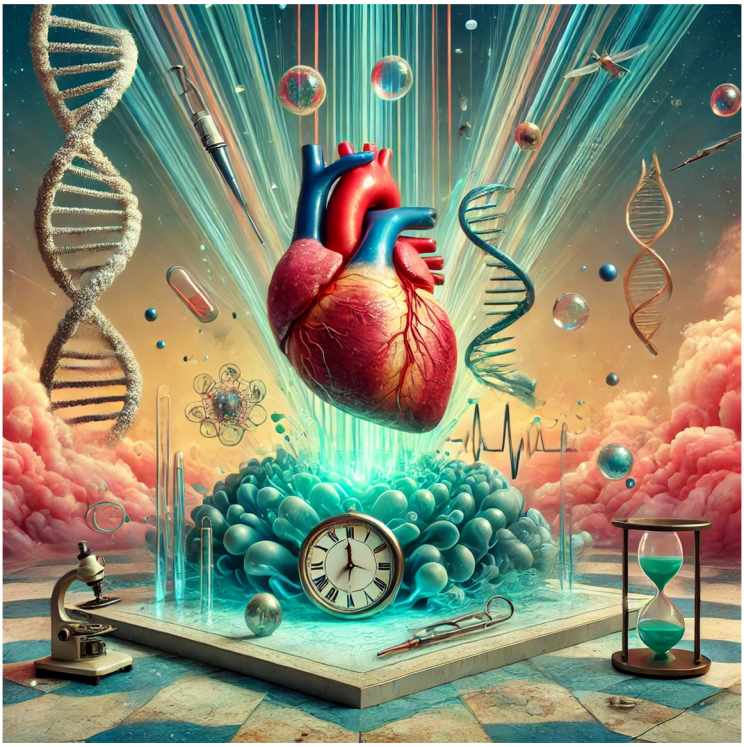

HEALTH SCIENCES IN THEORY AND PRACTICE

Editor
Prof. Dr. Gönül GÜROL ÇİFTÇİ

DUVAR

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HEALTH SCIENCES IN THEORY AND PRACTICE
Editor: Prof. Dr. Gönül GÜROL ÇİFTÇİ

Editor in chief: Berkan Balpetek
Cover and Page Design: Duvar Design
Printing : December -2024
Publisher Certificate No: 49837
ISBN: 978-625-5530-70-7

853 Sokak No:13 P.10 Kemeraltı-Konak/İzmir
Tel: 0 232 484 88 68

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CHAPTER 1

The Importance of Personnel Hygiene and Hygiene Training in Food Businesses

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Abstract

Foodborne diseases continue to be an important problem that threatens public health worldwide. Ensuring food safety in developed and developing countries is a priority goal in protecting public health. Hygiene knowledge and practices of personnel working in food establishments play a critical role in preventing foodborne diseases. However, despite efforts for hygiene education and modern food processing technologies, inadequate hygiene practices pose serious risks. Studies show that inadequate hand washing habits are up to 97% effective in the occurrence of foodborne diseases. From production to consumption, food can be contaminated by personnel, equipment, and surfaces, resulting from poor hygiene, lack of access to clean water, and inadequate hygiene education. Depending on personnel hygiene, pathogens such as *Staphylococcus aureus*, *Salmonella spp*., *Escherichia coli*, and Norovirus contaminate food and threaten public health. Hand washing is one of the basic elements of personnel hygiene and is important in limiting the spread of pathogens. However, studies show that hand hygiene is often neglected in the food sector, leading to serious health risks. One of the most effective methods to ensure food safety is to increase the training of personnel on hygiene and the effective implementation of Food Safety Management Systems. The knowledge and awareness of the personnel play a critical role in preventing foodborne diseases.

Keywords: personnel hygiene, hand hygiene, food safety, hygiene training, public health

INTRODUCTION

Foodborne diseases continue to threaten public health as a significant cause of morbidity and mortality worldwide. Ensuring food safety in both developed and developing countries is recognized as a priority issue in protecting public health (WHO, 2019). Good hygiene knowledge, attitude, and behavior of personnel working in food establishments play a critical role in preventing foodborne diseases (Sharif et al., 2013; Motarjemi & Lelieveld, 2014).

