedades, por lo que la salud de una persona está influida por diversos factores como la biología, el estilo de vida y el entorno. Por ello, la colonización microbiana desempeña un papel crucial en muchas de estas variables que, de alterarse, tendrían un impacto considerable en la salud del huésped. Por lo tanto, una intervención nutricional adecuada puede tener un impacto significativo en el estado óptimo de la microbiota intestinal, ya que la dieta influye directamente en la composición y diversidad de las bacterias y otros microorganismos que habitan en el intestino. A través de diversos mecanismos, la nutrición puede contribuir a equilibrar y mejorar la salud de la microbiota.
Palabras clave:
Fisiología; metabolismo; microbiota; nutrición; salud.

Resumo

A microbiota intestinal desempenha um papel crucial na saúde e no desenvolvimento de diversas doenças, por isso a saúde de uma pessoa é influenciada por diversos fatores, como a biologia, o estilo de vida e o ambiente. Por isso, a colonização microbiana desempenha um papel crucial em muitas dessas variáveis que, se alteradas, teriam um impacto considerável na saúde do hospedeiro. Portanto, uma intervenção nutricional adequada pode ter um impacto significativo no estado óptimo da microbiota intestinal, já que a dieta influencia diretamente a composição e diversidade das bactérias e outros

microrganismos que habitam o intestino. Através de diversos mecanismos, a nutrição pode contribuir para equilibrar e melhorar a saúde da microbiota.
Palavras-chave:
Fisiologia; Metabolismo; Microbiota intestinal; Nutrição; Saúde.

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Chapter 6

Effect of nutritional interventions on the risk of malnutrition in breast cancer patients

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Abstract

Breast cancer is a disease that mainly affects women. Cancer treatments used against breast cancer can cause negative effects, including malnutrition. Nutritional screening is used to identify the risk of malnutrition in patients with breast cancer. To reduce the risk of malnutrition in cancer patients, nutritional interventions have been proposed. There are different types of nutritional interventions such as the calorie restriction diet, ketogenic diet, intermittent fasting, vegetarian diet, Mediterranean diet and the traditional Mexican diet. These nutritional interventions have had positive results in patients with breast cancer, impacting their body composition, anthropometric measurements and serum markers, resulting in tumor reduction in some cases. For these reasons, nutritional interventions are considered as adjuvants in the treatment of breast cancer. However, these interventions must be individualized and appropriately selected, considering the nutritional needs, lifestyle, and preferences of the patient.
Keywords: Assessment algorithm; Malnutrition; Breast cancer; Nutritional intervention; Nutritional screening.

Introduction

Breast cancer is a disease in which cells in the breast tissue multiply uncontrollably and form primary tumors. The cells can metastasize, that is, they break away from the primary tumor and invade nearby tissues such as bone, spleen, lung, and brain (Obeagu and Obeagu, 2024). Patients with breast cancer are at high risk of developing malnutrition, especially in advanced stages of the disease (Arends et al., 2024). Malnutrition results from the combination of metabolic dysregulation and anorexia (Bossi et al., 2022). Nutritional screening is used to identify whether breast cancer patients are malnourished or at risk of malnutrition.

Nutritional screening is a procedure in which the nutritional status of individuals is assessed (Álvarez, 2018). In Mexico, a comprehensive care protocol has been proposed by the Mexican Social Security Institute (IMSS, 2017), as well as the publication of the Mexican Official Standard (NOM-041-SSA2-2011) which establishes the guidelines for the prevention, diagnosis, treatment, control and epidemiological surveillance of breast cancer in order to establish tools aimed at health personnel involved in the care of this type of patients (Diario Oficial de la Federación, 2011). Both are governed by the guidelines of the European Society of Clinical Nutrition and Metabolism (ESPEN) (Arends et al., 2017).

To reduce the risk of malnutrition in cancer patients, nutritional interventions have been proposed, defined as "intentionally planned actions aimed at positively changing a nutrition-related behavior, an environmental condition, or an aspect of health status" (Swierz et al., 2020). Such interventions have demonstrated positive clinical results on disease prognosis. Among the nutritional interventions we find the calorie restriction diet, the ketogenic diet, intermittent fasting, the vegetarian diet, the Mediterranean diet, and the traditional Mexican diet.

Breast cancer and its risk factors

Cancer is a disease in which some cells undergo carcinogenesis (Matthews, 2022). Carcinogenesis is a multifactorial process stimulated mainly by epigenetic causes (Łukasiewicz et al., 2021). During carcinogenesis, cells undergo alterations in the genes involved in the control, growth, and division of the cell cycle. Such genes are called proto-oncogenes, when they are mutated, that is, they undergo a change in the DNA sequence that makes up these genes, they become oncogenes. This is how cancer cells acquire the capacities to maintain proliferative signaling, evade growth suppressors, resist cell death, allow replicative immortality, induce/access the vasculature, activate invasion and metastasis, reprogram cellular metabolism and avoid immune destruction (Hanahan, 2022).

Tumor suppressor genes are critical for controlling normal cell growth. These genes encode proteins that function to limit proliferation. Both BRCA1 (breast cancer) and *BRCA2 (*breast cancer) 2 are thought to be involved in the control of normal cell growth. cancer 1), located on chromosome 17 like *BRCA2* (from its acronym in English " Breast Cancer Type 2 susceptibility protein") located on chromosome 13 act as tumor suppressor genes. However, a mutation in *BRCA1* or *BRCA2* confers an increased risk of breast and other cancers (Casaubon et al., 2023). Up to 25% of inherited cases are due to a mutation in one of a few identified, but highly penetrant, rare genes (BRCA1, BRCA 2, PTEN, TP53, CDH1, and STK11), which confer up to an 80% lifetime risk of breast cancer. An additional 2%–3% of cases are due to a mutation in a moderately penetrant rare gene (e.g., CHEK2, BRIP1, ATM, and PALB2), each associated with a twofold increased risk (Shiovitz et al., 2015). Patients with *BRCA1* and *BRCA2 mutations* have worse breast cancer-specific survival compared with *BRCA1 patients negative. BRCA1* carriers have a worse overall survival than BRCA2 patients (Casaubon et al., 2023).

Breast cancer is a disease characterized by uncontrolled growth of cells that form breast tissue, mainly from the inner lining of the ducts or from the cells of the breast lobules (Łukasiewicz et al., 2021). Breast cancer can be classified according to tumor size, location, and degree of spread (stage), with 0 being the least advanced and 4 being the most advanced, or by the presence of hormone receptors (subtypes) such as human epidermal growth factor receptor 2 (HER2) protein, estrogen receptors (ER), and progesterone receptors (PR), as shown in Table 1.

Table 1. Breast cancer classification.

Classification	Subtype	Feature
According to the degree of invasion	In situ	Inside the milk ducts that carry milk to the nipple
	Infiltrating	The tumor breaks the duct and invades the fat of the breast.
Depending on where the tumor originates and its appearance	Lobular	It originates in the lactiferous ducts.
	Ductal	Present in the lining of a mammary duct.
	Medullary	Grouped cancerous marrows.
	Colloid	Infiltrating ductal carcinoma.
	Inflammatory	Blockage of lymphatic vessels causing inflammation.

Classification	Subtype	Feature
According to the biological and genetic characteristics of the cells	Epithelial basal	Absence of ER and human epidermal growth factor receptor 2.
	HER2 positive	High expression of the HER2 protein.
	HER2 negative	Little or no HER2 protein in cancer cells.
	Luminal A	High expression of ER.
	Luminal B	Positive for one of the hormone receptors, either ER or PR.
	Luminal B and C	Low to moderate expression of specific genes including ER.
	Triple negative	HER, ER and PR negative.
According to the stage of cancer development	Stage 0	Abnormal cells are present, but have not spread to other tissue.
	Stage I	Early stage (tumors spread to other tissues in small areas)
	Stage II	Localized (tumor 20 to 50 mm and affected node, or 50> mm without affecting the node).
	Stage III	Regional spread (tumor 50> mm and affected node in a wider region).
	Stage IV	Foreign spread (cancer spread to more parts of the body).

RE: Estrogen Receptor; PR: Progesterone receptor

Source: Lehmann (2016).

Female breast cancer had a global incidence in 2022 of more than 2.3 million new cases, comprising 11.6% of all cancer cases. In addition, it was the fourth leading cause of cancer mortality worldwide with more than 666,000 deaths (6.9% of all cancer deaths) (Bray et al., 2024). In Mexico, it has had a constant increase, both in its incidence and mortality (Cárdenas-Sánchez et al., 2023). According to data from the World Cancer Observatory in Mexico, in 2022 more than 111,200 new cases were reported in the female population, and more than 49,795 died from this cause (Ferly et al., 2024). In 2023, according to the National Institute of Statistics, Geography and Informatics, there were 8,034 deaths from breast cancer in the population aged 20 years and older, of which 99.5% occurred in women. At the national level, the mortality rate in women aged 20 years and older from breast cancer was 17.9 per 100,000. Sonora had the highest rate (27.5) and Campeche, the lowest (9.9) (INEGI, 2024).

The causes of the appearance of breast cancer are varied, which is why it is considered a multifactorial disease. Among the risk factors for breast cancer

are non-modifiable and modifiable. It is known that non-modifiable factors are female sex, age, family history (of breast or ovarian cancer), genetic mutations, race/ethnicity, pregnancy and lactation, menstrual period and menopause, breast tissue density, previous history of breast cancer. Modifiable factors include hormone replacement therapy, physical activity, development of overweight/obesity after menopause, alcohol and cigarette consumption, exposure to chemicals and nutritional factors (Łukasiewicz et al., 2021; Martínez, 2019).

There are multiple studies that indicate that nutritional factors have a great impact on the risk and progression of cancer, among them are the Western-type diet, excessive consumption of fats, especially animal fats, high consumption of red and fried meats, high consumption of iron, low consumption of fresh vegetables and fruits, low consumption of phytoestrogens (isoflavones, lignans) (Dong, 2023; Łukasiewicz et al., 2021). Likewise, cachexia, sarcopenic obesity and malnutrition are secondary conditions that frequently develop in patients with breast cancer (Rodríguez, 2023).

Malnutrition

Malnutrition is the result of the combination of metabolic dysregulation and anorexia. The causes are classified as those related to the tumor itself, to the patient, or to cancer treatments. Several mechanisms have been proposed for why malnutrition may occur in cancer patients: decreased desire to eat, difficulties in eating, alteration of gastrointestinal motility, digestion and/or absorption, decreased ability to use nutrients, and increased energy expenditure as shown in Table 2 (Bossi et al., 2022).

Table 2. Effects of Disease and Treatment on Nutritional Status and Clinical Outcome.

Causes of malnutrition	Causes of metabolic disorders
Decreased desire to eat (e.g. anorexia, changes in smell and taste, nausea)	Inflammatory and immune cells in the tumor microenvironment
Difficulty eating (e.g., impaired chewing, dysphagia, vomiting, abdominal pain)	Cancer cell-derived mediators
Disturbance of gastrointestinal motility, digestion and/or absorption (e.g. mucositis, stenosis, diarrhea)	Outbreaks of infections
Decreased ability to utilize nutrients (e.g., low body cell mass, hypothyroidism)	Tissue destruction by invasive cancer, wounds, or therapeutic interventions (e.g., surgery, radiotherapy, systemic therapies)

Causes of malnutrition	Causes of metabolic disorders
Increased energy expenditure (e.g. increased activity, heat losses)	

Source: Arends (2024).

