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CHAPTER I

Some Studies Conducted in 2024 on The Use of Folic Acid/Folate During Pregnancy

Fatma KAYIKCI

Introduction

Folic acid is of vital importance in supporting the health and development of the baby during pregnancy (Cai et al., 2024; Jena, Masih & Dash, 2024; Yoshikawa & Suemaru, 2024). By meeting the increased folate requirement during pregnancy and lactation, maternal physiological changes are supported and, optimal growth and development of the fetus is also ensured (Akwaa Harrison et al., 2024). Folate, also known as vitamin B9, is naturally found in foods. The synthetic form of vitamin B9, folic acid, has higher bioavailability and is found in vitamin supplements, fortified foods and medicines (Samaniego-Vaesken et al., 2024; Tola, 2024; Xu et al., 2024). The chemical form of folic acid is pteroylglutamic acid. Folic acid is part of the folate group. Folic acid is the fully oxidized and water-soluble monoglutamic form of vitamin B9. The metabolism of folate, which is required in periconceptional nutrition, is quite complex. It is associated with many metabolic pathways for cell protection and survival. The active form of folate is tetrahydrofolate, which plays important roles in homocysteine degradation, DNA synthesis, repair, and methylation. It acts as a coenzyme in the synthesis of purines, pyrimidines, and amino acids by facilitating the transfer of methyl groups among molecules. These functions of folic acid reveal its importance in reproductive health (Akwaa Harrison et al., 2024; Ren et al., 2024; Samaniego-Vaesken et al., 2024; Tola, 2024; Xu et al., 2024; Vegrim, 2024). Adequate maternal folate supplementation promotes cell proliferation (Xu et al., 2024).

It is essential to maintain normal serum folate levels during pregnancy, and deficiencies or excesses in these levels may cause various pregnancy complications. It has been reported that folate deficiency during pregnancy increases the incidence of adverse effects such as neurodevelopmental anomalies, food allergies, and ophthalmic deficiencies (Tate et al., 2024). Due to the critical effects of folic acid, a synthetic derivative of folate, on fetal development and rapidly proliferating tissues such as trophoblastic tissue, it is recommended that women of childbearing age take at least 400 μg daily before pregnancy and during the first trimester of pregnancy (Ledet et al., 2024; Özdemir et al., 2024; Ren et al., 2024; Sulistyoningrum et al., 2024; Tate et al., 2024; Tola, 2024). The World Health Organization recommends folic acid supplementation during pregnancy as a preventive measure in order to reduce the risks of fetal complications such as neural tube defects and congenital abnormalities. But, compliance with this is not fully achieved (Ahmar et al., 2024). It is reported that folic acid taken during the periconceptional period reduces/prevents the risk of congenital anomalies, especially neural tube defects (Adhikari et al., 2024; Moges et al., 2024; Paduch-Jakubczyk & Dubińska, 2024). Most birth anomalies occur in the central nervous system. Neural tube defects, which are formed during embryonic development depending on genetic and environmental factors, are classified according to their anatomical location and severity of the defect. Spina bifida, one of the neural tube defects, is a malformation characterized by an opening in the vertebral arch. Although it is stated in the literature that maternal folic acid intake prevents neural tube defects, it is stated that approximately 300,000 cases occur every year and 88,000 of them result in death (Ledet et al., 2024).

Literature Information

When examples from some studies on the effects of folic acid/folate were examined, the following information was obtained.

Zhang et al. (2024) reported that prenatal folic acid intake reduces neural tube defects. Moreover, they concluded that folic acid supplementation, dietary folate intake, and overall folate intake were not associated with sex ratio at birth, but they were positively associated with infant birth weights.

Akwaa Harrison et al. (2024) said that the risk of congenital anomalies during the periconceptional period was reduced. Although the high awareness of women taking folic acid supplements during pregnancy and lactation, low rates of consumption of folate-containing foods and use of folic acid supplements were observed.

Adhikari et al. (2024) stated that the effect of periconceptional folic acid supplementation on reducing the incidence of neural tube abnormalities is known. However, they stated that Nepalese women are mostly unaware of this situation. They emphasized that public awareness should be created in Nepalese society to increase information and intake about folic acid in order to reduce the prevalence of birth abnormalities.

Moges et al. (2024) reported that periconceptional folic acid intake by mothers reduced the risk of congenital anomalies in children by 77% rate.

Samaniego-Vaesken et al. (2024) declared that clinical studies might be conducted regarding the use of 5-methyltetrahydrofolate as a supplement, its dosage, timing and safety as an alternative to folic acid, which is known to have an effective role in preventing neural tube defects.

Tate et al. (2024) stated that they support the use of 5-methyltetrahydrofolate instead of prenatal folic acid supplementation due to its increased bioavailability, resistance to genetic polymorphisms and to avoid different potential risks associated with folic acid supplements.

Schmidt et al. (2024) reported that prenatal folic acid intake is associated with autism spectrum disorder and developmental delays.

He et al. (2024) investigated the effects of folic acid intake, multiple genetic polymorphisms in folate metabolism, and environmental factors on erythrocyte folate levels in subjects preparing for pregnancy and explained that they were partially effective.

Lev et al. (2024) declared that the relationship between vitamin B12 and folic acid, which is associated with maternal and fetal health outcomes in pregnant women with celiac disease, should be investigated.

Santos-Calderon et al. (2024) reported that only 36.1% of participants took folic acid before pregnancy in the absence of mandatory folic acid supplementation. They stated that factors determining the status of erythrocyte folate levels were planned pregnancy, folic acid supplementation, plasma cobalamin and methylenetetrahydrofolate 677C>T genotype.

Cochrane et al. (2024a) showed that (6S)-5-methyltetrahydrofolic acid supplementation was as effective as folic acid in maintaining maternal folate status in pregnant women in Canada while (6S)-5-methyltetrahydrofolic acid supplementation reduced unmetabolized folic acid in maternal plasma by 50%.

Cochrane et al. (2024b) reported that folic acid and (6S)-5-methyltetrahydrofolic acid supplements resulted in different folate forms in breast milk and, these supplements did not cause any difference in breast milk oligosaccharide concentrations.

Sulistyoningrum et al. (2024) said that the removal of folic acid from prenatal micronutrient supplements of pregnant women at 12-16 weeks of gestation resulted in decreased maternal serum unmetabolized folic acid concentrations at 36 weeks of gestation in their study conducted in South Australia

Pattisapu et al. (2024) stated that neural tube defects such as spina bifida and anencephaly are highly prevalent in India, and that folic acid is effective in reducing these complications. In the study, non-pregnant and non-breastfeeding women declared that iodized salt fortified with folate was acceptable in terms of color and taste, and that this salt increased their serum folate concentrations.

Peng et al. (2024) reported that periconceptional folic acid supplementation in pregnant women with epilepsy may improve neurobehavioral outcomes while increasing the risk of major congenital malformations.

Kolmaga et al. (2024) explained that periconceptional folic acid deficiency and dietary supplementation before pregnancy had been associated with fetal congenital heart defects. They reported that deficiency in preconception folic acid supplementation increased the risk of congenital heart defects by 4-fold while supplementation after the 8th week of pregnancy increased this risk by almost 3-fold.

Özdemir et al. (2024) stated that taking folic acid before pregnancy has positive effects on the continuation of pregnancy and folate deficiency may cause implantation disorders. They observed that mRNA levels of Estrogen Receptor Alpha, Vascular Endothelial Growth Factor-A and Integrin alpha V and beta3 increased significantly in the high-dose folic acid group while they found that they decreased significantly in the folate deficiency group compared to the control group.

Ledet et al. (2024) reported that folic acid may be an important factor in reducing the incidence of spina bifida by providing awareness and knowledge in the prevention of spina bifida worldwide.

Tukeman et al. (2024) declared that the risk of fetal neural tube defects increased nine-fold in pregnant women treated with dolutegravir. They found that low folate status increased the risk of neural tube defects such as exencephaly in pregnant mice that fed low folic acid diets and treated with dolutegravir. Cleft palates occurred in both folate conditions.

Alampi et al. (2024a) observed that folic acid supplementation might modify the associations between gestational lead exposure and autism or autistic-like behaviors and attenuated the neurotoxic effects of prenatal lead exposure.

Morales et al. (2024) reported that folic acid intake above the tolerable upper intake level of 1000 μg/day by mothers from pre-pregnancy to the first trimester of pregnancy reduced the overall DNA methylation levels of babies.

Wiedeman et al. (2024) stated that pregnant women at risk of miscarriage were consuming more than the recommended daily 400 μg of additional folic acid and that they were concerned that other foods would not meet this recommended dose. The study reported that 45.3% of these women had a daily additional folic acid intake of more than 1000 μg.

Abate et al. (2024) emphasized the need to include folic acid and multivitamin supplements in pre-pregnancy neural tube defect prevention strategies, as these supplements lead to a decrease in neural tube defects in children.

Xu et al. (2024) suggested that excessive maternal folate supplementation may have potential adverse effects on offspring, such as changes in gene expression and behavior.

An et al. (2024) reported that pre-pregnancy folic acid supplementation in older pregnant women is associated with the risk of large babies.

Tola (2024) low blood folic acid levels cause neural tube defects because they prevent DNA replication and its repair, RNA synthesis, histone and DNA methylation, methionine production, and homocysteine remethylation reactions. They recommend that 400 µg/day of folic acid might be taken before conception and in the first trimester of pregnancy to prevent these defects.

Ren et al. (2024) examined the relationship between folic acid use and placental development. And, they found that periconceptional folic acid intake in early/mid pregnancy may increase placental width, area, and thickness.

Mirabal-Beltran et al. (2024) stated that neural tube defects are more common in babies born to Hispanic women in the USA. They said that women's awareness of folic acid supplementation, their preferences for receiving health information, and the role of religiosity in making decisions about neural tube defect diagnosis are effective.

Khan et al. (2024) reported that there is a lack of awareness about preventable pregnancy-related diseases and their consequences in Pakistan. They found that only 38% women use folic acid during the periconceptional period. This result shows that there is a significant lack of knowledge about folic acid, especially in the illiterate group.

Zhao et al. (2024) emphasized that Vit B12, homocysteine, erythrocyte folate and folic acid metabolic gene polymorphisms are closely associated with adverse pregnancy outcomes.

Qu et al. (2024) examined the relationship between maternal serum folate levels in early and mid-pregnancy and the risk of congenital heart disease in infants. As a result of the study, they stated that low and high maternal serum folate levels increase the risk of congenital heart disease.

Alampi et al. (2024b) reported that there is an inconsistent relationship between gestational environmental chemical mixtures such as metals, persistent organic pollutants and childhood autistic behaviors and, some relationships may be stronger with high or low gestational folic acid supplementation.

Jacobson et al. (2024) demonstrated that there was no problem in the cellular uptake of folate and the transport of folate to the baby in pregnant women who received dolutegravir or efavirenz treatment during pregnancy and their newborns with no clinical difference in erythrocyte folate levels.