Despite advances in hygiene and sanitation principles, innovations in food processing technologies, and increased efforts towards hygiene education of personnel, foodborne diseases continue to pose a significant threat to public health (Dominquez et al., 2002). In particular, inadequate handwashing habits have been reported to be up to 97% effective in the occurrence of these diseases (Howes et al., 1996; Green et al., 2007; Kahraman et al., 2010).

Foods are frequently contaminated by personnel, equipment, and surfaces from production to consumption (Tayar & Yıbar, 2013). Studies show that 70% of diarrhea cases in developing countries are associated with contaminated food consumption. "Furthermore, poor hygiene practices of infected food handlers play a significant role in the spread of gastroenteritis agents (Michaels et al., 2004), with this being attributed to factors such as poor hygiene, lack of access to clean water, inappropriate storage conditions, and lack of hygiene education. (Stratev et al., 2017).

Microbial hazards, mainly due to the rapid growth of pathogenic microorganisms, pose serious health risks and threaten food safety. *Staphylococcus aureus*, *Salmonella spp*., *Shigella spp*., *Campylobacter spp*., enterotoxigenic *Escherichia coli*, *Bacillus cereus*, Hepatitis A and Norovirus are among the microbial risks related to personnel hygiene in food establishments (Shojaei et al., 2006; Chai et al., 2007; Lee et al., 2009). It has been reported that these pathogens can survive on hands, clothing, surfaces, and equipment for hours or even days (Pérez-Rodríguez et al., 2013). Hands contaminated with the feces of food workers can transmit pathogens to food, customers, and other workers through sneezing, coughing, or infected skin lesions. Although service utensils such as ladles, spatulas, and personal protective equipment provide a physical barrier to prevent the transmission of microorganisms, they cannot prevent them completely. Therefore, staff hand hygiene is paramount, and gloves cannot replace hand washing (Todd et al., 2010a).

Studies show that handwashing habits need to be at the desired level (Curtis et al., 2011). However, improving hygiene behaviors is possible with easily applicable methods that do not require new technologies or costly investments (Curtis et al., 2011). Among these methods, it is of great importance to comply

with basic rules such as the importance of personal hygiene to ensure food safety, adequate cooking of food, prevention of cross-contamination, attention to proper storage conditions, and consumption of food from reliable sources (Medeiros et al., 2001).

The most important factor in ensuring hygiene in food establishments is kitchen personnel's compliance with hygiene and sanitation rules. Beyond the fact that the personnel's hygiene knowledge is sufficient, it must be reflected in their attitudes and behaviors. Especially the personnel involved in the final stages of food production or service processes should have the knowledge and awareness level to take the necessary measures to prevent the transmission of pathogenic microorganisms (Medeiros et al., 2004).

In many countries, food safety training programs have been made mandatory. For example, in the USA, many state and local governments require food safety training, but there is no standardized training type (Howton et al., 2016). In Turkey, it is a legal obligation to employ hygiene-trained personnel in food establishments. Workplace owners or operators are primarily responsible for ensuring staff receive this training.

Today, the most effective method of ensuring food safety in food businesses is establishing and effectively implementing food safety management systems (Koçak, 2015). In this context, Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP), the Hazard Analysis and Critical Control Points (HACCP) system, methodologies such as ISO 22000, and personnel hygiene training stand out as effective strategies for the prevention of foodborne diseases.

Therefore, personnel hygiene is a fundamental factor in preventing contamination in the food production chain. This section will discuss the importance of personnel hygiene in food businesses and the effects of hygiene training on food safety.

1. Personnel Hygiene and its Importance

Proper hand hygiene is one of the most important aspects of personal hygiene. It effectively limits the transmission of foodborne and many other diseases (Scot et al., 2007). In a study evaluating the risks that Norovirus-contaminated food workers may pose to product contamination and consumers, it was reported that 6 log10 viruses were removed. Thus, the contamination of products was maximally reduced when the personnel washed their hands using soap and water for 30 seconds, and 100% compliance was achieved. This study emphasizes that all personnel should wash their hands 100% of the time to remove 5 log10 viruses that pose a consumer risk (Sobolik et al., 2021).