Early diagnosis of nutritional problems can ensure adequate management of malnourished cancer patients as well as those at high risk of malnutrition. Such diagnosis can be made by standardizing protocols, performing nutritional screening tests, and including nutritional parameters in the patients' medical history would help achieve good clinical outcomes. Nutritional screening should begin at the time of diagnosis and be repeated at each visit to initiate nutritional intervention early, before the general condition is severely compromised and the chances of recovering normal body conditions are low. The goals of nutritional treatment are to prevent and treat malnutrition, reinforce the effects of anti-tumor treatment by reducing its adverse effects, and improve quality of life (Arends, 2024).

Nutritional screening

Nutritional screening is a procedure in which the nutritional status of individuals is assessed in order to identify whether they are malnourished or at risk of malnutrition. The steps to perform nutritional screening are: 1) Screen all cancer patients at risk of malnutrition early, 2) Expand assessment measures to include measures of anorexia, body composition, inflammatory biomarkers, resting energy expenditure, and physical function, 3) Use individualized multimodal nutritional interventions to increase nutritional intake, decrease inflammation and metabolic stress, and increase physical activity (Arends et al., 2017).

ESPEN recommends simple nutritional screening methods including: **Nutritional Risk Screening 2002 (NRS, 2002):** This screening material is designed for use in hospitalized adults at risk of malnutrition, as well as being a more widely validated predictor for patients in Intensive Care Units (ICU). It consists of four questions that are answered with "yes" or "no", and the more negative answers obtained, the lower the patient's risk of malnutrition (Kondrup, 2003).

Malnutrition Universal Screening Tool (MUST): MUST is a 5-step tool to identify adults with malnutrition (undernutrition or obesity) and is a management guide to develop a care plan. This tool is primarily used in hospital and community settings (Russell and Elia, 2012).

Mini Nutritional The MNA (National Nutritional Assessment) tool can identify elderly patients aged 65 years and older who are at risk of malnutrition, both in the hospital and community settings, as well as in long-term care and rehabilitation. The MNA was developed approximately 20 years ago and remains the best validated tool for this population group. This tool consists of 6 questions with answers ranging from 0 to 3 points, the higher the final score, the lower the risk of malnutrition (Nestlé Nutritional Assessment Institute, 2013).

Malnutrition Screening Tool (MST): This is one of the easiest and simplest tools to handle, which is designed for use in mainly hospitalized adult patients. The MST consists of 2 questions, with answers that have scores ranging from 0 to 4 points, and the higher the score, the greater the risk of malnutrition (Tasmanian Department of Health, 2021).

It should be noted that nutritional screening is a primary tool for the management of patients with a degenerative disease such as cancer, thus becoming a necessity for healthcare as it is the first step in addressing disease-related malnutrition. In addition, it is the basis for finding the appropriate dietary intervention that adapts to the specific nutritional needs that the patient requires in the course of his or her disease (Álvarez, 2018).

Dietary interventions in patients with breast cancer

For many years, nutritional intervention has been performed only in cancer patients in advanced stages of the disease, as part of a palliative treatment regimen. However, the greater efficacy of nutritional support is related to an early approach. However, early nutritional assessment is not routinely performed (<50% of patients) and a large proportion of patients are not identified as at risk or malnourished at the time of cancer diagnosis. Evidence indicates that almost 65% of patients remain without any nutritional intervention. Nutritional interventions in cancer patients are not only effective in preventing malnutrition in cancer patients, but also have positive effects even in patients with a normal nutritional status (Bossi et al., 2022).

Calorie restriction diet

Calorie restriction is characterized by a reduction in calorie intake (Pons et al., 2018). Calorie restriction interventions in the oncology setting have the assumption that starvation-induced autophagy can sensitize cancer cells to chemotherapy by reducing side effects. Such sensitization promotes an effect

known as "differential stress resistance." Furthermore, caloric restriction brings about beneficial effects such as the reduction of oxidative stress and growth factors related to cell proliferation of cancer cells (Gray, 2022).

This is due to its impact on reducing oxidative stress, acting through three cellular mechanisms: a decrease in the generation of free radicals, an increase in their elimination, and the activation of repair processes. The main source of reactive oxygen species (ROS) is the mitochondria, and caloric restriction modulates their production without affecting the activity of the electron transport chain, but rather through changes in the mitochondrial membrane potential (Alidadi et al., 2021).

According to various studies, caloric restriction in breast cancer patients undergoing neoadjuvant treatment (chemotherapy, radiotherapy, hormonal therapy, immunotherapy) and macronutrient distribution showed a significant improvement in quality of life. As well as a decrease in the stage of axillary lymph nodes in more than 60% of the participants. Another significant improvement was the reduction in body mass index (BMI). In addition to the reduction in tumor size and no signs of tumor progression (Vafa et al., 2020; Castellano et al., 2023).

Intermittent Fasting

Intermittent fasting is an ancient practice with a pattern where food and drink are not consumed for a period of time. Different approaches have been proposed, among the most popular ones being the time-restricted diet (TRF) and the intermittent fasting mimicking diet (FMD) (Vega et al., 2024) ; (Vasim et al., 2022).

In the time-restricted diet, intake is limited to 4 to 12 hours daily. The effect of this method regulates appetite and accelerates fat mobilization through the circadian cycle and interacts with RNA to regulate glucose and lipid metabolism, also improving axonal and hematopoietic stem cell (HSC) regeneration. Each fasting method, including FMD (Intermittent Fasting Mimicking Diet), presents different physiological mechanisms that impact health (Dogmeni et al., 2023).

In the intermittent fasting-mimicking diet, caloric intake is reduced for 5 days per month. The macronutrient distribution on the first day is 40-50% of the regular caloric intake and on the following days around 10-20%. The benefits are associated with the regeneration of tissues and cells such as β cells and neurons. In addition, intestinal cells improve the anti-tumor immune response and chemotherapy toxicity (Bocardi et al., 2023).

Among the benefits of intermittent fasting is the synergy with drugs, strengthening the immune system, improving the effect of chemotherapy and

protecting the body from toxins. One of the proposed mechanisms is that tumor cells become sensitive to chemotherapy and side effects are reduced. At the same time, the liver oxidizes fatty acids and provides fuel in the form of ketone bodies that inhibit the growth of carcinoma cells. Likewise, the autophagy of fasting protects cells from cancerous mutation (Dogmeni et al., 2023). Studies have shown that adherence to intermittent fasting patterns improves overall well-being, which contributed to weight reduction and waist circumference (Lutenberg et al., 2021) (Vega et al., 2024).

Ketogenic diet

The ketogenic diet is characterized by a high fat intake (55%-60%) (Moon et al., 2017), mostly long-chain triglycerides (Pedron et al., 2016), moderate protein intake (30%-35%), and low carbohydrate intake (5%-10%) (Moon et al., 2017). This type of diet causes ketosis (Salvatierra et al., 2012), which is defined as a metabolic pathway that produces ketone bodies (Padron et al., 2016).

The primary goal of the ketogenic diet is to decrease overall body fat and improve metabolic health. Recent research indicates potential benefits in type 2 diabetes, hyperlipidemia, heart disease, and cancer(Masood et al., 2023) . Currently, there are different ketogenic diet patterns, such as the classic ketogenic diet, the medium-chain triglyceride (MCT) diet, the modified Atkins diet (MAD), and the low glycemic index treatment (LGIT). The difference between these patterns lies in the distribution of macronutrients (Moon et al., 2017).

During ketogenesis, low insulin secretion regulates blood glucose levels, which reduces the stimulation of fat and glucose storage (Masood et al., 2023). The human body metabolizes fat stores through lipolysis and fatty acids through beta-oxidation, giving rise to ketone bodies (KB) such as acetoacetate, β-hydroxybutyrate, and acetone (Pedrón et al., 2016). Ketone body production depends on resting metabolic rate, BMI, and fat percentage (Masood et al., 2023). In this sense, ketone body production increases due to decreased carbohydrates and increased fatty acids (Dillon and Gupta, 2023). The way in which side effects on tumor growth are minimized is through the production of ketone bodies, which replace glucose as an energy source (Masood et al., 2023).

These metabolites can be used as energy precursors and generate adenosine triphosphate (ATP). Therefore, in cancer, the KD (ketogenic diet) can exert a protective effect, providing an additional energy substrate to tissues at risk of cell death (Pedrón et al., 2016). Glucose is crucial for tumors and they depend on it to survive and multiply. Ketone bodies increase in the body and cancer cells use them for ATP production. Therefore, KD causes malnutrition of tumor cells promoting an anticancer effect (Talib et al., 2021).

In this sense, the tumor tissue absorbs glucose and secretes lactate, which promotes angiogenesis and plays a crucial role in the metabolism, development and growth of cancer cells. This metabolic alteration is known as the Warburg effect (Dong et al., 2015). Most preclinical and clinical studies support that the use of a ketogenic diet in combination with standard therapies enhances the antitumor effects of conventional chemotherapy. It is a safe, tolerable diet that improves quality of life (Jemal et al., 2021).

Similarly, according to new evidence, it reduces the level of glucose and insulin in the blood, decreasing the dependence between this axis that promotes tumor growth. Changes in the use of substrates such as fatty acid oxidation and decreased use of glucose may be therapeutic for the treatment of breast cancer (Jamal et al., 2021). In this sense, the host's hormonal and inflammatory environment is restored, which suppresses tumor growth. The ketogenic diet promotes an anti-inflammatory phenotype, which may result in lower invasiveness and survival. Finally, it improves biochemical parameters and body composition. Clinical studies showed that adherence impacted the decrease in body weight and fat mass. Also, hormonal benefits were obtained such as a decrease in T3 and fasting plasma insulin levels, improving quality of life (Jamal et al., 2021).

Mediterranean diet

In the area of nutrition, the Mediterranean diet is the most studied and recommended. It mainly leans towards a high consumption of fruits, vegetables, whole grains and legumes; in addition to olive oil, nuts, seeds and dairy products. It promotes a moderate intake of poultry and fish, as well as low consumption of red meat, sweets and processed foods (Wang et al., 2018) ; (Augimeri et al., 2021). Therefore, it is a diet low in saturated fat, cholesterol, rich in carbohydrates, monounsaturated fats, fibers and antioxidants. It provides cardiovascular benefits and prevents type 2 diabetes. It helps in the management and prevention of different types of cancer, including breast cancer (Hernando and García, 2021).

Diet plays an important factor in the incidence of breast cancer; Between 30 and 35% of cancer cases are related to eating patterns. The Mediterranean diet rich in polyphenols and vitamins protects cells from oxidation and inflammation by inhibiting carcinogenesis and increasing antiproliferation in different neoplasms (Augimeri et al., 2021). Studies have shown that adherence to the Mediterranean diet is associated with a better level of physical activity. Consequently, loss of body weight in cases of overweight and obesity. Consequently, improving the secondary symptoms derived from anticancer treatment. Likewise, smaller tumor size and absence of metastasis in lymph nodes were observed (Mantzorou et al., 2022) (Montagnese et al., 2020).