Finnell & Zhu (2024) pointed out that further studies should be conducted to reveal the mechanisms of how periconceptional maternal folate supplementation protects the formation of various congenital malformations such as neural tube defects, congenital heart defects, oral clefts, congenital kidney and urinary tract anomalies.

Paduch-Jakubczyk & Dubińska (2024) stated that folate is of vital importance for the healthy maintenance of brain functions, erythrocyte production together with vitamin B12, and the functioning of iron in the body. They also declared that individuals with the methylenetetrahydrofolate reductase (MTHFR) gene mutation, which can disrupt the conversion of 5-methyltetrahydrofolate, the active form of folic acid, may benefit more from direct 5-methyltetrahydrofolate supplementation instead of folic acid for better absorption and lower cardiovascular risks.

Yoshikawa & Suemaru (2024) reported that prenatal folic acid deficiency leads to a decrease in synaptic protein levels in the frontal cortex and hippocampal area of the brain, and behavioral disorders such as sociality, spatial memory, and novel object recognition.

Hopperton et al. (2024) observed that folate and its derivatives showed more change than minerals in their study defining the concentrations of nutrients in breast milk composition in Canada.

Ramijinni et al. (2024) stated that changes in maternal erythrocyte folate and serum vitamin B12 ratios are associated with negative growth and development in the newborn. They declared that maternal erythrocyte folate and serum homocysteine levels decreased in groups with vitamin B12 and folate imbalance.

Wang et al. (2024) reported that mice given high doses of folic acid during pregnancy experienced developmental delays such as earlobe separation, fur appearance, and incisor tooth eruption, and that their proximity to anxiety and depression-like neurobehavioral behaviors increased. They stated that this may be due to the induction of mild inflammation in the brain.

Aranlı et al. (2024) examined the relationship between folic acid levels and preeclampsia in pregnant women in the second and third trimesters. As a result of the study, they stated that folic acid supplementation increased folate and hemoglobin levels, and that folic acid may play a role in the pathogenesis of preeclampsia.

Zheng et al. (2024) reported that different folic metabolites for example high unmetabolized folic acid and homocysteine levels in the 6-17th weeks of pregnancy and high erythrocyte and plasma 5-methyltetrahydrofolate and 5,10-methylenetetrahydrofolate levels at 20-26th weeks of pregnancy were associated with the development of gestational diabetes.

Vegrim (2024) stated that higher folic acid (>1 mg) is recommended for pregnant women using antiepileptic drugs to protect fetal development. However, experimental studies have shown that high-dose folic acid exposure is associated with an increased risk of cancer in mothers and children.

Wantong et al. (2024) investigated the relationship between folic acid and hypertensive disorders in pregnancy. In this study, it was reported that periconceptional folic acid intake reduces the risk of hypertensive disorders in pregnancy, especially gestational diabetes.

Cai et al. (2024) revealed that excessive folic acid supplementation harmed heart function due to a decrease in left ventricular ejection fraction in the offspring of pregnant mice.

Jiang et al. (2024) researched the relationship between maternal folic acid supplementation during pregnancy/prenatal periods and the risk of autism spectrum disorder in children. They found that folic acid intake during these periods significantly increased the risk of having a child with autism spectrum disorder compared to mothers who did not take folic acid. The most critical period for intervention is considered to be prenatal.

Cui et al. (2024) examined the relationship between folic acid supplementation during pregnancy and the risk of preeclampsia. However, they concluded that folic acid alone may not be effective in reducing the risk of preeclampsia. The researchers state that higher quality studies are needed.

Chen et al. (2024) suggested that although it is well known that folic acid prevents neural tube defects, neural tube defects develop in some people despite folic acid supplementation. And, they declared that the underlying mechanism was due to epigenetic irregularity.

Dey et al. (2024) reported that folic acid insufficiency during pregnancy is associated with the risk of pregnancy complications such as anemia, miscarriage, preterm birth, and fetal growth restriction.

Song et al. (2024) investigated the effects of different folic acid supplements on pregnancy and concluded that 5-methyltetrahydrofolate reduced serum homocysteine levels. Moreover, they found a lower incidence of adverse pregnancy outcomes compared to synthetic folic acid.

Hung et al. (2024) reported that maternal folic acid supplementation during pregnancy reduces the risk of obesity and overweight in children of parents who never breastfed and have low levels of education.

Feng et al. (2024) examined the relationship between prenatal folic acid supplementation and the onset of postpartum depression. Ultimately, they concluded that folic acid intake was insufficient to alleviate the onset of postpartum depression.

Conclusion

The changes that occur in the mother and fetus during pregnancy cause the metabolism to accelerate, the need for energy and nutrients to increase. In order to protect maternal health and prevent fetal congenital anomalies, the increased nutrient needs must be met in the recommended amounts during pregnancy. If maternal needs are not met, many unwanted complications may occur in the mother and/or the baby. Intake of folic acid is as important as other nutrients in preventing pregnancy complications. Studies have reported that folic acid supplementation taken in the recommended amounts periconceptionally and during pregnancy gives positive results in preventing neural tube defects, congenital anomalies, neurobehavioral disorders, postpartum depression and diseases such as autism spectrum disorder. However, excessive intake of folic acid may lead to the emergence of various disorders as well as insufficiency. It is observed that women have insufficient information about folic acid supplementation despite their awareness. For this purpose, researchers recommend that health education programs should be organized to increase folic acid knowledge and intake for women of childbearing age, especially in countries with poor sociodemographic characteristics, and thus public awareness should be increased. In addition, more studies are needed to understand the protective effect of folic acid in preventing adverse pregnancy outcomes and take to minimize risks. It is necessary to determine the optimal dose, duration and timing of folic acid and multivitamin supplements that mothers should take.

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CHAPTER II

Evaluation of Sustainable Nutrition Knowledge Level and Adherence to the Mediterranean Diet in Adults

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1.Sustainability

The concept of sustainability is defined as the ability to continue, endure, and preserve existence for the future. It was first defined in 1987 in the report "Our Common Future" by the World Commission on Environment and Development (WCED). The report states, "Humanity has the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).

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The rapid increase in global population and urbanization, among other factors, has led to a rise in individual needs. In contrast, the limited nature of the world's resources and their continued depletion has made the term sustainability increasingly important. The rapid depletion of natural resources and the growing environmental pollution have led many countries to seek solutions and establish various environmental regulations (Wu et al., 2022).

As a result of these efforts, the Sustainable Development Goals (SDGs), known as global goals, were adopted in 2015 by 193 United Nations (UN) member states. These goals aim to eliminate poverty, protect the planet, and ensure peace and prosperity for all by 2030. A total of 17 sustainable development goals (Figure 2.1) were integrated into this framework. The awareness that actions in one area can affect outcomes in other areas and that development must be addressed in a holistic manner, considering social, economic, and environmental sustainability, is also a key part of these goals (Bianchi et al., 2022).

Sustainable Production and Consumption

The rapid growth of the global population brings about environmental and nutritional issues (Muslu, 2020). There are many harmful factors to the environment at various stages, from food production to consumption. As the population continues to grow, it indicates that this crisis will deepen in the future (Willett et al., 2019). Research shows that in the last 50 years, average consumption per capita has tripled, and human consumption has exceeded the natural self-renewal capacity of nature by 30%, signaling that the food supply chains of the past can no longer effectively meet the demand (Staniškis, 2012). One consequence of this rapid consumption is the increased need for production (Govindan, 2018). As a result of all these factors, the increasing production and consumption directly or indirectly have many environmental impacts, such as the rise of CO_2 levels, the reduction of biodiversity, global warming, and the rapid depletion of natural resources (Chun and Bidanda, 2013).

Sustainable production is the concept of carrying out production activities by considering the consumption of natural resources, conserving energy, and minimizing environmental harm. Sustainable production also includes the collection of used products, processing them, and then reintroducing them to the market (Amrina and Vilsi, 2015). The United Nations Environment Programme (UNEP) has stated that in order to achieve sustainability goals, it is necessary to transition to an environmentally sensitive, resource-efficient, and economically and securely produced system (UNEP, 2011).

The Norwegian Ministry of the Environment defines sustainable consumption as: "While meeting basic needs and providing a better quality of life, it aims to minimize the use of natural resources, toxic substances, waste emissions, and environmental pollutants, with consideration for the needs of future generations" (Seyfang, 2004). Proposed solutions for sustainable consumption focus on changing consumption behavior and reducing consumption levels (Schaefer and Crane, 2005). However, UNEP has stated that reducing consumption levels is not a mandatory solution for achieving sustainable consumption goals; rather, it emphasizes the need to change individual consumption behaviors (UNEP, 2015). In conclusion, achieving sustainability goals can be realized by ensuring that the production and consumption process functions as a whole and progresses according to the decisions made (Amrina and Vilsi, 2015).

3. Sustainable Nutrition

Sustainable nutrition is defined as being protective, respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable, nutritionally adequate, safe, and healthy. It also optimizes the use of natural and human resources (Food and Agriculture Organization of the United Nations, 2012). The goal of sustainable nutrition is to ensure the continuation of normal growth and development for all individuals, maintain physical, mental, and social well-being throughout life, prevent all forms of malnutrition (including undernutrition, micronutrient deficiencies, and obesity), reduce the risk of non-communicable diseases, prevent poverty, protect biodiversity, and contribute to the preservation of the planet for future generations (Pekcan, 2019). All these definitions and goals demonstrate that human health and the ecosystem are inseparable and interconnected (Smetana et al., 2019).

Nutrition is primarily concerned with food groups, their effects on health, and issues such as nutrient deficiencies. In recent years, however, diets have focused on both human health and the environment as well as food production systems (Alsaffar, 2016). Food systems have the potential to protect health and support the sustainability of the environment. However, with the increasing global population, food systems are sometimes hindered, and urgent measures must be taken to ensure healthy and accessible nutrition from sustainable food systems (Willett et al., 2019).

Studies show that more than a third of the food produced globally is wasted. Food waste in the system not only increases the demand for food production but also increases the environmental damage by 15% compared to situations without food waste. Every food produced unsustainably, without considering sustainability, is a major risk for both the world and humanity, which is why it is considered a global issue (Palmisano et al., 2021).

Although nearly enough food is produced globally to feed almost 13 billion people, it remains a fact that there are still people suffering from chronic hunger. According to the FAO's State of Food Security and Nutrition Report, about 690 million people (8.9% of the global population) were undernourished in 2019. This figure shows that 60 million more people have been affected by hunger since 2014. Additionally, the COVID-19 pandemic in 2020 is estimated to have added between 83 and 132 million more people to the list of those experiencing undernutrition compared to 2019 (FAO, 2020). Without the management of natural resource use and the promotion of sustainable production methods, people in many parts of the world will continue to face food security and nutrition risks (Chen et al., 2020).