In another study, Clayton and Griffith (2004) evaluated 31,050 food preparation and hygiene actions by examining 115 food workers in 29 catering establishments in Wales. The study found that hand hygiene was only adequately practiced 31% of the time and not practiced at all 55% of the time. The most common errors were failure to wash hands after touching potentially contaminated surfaces (75%), failure to use soap (39%), and failure to dry hands adequately (42%).

The primary factors contributing to foodborne illnesses caused by food handlers include cross-contamination between raw and processed foodstuffs, processing and storage of food under unfavorable conditions, use of contaminated tools and equipment, bare-handed handling of food by infected food handlers, and inadequate hand washing (Al Suwaidi et al., 2015; Todd et al., 2007). The dirty hands of food handlers seriously threaten public health (Kariuki et al., 2017; Ghartey & Antwi, 2019) by transmitting microbial agents to foods through cross-contamination (Shojaei et al., 2006).

Studies reveal that insufficient awareness of food safety and hygiene is an important factor in spreading foodborne diseases. A study was conducted in Şanlıurfa City Centre to evaluate the hygiene knowledge and practices of 207 staff members working in the kitchen departments of accommodation facilities with varying statuses. While the participants demonstrated awareness regarding the importance of body bathing for cleanliness, proper handwashing techniques, oral hygiene, and nasal cleaning, shortcomings were identified in areas such as trimming hand and toenails and maintaining cleanliness of hair and feet (Arısoy et al., 2021). Emery (1990) reported that although handwashing procedures are easy and feasible, handwashing habits in health and food services are poor. In a study, 60% of food service workers did not wash their hands after using the toilet. Similarly, outbreaks of *Escherichia coli O157:H7* in Scotland and Wales and *Salmonella Typhimurium* associated with peanut butter in the United States have been reported to have occurred as a result of serious lapses in basic hygiene practices (Medus et al., 2009; Todd, 2010a).

In conclusion, for the effective implementation of food safety and hygiene practices, the knowledge of the personnel should be transformed into correct practices as well as the knowledge of the personnel. Training, regular information, promotion of appropriate hygiene standards, and periodic controls are among the key elements in preventing foodborne diseases.

2. Rules to be Followed by Personnel in Food Establishments

The most important step in terms of food safety is for personnel working in food establishments to comply with personal hygiene rules and be knowledgeable

about hygiene. Personnel can often unknowingly contaminate food due to carelessness or insufficient knowledge. Sick or potentially infectious employees can transmit microorganisms to tools, equipment, surfaces, and food by coughing/sneezing directly on food or indirectly through hands contaminated with feces (Uğur et al., 2001).

As stated in the hygiene principles and good practice guidelines for places of mass consumption of the Ministry of Agriculture and Forestry, the personnel working in food establishments should strictly comply with cleaning and hygiene standards, wear their work clothes only at work, and keep them clean, do not enter the production area with street clothes or shoes, use protective equipment such as bonnets, masks, gloves, overshoes, etc. correctly, do not wear jewelry and wristwatches, male employees should preferably have short hair. They should not grow a beard, and all mustachioed personnel should use mouth masks during food production and preparation stages when necessary. There should be no personal belongings or clothes belonging to the employees in the production areas, and the areas that meet the rest and social needs of the personnel should be separate from the food preparation, production, and presentation areas. According to the same guideline; there should be instructions reminding the rules to be followed by the personnel, people who are at risk of carrying foodborne diseases or who have diseases such as contagious wounds, skin infections, and diarrhea should not be employed, preferably blue colored band-aids should be used in hand injuries and gloves should be worn. In addition to these, regarding hand hygiene, the nails of the personnel should be short and clean, nail polish or artificial nails should not be used, hands should be washed and disinfected regularly and effectively when necessary, especially after using the toilet, sufficient gloves should be available in production, processing, preparation and presentation areas, and gloves should be replaced with new ones when necessary (Anonymous, n.d.).

According to the Five Keys To Safer Food Manual published by the World Health Organisation, hands should be washed frequently before and during food preparation, before eating, after using the toilet, after contact with raw meat or chicken, after changing nappies, blowing the nose, contact with garbage or waste, working with cleaning agents, playing with pets and smoking. It was also emphasized that if gloves are used during work, they should be changed frequently to ensure hygiene (WHO, 2006).