Vegetarian Diet

A vegetarian diet focuses on eating vegetables. This includes fruits, vegetables, dried peas and beans, grains, seeds, and nuts. There is no single type of vegetarian diet. There are different models of vegetarian diets, such as the strict diet that excludes all meats and animal products. The lacto-vegetarian diet is another model that consists of including foods derived from plants and dairy products. A third alternative to the vegetarian diet is the lacto-ovo vegetarian diet, which in addition to including vegetables, includes dairy products and eggs (González et al., 2022).

Vegetarian diets have been associated with a lower risk of cancer in general and a lower risk for some types of cancer (colorectal, breast and prostate). Despite this, the evidence in this regard remains insufficient (Godos et al., 2017). According to various studies on the effects of vegetarian diets, it was found that, although people who follow this type of diet do not have a lower risk of developing breast cancer, they do have some protection against it compared to omnivorous people. Other benefits that could be observed are weight loss, decreased fasting insulin, and decreased total cholesterol. The vegetarian diet can be a good alternative for the treatment and prevention of breast cancer, however, some of its limitations must be taken into account to prevent it from causing damage to health, such as insufficient intake of high-quality proteins, omegas, DHA, EPA, iodine, vitamin B12, zinc, iron, and vitamin D (Campbell, 2024; Heianza, 2018).

Traditional Mexican diet

The traditional Mexican diet is characterized by its high nutritional quality, due to the high consumption of legumes such as beans, lentils and chickpeas, cereals such as corn (mainly), rice and wheat, and proteins of animal origin such as eggs, chicken, beef and pork, as well as vegetables and quelites typical of each region, including all elements of the milpa (Figure 1) (Galán, 2021).

Among its main advantages are: an excellent protein balance, since when consuming foods with a large amount of fiber it is difficult to exceed in proteins, it favors the acid-alkaline balance because the vegetable protein has a greater contribution of calcium and magnesium, therefore, more adequate values of the acid renal potential, lower contribution of fats, favors the state of oxidative balance, in addition to favoring the elimination of toxins through its contribution of substances that favor the lower formation of toxic substances in the metabolisms and the optimization in the elimination of these substances.

Figure 1. Traditional Mexican diet or milpa diet.

Source: Secretaría de Salud

The traditional Mexican diet has no disadvantages, since it is a traditional, sustainable, and accessible model that even promotes a greater consumption of vegetables and fruits from each region and the reduction of consumption of products of animal origin. However, being a diet specific to the country, it is difficult to replicate it outside the national territory (Secretaría de Salud, 2025).

The traditional Mexican diet is said to be a great ally in reducing the rates of malnutrition and other diseases such as obesity and diabetes, in addition to acting as a protective factor in the treatment and prevention of breast cancer (Galán, 2021).

According to some studies that sought to demonstrate the protective effect of the traditional Mexican normocaloric diet appropriate to the patient's needs for the prevention of breast cancer, it was shown that the benefits may vary according to BMI and menopausal status (women with BMI <25 kg/m2 and premenopausal women having a lower risk of breast cancer), in addition to modestly improving insulin biomarkers by 14% (Murtaugh et al., 2008; Torres et al., 2016).

Conclusion

Breast cancer is a multifactorial disease and is considered one of the main causes of death in women worldwide and nationally. In order to reduce the risk of malnutrition in cancer patients, nutritional interventions such as caloric restriction, intermittent fasting, ketogenic diet, vegetarian diet and traditional Mexican diet have been proposed. Although the aforementioned diets have different characteristics, they are all used as a tool to improve the quality of life of patients with breast cancer in order to avoid the side effects of cancer treatments such as malnutrition.

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Efecto de las intervenciones nutricionales sobre el riesgo de desnutrición en pacientes con cáncer de mama

Efeito das intervenções nutricionais sobre o risco de desnutrição em pacientes com câncer de mama

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Resumen

El cáncer de mama es una enfermedad que afecta principalmente a las mujeres. Los tratamientos oncológicos utilizados contra el cáncer de mama pueden provocar efectos negativos, incluida la desnutrición. Con el fin de identificar el riesgo de desnutrición en pacientes con cáncer de mama es utilizado el cribado nutricional. Para disminuir el riesgo de desnutrición en los pacientes oncológicos se han propuesto a las intervenciones nutricionales. Existen diferentes tipos de intervenciones nutricionales como la dieta de restricción calórica, dieta cetogénica, el ayuno intermitente, dieta vegetariana, dieta mediterránea y la dieta tradicional mexicana. Dichas intervenciones nutricionales han tenido resultados positivos en los pacientes con cáncer de mama que impactan en su composición corporal, medidas antropométricas y marcadores séricos, dando como resultado en algunos casos la reducción de tumores. Por tales razones se consideran a las intervenciones nutricionales como coadyuvantes en el tratamiento del cáncer de mama. Sin embargo, dichas intervenciones deben ser individualizadas y seleccionadas adecuadamente, considerando las necesidades nutrimentales, estilo de

vida y preferencia de los pacientes.
Palabras clave: Algoritmo de evaluación; Malnutrición; Cáncer de mama; Intervención nutricional; Cribado nutricional.

Resumo

O câncer de mama é uma doença que afeta principalmente as mulheres. Os tratamentos usados contra o câncer de mama podem causar efeitos negativos, inclusive a desnutrição. A triagem nutricional é usada para identificar o risco de desnutrição em pacientes com câncer de mama. Para reduzir o risco de desnutrição em pacientes com câncer, foram propostas intervenções nutricionais. Há diferentes tipos de intervenções nutricionais, como a dieta de restrição calórica, a dieta cetogênica, o jejum intermitente, a dieta vegetariana, a dieta mediterrânea e a dieta tradicional mexicana. Essas intervenções nutricionais tiveram resultados positivos em pacientes com câncer de mama, afetando a composição corporal, as medidas antropométricas e os marcadores séricos, resultando na redução do tumor em alguns casos. Por esses motivos, as intervenções nutricionais são consideradas adjuvantes no tratamento do câncer de mama. No entanto, essas intervenções devem ser individualizadas e adequadamente selecionadas, considerando as necessidades nutricionais, o estilo de vida e as preferências do paciente.
Palavras-chave: Algoritmo de avaliação; Desnutrição; Câncer de mama; Intervenção nutricional; Triagem nutricional.

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Chapter 7

Challenges in postpartum follow-up of women with obesity and gestational diabetes

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Abstract

This chapter explores the challenges of postpartum follow-up in women with obesity and gestational diabetes, emphasizing its impact on maternal and neonatal health. Obesity and hyperglycemia during pregnancy increase the risk of gestational diabetes, which in turn raises the likelihood of developing type 2 diabetes postpartum. The chapter highlights the importance of continuous monitoring and the use of technologies such as digital platforms and mobile applications to enhance early detection and timely intervention. Postpartum is identified as a critical perior for implementing preventive strategies, where surveillance and nutrition play a key role in reducing risks and promoting long-term health in the mother-child dyad.

Keywords:
Maternal obesity; Gestational diabetes; Hyperglycemia; Type 2 diabetes; Digital monitoring.

Introduction

Obesity and gestational diabetes are public health issues affecting many women of childbearing age, especially in countries like Mexico. The prevalence of obesity in pregnant women is high, significantly increasing the risk of developing gestational diabetes. This condition not only affects the mother's health during pregnancy but also has long-term repercussions for both the mother and the baby, who may face a higher risk of metabolic diseases, such as type 2 diabetes.

One of the biggest challenges in managing gestational diabetes is proper postpartum follow-up. After childbirth, many women do not receive the necessary care to prevent the development of type 2 diabetes, which can worsen long-term health outcomes for both mother and child. In this context, breastfeeding plays a relevant role, as it has been associated with benefits for both mother and baby, such as improving glucose control in the mother and reducing the risk of obesity and diabetes in the child.

In response to these challenges, emerging technologies and specific nutritional strategies offer promising solutions to improve postpartum follow-up. Advances in the use of electronic devices for continuous glucose monitoring, along with nutrition programs tailored to the specific needs of women who have had gestational diabetes, present opportunities for more effective management. This chapter explores these solutions, analyzing how the combination of technologies and personalized nutrition can transform follow-up care and prevent long-term complications.

Obesity and Hyperglycemia During Pregnancy

Obesity is a chronic, multifactorial condition characterized by excessive body fat accumulation, which increases the risk of developing various health complications. Its global prevalence has risen alarmingly, making it a public health crisis. The onset and progression of obesity result from a combination of internal and external factors, such as an obesogenic environment, psychosocial conditions, and genetic predisposition. Factors like unhealthy diets, lack of physical activity, and environments promoting processed food consumption, along with limited promotion of physical activity, are key contributors to its development. These social determinants, such as psychosocial conditions and, especially, income inequality, which have been linked to a higher prevalence of obesity, particularly in urban contexts and among women, play a significant role. While obesity affects people of all ages, it presents unique challenges for women, as it is closely linked to hormonal and social factors, making it more difficult for women to maintain a

healthy weight (World Health Organization [WHO], 2024) (NHLBI, 2022) (Phelps et al., 2024) (Tumas et al.,2022). Obesity in women has particular implications due to hormonal, social, and cultural factors that influence eating habits and physical activity levels. Over their lifetimes, women experience significant hormonal changes, such as those related to menstruation, pregnancy, and menopause, which affect fat distribution and increase susceptibility to obesity (NHLBI & NIH, 2022) (McKenzie et al., 2024). Additionally, women, especially those from economically and socially vulnerable backgrounds, face greater barriers to accessing healthy food and exercise opportunities, contributing to the higher prevalence of obesity in this group. Maternal obesity is associated with an increased risk of complications during pregnancy, highlighting the need for preventive strategies, particularly in cases of pre-pregnancy obesity, which increases the likelihood of developing metabolic complications during pregnancy (NHLBI, 2022) (WHO, 2022).

Globally, women have a higher prevalence of obesity (40%) compared to men (35%), especially in low- and middle-income countries, where social and economic inequalities exacerbate the issue (NHLBI & NIH, 2022). In Mexico, the increase in pre-pregnancy overweight and obesity in women of reproductive age has become a public health problem with significant consequences for maternal and infant health. Pre-pregnancy obesity, defined as a BMI greater than 30 kg/m^2 before pregnancy, is a key factor in the development of hyperglycemia during pregnancy, emphasizing the importance of early interventions to reduce risks for both the mother and the baby (Hernández-Ruíz et al., 2023).

Hormonal changes during pregnancy increase insulin resistance, which, in women with pre-pregnancy obesity, can impair glucose control and elevate the risk of gestational diabetes (International Federation of Gynecology and Obstetrics [FIGO], n.d.).

Hyperglycemia is common during pregnancy, and although it is not always diagnosed as diabetes, it can lead to complications. Hormonal changes increase insulin resistance, which, in predisposed women, such as those with pre-pregnancy obesity, can affect glucose control and increase the risk of gestational diabetes (Mohan & Egan, 2024). Despite advancements in treatment, the exact glucose levels to measure at the beginning of pregnancy are still unclear, as current tests are not always precise. Additionally, clear methods for identifying high-risk women have yet to be established. Continuous glucose monitoring could help detect the problem earlier, improving prevention and reducing the risk of gestational diabetes (Li & Sheu, 2022).