4 The Environmental Impacts of Nutrition

4.1. Climate Change and Greenhouse Gases

In addition to the increasing use of fossil fuels and rapid population growth, factors such as deforestation and the reckless use of natural resources contribute to the emission of greenhouse gases, which disrupt the natural balance of the atmosphere and have a negative impact on global climate (Kayıkçıoğlu & Okur, 2012). Greenhouse gases are gases that trap and insulate heat in the atmosphere. Greenhouse gas emissions resulting from human activities are considered the main cause of climate change. The

United Nations Framework Convention on Climate Change (UNFCCC) called for actions to prevent interventions to maintain atmospheric greenhouse gas levels at a certain level in 1992, and in 1997, developed countries first accepted this in Kyoto (Berners et al., 2012). After the expiration of the Kyoto Protocol, the Paris Agreement was adopted in 2015 under the UNFCCC framework to establish the framework for the climate change regime for 2020 and beyond. The agreement, which includes many countries, aims to limit the global average surface temperature rise to 2 degrees Celsius and, if possible, to keep it below 1.5 degrees (Christoff, 2016). However, the 2021 Intergovernmental Panel on Climate Change (IPCC) assessment report examined environmental issues, greenhouse gases, and climate change and revealed that countries have been insufficient in taking the necessary measures. According to the report, the global surface temperature has increased more rapidly since 1970 compared to other 50-60 year periods in the past 2000 years. The same report also states that in 2019, carbon dioxide (CO_2) levels in the atmosphere increased by 47% and methane (CH_4) levels by 156% (Türkeş, 2022). According to the IPCC report, the main cause of these temperature increases leading to climate change is human-induced factors (Demirbaş & Aydin, 2020).

4.2. Greenhouse Gas Impacts of Foods

It has been better understood in recent years that nutrition is an inseparable whole with the environment and human health (Tilman & Clark, 2014). The functioning of food systems can be affected by environmental changes in terms of food security, efficiency, and quality, and one of the most important contributing factors to environmental changes is the processes and outputs of food systems (Allen & Prosperi, 2016). There is interaction with the environment at many stages of food production systems, such as production, storage, transport, distribution, and waste (Roy et al., 2009). Food production systems are responsible for a significant portion of greenhouse gas emissions (20-33%) and are also a major factor in biodiversity loss (Mertens et al., 2020). With the growing concern for sustainable food production and consumption, the impact of food systems, including agricultural products, on climate change is being evaluated in relation to greenhouse gas emissions (GHG) by considering all processes such as production, distribution, and storage. This evaluation is made possible through Life Cycle Assessment (LCA) studies, which are based on ISO 14040 standards. Life Cycle Assessment is a method that calculates the environmental impact that occurs in all stages of a product, including raw material procurement, production, distribution, reliability, and even consumption (Weidema & Stylianou, 2020).

In reducing greenhouse gas emissions, it is necessary not only to improve food production systems but also to change individual lifestyles and food choices (Boehm et al., 2019). Research indicates that to ensure sustainability in diets, nutritional patterns should be evaluated not only for health effects but also considering their environmental impact (Kramer et al., 2017). In a study on food choices, it was found that as individuals' economic status increases, the consumption of meat, dairy, fats, salt, and processed foods also increases. Particularly in high-income countries, the high consumption of animal-based foods and the resulting increase in their production contribute to higher GHG emissions, leading to climate change (Keats & Wiggins, 2019).

It is known that animal-based foods have a higher environmental impact, which is why sustainable diet models limit animal products

(Horgan et al., 2016). The production of animal-based foods is one of the most harmful processes for the environment due to the use of natural resources, negative impacts on biodiversity, increased GHG emissions, and many other environmental burdens. Greenhouse gas emissions are the main cause of climate change, and research shows that 15.5% of GHGs come from livestock farming. Animal-based foods, such as meat and dairy products, contribute more to GHG emissions than plant-based foods (Jallinoja et al., 2016). Consumption of plant-based foods generates less GHG than animal-based diets, which is why plant-based nutrition is thought to have positive effects both on health and the environment (Yüksel & Özkul, 2021). According to a study, replacing the current dietary model with a vegetarian diet pattern would reduce GHG emissions by 22% (Berners-Lee et al., 2012). A study conducted in Germany showed that replacing 5% of beef consumption in individual diets with pea protein would reduce CO_2 emissions by 8 million tons annually (Bryant, 2022). Western-style diets are rich in animal and processed foods, and such diets significantly contribute to GHG emissions. Studies examining the environmental impacts of Western diets show that if Western diet models are replaced with sustainable diets, GHG emissions could be reduced by 70% and water usage by 50% (Aleksandrowicz et al., 2016).

4.3 Components Impacting Greenhouse Gas Emissions in the Life Cycle of Foods

4.3.1. Transportation

With the increasing consumer demand for various food products, transportation has become a significant link in the food supply chain. The way food is transported is critical for food safety and often requires the use of high-energy-consuming refrigeration.

It has been reported that transportation accounts for approximately 19% of the total food supply chain emissions (Li et al., 2022).

4.3.2. Food Waste

Analyses that link nutrition quality with environmental sustainability often focus on a limited number of sustainability indicators, and there is limited research on where and how food is wasted within the food system. The term food waste refers to any portion of food that cannot be consumed due to spoilage, damage in the supply chain, cooking losses, and plate waste (Birney et al., 2017). Globally, it has been reported that enough food is wasted each year to feed approximately 2 billion people with a 2,100 kcal/day diet (Jessica, 2015). A study conducted with American consumers showed that, between 2007-2014, an average of 422 grams of food per person per day was wasted, and to reproduce this amount of wasted food, around 30 million acres of arable land were used annually. Of the wasted food, 39% consisted of vegetables and fruits, 17% dairy products, and 14% meat (Conrad et al., 2018).

4.3.3. Packaging

Food packaging is crucial for food safety and guarantees the quality of food throughout the supply chain. Both are achieved through the protective function of the packaging against harmful environmental effects such as mechanical damage, light, or water vapor. The materials, weight, and design of packaging differ, which also affects the environmental impact of packaging. Although the use of materials such as plastic and paper in food packaging can have negative ecological consequences, packaging also has positive effects, such as reducing food waste and extending shelf life (Cruz et al., 2023). In recent years, increasing environmental awareness and the need to protect the environment have influenced consumers' choices towards eco-friendly packaging. As a result, the packaging industry has been working on new products that focus not only on the primary functions of packaging but also on sustainable environments, food conservation, and waste reduction (Otto et al., 2021). Sustainable food packaging has many advantages, including the use of recyclable materials, reduction of natural resource consumption (especially water), reduction of storage waste, prevention of air pollution, greenhouse gas emission reduction, and safeguarding human health (Jang et al., 2020). In a sustainability study called "Snap Pack," plastic packaging was reduced by using biodegradable adhesives, saving over 1,200 tons of global plastic waste annually, and reducing global plastic use by 75% (Licciardello and Piergiovanni, 2020).

2.4.4. Water Footprint of Foods

The water footprint is defined as the total volume of water used, consumed, processed, or polluted during the production process of a product. A study conducted by Twente University of the Netherlands and the Water Footprint Network reported that the water footprint calculations encompass all processes from raw material processing to direct operations and the consumer’s use of the product (Zhang et al., 2019). Around one-third of the total global water footprint is related to the production of animal-based products. The water footprint of any animal product is greater than that of plant-based products with equivalent nutritional value (Gibin et al., 2022). The water footprint associated with food production and consumption has increased by an average of 31% over the last decade (Souissi et al., 2019). According to a study examining the water footprint of food groups, the average water footprint of beef is

20 times greater than that of grains and plants, and the water footprint per gram of protein is 1.6 times higher in animal products like milk, eggs, and chicken than in legumes (Mekonnen and Hoekstra, 2011). A study conducted in Belgium found that the water footprint of 1 liter of soy milk is approximately 300 liters, while the water footprint of 1 liter of cow's milk is more than 900 liters (Ercin et al., 2011). Due to the rapid increase in the world's population, food production and consumption have also increased, particularly in developing countries where diets include more animal-based products, contributing significantly to the global water footprint (Drewnowski and Poulain, 2018). A study analyzing the impact of food production and consumption processes revealed that reducing the water footprint initially started with reducing water usage at home. However, more recent research indicates that household water use only accounts for 4% of the total water footprint, while the production of animal-based products accounts for approximately 27%. The research suggests that to reduce the global water footprint, dietary habits must be reconsidered and improved (Hoekstra, 2012).

2.4.5. Food Waste and Losses

Improving nutrition quality, while also reducing environmental impact and achieving sustainable development goals, has become a critical focus worldwide. Although various studies have made strides in improving nutrition quality and environmental sustainability, food waste and losses within food systems have not been thoroughly addressed (Rockström et al., 2016). However, food waste and losses have become one of the most urgent and challenging issues humanity faces today (Al-Obadi et al., 2022). Within food systems, errors such as quality degradation during processing, damage during transportation, overproduction due to poor demand forecasting, improper storage, and failure to assess consumer habits and needs appropriately all contribute to increased food losses (Chen et al., 2020). According to the Food and Agriculture Organization (FAO), approximately one-third of the food produced for human consumption globally is lost or wasted. FAO has reported that food waste and losses account for 6.8% of global greenhouse gas emissions annually (FAO, 2015). It has been reported that globally, enough food is wasted each year to feed approximately 2 billion people with a 2,100 kcal/day diet. Additionally, research conducted between 2007 and 2014 in the U.S. revealed that each individual wasted an average of 422 grams of food per day (Conrad et al., 2018). Food waste is not only the waste of natural resources but also the waste of people's right to nutrition. Resources such as water, energy, land, and fertilizers, used in food production, are wasted along with food waste. This highlights the need for more conscious action in a world where resources are depleting and the demand for food is rapidly increasing (FAO, 2018).

2.5 Sustainable Nutrition and Health

Sustainable healthy eating models are dietary habits that support an individual's health and well-being in all aspects. Their goals are to help all people grow and develop in the best possible way, stay physically, mentally, and socially healthy and happy throughout life, prevent problems caused by undernutrition or overnutrition, and protect against nutrition-related diseases (Renzella, 2018).

A significant part of sustainable diet models consists of plant-based foods. The positive effects of proposed sustainable diets on health have been reported to stem from an increase in plant-based food consumption and a reduction in the consumption of red and processed meats (Atwoli et al., 2021). Studies have shown that as plant-based food consumption increases, there is a lower risk of diseases. This is because plant-based foods have higher contents of certain vitamins, minerals, and phytochemicals compared to animal products, and they also have a lower energy density. However, completely eliminating animal foods from the diet can cause significant health problems. Therefore, moderate consumption is crucial for public health (Sánchez et al., 2020).

2.6 Sustainable Nutrition Models

The Food and Agriculture Organization (FAO) defines sustainable diets as "those that contribute to food and nutrition security, healthy living for present and future generations, with low environmental impacts. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair, and affordable; nutritionally adequate, safe, and healthy; and optimize natural and human resources" (FAO, 2010). According to a study conducted in the Netherlands, in terms of health score comparison, the Mediterranean diet had a higher score than all other diets, and in terms of sustainability, the semi-vegetarian diet, traditional vegetarian diet, vegan diet, and Mediterranean diet all scored within the ideal range, with the vegan diet achieving the highest sustainability score (Dooren, 2021).