3. Hygienic Hand Washing: Why, When, How?

Skin flora in humans consists of two types of microorganism communities: permanent and temporary. Permanent flora consists of microorganisms that settle in the upper layers of the skin and generally do not cause disease; these

microorganisms do not decrease much with hand washing with soap and water. Transient flora are microorganisms that settle on the skin's surface by contamination from saliva, nasal secretions, or dirty tools and potentially cause disease. Transient flora may cause the spread of foodborne diseases due to a lack of personal hygiene in public nutrition workers (Bilici, 2008). Proper hand hygiene is essential for food workers to prioritize to avoid contamination during food preparation and processing. (Todd et al., 2010b). Hands should be washed with appropriate technique at the beginning of each job, after contact with raw foods, after leaving the toilet, after smoking and using handkerchiefs, after touching wounds and pimples, after handling dirty tools and equipment, after coughing and sneezing, after throwing garbage, and before serving food (Bulduk, 2007; Prague et al., 2007).

Toilet usage and handling of contaminated raw foods or food packaging can result in hands being contaminated with as many as 1 million enteric bacteria (Marie, 2002). In the Turkey Handwashing Survey, it was determined that the most common habits were washing hands after using the toilet (91.1%), after getting up in the morning (85.7%), after touching the garbage (83.5%), and after blowing the nose (83.1%). It was found that the frequency of hand washing before meals and after the toilet increased depending on age, gender, education level, and urban living conditions. The reasons for not washing hands were grouped as personal (forgetting, not feeling the need) 53.3%, environmental (lack of cleaning materials or suitable environment) 39.2%, and combined reasons 7.5% (Anonymous. 2012).

Most surface microorganisms on the hands are easily removed by washing, but microorganisms may remain in skin folds, cracks, crevices, and between the nails (Sheena & Stiles, 1983; Todd et al., 2010b). Effective handwashing should eliminate resident and transient microorganisms through soap, detergents, and antimicrobial compounds. However, hand washing cannot achieve sterility due to resident skin flora. The success of handwashing is influenced by several factors, including the extent of microbial and organic contamination, the quality of water used, the length of time spent washing, the type and quantity of soap, the handwashing technique (such as palm, fingers, areas under the nails, back of the hands, and wrists), and the duration and intensity of rubbing the palms and fingers during the process (Price, 1938; Todd et al., 2010b).

The main goal of handwashing is to remove transient microorganisms from the hands physically. When antimicrobial soap is used, the aim is to neutralize both transient and resident flora by killing or suppressing them (Larson, 1989). Workers in the food sector must comply with hygiene rules to ensure food safety and prevent the spread of infectious diseases. Hand washing should be done for

at least 20 seconds before starting work, between work, between contact with raw and cooked foods, and when changing tasks. In this process, friction between the hands should be provided for 10-15 seconds, then rinsed thoroughly and dried with a clean paper towel (FDA, 2013).

Steps to be followed in hygienic hand washing;

- Hands are wetted by opening the tap
- To clean hands, use sufficient liquid soap to cover the entire surface of the hand.
- The palms are rubbed.
- The spaces between the fingers are cleaned.
- Fingertips are cleaned.
- Fingers are closed, and nails are cleaned.
- All of the fingers are rubbed one by one with the other palm.
- Paper towels must be used for drying.
- Hands, including the sides, fingertips, fingertips, nail surroundings, and wrists, are dried.
- The tap is closed with the paper towel with which the hands are dried (Anonymous, n.d.).

Workers in the food sector must comply with hygiene rules to ensure food safety and prevent the spread of infectious diseases. Hand washing should be done for at least 20 seconds before starting work, between work, between contact with raw and cooked foods, and when changing tasks. In this process, friction between the hands should be provided for pathogen assessments, and washing frequency is important in selecting handwashing products. When frequent hand washing is required, a sensitive hand washing soap should be used so the staff can accept this. Handwashing soaps should be effective at producing a good lather, have a pleasant scent, and maintain a smooth consistency. Additionally, they should be free from ingredients that could lead to skin dryness or irritation (Todd et al., 2010b). Rinsing hands is crucial as it helps eliminate potential skin irritants and contact allergens from food, soap, and disinfectants, which could otherwise lead to dermatitis. Using hot water above 120°F (49°C) to rinse hands can cause scalding, irritation, pain, cracking, lacerations, and possible pathogen colonization. These conditions, in turn, may prevent future hand washing and lead to increased microbial load on hand surfaces (Michaels et al., 2001).