Addressing maternal nutrition, obesity, and hyperglycemia during pregnancy is essential to reduce complications for both mother and baby. Hyperglycemia, even without meeting the diagnostic criteria for gestational diabetes, can increase the risk of obstetric and metabolic complications. In the

case of gestational diabetes, it is associated with a higher risk of low birth weight or poor fetal growth, highlighting the importance of screening all pregnant women for potential glucose abnormalities. Maternal obesity affects millions of pregnancies and increases the risk of hyperglycemia, making early detection and timely interventions crucial. Raising awareness about the risks of hyperglycemia during pregnancy should be a priority in prenatal care, including proper postpartum follow-up and preconception counseling, as recommended by major health organizations (FIGO, n.d.).

Gestational Diabetes

Diabetes mellitus is a global public health issue due to its endocrine-metabolic nature. Its prevalence continues to rise, largely due to inadequate nutrition education, limited access to healthy foods, insufficient weight control, and the lack of regular medical visits. This condition is associated with disturbances in the metabolism of carbohydrates, proteins, and fats. Risk factors, such as excessive weight gain during and after pregnancy, are significant determinants in the development of gestational diabetes, exacerbating complications for both mother and child (Beltrán-Cámara et al., 2013).

Gestational diabetes is defined as hyperglycemia detected for the first time during pregnancy, without meeting the diagnostic criteria for overt diabetes. Its global prevalence is approximately 14%, with significant variations based on risk factors and screening strategies, and it is increasing in parallel with obesity and type 2 diabetes. This condition represents a considerable economic burden due to its complications. Between 30% and 70% of cases are diagnosed before 20 weeks of gestation, a phenomenon known as early gestational diabetes, which is associated with poorer obstetric outcomes compared to late gestational diabetes, diagnosed between 24 and 28 weeks of gestation.Early diagnosis and treatment are beneficial, highlighting the need for a life-course precision medicine approach. Additionally, lifestyle interventions, when initiated postpartum, could have a significant long-term impact on the health of women with a history of gestational diabetes, preventing the development of type 2 diabetes and cardiovascular diseases, as well as reducing the risk of obesity and type 2 diabetes in their children. (Smith y Jones, 2024)

Nutritional interventions for women who have had gestational diabetes are crucial in preventing type 2 diabetes. Adopting healthy dietary patterns, including foods such as whole grains, fish, olive oil, fruits, vegetables, and omega-3 fatty acids, helps improve glucose regulation and insulin sensitivity. Additionally, it is recommended to reduce the consumption of red meat and sugary beverages.

While some foods, like tubers, do not have a clear link to the risk of gestational diabetes, maintaining a balanced diet remains essential (Willett et al., 2019).

Exposure to hyperglycemia during pregnancy can cause lasting changes in maternal metabolism, maintaining an elevated risk of glucose intolerance and progression to type 2 diabetes. These consequences not only affect the mother's health but also her family environment and potential future pregnancies.

Gestational Diabetes and the Risk of Progression to Type 2 Diabetes

Women with a history of gestational diabetes have a significantly higher risk of developing type 2 diabetes compared to those who have had a normoglycemic pregnancy (Vounzoulaki et al., 2020). This underscores the urgent need for preventive care for mothers who have had gestational diabetes. Interventions addressing metabolic and behavioral factors are essential to prevent the onset of type 2 diabetes, even years after delivery. However, definitive metrics, are still lacking, and there are few meta-analyses evaluating the incidence rate of type 2 diabetes in women with a history of gestational diabetes (Li et al., 2020).

In this context, it is crucial to address factors such as physical activity and the adoption of healthy eating habits under the guidance ofa healthcare professional, especially from the field of nutrition. Additionally, periodic preventive exams in the years following childbirth are essential for early detection of type 2 diabetes development (American Diabetes Association Professional Practice Committee, 2025).

Access to healthcare fduring postpartum period plays a key role in the early detection of type 2 diabetes. The later the diagnosis and treatment of this condition, the greater the impact on the patient's quality of life. However, if basic diagnostics, such as blood glucose measurement, are available, diabetes can be detected and treated earlier, reducing the risk of cardiovascular complications, eye, kidney, and foot damage associated with type 2 diabetes (Wong et al., 2022).

Historically, type 2 diabetes was primarily diagnosed in adults, but today there is an increasing diagnosis among the pediatric population (Pan American Health Organization, n.d.). In this context, it is essential for children of women with pregestational diabetes, gestational diabetes, and hypoglycemia to receive proper growth and development monitoring, allowing for timely identification of any issues. Moreover, education about healthy eating habits and physical activity will play a vital role in their development, as this early stage is key to reducing the risk of developing type 2 diabetes later in life.

Social determinants of health play a key role in the prevention and management of diabetes, particularly among women who have experienced or currently live with gestational or type 2 diabetes. When timely intervention is lacking, health complications can persist for both the mother and child, ultimately increasing the burden on healthcare systems. Addressing the social context in healthcare strategies is essential to effectively combat this disease (Seiglie et al., 2021; American Diabetes Association Professional Practice Committee, 2025).

Addressing this issue requires a holistic approach that involves policy, the healthcare system, and healthcare professionals. Personalized care that takes into account the unique life context of individuals with diabetes is necessary throughout their entire lifecycle. In this regard, education and self-management support services are fundamental. These services should focus on informing and empowering individuals—especially pregnant women—to prevent gestational diabetes and its long-term complications. Additionally, ensuring smooth transitions from obstetric care to primary care is crucial for guaranteeing continuous care for both mother and child during the postpartum period (American Diabetes Association Professional Practice Committee, 2025).

Despite progress in the field, current recommendations still focus primarily on managing gestational diabetes during pregnancy, mainly through blood glucose control and prioritizing care during pregnancy and the immediate postpartum period. One area that warrants more attention is breastfeeding support. Breastfeeding not only strengthens the maternal-child bond but also provides significant metabolic benefits. For mothers with a history of gestational diabetes or obesity, it lowers the risk of developing type 2 diabetes and supports postpartum weight recovery. For infants, breastfeeding reduces the risk of childhood obesity and type 2 diabetes later in life (González-Castell et al., 2024). However, in Mexico, only 33.6% of newborns receive exclusive breastfeeding during the first six months, highlighting the need to improve education and support for mothers, especially those in high-risk groups (González-Castell et al., 2023).

It is vital for the healthcare system to have the resources, training, and infrastructure necessary to provide adequate postpartum care, particularly for women in vulnerable situations. This is especially important for women from indigenous Mexican ethnicities, who experience higher levels of food insecurity and face greater challenges in accessing healthcare and addressing their needs, not only in health but across multiple social aspects (American Diabetes Association Professional Practice Committee, 2025). While we take pride in celebrating the legacies of indigenous peoples, such as their pyramids and archaeological remains, it is equally important not to overlook the ongoing health needs of these living communities. These disparities emphasize the necessity of integrating social determinants of health into the development of strategies aimed at preventing

and treating obesity, with a particular focus on tailoring these strategies to meet the needs of women.

Technology and Strategies to Improve Postpartum Monitoring

The implementation of strategies to address healthcare throughout the life cycle is crucial, particularly during the postpartum period,, which involves both the mother and the newborn. This critical period requires not only medical and psychological support but also proper nutrition, which plays a fundamental role in the mother's recovery and the baby's well-being. Adequate nutrition during the postpartum stage is essential for preventing chronic conditions like type 2 diabetes in the mother and promoting the baby's health. However, more than three out of ten women and babies do not receive adequate postnatal care in the first few days after birth, a period when most maternal and infant deaths occur (World Health Organization [WHO], 2022). Timely and effective monitoring during this stage is essential to improve the quality of life for both and prevent long-term complications.

Proper nutritional monitoring and glycemic control are crucial role in the recovery of mothers' health after childbirth, helping to reduce the risk of developing chronic diseases like type 2 diabetes. An appropriate nutritional strategy is key to postpartum weight loss and the prevention of future complications (Revista de Diabetes, 2025).

opportunity to enhance postpartum care. The rapid expansion of telehealth and mobile technologies, especially after the COVID-19 pandemic, has opened new doors to reach women who might otherwise lack access to timely follow-up. Through virtual consultations, glucose monitoring apps, and digital support platforms, healthcare professionals can maintain communication and provide personalized guidance to new mothers. These tools not only improve care continuity but also empower women to take an active role in their recovery and diabetes prevention. Remote strategies help close existing gaps, particularly for those living in underserved or rural areas, ensuring that both mother and child receive the attention they need during this crucial period. However, there are limitations, such as social determinants of health, which can prevent a woman from dedicating the necessary time to her postpartum healthcare. Additionally, public policies often fail to facilitate women's access to baby care, nor is there enough information available to promote breastfeeding, postpartum care, and follow-up (Arias et al., 2022).

During the postpartum period, the mother may not feel fully prepared, as the new responsibilities of motherhood, such as caring for the baby and emotional

adjustment, do not always align with the healthcare system, which sometimes does not offer the necessary support at the right time. However, postpartum monitoring can be essential to support the mother's self-care, reduce symptoms of depression, extend breastfeeding duration, decrease anxiety, improve urinary incontinence control, provide contraceptive options, and balance mood changes. Furthermore, efforts in remote postpartum monitoring can enrich in-person visits for the mother's checkups, helping to reduce risks for developing conditions such as diabetes mellitus, hypertension, and insulin resistance (He et al., 2024).

In addition to supporting recovery and chronic disease prevention, remote healthcare strategies have shown great potential in promoting breastfeeding—a fundamental component of infant nutrition and maternal health. Although exclusive breastfeeding is recommended for the first six months of life, many mothers discontinue earlier due to lack of access to specialized support. Telehealth services, which allow real-time communication with healthcare professionals, have proven to be an effective and practical strategy to encourage breastfeeding, extend its duration, and reduce early weaning. Moreover, this method is generally well accepted by mothers, who often report high levels of satisfaction with the support received remotely (Hubschman-Shahar, 2022).

mHealth has been shown to offer significant advantages, as it reduces costs while allowing healthcare professionals to provide personalized follow-up to their patients. A study demonstrated that pregnant women use their smartphones to search for information about childbirth and share experiences with other women via social media. Additionally, mHealth enables the use of health apps focused on the postpartum period and the prevention and treatment of gestational diabetes (GDM). Women diagnosed with GDM face challenges that can be addressed using mHealth (Edwards et al., 2021).

Therefore, we emphasize the need to intensify efforts to address social health determinants and public policies, ensuring that both maternal and infant health remain optimal by leveraging technology, applications, virtual meetings, calls, scheduling visits, and using postpartum follow-up as an opportunity to improve both the current and future health of the mother and child(Wang et al., 2022).

Conclusion

In conclusion, postpartum follow-up for women with obesity and gestational diabetes remains a critical yet often neglected aspect of maternal healthcare. The intersection of obesity, hyperglycemia during pregnancy, and the heightened risk of progressing to type 2 diabetes necessitates a multifaceted approach to care. Key strategies, such as proper nutrition, early intervention, and the use of digital platforms for continuous monitoring, are essential for mitigating long-term

health risks for both the mother and child. Emerging technologies offer significant promise in overcoming barriers to timely and effective follow-up care, while addressing the social determinants that disproportionately impact vulnerable populations, especially in countries like Mexico. It is crucial that healthcare systems evolve to offer personalized, continuous, and accessible care throughout the entire maternal lifecycle, from pregnancy to postpartum, to ensure the long-term health and well-being of both mother and child.