2.6.1. Mediterranean Diet

An ideal sustainable food system is one that is protective of biodiversity and ecosystems, culturally acceptable, accessible to all, economically fair and affordable, nutritionally adequate, safe, and healthy. As interest in the transition to sustainable food systems and

diets has grown, attention has also been drawn to the Mediterranean diet, which has proven health benefits (Sánchez et al., 2020). The health benefits of the Mediterranean diet were discovered in the early 1960s, and subsequent studies have recommended following the Mediterranean diet to improve health, enhance well-being, and prevent diseases (Mentella, 2019).
The Mediterranean diet is rich in plant-based foods such as olive oil, grains, legumes, fruits, and vegetables but low in red and processed meats. It includes moderate amounts of fish, seafood, eggs, poultry, dairy products, and wine in measured quantities (Trajkovska, 2021). A plant-based dietary model, the Mediterranean diet was highlighted by Joan Dye Gussow as a sustainable diet model due to its reduced demand for water, land, and energy resources, its economic benefits, and its ability to reduce greenhouse gas emissions (Broekema, 2020). Research led to a consensus during the "Biodiversity and Sustainable Diets" symposium organized by FAO in 2010, where the Mediterranean diet model was recognized as an example of a sustainable diet (Dernini and Berry, 2015).

2.6.2. Double Pyramid Model

The Double Pyramid nutrition model, developed by the Italian Barilla Food and Nutrition Foundation in 2009, categorizes foods according to their health and environmental impacts. The Food Pyramid on the left side of the model is based on the principles of the Mediterranean diet, which FAO has clearly identified as an example of a sustainable diet. The pyramid on the right, the Environmental Pyramid, classifies foods based on their ecological footprint, creating a diagram of environmental impacts (Rosi et al., 2022). In constructing the Environmental Pyramid, ecological footprint was used as a reference, as it considers multiple environmental factors simultaneously. The Double Pyramid model suggests that foods recommended for more frequent consumption (such as vegetables, fruits, grains, etc.) are also those with lower environmental impacts, while foods recommended for less frequent consumption (such as red meat, saturated fats, etc.) have higher environmental impacts (Kadioglu, 2022). The Double Pyramid model is shown in Figure 2.1 (Ruini et al., 2015).

2.6.3. DASH Diet

The Dietary Approaches to Stop Hypertension (DASH) diet model was developed in the mid-1990s in response to the increasing prevalence of hypertension in the United States. Although this diet was initially designed to lower blood pressure, it has been reported to have positive effects on various disease risk factors and outcomes, including improvements in cholesterol levels and insulin sensitivity (Atabilen & Akdevelioğlu, 2021). The DASH diet recommends the consumption of whole grain products, vegetables and fruits, low-fat dairy, lean red meat, poultry, fish, as well as oily seeds and legumes, while limiting total fat, saturated fat, and cholesterol intake. This results in a diet rich in potassium, calcium, magnesium, fiber, and plant-based proteins, while refined carbohydrates and saturated fats are minimized (Theodoridis et al., 2023).

The DASH diet model, by reducing red meat consumption, total and saturated fat intake, and increasing the consumption of plant-based foods, has become a model that not only provides health benefits but also reduces the potential environmental harms of food production (Atwoli et al., 2021). When evaluating the environmental impact of dietary patterns, greenhouse gas emissions are most commonly assessed (Reinhardt et al., 2020). A study assessing the relationship between adherence to the DASH diet and greenhouse gas emissions found that increased adherence to the DASH diet was associated with 16% lower greenhouse gas emissions (Perignon et al., 2017). In a 2023 study conducted in the United States comparing the Western-style American diet and the DASH diet in terms of greenhouse gas emissions and land use, it was reported that the DASH diet is more environmentally sustainable (Kling et al., 2023).

2.6.4. New Nordic Diet

Also known as the Scandinavian Diet, the New Nordic Diet was developed to encourage the people of Nordic countries to consume more fresh, seasonal, and local foods, and it was modeled after the Mediterranean diet (Krznarić et al., 2021). The New Nordic Diet emphasizes the health benefits of nuts, cabbage, root vegetables, oats, and legumes, focusing on the consumption of fruits and vegetables grown in the Nordic regions (Mazzocchi et al., 2021). The New Nordic Diet and the Mediterranean Diet are similar in their recommendations to consume more vegetables and fruits, whole grain products, and fish; moderate consumption of low-fat dairy; limited intake of meat and sweets; and avoidance of processed foods. The main difference between the Mediterranean and Nordic diets is the use of rapeseed (canola) oil in the Nordic diet instead of olive oil (Sezgin et al., 2023). Research on the Nordic Diet mainly focuses on adult populations and has shown positive results regarding body weight, metabolic health, and cardiovascular diseases (Ramezani-Jolfaie et al., 2020). When evaluating the environmental impact of the New Nordic Diet, the diet's emphasis on locally sourced and organic foods aims to minimize the environmental impact from production to transportation. As a result, the New Nordic Diet is considered a sustainable dietary model (Mogensen et al., 2020).

2.6.5 Vegetarian and Vegan Diet Models

Vegetarianism is generally a dietary pattern that involves the consumption of plant-based foods instead of animal-derived foods (Paslakis et al., 2020). A vegetarian diet is one that excludes all types of animal meat (red meat, chicken, fish, and other seafood) but may include limited amounts of secondary animal products (eggs, milk, and dairy products) depending on preference. The vegan diet model, on the other hand, is a dietary pattern that excludes and does not use any animal products, including leather, wool, and silk (Brytek-Matera, 2020). According to the Canadian Dietetic Association, properly planned vegan and vegetarian diets are nutritionally adequate, suitable for individuals at all stages of the life cycle, and provide health benefits for disease prevention and treatment (Wang et al., 2023). Vegetarian and vegan diets have become increasingly popular in many countries not only for health reasons but also due to animal protection and ecological concerns. It has been shown that removing animal foods, especially meat and meat products, from the diet can reduce greenhouse gas emissions by as much as 80.0% (Forber et al., 2020). A study reported that the vegan diet model is the most environmentally suitable diet model because plant-based food production causes lower levels of greenhouse gas emissions compared to animal-based food production (Chai et al., 2019). The sustainability of vegan and vegetarian diets stems not only from their relatively low environmental impact but also from the fact that these diets are safe for consumption, healthy, provide adequate nutrition, and are culturally acceptable for most people (Modlinska et al., 2020).

2.7. The Mediterranean Diet as a Sustainable Nutrition Model

The United Nations Sustainable Development Goals agenda includes various points related to nutrition, including the eradication of hunger and all forms of malnutrition, ensuring good health and well-being for all, and promoting sustainable approaches with low environmental impact to protect global health (Grosso et al., 2020). In line with this goal, there has been increased awareness of sustainable food systems and diets, with the Mediterranean diet gaining attention as a sustainable dietary model. The Mediterranean Diet is defined as a sustainable dietary pattern, and adherence to it is recommended for improving health, preventing diseases, and protecting the ecosystem (Guasch-Ferré and Willett, 2021).

2.7.1. Foods in the Mediterranean Diet

First developed by Angel Keys, the Mediterranean diet's main characteristic is its diversity of foods, making it a rich dietary model. The Mediterranean Diet model includes large amounts of olive oil, olives, vegetables, fruits, grains, legumes, and nuts; moderate amounts of fish and dairy products; and small amounts of meat and meat products, with moderate wine consumption. The Mediterranean diet is characterized by high olive oil consumption and is low in saturated fats. The diet is rich in fiber, vitamins, minerals, antioxidant compounds, and bioactive elements with anti-inflammatory effects, and it has a low glycemic index (Trajkovska, 2021). For this reason, the Mediterranean diet is considered an example of adequate and balanced nutrition (Grosso et al., 2020).

2.7.2 The Relationship Between the Mediterranean Diet and Sustainable Nutrition

The traditional Mediterranean diet is defined as a dietary pattern that was practiced in the olive-growing regions of the Mediterranean during the early 1960s (Trichopoulou, 2021). Starting in the early 1990s, in response to growing concerns about environmental sustainability, the Mediterranean diet, a plant-based dietary pattern, began to be studied as a model for sustainable nutrition (Dernini et al., 2018). As a result of research, in 2010, at the FAO-organized symposium on "Biodiversity and Sustainable Diets," consensus was reached, and the Mediterranean diet model was recognized as an example of a sustainable diet (Berry, 2019). At a conference evaluating the benefits of the Mediterranean diet and its sustainability, it was emphasized that the sustainable Mediterranean diet contributes to sustainability through its health benefits, low environmental impact, economic feasibility, and alignment with socio-cultural values (Dernini et al., 2017). As a result, the Mediterranean diet model is recognized as supporting sustainable development and having positive effects on the ecosystem (Olgun et al., 2022).

2.7.2.1 Relationship Between the Mediterranean Diet and Health

The Mediterranean Diet is recommended as a model for improving health, promoting well-being, and preventing diseases, and is considered one of the healthiest dietary patterns worldwide (Ventriglio et al., 2020). The Mediterranean diet pattern is low in saturated fats and animal proteins but rich in antioxidants, fibers, and monounsaturated fats, and shows a sufficient balance of omega-6/omega-3 fatty acids. As a result, its health benefits are explained by the high intake of antioxidants, fibers, monounsaturated fats, omega-3 fatty acids, phytosterols, and probiotics (Schwingshackl et al., 2020).

Clinical studies have shown that the Mediterranean diet includes many protective factors against cardiovascular diseases, which are among the leading causes of death worldwide. According to one study, following a Mediterranean diet reduces the incidence of major cardiovascular events by approximately 30% (Ahmad et al., 2018).

Data from studies indicate that adherence to the traditional Mediterranean diet model is associated with a decreased risk of various types of cancer, including those of the upper digestive system, stomach, and colorectal cancer. Additionally, the Mediterranean diet, rich in fruits and vegetables, has been reported to significantly increase serum antioxidant capacity and prevent lipid peroxidation (Morze et al., 2021).

The Mediterranean diet, with its significant anti-inflammatory properties, is being researched as the best dietary model for reducing the development of type 2 diabetes by helping to reduce oxidative stress and insulin resistance (O'Connor et al., 2020). A meta-analysis of five randomized controlled trials found that the Mediterranean diet provided better glycemic control compared to control diets, including low-fat diets, in patients with type 2 diabetes and prediabetes (Jannasch et al., 2017).

2.7.2.2 Environmental Impact

Nutrition is one of the main causes of global environmental change. Food production and consumption are responsible for 30% of global greenhouse gas emissions and 70% of freshwater usage

(Serra-Majem et al., 2020). Therefore, providing healthy and sustainable nutrition to the growing global population has become a necessity to protect both human health and the planet. Studies show that the Mediterranean diet can be part of the solution to this issue (Baudry et al., 2019).