Hand drying is an important part of good hand hygiene, but it needs to be addressed. Since water remaining on hands after washing can increase the amount of bacteria, hand drying is crucial to prevent wet hands from transferring bacteria to other surfaces (Foddai, 2016). Hand drying serves two main purposes:

absorbing moisture and removing microorganisms through friction. The friction during drying is even more crucial than during washing, as the washing phase removes microorganisms from the skin. The drying process further helps to physically eliminate any remaining microorganisms from the surface of the skin (Byrne, 1985).

The rougher the texture of the paper towel, the more effective it is at creating friction, which helps to remove microorganisms from the skin (Blackmore, 1989; Michaels et al., 2003). Thus, hand hygiene's effectiveness relies on the efficiency of the washing process (including soap, water, scrubbing, and rinsing) and the hand drying process (Michaels, 2002; Michaels & Ayers, 2000).

Disinfectants should not be used as a substitute for hand washing (Foddai, 2016). Disinfectants are insufficient to prevent contamination and should not be preferred over hand washing or changing gloves. Because disinfectants cannot remove food residues on the hands, the surfactant effect and friction obtained during hand washing with soap and water cannot be achieved with disinfectants. In addition, gloves should be replaced in case of contamination or damage during the task. Ready-to-eat foods should not be handled with bare hands but with spoons, spatulas, gloves, etc. (FDA, 2013).

Effective hand washing performed by hygienic hand washing procedures reduces the likelihood of potential pathogenic microorganisms and their transmission to food. Minimizing the risk of transferring personnel-related pathogens to food is essential for ensuring safe food production.

4. Importance of Personnel Hygiene Training

The food industry is one of the areas where the human factor plays the most important role, and employees' knowledge of food safety and hygiene has a critical impact on the spread of foodborne diseases (Jahan, 2012). In food production, the ability of personnel to apply the correct processing methods is directly related to their knowledge and training, which is of great importance as an essential element of their work. Employees' lack of knowledge about food safety is a significant barrier to following safe food handling practices (Arendt et al., 2015). Hygiene deficiencies in food personnel can cause the spread of foodborne diseases. To prevent this problem, food business owners should provide regular and comprehensive training to their staff. The primary purpose of training is to provide the personnel with the proper knowledge and skills regarding food safety and quality standards (Bulduk, 2007).

It is emphasized that training should include not only information transfer but also practical learning. The training process should enable employees to learn through their experiences. It is important for the personnel working in the field

of food to understand the connection of their work with human health and to know what and why they do what they do (Bulduk & Bulduk, 2014). It has been reported that food safety training is more effective than training based only on theoretical training when it combines theoretical and practical components (Insfran-Rivarola et al., 2020).

The higher the level of education and the more work experience, the better hygiene practices are observed in the kitchen. Studies have shown that differences in education level lead to differences in hygiene status and that food handlers' previous work experience plays an important role in their current hygiene practices. It has been observed that more experienced food handlers learn more about improved hygiene practices (Bhattacharya et al., 2019). In a similar vein, a study by Thakur et al. (2013) highlighted that the level of basic education significantly influences the hygiene practices of food handlers. Food handlers with more experience tend to demonstrate better hygiene habits and achieve higher standards of food safety compared to those with less experience (Akabanda et al., 2017).

Research indicates that various factors, including time constraints, availability of equipment and resources, management and staff focus on food hygiene, education and training, and the quality of environmental health services, all influence food handlers' capacity to prepare food in a hygienic manner (Patah et al., 2009). Food businesses must manage these factors effectively to ensure food hygiene and safety.