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Retos en el seguimiento posparto de mujeres con obesidad y diabetes gestacional

Desafios no acompanhamento pós-parto de mulheres com obesidade e diabetes gestacional

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Resumen

Este capítulo explora los retos del seguimiento posparto en mujeres con obesidad y diabetes gestacional, haciendo hincapié en su impacto sobre la salud materna y neonatal. La obesidad y la hiperglucemia durante el embarazo aumentan el riesgo de diabetes gestacional, lo que a su vez eleva la probabilidad de desarrollar diabetes tipo 2 en el posparto. El capítulo destaca la importancia de la monitorización continua y el uso de tecnologías como plataformas digitales y aplicaciones móviles para mejorar la

detección precoz y la intervención oportuna. El posparto se identifica como un perior crítico para la implementación de estrategias preventivas, donde la vigilancia y la nutrición juegan un papel clave en la reducción de riesgos y la promoción de la salud a largo plazo en la díada madre-hijo.
Palabras clave: Maternal obesity; Gestational diabetes; Hyperglycemia; Type 2 diabetes; Digital monitoring.

Resumo

Este capítulo explora os desafios do acompanhamento pós-parto de mulheres com obesidade e diabetes gestacional, enfatizando seu impacto na saúde materna e neonatal. A obesidade e a hiperglicemia durante a gravidez aumentam o risco de diabetes gestacional, o que, por sua vez, aumenta a probabilidade de desenvolver diabetes tipo 2 no pós-parto. O capítulo destaca a importância do monitoramento contínuo e do uso de tecnologias, como plataformas digitais e aplicativos móveis, para melhorar a detecção precoce e a intervenção oportuna. O pós-parto é identificado como um período crítico para a implementação de estratégias preventivas, em que a vigilância e a nutrição desempenham um papel fundamental na redução dos riscos e na promoção da saúde a longo prazo na díade mãe-filho.
Palavras-chave: Obesidade materna; diabetes gestacional; hiperglicemia; diabetes tipo 2; monitoramento digital.

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Chapter 8

Schools and nutrition as a key element in the prevention of obesity in schoolchildren

Jacqueline Noriega Vidaña, Alejandra Barbosa Arnero

Abstract

Food is one of the key elements for the prevention of illnesses. In Mexico alone, the wrong choice of food and food insecurity is what has led to leading the list of childhood obesity worldwide. According to data from ENSANUT. 2024. The prevalence of overweight and obesity was 36.5 – 40. The prevalence of overweight and obesity was 36.5 – 40.4% in school children and adolescents. Behind these figures there are several social, cultural and even environmental factors that lead us to a single decision, in school environments these influence in an exorbitant way because it is the main element in the development of the person, this chapter will cover the relationship and importance of the school environment with focus on nutritional aspects evaluating common practices, statistics, food programs, the knowledge provided about healthy eating, and merely the influence on the judgment of the person to establish conviction on a particular dietary regime.
Keywords:
Education; Nutrition; Health; Food; Social behavior.

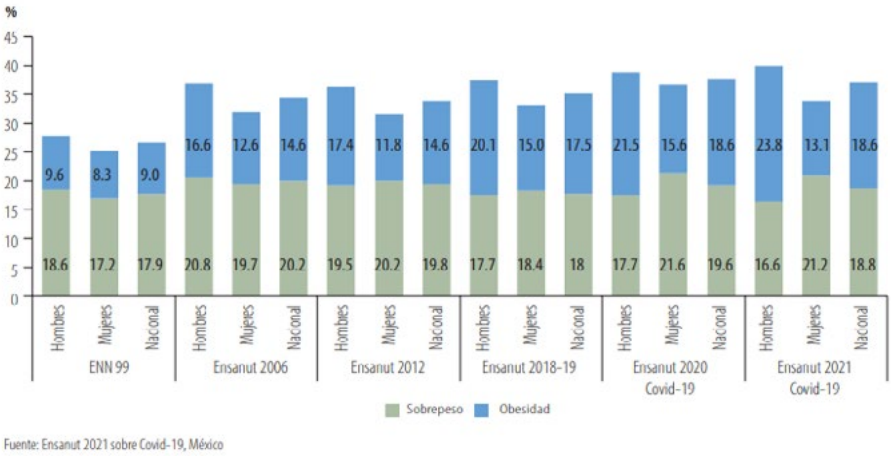
Introduction

During the first stages of life, a sufficient, varied and safe diet plays a significant role, establishing itself as a basis for decision making, in relation to the aspects of selection, beliefs and a series of behaviors that will have an impact in the medium or long term on their health. Adequate nutrition will provide children with multiple health benefits, such as the reduction in the risk of presenting various pathologies, thus improving their quality of life, one of them being the improvement in academic performance. The study presented by González-Hinojosa et al. (2022), revealed that knowledge about healthy eating habits improved by 14% which favors the health of the population, allowing them to lead a better quality of life, the school environment stands out as an area where knowledge is acquired regarding multiple branches, being the social ties that affect the criteria of each individual, especially during recess which is where food trends are usually developed, Therefore, it is important to analyze the components that are provided to schoolchildren to educate them about food and health issues, analyzing the food and social behaviors that are often performed within these spaces so that in this way they not only succeed with food issues in the classroom and at the same time implement it as part of their daily lives, motivating those around them to make appropriate decisions to improve their quality of life.

Statistics

The National Health and Nutrition Survey of 2021, in boys and girls from 5 to 11 years old, the national prevalence of overweight was 18.8 %, in males 16.6 % % and in females 21.2 %. The prevalence of obesity was found to be 18.6 % of school children, 23.8 % in males and 13.1 % in females, these two prevalences when compared with the previous ENSANUT there is no difference in the prevalence of national obesity, and a slight decrease in national overweight. However, according to sex, especially in school-age males, an increase in the prevalence of obesity was found.

Figure 1. Comparison of the national prevalence of overweight and obesity in the population aged 5 to 11 years, from ENN-1999 and ENSANUT 2006, 2012, 2018-19, 2020 and 2021, by sex.



Fuente: Ensanut 2021 sobre Covid-19, México

Source: ENSANUT 2021 sobre COVID-19, México.

Parents and food promotion

Parents are key in the development of their children's eating behavior being the main decision makers at home, so the habits that students follow at school will be influenced by the decisions made by their parents at home, it is important to take into account the participation of parents when educating about food as this will directly influence the development of the student.

Influence of schools in childhood

Schools are the main source of knowledge for students, providing the necessary tools for the future, what is learned in these areas will not only have an impact on a person's life, it will also have an impact on the lives of those around them, thus creating habits, regarding food, what they are used to consume during breaks, the availability of food, preferences and information provided, will be the basis that the student will take into account when making a decision regarding their diet.

In research conducted by De Lira-García et al. (2018), analyze food preferences during school recess they divided it into 3 stages the first stage consisted of the characteristics of the school environment and to know the food offered within the

school, then they conducted interviews with students about their favorite foods and those consumed at school during that day, likewise the sensory characteristics by which they decided to choose certain foods, during the last stage they gave them the indication to draw their favorite food, when they finished their drawing, each child was called to explain the reason for the choice of that specific food. The favorite foods of the participating elementary school children were: salty snacks, cookies, pizza, tacos and spaghetti; and the least preferred foods were: lentils, vegetables, tuna, meatballs and fish.

According to Shamah-Levy et al. (2024), the gaps between the school and adolescent population with overweight and obesity in rural and urban areas, regardless of their welfare conditions have been narrowing and it is expected that, in the future, the most vulnerable will be those who may have the greatest burden of obesity; in addition to reporting a strong association between the BMI of parents and the development of overweight and obesity in their children. The consumption of energy-dense foods, including sugar-sweetened beverages, where 65% of the Mexican population is far from reaching the limits recommended by the WHO to reduce consumption to <10% of total energy intake. It is here where we can see the influence of the school for the options it offered, the parents for the diet they decided to follow and their preferences in selecting the foods they would consume.

Eating behavior

The WHO defines eating behavior as the behaviors expressed in response to biological, psychological and sociocultural motivation linked to food intake, which gives certainty to this relationship that exists between the own criteria and social opinion, it is worth mentioning that this behavior is developed mainly by the subject and the environment that surrounds it, therefore, In the school environment where a child usually spends part of his day begins to develop habits and food trends that can be observed in their food intake during breaks, if they carry lunch box these behaviors will usually go according to what parents provide as food, or on the other hand if they usually consume food from the cafeteria their own criteria influenced by the options that are available will be what will be taken into account when selecting a particular food.

Although the dietary guidelines mention that foods of vegetable origin should be consumed in greater proportion than those of animal origin, in school cafeterias what a child usually has access to is “junk food” such as chips, cookies, candy, chocolates, soft drinks, etc., as a result of various factors such as economic aspects, preferences, availability, etc., offering students limited options that do not meet the requirements of NOM-043, This is a consequence of different factors

such as economic aspects, preferences, availability, etc., offering students limited options that do not comply with the NOM-043, being one of the main reasons why the food they usually consume during this period of time does not contribute to a healthy diet.

Food programs in Mexico

The main purpose of school food programs is to ensure that children attending public schools enjoy the possibility of consuming nutritious and healthy food that favors their development. These programs are continually updated to provide new guidelines that benefit the population and combat the obesity that currently prevail in our country. The Official Gazette of the Federation, 2024 shows a list with the purpose of promoting the sale and consumption of natural foods and beverages, based on healthy preparations that do not contain excessive levels of sugar, fats and sodium, general guidelines were established on the distribution of junk products within educational institutions, it is also mentioned that the school authority that promotes the sale or dissemination of advertising of food and beverages not allowed for schools in contravention of the provisions will incur in the infractions provided and will be liable to the penalties previously established.

Conclusion

Ultimately, it would be attractive to remember that everything that surrounds a person and is part of their daily life will contribute to a number of decisions so it is important to highlight the relevance of schools in the development of students and how these are closely related to their food and therefore future eating behaviors that not only will practice these also will participate to their family, so it is important to encourage them correct selection of food instead of labeling them as good or bad.

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La escuela y la alimentación como elemento clave en la prevención de la obesidad escolar

Escolas e nutrição como um elemento-chave na prevenção da obesidade em crianças em idade escolar

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Resumen

La alimentación es uno de los elementos clave para la prevención de padecimientos, tan solo en México la selección errónea de los alimentos e inseguridad alimentaria es lo que ha llevado a encabezar la lista de obesidad infantil a nivel mundial. Según datos de ENSANUT. 2024. La prevalencia de sobrepeso y obesidad fue de 36.5-40.4% en escolares y adolescentes, detrás de estas cifras intervienen diversos factores sociales, culturales e incluso ambientales, los cuales nos conducen hacia una sola decisión, en ámbitos escolares estos influyen de manera exorbitante debido a que se sitúa como principal elemento en el desarrollo de la persona, el presente capitulo abarcara la relación e importancia del ámbito escolar con enfoque en aspectos nutricionales evaluando prácticas comunes, estadísticas, programas alimentarios, los conocimientos brindados acerca de una alimentación saludable además de la influencia en el juicio de la persona para establecer una decisión sobre un régimen alimenticio.
Palabras clave: Educación; Nutrición; Salud; Alimento; Comportamiento social.