The Mediterranean diet is characterized by a high intake of olive oil, vegetables, fruits, whole grains, legumes, and oilseeds; a moderate intake of dairy products, wine, eggs, chicken, and fish; and a low consumption of red meat, processed meat products, saturated fats, and sugary foods (Yüksel & Özkul, 2021). Plant-based dietary patterns, due to their lower environmental impact compared to other dietary patterns, are important for preventing climate change and reducing greenhouse gas emissions and water footprints (Sugimoto et al., 2020).

The Mediterranean diet is considered sustainable due to its alignment with human nature and seasonality, and its low environmental impact due to the limited consumption of animal products (Álvarez et al., 2024). A study in Sweden reported that reducing meat consumption by replacing it with legumes resulted in a 20% improvement in the carbon footprint (Röös et al., 2020). A systematic review also concluded that switching from a Western dietary pattern to the Mediterranean diet could reduce land use and greenhouse gas emissions by up to 70% (Aleksandrowicz et al., 2016). Given the impact of the Mediterranean diet model on both health and environmental sustainability, it is thought to be significantly effective in addressing the health-diet-environment triad in a positive manner (Belgacem et al., 2021).

2.7.2.3 Socio-Cultural Impact

The Mediterranean diet represents a lifestyle that has existed for centuries and spread from Mesopotamia and the Eastern Mediterranean region. It is considered not just a dietary pattern, but a broader way of life, developed and adopted in the Mediterranean region, encompassing various aspects, including nutrition (Dernini et al., 2023).

The Mediterranean diet is closely related to social and cultural factors. Sharing meals and eating together is one of the key features of the Mediterranean diet model, and this practice represents the cultural identity and continuity of communities in the Mediterranean basin (Sikalidis et al., 2021). One of the principles of the Mediterranean diet is frugality, which refers to moderation in portion sizes and avoiding waste. Additionally, eating locally, organically, and seasonally is culturally, socially, and economically significant for Mediterranean people. In 2010, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) recognized the Mediterranean diet as an Intangible Cultural Heritage of Humanity (Benedetti et al., 2016).

2.7.2.4 Economic Impact

The Mediterranean diet is considered an economically beneficial dietary model, in addition to its health benefits and its role in protecting biodiversity and ecosystems. For countries in North Africa and the Near East, greater adherence to the Mediterranean diet has been reported to reduce their dependence on agriculture and food imports, providing economic benefits (D’Innocenzo et al., 2019).

The ‘food conservation culture’ inherent in the Mediterranean diet helps reduce food waste and contributes economically by encouraging individuals to adopt the Mediterranean diet (Dernini et al., 2017).

However, a study in Italy documented a striking shift in the relationship between adherence to the Mediterranean diet and economic status: between 2007 and 2010, higher socioeconomic indicators were strongly associated with greater adherence to the Mediterranean diet, while no such relationship was observed before 2007. This change was attributed to the economic crisis (Middleton et al., 2015). A recent study evaluating the societal cost savings from the adoption of the Mediterranean diet in Canadian and American populations reported that increased adherence to the Mediterranean diet reduced the financial burden of treating cardiovascular diseases in these countries, contributing to their national economies (Delarue, 2022).

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CHAPTER III

Dietary Components and Mediterranean Diet in Non-Alcoholic Fatty Liver Disease

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Introduction

In recent years, there has been an increase in the incidence of various chronic diseases due to changes in individuals' nutrition and lifestyle. These changes cause an increase in the incidence of non-alcoholic fatty liver disease as well as other diseases (Araújo et al., 2018). The first cause of non-alcoholic fatty liver disease is hepatic steatosis. Hepatic steatosis is defined as the accumulation of lipid droplets containing high amounts of triglycerides in hepatocytes (Gan et al., 2015). Hepatic steatosis occurs when the amount of

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triglycerides accumulated in the liver exceeds 5% of the liver weight (Al-Dayyat et al., 2018). The most common liver disease today is non-alcoholic liver disease. It is quite difficult to determine the true prevalence of non-alcoholic fatty liver disease due to the disease's usually asymptomatic progression, the lack of biopsy for diagnosis, and the variety of other methods used for diagnosis (Lindenmeyer and McCullough, 2018; Koch and Yeh, 2018).

1.Non-Alcoholic Fatty Liver Disease (NAFLD)

Non-alcoholic fatty liver disease is a liver disorder characterized by lipid accumulation in hepatocytes without significant alcohol consumption, infection, or medication use (Stefan et al., 2019). A systematic review and meta-analysis published in 2022 examined 245 studies from 17,244 articles and 5,399,254 individuals between 1990 and 2019. The overall global prevalence of NAFLD was determined to be approximately 30% for the period from 1990 to 2019 (Le et al., 2022). Age, gender, race, and ethnicity play a role in the incidence of the disease. The prevalence of NAFLD increases with advancing age (El-Kader and Ashmawy, 2015).

1.1.Non-Alcoholic Fatty Liver Disease and Dietary Components

The most important factor causing non-alcoholic fatty liver disease is unhealthy diet. Since there is no specific and approved drug treatment for NAFLD treatment, treatment focuses on improving individuals' nutrition and exercise habits. It has been reported that Mediterranean diet intervention in individuals with NAFLD normalizes aminotransferases and reduces intrahepatic fat. Exercise has been reported to increase insulin sensitivity and reduce body mass index (BMI) in individuals with NAFLD (Zou et al., 2018; Romero-Gómez et al., 2017). It is thought that diets that reduce insulin resistance, oxidative stress or inflammation may be effective in the treatment of NAFLD. Numerous studies have been conducted on the relationship between basic nutrients (carbohydrates, fats and proteins), food groups and dietary patterns and NAFLD (Lujan et al., 2021).

1.1.1.Non-Alcoholic Fatty Liver Disease and Carbohydrates

It has been reported that low carbohydrate consumption (≤40% of daily energy) and a low glycemic index diet have beneficial effects in individuals with NAFLD. Most studies examining the relationship between NAFLD and carbohydrate consumption have focused on added sugar consumption, especially fructose (Lujan et al., 2021). Observational studies have found a close relationship between excessive added sugar consumption and the development of NAFLD in adults and children. One study observed that those who consumed sugar-sweetened beverages had a 53% increased risk of developing NAFLD compared to those who did not consume (Wijarnpreecha et al., 2016).

1.1.2.Non-Alcoholic Fatty Liver Disease and Fats

In epidemiological studies examining the relationship between NAFLD and fat consumption, it was observed that individuals with NAFLD consumed more saturated fatty acids and cholesterol and less polyunsaturated fatty acids compared to healthy individuals (Lujan et al., 2021). In a clinical study, 38 overweight individuals were fed different macronutrients (saturated fats, unsaturated fats and simple carbohydrates) (+1000 kcal/day) for 3 weeks. At the end of the study, it was observed that intrahepatic triglyceride (IHGT) accumulation increased by 55% in individuals fed saturated fat and

15% in individuals fed unsaturated fat; and intrahepatic triglyceride (IHGT) accumulation increased by 33% in individuals fed simple carbohydrates due to the stimulation of de novo lipogenesis (Luukkonen et al., 2018). When the diets of individuals with NAFLD were examined, it was observed that the diets of the patients generally contained less omega-3 polyunsaturated fatty acids compared to healthy individuals, and the diets of these patients were found to have a higher omega-6:omega-3 ratio (Perdomo et al., 2019). The relationship between fat and NAFLD varies depending on the type of fat. Studies have shown that monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) have positive effects on NAFLD. It has been reported that the consumption of saturated fatty acids (SFA) and trans fatty acids (TFA) have negative effects on NAFLD (Lujan et al., 2021).

1.1.3.Non-Alcoholic Fatty Liver Disease and Proteins

Since most studies examining the relationship between NAFLD and macronutrients focus on carbohydrates and fats, studies examining the relationship between NAFLD and protein are limited. The results of studies on protein consumption are contradictory. The reason for the contradictions regarding the relationship between protein consumption and NAFLD is based on the type of protein consumed in the studies. While animal proteins are observed to have a negative effect on NAFLD, plant proteins have been observed to have a positive effect on NAFLD (Lujan et al., 2021).

1.1.4.Non-Alcoholic Fatty Liver Disease and Dietary Fiber

Studies examining the relationship between NAFLD and fiber consumption have found conflicting results, as with protein. A study conducted to examine the relationship between dietary fiber consumption and NAFLD in adults found a negative relationship between dietary consumption of total grains, vegetables, fruits, and plant fiber and the risk of NAFLD. It was observed that increasing total fiber consumption from 38 mg/kg/day to 117 mg/kg/day reduced the risk of NAFLD by 60% (Zhao et al., 2020).

1.1.5.Non-Alcoholic Fatty Liver Disease and Vitamins

Since deficiencies of vitamins with antioxidant functions, especially A, C, D, and E, are frequently observed in individuals with NAFLD, it is thought that vitamin supplementation in individuals with NAFLD may be a useful treatment option to prevent NAFLD from progressing to NASH (Licata et al., 2021). Studies have observed that serum levels of retinoic acid, a metabolite of vitamin A, are lower in individuals with NAFLD compared to healthy individuals. Various studies have been conducted to determine the relationship between NAFLD and niacin (vitamin B3) due to the protective effect of niacin supplementation on cardiovascular health and cardiovascular oxidative stress. In one study, NAFLD was induced by giving rats a high-fat diet. It was observed that after niacin supplementation was given to rats after induction of NAFLD, both hepatic and serum triglyceride levels decreased significantly, hepatic steatosis improved, and hepatic lipid peroxidation decreased (Pickett-Blakely et al., 2018). Another study also observed that vitamin B6 was negatively associated with hepatic steatosis (Kessoku et al., 2021). Various studies have examined the relationship between NAFLD and hyperhomocysteinemia. High homocysteine serum concentrations cause an increase in oxidative stress, affecting signaling pathways in lipid metabolism and leading to the progression of NAFLD (Munteanu & Schwartz, 2023). In one study, 1000 μg cyanocobalamin was administered daily to individuals with NAFLD for 3 months and it was observed that cyanocobalamin administration reduced the serum concentration of homocysteine. It was observed that vitamin B12 supplementation significantly reduced the serum homocysteine concentration in individuals with NAFLD. As a result of the study, it was concluded that vitamin B12 supplementation may have therapeutic effects on NAFLD pathology (Talari et al., 2022). Various studies have shown that antioxidant vitamins are reduced in obese individuals and those with NAFLD. Vitamin C deficiency predisposes individuals with NAFLD to oxidative stress. Therefore, the link between obesity, NAFLD, and oxidative stress suggests that the progression of NAFLD may be accelerated by vitamin C deficiency and that vitamin C supplementation may have positive effects in the treatment of NAFLD (Licata et al., 2021). In a cross-sectional study conducted to observe the relationship between vitamin D and NAFLD, low 25-(OH)-D levels were found to be associated with advanced hepatic steatosis and fibrosis in individuals with NAFLD. Studies comparing serum vitamin D levels in individuals with NAFLD of different histological severities have indicated that low vitamin D levels are not associated with higher stages of fibrosis. It is observed that the results of studies on NAFLD and vitamin D are contradictory (Licata et al., 2021). In studies conducted to observe the relationship between NAFLD and vitamin E, it was observed that vitamin E has antisteatotic, anti-inflammatory and antifibrotic effects (Pickett-Blakely et al., 2018). ESPEN recommends that vitamin E (800 IU α-tocopherol daily) be prescribed to non-diabetic adults with histologically confirmed NASH, aiming to improve liver enzymes and histology (Bischoff et al., 2020).