Studies conducted in various regions of Turkey have revealed notable differences in the knowledge levels of personnel working in the food sector. A study conducted in a hospital in Edirne found that most of the food staff had significant knowledge of food hygiene, but still had some training deficiencies. All the staff knew that hands should be washed before food preparation, knew the importance of using gloves, caps, and overshoes, and understood the effectiveness of disinfection in killing bacteria. However, in a Turkey-wide study by Baş et al. (2006), it was reported that 47.8% of 764 food personnel had not received food safety training, revealing their lack of hygiene knowledge. A study conducted in catering establishments in Istanbul found that most of the personnel did not know the symptoms of food poisoning and E. coli, which is one of the fecal bacteria, although they had received hygiene training. This situation shows that having received training does not always translate into sufficient knowledge. Demirel's (2009) study emphasized that the hygiene-trained personnel had more knowledge than others, but this knowledge was not fully reflected in food preparation processes.

In a study conducted in holiday villages in Muğla, the sanitation situation in kitchens with hygiene-trained personnel was evaluated as 'good.' However, it was stated that the frequency and adequacy of training should be increased (Babür, 2007). However, lack of training leads to serious problems in food safety and hygiene practices. In the study of Çıkmaz (1997), 96.8% of the employees in Medical Faculty hospitals stated that they wash their hands before preparing food. However, it was determined that they had difficulties in hygiene practices due to a lack of soap and towels. (2005) stated that 60% of the food personnel did not wash their hands properly, and this situation revealed that employees caused 25-40% of foodborne diseases.

In a study in the USA, Green et al. (2006) reported that only 27% of kitchen staff washed their hands adequately and glove use needed to be more regular, showing that hygiene training does not have a sufficient effect on basic practices such as hand washing and glove use. In conclusion, having the proper knowledge of food hygiene is not only a theoretical requirement; this knowledge must be translated into practice. In a study at a university in Kuala Lumpur, although food safety knowledge needed to be adequate, inadequacies in practices were identified. In the Lee et al. (2017) study, it was emphasized that microorganisms were found in the hands of kitchen workers; even Salmonella spp. was detected in 48% of them, and despite the knowledge, practices were incomplete. This situation shows the gap between hygiene education and practice.

Similarly, another study conducted in Antalya city center examined the personal hygiene knowledge and practices of 400 personnel working in accommodation facilities. In this study, although they had certain knowledge about hygiene, inadequacies were found, especially in cleaning materials and dental health (Yıldırım, 2014). Such findings show that personnel hygiene should not only be based on knowledge but should be reinforced with practical and continuous training. Although training is an important step to increase the knowledge level of staff, factors such as continuous training and the use of correct equipment play a critical role in the effectiveness of hygiene practices.

5. Personnel Hygiene Training: Legal Requirements and Practices

Hygiene training plays a critical role in raising personnel's hygiene awareness and ensuring that they adopt the right practices. The Hygiene Training Regulation (Anonymous, 2013), published in the Official Gazette on 5 July 2013 and numbered 28698, abolished mandatory porter examinations for food workers and made hygiene training mandatory instead. This Regulation aims to strengthen employees' contribution to food safety processes.

The relevant Regulation covers many sectors, including food production and retail workplaces, drinking and natural mineral water production facilities, and accommodation establishments. The Regulation requires hygiene training for employees who provide direct service and for business owners or operators of workplaces if they work in person.

These trainings are organized by public education centers, vocational education centers, tourism education centers, and maturation institutes under the General Directorate of Lifelong Learning of the Ministry of National Education. Training contents are prepared using the framework determined by a Ministry-established commission and last at least eight hours. In the training, many topics are covered, from the general characteristics of microorganisms of viruses, bacteria, parasites, fungi, and other infectious agents to the ways of transmission, from their effects on public health to prevention methods. In addition, hygiene and cleaning principles specific to business lines and other topics that are considered to be helpful can be included in the commission's training content.

Participants are given certificates at the end of the training, and these documents are checked during inspections. In the absence of hygiene training certificates, the Ministry of Agriculture and Forestry or local administration auditors responsible for inspections take action in accordance with Article 282 of the Public Hygiene Law No. 1593 (Anonymous, 1930).

Hygiene training is one of the cornerstones of sustainable food safety. The Turkish Food Codex Food Hygiene Regulation and good hygiene practice guidelines ensure this training is mandatory in food businesses. Operators are responsible for improving the hygiene awareness of the personnel, ensuring that they work according to HACCP (Hazard Analysis and Critical Control Points) principles, and repeating these trainings regularly. These responsibilities are important in protecting consumer health, strengthening brand reputation, and ensuring business legal compliance.