Resumo

A alimentação é um dos principais elementos para a prevenção de doenças. Somente no México, a escolha errada de alimentos e a insegurança alimentar é o que levou o país a liderar a lista de obesidade infantil em todo o mundo. De acordo com dados da ENSANUT. 2024. A prevalência de sobrepeso e obesidade foi de 36,5 a 40. A prevalência de sobrepeso e obesidade foi de 36,5 a 40,4% em crianças e adolescentes em idade escolar. Por trás desses números existem diversos fatores sociais, culturais e até mesmo ambientais que nos levam a uma única decisão, em ambientes escolares esses influenciam de forma exorbitante por ser o principal elemento no desenvolvimento da

pessoa, esse capítulo abordará a relação e a importância do ambiente escolar com foco nos aspectos nutricionais avaliando práticas comuns, estatísticas, programas alimentares, o conhecimento fornecido sobre alimentação saudável, e meramente a influência no julgamento da pessoa para estabelecer convicção em um determinado regime alimentar.
Palavras-chave: Educação; Nutrição; Saúde; Alimentação; Comportamento social.

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Chapter 9
Spirulina algae in patients with obesity

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Abstract

Spirulina is a microalgae recognized for its rich nutritional composition that makes it a valuable food and therapeutic agent. The chapter highlights the nutritional characteristics (proteins, essential fatty acids, vitamins, minerals and the pigments phycocyanin, polysaccharides and carotenoids), the various biological activities, such as antioxidant, anti-inflammatory, immunomodulatory, antiviral, anticancer, antidiabetic and lipid-lowering effects and the potential a promising candidate for preventing chronic diseases, such as obesity. In addition, this food has been gaining interest for implementation in the industrial food sector.
Keywords: Spirulina; obesity; nutrition; nutritional composition; nutrition.

Introduction

Spirulina has existed for more than 3.5 billion years as a prokaryotic cyanobacterium, and is currently considered the food of the future, thanks to its great nutritional and antioxidant contribution (Stunda-Zujeva et al., 2023). This alga belongs to the Arthrospira family, used for nutritional and pharmacological purposes. Studies have proven its effectiveness in the treatment of different types of diseases, including obesity (Malpartida et al., 2022). The objective of this chapter is to know how good it is to take, eat spirulina seaweed in its different presentations, for patients with obesity, it will be about looking for the doses that the patient should ingest so that it can take effect, as well as if consuming large quantities, can affect the patient to develop some extra disease, or if it simply helps the patient to lose weight, with exercise aids, good nutrition and a good administration of spirulina seaweed.

Arthrospira (Spirulina)

Arthrospira sp, commercially known as spirulina, is a blue-green microalgae (due to its content of carotenoids, xanthophyll, phycocyanin and chlorophyll) belonging to the cyanobacteria, considered a photosynthetic microorganism that has the form of cylindrical filaments arranged in noramified open helical trichomes with 20 to 100 μm in diameter (Figure 1). Its cells are surrounded by a mucilaginous film of mucopolysaccharides without a defined nucleus, since nucleic acids and other nuclear components are randomly distributed throughout the cell mass. Cyanobacteria are composed of cells measuring 1 to 3 μm in the smallest species and 3 to 12 μm for the largest or take a straight shape in artificial cultures (Vonshak, 1997).

The existence of spirulina can be calculated between 3.1 and 3.5 billion years ago, so it is located at the absolute base of the food chains that were built from it. In pre-Hispanic times it was consumed and known as tecuitlatl in Mexico, while in Africa, in the native tribes of Lake Chad it was known as dihé (Muñoz Hernández, 2019). Its taxonomic composition can be seen in Table 1.

Table 1. Taxonomic composition of *Arthrospira* sp.

Kingdom	**Bacteria**
Phyllum	Cyanobacteria
Class	Cyanophyceae
Subclass	Oscillatoriophycideae

Kingdom	Bacteria
Family	Phormidiaceae
Genero	Arthrospira
Especie	Platensis

Source: own elaboration

Most species of the genus *Arthrospira* are found in alkaline waters, since they tend to grow abundantly in this type of habitat; while others are found in fresh water for HCO_3, Na^+ and K^+ supplements and in warm and highly alkaline waters of Asia, Africa, North and South America for reproduction. They are easy to cultivate since they can grow anywhere, as long as they have access to sunlight and essential nutrients, although their growth rate also depends on the availability of an addition of certain specific compounds. Their metabolism can be autotrophic, heterotrophic, mixotrophic and photoheterotrophic (Belay, Kato, and Ota, 1996). It is necessary to name the best known species of the genus Arthrospira as shown in Table 2.

Table 2. Species of *Arthrospir.*

Species	Origin place
Arthrospira platensis	Montevideo, Uruguay, standing water Arthrospira spirulinoides Lahore, Pakistan, stagnant rain water
Arthrospira fusiformis	Siberian steppe, Russia, Tunatan Lake
Arthrospira gomontiana	North America, stagnant water Arthrospira indica Madurai, India, natural pond
Arthrospira jenneri	Europe, stagnant water Arthrospira khannae Rangoon, Myanmar, natural pond
Arthrospira massartii	Luxembourg, spring water
Arthrospira máxima	Oakland, California, salt pond

Source: own elaboration

Nutritional composition

In its proximal composition stands out its protein percentage between 65–75 % approximately, it contains essential amino acids that are indispensable for a healthy diet, for human beings (Hoseini, Khosravi-Darani, Mozafari, 2013). It contains between 60-70 % of proteins distributed by essential amino acids (leucine 8.7%, valine 6.5%, isoleucine 5.6%, threonine 5.2%, lysine 4.7%, phenylalanine 4.5%, methionine 2.3% and tryptophan 1.5%) and it can be said that spirulina is

an ideal nutritional supplement, together with the presence of polyunsaturated acids (5-10%) (Hoseini, Khosravi-Darani, Mozafari, 2013). Gutiérrez-Salmeán Fabila-Castillo and Chamorro-Cevallos (2015) reports that spirulina contains between 13–16.5% carbohydrates; 0.1-0.9% dietary fiber, as well as a high content of vitamins, minerals, antioxidants and phytonutrients (Stunda-Zujeva, Berele, Lece, Šķesters, 2023). It also contains three extremely important pigments: phycocyanin (blue), chlorophyll (green) and carotenoids (red-orange) (Table 3). Therefore, spirulina is classified as a highly nutritious food because of its contribution of macro and micronutrients (Rodriguez, 2021), which are described in Table 3 below.

Table 3. Nutritional composition of spirulina algae.

Composition	**Content (100 g)**	**Composition**	**Content (100 g)**
Macronutrients		Vitamins (mg)	
Calories (Kcal)	373	Vitamin A	352000
Total fatl (g)	4.3	Vitamin K	1090
Saturated	1.95	Tiamin	0.5
Polyunsaturated	1.93	Riboflavin	4.53
Monounsaturated	0.26		14.9
Cholesterol (mg)	0.1	Vitamin B6	0.96
Total carbohydrates (g)	17.8	Vitamin B12	162
Dietary fiber (g)	7.7	Minerals (mg)	
Lactose (g)	0.1	Calcium	468
Protein (g)	63	Iron	87.4
Essential amino acids (mg)		Phosphorus	961
Histidine	1000	Iodine	142
Isoleucine	3500	Magnesium	319
Leucine	5380	Zinc	1.45
Lisine	2960	Selenium	25.5
Methionine	1170	Copper	0.47
Phenylalanine	2750	Manganese	3.26
Threonine	2860	Chromium	400
Tryptophan	1090	Potassium	1660
Valine	3940	Sodium	641
		Phytonutrients	

Composition	Content (100 g)	Composition	Content (100 g)
Non-essential amino acids (mg)		Phycocyanin (%)	17.2
Alanine	4590	Chlorophyll (%)	1.2
Arginine	4310	SOD (IU)	531000
Aspartic acid	5990	gamma linoleic acid (mg)	1080
Cystine	590	Total carotenoids (mg)	504
Glutamic acid	9130	-carotene	211
Glycine	3130	Zeaxanthin	101
Proline	2380		
Serine	2760		
Tyrosine	2500		

Source: SOD Super oxide dismutase Giraldo y Siller (2016).

Spirulina has aromatic rings containing substituents which allow it to act as electron donors or free radical scavenger (Skerget et al., 2005; Ibañez et al. 2012), and has a chemical structure suitable for antioxidant action. Its main active part is phycocyanin, which has a sequestering capacity of alkoxyl, hydroxyl and peroxyl radicals, is formed by two polypeptide chains α and β, which are linked by non-covalent interactions and has three chromophores phycocyanobilin, which is a linear tetrapyrrole which sequesters free radicals by thioether bonding (Domínguez et al., 2018).

Beneficial contributions to health

This cyanobacterium has immunological, antioxidant and antiviral properties, it is an anti-aging supplement, effective against anemia, demineralization and exhaustion, it favors physical and energetic recovery and detoxification of the organism (Wu et al., 2005). Phycocyanin stimulates lymphocyte activity, in the prevention of cancer cell growth. It has also been reported to have favorable effects on the inhibition of HIV-1 replication, antiseptic and detoxifying, as well as acting synergistically in iron uptake and assimilation (Ferruzzi and Blakeslee, 2007). Lacking cell membranes, its digestibility reaches 88-92%, which increases the bioavailability of its polyunsaturated acids, proteins and phytonutrients, providing benefits to the organism such as blood pressure regulation, cholesterol synthesis and cell division (Ibañez et al. 2012).

Spirulina has been studied for its possible impact on obesity due to its high content of dietary fiber and bioactive compounds (Marjanović et al., 2024). Despite its low caloric intake and its ability to induce satiety, experimental studies have shown mixed results in weight reduction. In a study with Wistar rats, no significant changes in body weight were observed after the administration of spirulina, although alterations were recorded in some biochemical markers such as increased urea and triglycerides. However, its richness in nutrients has been valued to improve energy metabolism and modulate inflammatory processes related to obesity (Hoseini et al., 2013). In addition, spirulina has been promoted for its antioxidant properties, its potential to strengthen the immune system and its use in the control of metabolic diseases. Although its role in weight loss is still debated, its use as a supplement in the diet of people with obesity could provide important nutritional benefits (Guillen-Martín del Campo et al., 2019).

Nutritional composition of spirulina and its relevance in obesity

Spirulina algae has a wide range of beneficial properties which, consequently, contains a significant amount of micronutrients (potassium, magnesium, calcium, zinc, manganese, selenium, iron and phosphorus), in addition to the contribution of macronutrients such as carbohydrates, lipids and proteins. Nutritionally, spirulina algae is an efficient tool to counteract oxidation and care against oxidizing agents, widely used in impersonation for people with pathologies derived from free radicals in the body. A comparison is also made between the differences between the nutritional information of the supplement today and that of research or publications in previous years. Scientific evidence also proves its efficacy as a means of supplementation rich in B vitamins, where we can specifically in vitamins B1, B2, and B3, which play a relevant role in the synthesis of plasma proteins and thus making a complement to the reinforcement of the immune system (Malpartida et al., 2022).