1.2.Non-Alcoholic Fatty Liver Disease and the Mediterranean Diet

Various studies have been conducted to examine the effects of different types of nutrition on NAFLD in adults. Studies have shown that the Mediterranean diet is more effective in reducing hepatic fat content in individuals with NAFLD compared to a low-fat diet and a low-carbohydrate diet. This beneficial effect of the Mediterranean diet is thought to be due to the high amounts of dietary fiber, antioxidants, phytochemicals and omega-3 fatty acids contained in the foods in the Mediterranean diet. Dietary fiber shows protective effects by regulating insulin resistance, free fatty acid concentrations and hepatic lipid metabolism. Phytochemicals and antioxidants show protective effects by reducing lipid peroxidation and oxidative damage. Omega-3 polyunsaturated fatty acids have a positive effect on NAFLD by increasing hepatic beta oxidation, peripheral insulin sensitivity and reducing endogenous lipid production thanks to their anti-inflammatory properties (Angelidi et al., 2022). In a meta-analysis study; It has been found that a Western-style diet, which includes processed foods, red meat, high-fat dairy products, and refined grains, significantly increases NAFLD. Again, in the same study, it has been found that the Prudent and Mediterranean diet models, defined by high intake of fruits, vegetables, whole grains, fish, and olive oil, reduce the risk of NAFLD. It has been reported that the Western-style diet increases the risk of NAFLD by 56%, while the Prudent (diet containing more vegetables, fruits, and whole grains) and the Mediterranean diet reduce the risk of NAFLD by 22% and 23%, respectively (Zadeh et al., 2021).

Conclusion

Despite significant investment in this area, there is currently no approved pharmacological treatment for NAFLD. Lifestyle changes with adequate and balanced nutrition and exercise are the most effective approaches to NAFLD treatment. Individuals with NAFLD or at high risk for NAFLD should be advised to reduce their intake of added sugars, especially fructose. A Mediterranean diet rich in dietary fiber, antioxidants, phytochemicals, and omega-3 fatty acids should be recommended to individuals to reduce the incidence of NAFLD.

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CHAPTER IV

Nutritional Strategies in Older Adults and Geriatric Nutrition Monitoring in Natural Disasters

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Hakan TOĞUÇ[2]

Introduction

Disaster situations, resulting from natural or man-made events, are scenarios that severely disrupt the normal functioning of communities and necessitate urgent intervention. Such events include earthquakes, floods, hurricanes, fires, and wars. These situations can impact all segments of society and often create challenging conditions with limited access to basic needs, particularly food and health services (Brown & Haun, 2014). Preparing preemptively for potential disasters is pivotal, as it significantly bolsters the efficacy of intervention and recovery endeavors should such crises materialize (Yavuz, Bölükbaşı, & Tekin, 2024). Furthermore, paramount consideration must be

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accorded to the needs of the most vulnerable segments of society—comprising older adults, infants, pregnant women, and persons with disabilities—in disaster preparedness initiatives (Daylan, Kosuva Öztürk, & Kılavuz, 2024). Prompt response is particularly crucial for the frail, disabled, or elderly demographic. Thus, it is imperative to develop tailored plans aimed at safeguarding the most vulnerable segments of survivors, considering their distinct requirements. Following a natural disaster, ensuring access to nutrition and clean water is paramount for the entire community's well-being. However, special consideration must be given to the unique needs of the older adult population, necessitating separate measures to address their specific concerns (Maeda, Shamoto, & Furuya, 2017).

Elderly individuals, typically defined as those aged 65 and over, are characterized by retirement, physical, and cognitive changes. Globally, the proportion of the elderly population is increasing. According to the United Nations 2023 data, approximately 9% of the world's population is over the age of 65, and this figure is expected to rise to 16% by 2050 (United Nations, 2023). When comparing the population pyramids of Turkey for the years 2007 and 2023, it is observed that due to a decrease in fertility and mortality rates, the elderly population has increased. The proportion of the population aged 65 and above has increased from 7.1% to 10.2% (TUIK, 2024).

As the global population continues to age, it is essential to develop effective nutritional strategies for older adults, particularly in the context of natural disasters. These strategies should consider the physiological changes and increased vulnerability to chronic diseases that come with aging. Furthermore, in the event of a natural disaster, it is crucial to have proper geriatric nutrition monitoring in place to ensure the well-being and health of older adults. Proactive disaster preparedness plans should include measures to ensure the availability of nutritious food options for older adults, such as stockpiling nutrient-dense foods and ensuring access to clean water.

Basic principles of elderly nutrition

The energy needs of elderly individuals are less than those of younger adults, but they require nutrient-dense foods. With aging, metabolism slows down, and physical activity decreases, leading to lower caloric needs (Bernstein, 2017). The older adult population's health is significantly influenced by nutrition due to the heightened susceptibility to malnutrition and dehydration resulting from various factors, which can lead to severe health consequences. Malnutrition is associated with elevated risks of infection, more frequent hospitalizations, prolonged recovery from acute illnesses, and increased mortality. It is recognized as a key factor contributing to sarcopenia and frailty (Morley, 2017). However, changes in body composition and increased risks of diseases necessitate optimization of protein, vitamin, and mineral intake in the elderly. Attention should be given to the intake of specific nutrients such as vitamin B12, vitamin D, calcium, and iron (Caruana & Vassallo, 2018). Elderly individuals experience a diminished sense of thirst, increasing the risk of dehydration. Adequate fluid intake is vital for maintaining overall health, kidney functions and cognitive functions. Daily fluid intake in the elderly should be at least 1.5-2 liters, although this amount can vary based on the individual's health status and environmental conditions (Alix, ve diğerleri, 2007).

According to guidelines *(Figure 1)*, the recommended energy requirement for older adults is typically 30 kcal/kg/day, although this figure may vary based on individual factors such as nutritional status, physical activity level, presence of comorbidities, and food tolerance. As individuals age, resting energy expenditure (REE) generally decreases due to a decline in fat-free body mass, averaging around 20 kcal/kg/day for both healthy and ill older adults. Total energy expenditure typically ranges from 24 to 36 kcal/kg/day for individuals with physical activity levels between 1.2 and 1.8. It's important to note that physical activity levels are determined by dividing an individual's total energy expenditure in a 24-hour period by their basal metabolic rate, falling within the range of 1.2 to 1.8. For the general population, a daily protein intake of 1 gram per kilogram of body weight is recommended. However, this should be increased to 1.2-1.5 grams per kilogram for older adults with acute or chronic diseases, and up to 2.0 grams per kilogram per day for those suffering from injuries or severe illnesses. Constipation and diarrhea are prevalent among older adults, with dietary fiber playing a crucial role in normalizing gastrointestinal function. Unfortunately, older adults often have insufficient fiber intake. In such cases, it is vital to augment their diet with fiber, aiming for a daily intake of 25 grams, which is considered adequate for older adults (Daylan, Kosuva Öztürk, & Kılavuz, 2024).

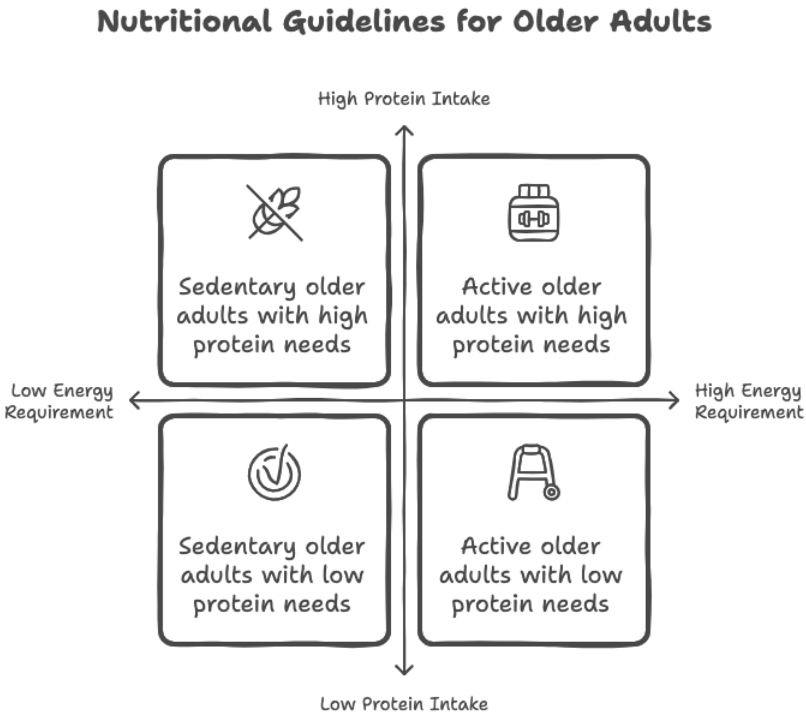

Figure 1: Nutritional Guidelines for Older Adults

Changes in the digestive system with age can affect nutrient absorption. For example, reduced stomach acid can negatively impact the absorption of vitamin B12 (Sanders, Goltz, & Maki, 2023). Constipation in the elderly individuals, often related to insufficient dietary fiber and low physical activity, can be managed with a diet rich in dietary fiber, adequate fluid intake, and regular physical activity. Due to the prevalence of chronic diseases in the elderly individuals, nutritional strategies must consider these health conditions. Conditions like diabetes, hypertension, heart disease, and osteoporosis come with specific dietary needs. Hence, a diet that supports blood sugar control for elderly individuals with diabetes and limited salt intake for those with hypertension is important (Ko & Song, 2018).

Nutritional strategies specific to disaster situations

In disaster situations, access to and storage of food become significant challenges. For the elderly individuals, choosing foods that are nutritious and can be stored for long periods without spoilage is crucial (Gupta, 2016). Foods such as dried legumes, whole grains, canned fruits and vegetables, nuts, and seeds are both nutrient-rich and have a long shelf life. Additionally, foods that are easy to prepare and consume should be preferred, especially for elderly individuals who have difficulties in eating, chewing, or preparation (Belice, 2020).

The primary objective of nutrition plans during emergencies is to prevent fatalities and meet the nutritional requirements of the affected population. While it's impractical to devise a one-size-fits-all nutrition program for all disasters due to their unique nature, two key interventions should be implemented in all such scenarios: ensuring the population has access to sufficient nutrition, and identifying and providing support to vulnerable groups with special needs (Tsuboyama-Kasaoka & Purba, 2014).

Food safety is of great importance in the periods before and after a disaster. In these times, when the risks of food poisoning increase, it is essential to store and prepare food safely. This is especially important in situations like power outages and water contamination. Elderly individuals and their caregivers should be educated about safe food storage and preparation techniques (Kosa, Cates, Godwin, Coppings, & Speller-Henderson).