In addition, supporting the training with practical methods is important to increase the permanence of the training and to show how hygiene will be applied in real work environments. For example, the effectiveness of personnel hand hygiene can be evaluated by microbiological analysis of hand swabs taken from employees. In the study by Sneed et al. (2004), values of less than 1.3 log10 CFU for Aerobic Plate Count (APC) and 1.0 log10 CFU for Enterobacteria were observed. and Staphylococcus aureus were determined as acceptable limits. Such applications allow concrete evaluation of hygiene practices.

Hygiene training is vital to minimizing both health and economic risks in food businesses. Employing personnel with Hygiene Certificates, renewing the training at regular intervals, and giving due importance to hygiene controls create

a safe operating environment. Hygiene training is not only a legal obligation but also a requirement for consumer health and the sustainable success of the business.

Workplace owners and managers are obliged to ensure the continuity of hygiene practices and regularly check the validity of the documents. In this process, improving the content and application dimension of training will increase employees' hygiene awareness and strengthen consumer confidence. Hygiene training, planned annually and supported by practical studies, will ensure effective hygiene in the workplace and prevent possible legal sanctions.

Conclusion and Recommendations

Hygiene training is one of the cornerstones of ensuring food safety. Hygiene awareness among personnel working in food businesses is not only a legal requirement but also one of the most effective ways to protect consumer health. Thanks to hygiene training, employees play a critical role in preventing foodborne diseases, preventing contamination, and protecting business reputation.

Repeating training regularly and keeping employees' knowledge levels up to date supports sustainable hygiene practices. However, reinforcing theoretical knowledge with practice ensures that behavioral changes become permanent. Proper teaching and implementing basic hygiene practices, especially hand washing, are among the most important links in the food safety chain.

Food businesses should aim to ensure that hygiene training is reflected in the daily practices of employees, rather than seeing hygiene training as a mere formality. The effectiveness of hygiene training should be evaluated through regular audits, and remedial steps should be taken to eliminate deficiencies. In addition, incentive policies should be developed to increase the hygiene awareness of the personnel, and hygiene practices should be made a part of the business culture.

In conclusion, hygiene training is indispensable for employees, food safety, and public health. This process should be considered an investment in healthy societies and reliable businesses and taken seriously. A safe food chain can be established for both employees and consumers by ensuring the continuity and effectiveness of training.

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CHAPTER 2

Digitalization in Medical Education

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Medical education is an interdisciplinary process structured to enhance the professional knowledge, skills, and attitudes of medical students. This process, which began with traditional methods, has undergone significant changes and transformations over time in line with technological advancements. Digitalization has become one of the key components of this transformation and is now an integral part of medical education.

Digitalization can be defined as the integration of analog processes with digital technologies, thereby supporting educational processes with these tools (Çetinkaya, 2024). In medical education, digitalization offers significant innovations in areas such as access to information, simulation-based training, data analytics, and digital assessment tools. These innovations facilitate student-centered learning, continuous feedback, and the creation of flexible learning environments (Küçükali & Coşkun, 2021).

The initial computer-assisted instructional materials and electronic resources in the field of medical education emerged in the early 1980s. With the proliferation of e-learning platforms and online educational materials in the 2000s, educational processes became more dynamic. Today, innovative technologies such as simulation-based learning, augmented reality (AR), virtual reality (VR), and artificial intelligence (AI) have become integral to medical education (Gürpınar & Zayim, 2008).

Application Areas Of Digitalization In Medical Education

Access to and Sharing of Information

Access to and sharing of information are among the most fundamental and transformative aspects of digitalization in medical education. Medical education requires the effective dissemination of rapidly evolving and continuously updated knowledge. Digital technologies offer learners and educators modern, efficient, and sustainable solutions to meet this need. Traditionally, access to information was often limited to physical libraries and printed materials (Söyler & Averbek, 2022). With digitalization, immediate access to medical databases, electronic books, and scientific articles via the internet has become possible. For instance, resources such as PubMed, Cochrane Library, and UpToDate support the educational process by providing quick access to up-to-date and reliable information.