It is because of all its properties and relationships with patients with obesity that makes it an excellent option to supplement diets. This seaweed has a high content of essential amino acids and nutrients that can help improve metabolism, especially that of lipids and carbohydrates. Its ability to promote satiety is one of its most prominent benefits, as its high protein content helps reduce caloric intake, which is useful for weight management. In addition, its antioxidant properties help combat oxidative stress, which is related to obesity and its complications. Spirulina has also been shown to have positive effects on lipid regulation, reducing fat levels in the body. Due to its nutrient-rich composition, this microalga can be a valuable supplement in obesity prevention and treatment strategies (Malpartida et al., 2022).

Spirulina in weight loss

Newly, it has been shown that spirulina algae has been used for weight reduction, as it is known that with only 36 g of this algae all the essential amino acids are obtained, as well as other compounds such as fiber and flavonoids, which could help treat obesity and overweight. The aim of the study was to analyze whether the administration of spirulina contributes to weight loss in Wistar rats and to observe its impact on several biochemical markers related to metabolism, such as lipid profile, urea and creatinine. An experimental study was carried out with 10 Wistar rats. Four rats were treated with 5.8 mg of spirulina dissolved in 1 ml of water, administered by orogastric tube for 8 weeks, while the control group, composed of 6 rats of the same species and initial weight, only received 1 mL of water. No significant differences in weight were observed between the experimental rats and those in the control group. Regarding biochemical markers, a significant increase in urea, total cholesterol and triglyceride levels was detected in the experimental rats compared to the control group. These results suggest that spirulina could be useful for weight control and in situations of malnutrition (Guillen-Martin del Campo et al., 2025).

Due to the concentrated nutritional value of spirulina it is also emerging as a supplement and just remember that this has to be accompanied by an exercise regime and good nutrition, since it will be useless to consume it if we do not manage to control that, spirulina will help us to control the binge eating that the individual is given on the days that this superfood is used and it is also voluntary to take it during the weight loss process (Innecco, 2021). Just like taking one gram of spirulina already demonstrated in human patients, it has been shown that with just one gram a day, it can help in weight loss, it can also be given for 12 weeks, since it will also help modulate body weight, as well as appetite, with these studies that could be carried out, it can be confirmed that there is a great efficacy of this supplement called spirulina, for the control and prevention of obesity and obesity-related disorders (Zeinalian et al., 2017).

Spirulina in lipid profiles and cardiovascular health

It has been shown that spirulina is very effective in lowering cholesterol and triglyceride levels in the blood. As mentioned, it has been shown that its regular consumption can significantly reduce LDL cholesterol and triglycerides, thanks to its high content of antioxidants and essential fatty acids, which help improve lipid metabolism. It should be remembered that spirulina can be consumed in different

formats such as powder, tablets or capsules, depending on the preference of each individual and their lifestyle, although spirulina powder can be recommended as it is more versatile and can be incorporated faster into the diet (Serban, 2016).

Cardiovascular disease is one of the leading causes of death, and high cholesterol and triglyceride problems are risk factors. In addition, oxidative stress, which occurs when there is an excess of free radicals in the body, also contributes to these diseases. To reduce these risks, the consumption of antioxidants is recommended. Spirulina, an algae rich in nutrients and antioxidants, has shown benefits for cardiovascular health. It helps reduce LDL cholesterol and triglyceride levels, improving lipid profiles. It also has antioxidant properties that protect the body from damage caused by free radicals. In summary, spirulina may be helpful in maintaining heart health and reducing cardiovascular risk factors (Hernández-Lepe et al., 2015).

It contains polyunsaturated fatty acids such as omega-3 and omega-6, which are good for the heart, and high-quality proteins with all essential amino acids. It is also rich in B vitamins, beta-carotene, minerals such as iron, zinc, magnesium, and other important nutrients such as fiber and antioxidants that have anti-inflammatory and cell-protective properties. The consumption of Spirulina platensis is linked to the reduction of obesity and associated comorbidities, such as diabetes, dyslipidemias (altered levels of lipids in the blood), hypertension, cardiovascular disease, and certain types of cancer. In addition, this seaweed can contribute to improving nutrition in overweight or obese people, helping to avoid nutritional deficiencies that sometimes occur due to inadequate or restrictive diets. Its satiating effect, together with its high nutrient content, makes it a good supplement for those looking to control their weight or improve their cardiovascular health without compromising their nutritional intake (Hernández, 2021).

Spirulina can be a useful supplement for people who are following a weight loss diet, as it helps avoid protein, vitamin, and mineral deficiencies that can occur on a restrictive diet. Despite being low in calories (3 g of spirulina contains only 11.28 Kcal), it offers several health benefits. It helps reduce visceral fat by decreasing macrophages in fat tissue, prevents excessive fat accumulation in the liver, improves insulin sensitivity, and reduces insulin levels in the blood. One of the important effects of spirulina is its ability to reduce appetite. This is because it contains mucilage (polysaccharides such as carrageenan), which upon entering the stomach expand by absorbing water, creating a feeling of fullness and reducing the desire to eat. In addition, spirulina contains phycocyanin, which helps remove cholesterol and bile acids from the body, reducing the absorption of fats in the intestine. This, along with niacin and other compounds such as the glycolipid H-b12, contributes to lowering triglyceride levels, which can help prevent cholesterol problems and obesity-associated diseases, such as dyslipidemia (Martínez et al., 2024).

Recommended dosage of spirulina in people with obesity

An appropriate dose for each individual is 3 to 5 g of spirulina daily, according to the weight of each individual, it does not specify that, if they are obese or not, the individual has to take more grams or less. Which is equivalent to a tablespoon of spirulina powder or 6 to 10 tablets of 500 mg, these doses should be consumed 30 minutes before each meal in order to reduce appetite. It is also advisable to always go to a doctor to allow us to use this supplement or not (Martinez et al., 2024).

Considerations for the consumption or use of spirulina

It should be taken into consideration that spirulina is more of a superfood, so it cannot be considered a medicine, people who consume it have to be very clear about that, but you can get some medicines because if some have been made with this algae, if people consume the recommended doses, there will be no need to be afraid, but on the contrary if the person is not so used to this superfood, they may present some diseases or negative effects such as dermis rash, thirst, constipation or milder gastric discomfort (Moyano Calero & Ochoa Galarza, 2022).

Conclusion

Spirulina's chemical composition and diverse bioactivities position it as an important and ideal candidate to be considered for nutritional supplementation and therapeutic use by individuals. Spirulina stands out for its high protein content, micronutrients and the presence of bioactive compounds. Its antioxidant, anti-inflammatory, anti-diabetic and lipid-lowering properties, among others, offer significant potential for the prevention of chronic diseases.

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Algas espirulina en pacientes con obesidad

Algas spirulina em pacientes com obesidade

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Resumen

La espirulina es una microalga reconocida por su rica composición nutricional que la convierten en un valioso alimento y agente terapéutico. El capítulo subraya las características nutricionales (proteínas, ácidos grasos esenciales, vitaminas, minerales y los pigmentos ficocianina, los polisacáridos y los carotenoides), las diversas actividades biológicas, como efectos antioxidantes, antiinflamatorios, inmunomoduladores, antivirales, anticancerígenos, antidiabéticos y reductores de lípidos y el potencial un candidato prometedor para prevenir enfermedades crónicas, como la obesidad. Además, este alimento ha ido aumentando el interés para implementarse en el sector industrial de los alimentos.
Palabras clave: Espirulina; obesidad; composición nutrimental; nutrición

Resumo

A espirulina é uma microalga reconhecida por sua rica composição nutricional, o que a torna um valioso alimento e agente terapêutico. O capítulo destaca as características nutricionais (proteínas, ácidos graxos essenciais, vitaminas, minerais e os pigmentos ficocianina, polissacarídeos e carotenoides), as diversas atividades biológicas, como efeitos antioxidantes, anti-inflamatórios, imunomoduladores, antivirais,

anticancerígenos, antidiabéticos e redutores de lipídios, e o potencial como candidata promissora para a prevenção de doenças crônicas, como a obesidade. Além disso, esse alimento vem ganhando interesse para ser implementado no setor industrial de alimentos.
Palavras-chave: Spirulina; obesidade; nutrição; composição nutricional; nutrição

Mendoza Hernández, N. G., Plascencia Molina, K. A., y Ramos Ramos, P. Y. (2025). Prevalence of eating disorders: Anorexia and Binge-eating disorders. En G. Mercado Mercado y M Del R. Moyeton Hernández (Coords). *Nutrition: Challenges, Opportunities, and Essential Strategies in the Prevention and Management of Chronic Diseases.* (pp. 153-163). Religación Press. http://doi.org/10.46652/religacionpress.280.c478

Chapter 10

Prevalence of eating disorders: Anorexia and Binge-eating disorders

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Abstract

Eating disorders are complex issues impacting both the physical and mental health of those who suffer from them. These disorders can be linked to difficulties in managing emotions and require comprehensive treatment for successful recovery. Teenagers often struggle with emotional regulation, worsening symptoms and affecting their mental health. Intense emotions like anxiety, sadness, or frustration may lead to problematic eating behaviors as a coping mechanism. Moreover, individuals with an eating disorder tend to ruminate on emotions and avoid emotional experiences, contributing to the disorder's persistence. Therapies focusing on emotional regulation have shown promising results in treating eating disorders.
Keywords: Nutrition, Mental Health, Eating Disorders, Teenagers, Self-Esteem.

Introduction to Eating Disorders

Eating disorders are psychological conditions involving drastic changes in eating-related attitudes and behaviors, driven by distorted body perceptions and intense fear of weight gain. These conditions affect not only health and nutrition but also interpersonal relationships (Guerrero Mothelet, 2025).

They predominantly affect teenagers undergoing physical, emotional, and social changes. Some studies show that up to 5% of young women may exhibit symptoms of anorexia nervosa. Women are more prone, with a 5-10:1 female-to-male ratio (Vaz Leal, 2005, p. 4). Individual factors include low self-esteem, body dissatisfaction, and perfectionism. Social factors like media pressure, beauty standards, and bullying also play crucial roles. Family environments with high expectations, conflict, or negative attitudes toward body image and food further contribute (Cortez et al., 2016). The National Institute of Psychiatry Ramón de la Fuente Muñiz (2023) notes a recent rise in eating disorders, attributed partly to social media influence and globalization of unrealistic beauty standards.

Prevalence of Eating Disorders in Teenagers

Globally, eating disorders are a significant problem, especially among teenagers. Prevalence varies by age and gender, being higher among females. In Mexico, the prevalence is 5.7% in recent years, and 8.6% in Chihuahua (Villalobos-Hernandez et al., 2022). At least 25% of Mexican teenagers fall within different risk ranges for eating disorders. Teenagers with eating disorders often also suffer from conditions like depression, social anxiety, generalized anxiety, or PTSD. Notably, for every male affected, there are about ten females (Health Ministry, 2023).

Factors include upbringing, culture, family relationships, social environment, and poor food interaction. Prevalence has been rising, partly due to updated diagnostic criteria. It is estimated that prevalence could rise to 25% in Mexico, driven by psychological issues like depression, anxiety, bipolar disorder, schizophrenia, and even feeding difficulties in hospitalized teenagers (Arija-Val et al., 2022).

Risk Factors for Eating Disorders

Currently, eating disorders are of unknown origin because most research focuses on a limited number of factors. It is necessary to thoroughly understand

the factors that affect them in order to establish prevention strategies and more specialized and personalized treatment for teenagers. To date, the factors that have been identified are biological, psychological, and sociocultural (Portela de Santana et al., 2012).