In disaster situations, elderly individuals may face specific challenges in accessing food. In such cases, food assistance and distribution services provided by local communities and aid organizations are crucial (Lentz, Barrett, & Hoddinott, 2005). Food packages for the elderly should be specially prepared to meet their nutritional needs and delivered directly to their living areas. This is particularly important for elderly individuals living in hard-to-reach or isolated areas (Diamantis, ve diğerleri, 2023). As per Turkey's National Disaster Response Plan, the Turkish Red Crescent is tasked with delivering nutritional services during times of disaster. This responsibility is bolstered by national-level support from the Ministry of Interior, the Ministry of Health, the Ministry of Family and Social Services, and the Ministry of Agriculture and Forestry. At the local level, cooperation with provincial organizations, Non-Governmental Organizations (NGOs), the private sector, and municipality-level units of the aforementioned institutions is essential for effective implementation (Ozkan, 2018).

Educating and informing elderly individuals about nutrition in disaster situations is important. Providing information about food choices, preparation methods, and nutritional needs helps the elderly to better protect themselves during disasters. Local health services and community centers can offer such educational and informational programs (Meydani, 2001).

Management of health issues related to nutrition

Chronic diseases common in elderly individuals are directly related to nutrition. Conditions like diabetes, heart disease, hypertension, and osteoporosis require specific dietary adjustments (Meydani, 2001). For instance, for diabetic patients, the preference of foods with a low glycemic index that help regulate blood sugar levels is recommended. Elderly individuals with heart disease should limit their intake of saturated fats, salt, and cholesterol (World Health Organization, 2021). Dietitians and health professionals can guide elderly individuals on these disease-specific dietary adjustments.

Medication use is widespread among the elderly, and certain medications can affect nutrient absorption and metabolism. Drug-nutrient interactions can reduce the effectiveness of the medication or cause side effects. Therefore, adjusting the diets of elderly individuals undergoing medication therapy to support the effects of the drugs is important. Health professionals should provide individual dietary recommendations considering these interactions (Boullata & Hudson, 2012).

Some elderly individuals may be at risk of inadequate nutrition or malnutrition. In such cases, nutritional support and supplements may be necessary. Protein supplements, vitamin and mineral tablets, or specialized nutritional supplements can be used to prevent malnutrition and improve overall health (Boullata & Hudson, 2012). The use of these supplements should be under the supervision of a health professional and tailored to the individual's health status.

Swallowing disorders, chewing problems, or digestive issues in elderly individuals bring about specific dietary requirements (Christmas & Rogus-Pulia, 2019). Foods that can be pureed, soft diets, or liquid supplements may be suitable for elderly individuals with these issues. Additionally, reductions in taste and smell senses in elderly individuals can affect their desire to eat, and this should also be considered in nutrition strategies (Schiffman & Zervakis, 2002).

Cultural Sensitivity in Elderly Nutrition During Disasters

In disaster situations, providing culturally sensitive nutrition to elderly individuals is crucial for their physical and emotional well-being. Cultural sensitivity in nutrition involves understanding and respecting the dietary habits, preferences, and traditions of elderly individuals, which can significantly impact their willingness to eat and their overall health during and after a disaster. This section explores the importance of cultural sensitivity in elderly nutrition and provides strategies for incorporating it into disaster preparedness and response plans.

Cultural background plays a significant role in shaping dietary habits and food preferences. Elderly individuals often have deeply ingrained eating patterns that are tied to their cultural identity. For example, certain cultures may have specific dietary restrictions (e.g., vegetarianism, halal, or kosher diets), traditional foods, or meal preparation methods that are important to their daily lives. In disaster situations, disrupting these dietary routines can lead to stress, reduced appetite, and even malnutrition.

There are several challenges in providing culturally sensitive nutrition during disasters. First, access to familiar and culturally appropriate foods may be limited due to supply chain disruptions, lack of resources, or logistical challenges. Second, disasters can cause significant psychological stress, particularly for elderly individuals who may feel isolated or displaced. Providing culturally familiar foods can offer comfort and a sense of normalcy during such times. Third, in multicultural communities, disaster relief efforts must cater to a wide range of cultural dietary preferences, which can be challenging to manage effectively.

To address these challenges, several strategies can be implemented. In pre-disaster planning, cultural assessments should be conducted to understand the dietary needs and preferences of elderly individuals in the community. This can be done through surveys, interviews, or community engagement programs. Additionally, culturally appropriate foods should be included in emergency food supplies, such as halal, kosher, or vegetarian options for communities with specific dietary requirements. Collaboration with local cultural organizations, religious institutions, and community leaders is also essential to identify and address the nutritional needs of elderly individuals from diverse backgrounds.

During disaster response, customized food packages should be prepared and distributed to cater to the cultural preferences of elderly individuals. This can include traditional staples, spices, or condiments that are familiar to their diets. Cultural liaisons or interpreters can be employed to communicate with elderly individuals and ensure their dietary needs are met. These liaisons can also help bridge cultural gaps between relief workers and the affected population. Flexible meal options should be offered to allow elderly individuals to choose foods that align with their cultural preferences, which can be particularly important in communal feeding centers or shelters.

In the post-disaster recovery phase, cultural sensitivity training should be provided for disaster relief workers, volunteers, and healthcare providers to ensure they understand and respect the dietary needs of elderly individuals from diverse backgrounds. Long-term nutritional support programs should be developed that incorporate culturally appropriate foods and dietary practices. This can include community kitchens, meal delivery services, or nutrition education programs tailored to specific cultural groups. Psychological and social support should also be provided to help elderly individuals cope with the emotional impact of disasters while maintaining their dietary traditions.

Several case studies highlight the importance of cultural sensitivity in disaster nutrition. After the 2011 earthquake and tsunami in Japan, relief efforts focused on providing traditional foods like rice, miso soup, and pickled vegetables to elderly survivors, which helped maintain cultural continuity and provided emotional comfort during the recovery process. In the aftermath of Hurricane Katrina in the United States, relief organizations worked with local communities to provide culturally appropriate meals to elderly African American and Vietnamese populations, including soul food and traditional Vietnamese dishes, which were well-received by the affected communities. Following the 2023 earthquakes in Turkey, the Turkish Red Crescent collaborated with local NGOs to distribute food packages that included traditional Turkish staples like lentils, bulgur, and dried fruits, ensuring that elderly survivors had access to familiar and culturally significant foods.

Cultural sensitivity in elderly nutrition during disasters is essential for ensuring the physical and emotional well-being of elderly individuals. By understanding and respecting their cultural dietary preferences, disaster relief efforts can provide more effective and compassionate support. Incorporating cultural sensitivity into disaster preparedness and response plans not only improves nutritional outcomes but also helps preserve the dignity and cultural identity of elderly survivors. Collaborative efforts between governments, relief organizations, and local communities are key to achieving this goal and ensuring that elderly individuals receive the care and support they need during and after disasters.

Psychosocial support for elderly nutrition post-disaster

Post-disaster, respecting the eating habits and cultural preferences of elderly individuals is important. Disaster situations can disrupt the usual dietary routines and create psychological stress, especially in the elderly. Providing culturally familiar foods can reduce this stress and encourage better nutrition in elderly individuals (Bolukbasi, 2018). This helps support both their physical and emotional well-being.

Post-disaster, ensuring that elderly individuals have access to culturally appropriate and familiar foods is not only a matter of nutrition but also a way to preserve their dignity and sense of normalcy. In times of crisis, the elderly are particularly vulnerable to malnutrition and dehydration due to physical limitations, chronic health conditions, or difficulties in accessing food. By offering meals that align with their cultural and personal preferences, caregivers and relief organizations can significantly improve their overall well-being.

As illustrated in *Figure 2*, addressing psychological issues, providing social support, and ensuring access to nutrition are interconnected strategies that play a critical role in the recovery process. Collaborative efforts among community groups, such as religious institutions, volunteer networks, and local authorities, can ensure that the elderly have consistent access to culturally appropriate food and other essential resources. These efforts, combined with emotional support from family and friends, help mitigate the psychological stress caused by disasters. In turn, such support strengthens the resilience of elderly individuals, enabling them to recover more effectively and maintain a higher quality of life in the aftermath of a disaster.

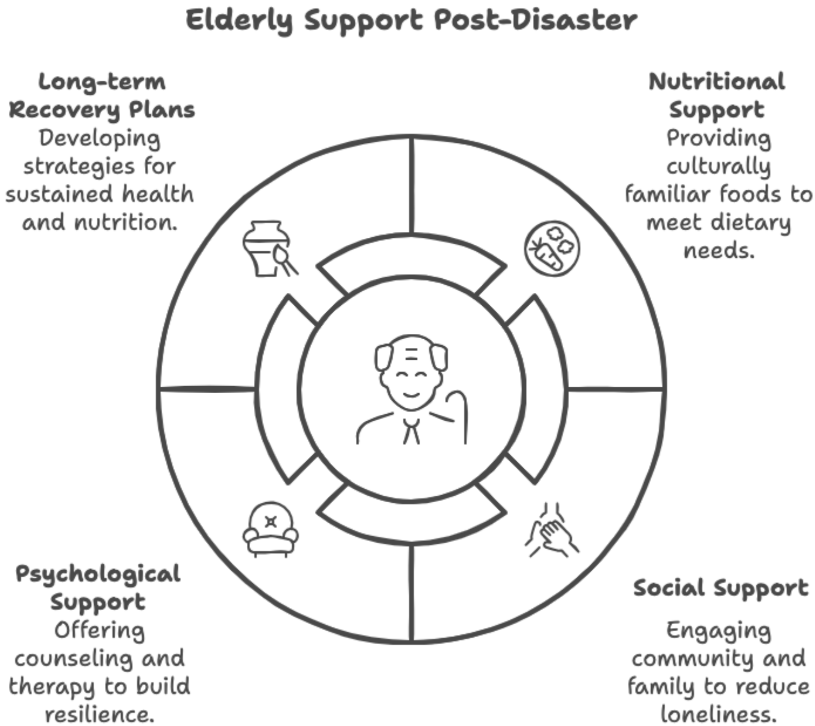

Figure 2: Holistic Support Framework for Elderly Post-Disaster

Social support is a significant factor in the post-disaster recovery process for the elderly. Support provided by family members, friends, and community groups can assist in meeting the nutritional needs of the elderly and reduce feelings of loneliness (Yavuz, Bölükbaşı, & Tekin, 2024). Additionally, community centers, religious groups, and volunteer organizations can provide significant resources to facilitate access to nutrition for the elderly individuals.

Disasters can have profound psychological impacts on elderly individuals, often leading to anxiety, depression, and other mental health issues. The trauma of experiencing a disaster, coupled with the disruption of daily routines, loss of homes, and separation from loved ones, can exacerbate existing mental health conditions or trigger new ones. For elderly individuals, who may already be dealing with age-related challenges such as chronic illnesses, mobility issues, or social isolation, the psychological toll of a disaster can be particularly severe. Supporting psychological resilience is not only crucial for mental well-being but also plays a significant role in maintaining healthy nutritional habits, as mental health and nutrition are deeply interconnected (Bui & Sankaran, 2001).