Among biological factors, these factors are highly involved in the development and maintenance of eating disorders. Genetics plays an important role, as it is estimated that during adolescence, genetic variations are responsible for 50 to 85% of the risk factors for eating disorder symptoms. Family studies have described an increased risk of eating disorders, up to 10 times higher, when a family member has a disorder. This makes the person more vulnerable but does not necessarily cause the disorder; in other words, additional factors are required to develop an eating disorder (Portela de Santana, 2012).

Regarding psychological factors, the construction of body image begins in adolescence because it is the stage where the most changes and most vulnerable people experience. Perfectionism leads to distorted thinking, and after all, they always have an excessive need for external approval. This is where concern about weight begins, the desire to have a perfect body, whether thin or muscular. They begin at a stage where they want to fit into the beauty standards dictated by society, but instead of being a positive influence, it becomes a risk for body dissatisfaction that leads to an eating disorder. Body dissatisfaction is present in 25% to 81% of women and 16% to 55% of men, and this contributes to behaviors such as lack of motivation to diet, compulsive eating, weight gain, depression, and anxiety (Portela de Santana, 2012).

Finally, sociocultural factors are currently one of the main factors that greatly influence an eating disorder in teenagers, considering that society and the media have sold and shown us the idea that the model of thinness is synonymous with beauty, freedom, youth, health, willpower and control over oneself and success, with this they encourage the most vulnerable population, in this case mainly teenagers, to carry out unhealthy behaviors, related to weight and eating only with the purpose of fitting in and reaching the ideal of beauty, regardless of the consequences. It is difficult to have control over the stereotypes dictated by society, that is why it is important from childhood that the family should guide boys and girls to say and inform them correctly about what is shown on television what is really in their environment, given that the media can negatively affect the body image and health of teenagers by transmitting contradictory messages and unattainable beauty standards. In the end, every practice and behavior carried out by teenagers to comply with the ideal stereotypes to achieve the perfect body, results in a risk factor that results in an eating disorder, because they do not feel totally satisfied with what they have achieved and this is where behaviors such as taking refuge in food begin, and then feeling guilt and regret (Mancilla Diaz et al., 2010).

Relationship Between Eating Disorders and Teenager Mental Health

Teenagers with eating disorders often experience difficulty regulating their emotions, which can exacerbate their symptoms and affect their mental health. The inability to manage intense emotions such as anxiety, sadness, or frustration can lead to resorting to dysfunctional eating behaviors as a coping mechanism. Furthermore, studies have shown that people with eating disorders have a greater tendency toward emotional rumination and experiential avoidance, which contributes to the maintenance of the disorder (Jáuregui, 2015).

Anorexia Nervosa

Mental behavioral disorder is the desire for thinness and the fear of gaining weight. This disorder is life-threatening because people avoid eating, restricting their food almost entirely, and resulting in excessive weight loss. People have an intense fear of gaining weight; they see themselves as overweight when they are actually very thin, and this is what drives them to extreme measures to achieve that "perfection." (Ibarzábal Ávila et al., 2015).

Anorexia is divided into two types: restrictive anorexia and binge-purging. Restrictive anorexia: People severely restrict the amount and type of food they eat and engage in excessive exercise, as a way of controlling or losing weight. Binge-purging: People severely restrict the amount and type of food they eat. However, they binge eat, followed by purging behaviors such as vomiting or using laxatives to eliminate what they have eaten (Ibarzábal Ávila et al., 2015).

Diagnosing it can be complicated, primarily due to denial and shame. This is why people with disorders should be referred to psychiatrists and psychologists to evaluate and diagnose the illness, with a special evaluation for people with eating disorders. In the following table, we can analyze the symptoms presented by a person with anorexia (Table 1). Risk factors are both physical and emotional, and it is very important to be aware of them and not normalize them (Ibarzábal Ávila et al., 2015).

Table 1. Behavior based on anorexia symptomatology.

Physical symptoms	Emotional symptoms	Behavior
A significant weight loss in a very fast way in just a few weeks	Intense fear of gaining weight (even if you're very thin or at an ideal weight)	Continue following restrictive, low-calorie diets, even when you are already very thin.
Abdominal pain	Excessive concern for self-appearance	Over-exercise
Fatigue and weakness	Feelings of guilt after eating	Use of laxatives, weight loss medications, vomiting
Brittle hair and nails	Anxiety and stress, due to lack of self-restraint	Wearing loose clothing to avoid showing your body
Loss of muscle mass	Depression	Avoid certain unhealthy foods
Amenorrhea (in women)	Obsession for food, kcal	Eating alone, avoiding company at mealtimes to avoid feeling judged or avoiding foods
Osteoporosis	Obsession with weight	Restriction of food groups, such as carbohydrates, fats and proteins
Dry skin	Social isolation	Count calories, look at product labels

Source: Lerro, 2024.

Treatment for anorexia nervosa should be individualized according to the patient's needs and clinical situation. The main goal is to return the patient to a healthy weight, while also addressing emotional issues and behavioral issues in order to break the pattern. This is done with the help of a specialized team such as (Ibarzábal Ávila et al., 2015):

- Psychotherapy: Helps change the thinking and behavior of a person with eating disorders.
- Doctors: The prescribed medicine helps treat anxiety and depression.
- Nutritionist: Restores and teaches the importance of a balanced and healthy diet.
- Hospitalization in case of very severe weight loss.

Bulimia Nervosa

Bulimia nervosa is an eating disorder characterized by compulsive episodes of uncontrolled, excessive food intake in very short periods of time. This is

associated with excessive concern about controlling body weight, followed by feelings of guilt and attempts to remedy the problem with self-induced behaviors such as vomiting, excessive exercise, and fasting (Rava & Silver, 2004). It is diagnosed when an affected person presents the following aspects (Attia & Walsh, 2022):

Reports having binge-eated at least once a week for at least three months and feels a loss of control during and after the binges. Compensates for binges by purging (e.g., inducing vomiting or using laxatives), fasting, or exercising excessively. Expresses marked concern about weight gain and bases her self-image largely on her weight and body shape.

Table 2. Physical and emotional effect from behavioral behavior due to bulimia nervosa.

Physical symptoms	**Emotional symptoms**	**Behavior**
Weight loss	Anxiety	Uncontrolled eating
Dental issues	Low self-esteem	Use of laxatives, vomiting
Reflux, indigestion, bloating	Depression, mood swings	Excessive exercise to compensate for overeating
Irregular menstruation (women)	Feelings of guilt	Wear loose clothing
Weakness, fatigue	Obsessive thoughts about food	Use the bathroom frequently after meals
Fainting, dizziness.	Intense fear of gaining weight	Avoid eating in front of other people.
Malnutrition	Insecurity	Food restriction

Source: Sandhya Pruthi, 2024.

Treatment includes proven therapies and medications that can help you get better.

Treatment typically involves a team effort that includes you, your family, your primary care provider, a mental health professional, and sometimes a dietitian who is knowledgeable about eating disorders.

Studies show that these types of talk therapy can reduce symptoms of bulimia nerviosa. (Sandhya Pruthi, 2024):

- Enhanced cognitive behavioral therapy
- Family-based treatment

- Dialectical behavior therapy

The binge-eating disorder is the most common disorder in obese people. This has rapidly increased its prevalence compared to the general population. (Cuadro & Baile I., 2015).

It is diagnosed with the following aspects (Attia & Walsh, Binge-eating disorder, 2022):

- Eating much faster than normal
- Eating until uncomfortably full
- Eating large amounts of food when there is no feeling of physical hunger
- Eating alone because you are embarrassed
- Feeling upset, depressed, or guilty after overeating

Table 3. Emotional aspects derived from bulimia nervosa symptoms.

Physical symptoms	**Emotional symptoms**	**Behavior**
Weight gain	Feeling of guilt and shame	Recurrent binges
Abdominal pain, diarrhea	Low self-esteem	Loss of control over eating
Obesity, diabetes	Anxiety and stress	Eating until uncomfortably full
Fatigue, weakness	Depression	Eating alone
Dental problems	Social isolation	Eating quickly

Source: Ragnhildstveit et al. (2024).

Treatment includes therapies such as (Attia & Walsh, Binge-eating disorder, 2022):

- Cognitive-behavioral therapy
- Sometimes, interpersonal psychotherapy
- Consideration of pharmacological treatment, generally with SSRIs or lisdexamfetamine

Conclusion

Eating disorders represent a public health problem, the repercussions of which go beyond the psychological level and directly impact the nutritional and physical status of those who suffer from them. It is essential to recognize that these disorders generate significant imbalances in nutrition, metabolism, and body function, seriously compromising overall health. Adolescence is a vulnerable stage for the development of eating disorders, as it coincides with significant physical, emotional, and social changes. Individual factors such as low self-esteem, perfectionism, and body dissatisfaction are common triggers. Likewise, early detection is necessary to identify warning signs, such as excessive dietary restrictions, compensatory behaviors (vomiting, laxative use, prolonged fasting), fear of gaining weight, weight fluctuations, among others.

The role of the social environment is crucial, as unrealistic expectations about physical appearance and "idealized" eating behaviors reinforce problematic behaviors related to food. This becomes even more acute in adolescence, where the search for belonging, acceptance, and external validation can lead young people to adopt extreme behaviors as a form of control. The consequences not only affect physical health but are also linked to psychological disorders such as anxiety, depression, and social isolation.

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Prevalencia de los trastornos alimentarios: Anorexia y trastornos por atracón

Prevalência de transtornos alimentares: Anorexia e transtornos da compulsão alimentar

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Resumen

Los trastornos de la conducta alimentaria son problemas complejos que afectan tanto a la salud física como mental de quienes los padecen. Estos trastornos pueden estar relacionados con dificultades en la gestión de las emociones y requieren un tratamiento integral para una recuperación satisfactoria. Los adolescentes suelen tener dificultades con la regulación emocional, lo que empeora los síntomas y afecta a su salud mental. Las emociones intensas como la ansiedad, la tristeza o la frustración pueden conducir a conductas alimentarias problemáticas como mecanismo de afrontamiento. Además, los individuos con un trastorno alimentario tienden a rumiar las emociones y a evitar las experiencias emocionales, lo que contribuye a la persistencia del trastorno. Las terapias centradas en la regulación emocional han mostrado resultados prometedores en el tratamiento de los trastornos alimentarios.
Palabras clave
Nutrición, salud mental, trastornos alimentarios, adolescentes, autoestima.

Resumo

Os transtornos alimentares são questões complexas que afetam tanto a saúde física quanto a mental de quem sofre com eles. Esses transtornos podem estar ligados a dificuldades no controle das emoções e exigem tratamento abrangente para uma recuperação bem-sucedida. Os adolescentes geralmente lutam com a regulação emocional, piorando os sintomas e afetando sua saúde mental. Emoções intensas como ansiedade, tristeza ou frustração podem levar a comportamentos alimentares

problemáticos como mecanismo de enfrentamento. Além disso, os indivíduos com transtorno alimentar tendem a ruminar as emoções e a evitar experiências emocionais, o que contribui para a persistência do transtorno. As terapias com foco na regulação emocional têm mostrado resultados promissores no tratamento de transtornos alimentares.

Palavras-chave
Nutrição, Saúde Mental, Transtornos Alimentares, Adolescentes, Autoestima.

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