The uncertainty and chaos that follow a disaster can lead to heightened anxiety and depression among elderly individuals. They may worry about their safety, the well-being of their families, and their ability to cope with the aftermath. These feelings can lead to a loss of appetite, changes in eating patterns, and ultimately, malnutrition. Some elderly individuals may develop Post-Traumatic Stress Disorder (PTSD) after experiencing a disaster. Symptoms can include flashbacks, nightmares, and severe anxiety, which can interfere with their ability to maintain a regular diet and nutritional intake. Disasters can disrupt social networks, leaving elderly individuals feeling isolated and lonely. Social isolation can lead to depression and a lack of motivation to prepare or eat meals, further exacerbating nutritional deficiencies. The loss of loved ones, homes, and personal belongings can cause profound grief in elderly individuals. This emotional burden can affect their desire to eat and their overall nutritional status (Bui & Sankaran, 2001).

Psychological resilience—the ability to adapt and recover from adversity—plays a critical role in how elderly individuals cope with the aftermath of a disaster. Resilient individuals are more likely to maintain healthy eating habits, seek out nutritional support, and adhere to dietary recommendations, even in challenging circumstances. Conversely, those who struggle with mental health issues may neglect their nutritional needs, leading to a decline in physical health and further exacerbating psychological distress (Bui & Sankaran, 2001).

Providing one-on-one counseling sessions with trained mental health professionals can help elderly individuals process their emotions, develop coping strategies, and address any underlying mental health issues. Counselors can also work with elderly individuals to identify and overcome barriers to maintaining a healthy diet, such as lack of appetite or difficulty preparing meals. Group therapy sessions and support groups offer elderly individuals the opportunity to share their experiences, receive emotional support, and learn from others who are facing similar challenges. These group settings can also provide a sense of community and belonging, which can be particularly beneficial for those who feel isolated after a disaster. Nutrition-focused support groups can encourage participants to share healthy eating tips, recipes, and strategies for maintaining a balanced diet during difficult times (Bui & Sankaran, 2001).

Comprehensive psychosocial support programs that address both emotional and nutritional needs can be highly effective in promoting resilience among elderly disaster survivors. These programs can include mental health counseling, nutritional education, meal planning assistance, and access to community resources. Health professionals and psychosocial support providers should work collaboratively to ensure that elderly individuals receive holistic care that addresses both their psychological and nutritional needs. Encouraging elderly individuals to participate in community activities, such as communal meals, cooking classes, or gardening projects, can help combat social isolation and promote mental well-being. These activities also provide opportunities for elderly individuals to learn about nutrition, share meals with others, and develop a sense of purpose and connection.

Certain nutrients have been shown to support mental health and resilience. For example, omega-3 fatty acids, found in fish and flaxseeds, have been linked to reduced symptoms of depression and anxiety. Similarly, foods rich in antioxidants, such as fruits and vegetables, can help combat oxidative stress, which is associated with mental health disorders. Nutritional interventions that focus on these and other brain-healthy foods can support both mental and physical well-being in elderly disaster survivors. Family members and caregivers play a crucial role in supporting the psychological resilience and nutritional health of elderly individuals. Educating caregivers about the signs of mental health issues and the importance of nutrition can help them provide better support to their loved ones. Caregivers can also assist with meal preparation, encourage healthy eating habits, and provide emotional support during the recovery process (Bui & Sankaran, 2001).

After the 2011 earthquake and tsunami, Japan implemented community-based programs that combined mental health support with nutritional assistance. Elderly individuals participated in group therapy sessions and communal meals, which helped reduce feelings of isolation and promote healthy eating habits. In the aftermath of Hurricane Katrina, mental health professionals in the United States provided individual and group counseling to elderly survivors. These services were integrated with nutritional support programs, ensuring that elderly individuals received comprehensive care that addressed both their emotional and dietary needs. Following the 2023 earthquakes, Turkey launched psychosocial support initiatives that included counseling, support groups, and nutritional education for elderly survivors. These programs were designed to address the unique psychological and nutritional challenges faced by elderly individuals in the wake of a disaster.

Supporting psychological resilience and maintaining healthy nutritional habits are essential components of disaster recovery for elderly individuals. By addressing the emotional and dietary needs of elderly survivors, disaster relief efforts can promote overall well-being and enhance the recovery process. Collaborative efforts between mental health professionals, nutritionists, caregivers, and community organizations are key to providing comprehensive support that helps elderly individuals rebuild their lives after a disaster (Bui & Sankaran, 2001).

As depicted in *Figure 3*, a comprehensive support framework for elderly individuals post-disaster includes nutritional support, psychological counseling, social engagement, and long-term recovery planning. These interconnected components ensure that elderly individuals are not only provided with immediate necessities but also equipped with the resources needed to rebuild their lives. Collaborative efforts among community groups, such as religious institutions, volunteer networks, and local authorities, play a vital role in ensuring access to culturally appropriate food and emotional support.

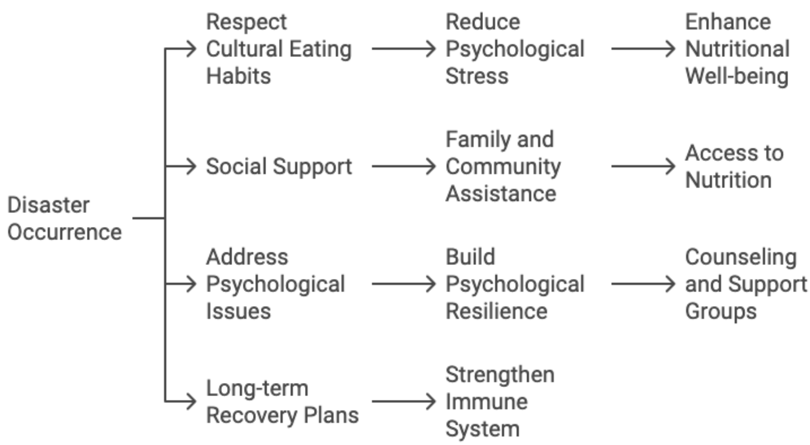

Figure 3: Psychosocial and Nutritional Strategies for Disaster Recovery

In the post-disaster period, the importance of nutrition strategies in the long-term recovery process of elderly individuals should be emphasized. Healthy nutrition supports the overall recovery process and strengthens the immune system of the elderly. Long-term recovery plans should be developed considering the dietary habits and health status of elderly individuals.

The role of technology in enhancing community-based nutrition support

In recent years, technology has emerged as a powerful tool in enhancing community-based nutrition support for elderly individuals during disasters. The integration of digital solutions into disaster response strategies has the potential to significantly improve the efficiency, reach, and effectiveness of nutritional interventions for older adults. Mobile applications, online platforms, telemedicine services, and other technological innovations can address many of the challenges faced by elderly individuals in accessing adequate nutrition during and after disasters.

In recent years, technology has emerged as a powerful tool in enhancing community-based nutrition support for elderly individuals during disasters. The integration of digital solutions into disaster response strategies has the potential to significantly improve the efficiency, reach, and effectiveness of nutritional interventions for older adults. Mobile applications, online platforms, telemedicine services, and other technological innovations can address many of the challenges faced by elderly individuals in accessing adequate nutrition during and after disasters.

Mobile applications can play a pivotal role in coordinating community-based nutrition support efforts. These apps can be used to organize volunteer activities, track food deliveries, and ensure that elderly individuals in need receive timely assistance. For example, apps can provide real-time updates on food distribution points, allowing elderly individuals or their caregivers to locate the nearest source of nutritious meals. Additionally, mobile apps can offer educational resources on safe food storage, meal preparation, and dietary recommendations tailored to the needs of older adults (Gupta, 2016). By leveraging mobile technology, communities can streamline their disaster response efforts and ensure that no elderly individual is left without access to essential nutrition.

Telemedicine services have become increasingly important in providing healthcare support during disasters, particularly for elderly individuals who may have limited mobility or chronic health conditions. Through telemedicine, dietitians and healthcare providers can offer remote nutritional counseling, helping elderly individuals manage their dietary needs even in the aftermath of a disaster. This is especially critical for those with conditions such as diabetes, hypertension, or osteoporosis, which require specific dietary adjustments. Telemedicine can also facilitate the monitoring of elderly individuals' health status, enabling early detection of malnutrition or dehydration and timely intervention (Maeda, Shamoto, & Furuya, 2017).

Online platforms can serve as hubs for resource sharing and collaboration among community organizations, healthcare providers, and volunteers. These platforms can host databases of nutritional resources, such as recipes for nutrient-dense meals that are easy to prepare with limited ingredients. They can also facilitate communication between different stakeholders, ensuring a coordinated approach to meeting the nutritional needs of elderly individuals. For example, online forums or social media groups can be used to share information about available food supplies, volunteer opportunities, and best practices for supporting elderly nutrition during disasters (Lentz, Barrett, & Hoddinott, 2005).

Wearable technology, such as smartwatches and fitness trackers, can play a role in monitoring the health and nutritional status of elderly individuals during disasters. These devices can track vital signs, physical activity levels, and hydration status, providing valuable data that can be used to identify potential health risks. For instance, a sudden drop in physical activity or changes in heart rate could indicate dehydration or malnutrition, prompting caregivers or healthcare providers to take action. Wearable technology can also remind elderly individuals to stay hydrated or take their medications, helping them maintain their health in challenging circumstances (Sanders, Goltz, & Maki, 2023).

While technology offers numerous benefits, there are also challenges to consider. Not all elderly individuals may be comfortable using digital tools, and access to technology can be limited in disaster-affected areas. Therefore, it is essential to provide training and support to help elderly individuals and their caregivers make the most of these technological solutions. Additionally, privacy and data security must be prioritized to protect the sensitive health information of elderly individuals.

Conclusion

Disaster preparedness planning should consider the specific nutritional needs of elderly individuals. This includes integrating strategies for addressing the nutritional needs of the elderly into disaster planning processes. Governments, disaster relief organizations, and local communities must collaborate to ensure food security, accessibility, and appropriate nutritional support for the elderly. This collaboration is critical for effectively meeting the nutritional needs of the elderly in disaster situations. Proactive steps should be taken to address the nutritional needs of the elderly to mitigate the potential impacts of disasters. This means creating emergency kits, establishing accessible and elderly-friendly food distribution points in disaster situations, and focusing on post-disaster nutritional support. Additionally, disaster education and preparedness programs should be designed considering the special needs of the elderly.

Elderly individuals are an integral part of communities, and their well-being is essential for the health and resilience of the entire society. Considering the nutritional needs of the elderly in disaster planning helps to ensure that communities are more robust and resilient during and after disasters. Communities developing comprehensive and integrated approaches to meet the nutritional needs of the elderly will be better prepared for disasters.

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