Medicine is a field where the half-life of knowledge is relatively short, and medical education relies on a constantly updated knowledge base. Digital platforms simplify access to the latest research findings and clinical guidelines, enabling students and educators to stay current.

Moreover, digitalization plays a significant role in promoting equity in information access. Open access resources (e.g., Open Access Journals, MedEdPORTAL) reduce geographical and economic barriers, contributing to the democratization of knowledge. Additionally, social media platforms (e.g., Twitter, LinkedIn) and professional networks (e.g., ResearchGate, Medscape) have become critical tools for accelerating information sharing. These platforms allow educators and students to discuss recent developments, share case studies, and foster collaborations.

Learning management systems such as Moodle, Blackboard, and Canvas facilitate the seamless delivery of digital materials to students, supporting both synchronous and asynchronous learning processes. Cloud-based storage and sharing systems, such as Google Drive and OneDrive, simplify collaboration and information sharing. Through these platforms, educational materials, lecture notes, and presentations can be easily distributed. Digital libraries (e.g., HINARI, OVID) and medical databases offer students and educators organized and comprehensive access to medical information. However, the digital sharing of medical information also introduces risks related to data privacy and security (Yüksel, 2019). Medical information is sensitive and legally protected, requiring careful handling to maintain patient confidentiality. Sharing such data on digital platforms carries the risk of unauthorized access due to malicious actors or cyberattacks. For instance, a student or educator inadvertently uploading patient information to a public platform can result in serious privacy breaches.

Cyberattacks targeting digital platforms with weak security measures can lead to large-scale data breaches. Additionally, digital data is vulnerable to manipulation or intentional misuse, which can negatively impact both educational processes and clinical decisions. Failure to comply with legal regulations such as the Personal Data Protection Law (KVKK) or the General Data Protection Regulation (GDPR) when sharing patient information on digital platforms may expose educators and students to legal liabilities and create ethical dilemmas in education (Yücedağ, 2019).

To mitigate these risks, platforms with strong security protocols and encrypted data protection should be preferred for information sharing. For example, systems with robust security infrastructure and controlled access permissions should be used for sharing medical information between students and educators. Moreover, raising awareness among students and educators about data security is crucial. Basic principles such as anonymizing patient information, using secure passwords, and sharing data only with authorized individuals should be emphasized.

Digitalization has greatly facilitated access to and sharing of information in medical education, but it also requires careful attention to data privacy and security. Educators and students should use these technologies in adherence to ethical and security principles to minimize potential risks.

While access to and sharing of information are among the most significant contributions of digitalization to medical education, managing these processes effectively requires enhancing the digital literacy skills of educators and students. Additionally, careful selection of educational materials is essential to ensure the accuracy and reliability of information. Strengthening technological infrastructure and supporting open access policies are critical steps toward increasing equity in information access.

Simulation-Based Education

Medical education encompasses a complex and intensive learning process in which students integrate theoretical knowledge with practical skills. In this context, ensuring that students acquire clinical skills without compromising patient safety is of utmost importance. Simulation-based education serves this purpose by recreating real-life clinical experiences in virtual or controlled environments.

Simulation-based education involves the replication of clinical scenarios using physical models, computer-based programs, virtual reality (VR), augmented reality (AR), or high-tech simulators. It is designed not only to enhance students' technical skills but also to develop non-technical competencies such as communication, teamwork, and problem-solving (Akçay, 2021).

Low-tech simulations

Low-tech simulations provide medical students with a safe and controlled environment to learn fundamental skills. These simulations deliver an effective learning experience without requiring complex technological devices or infrastructure.

- **Anatomical models:** These models are widely used for teaching basic procedures. Examples include latex arm models for injection simulation and simulation pads made from tissue-like materials for surgical training. Models that mimic real tissue help students improve motor skills, build confidence, and prevent errors in real patient scenarios.
- **Standardized patients:** Standardized patients are professional actors or trained individuals who portray specific patient scenarios for educational purposes. This method is particularly effective in developing

doctor-patient communication and clinical decision-making skills. Educational goals include practicing history-taking and physical examination, enhancing patient-physician interaction, and addressing challenging patient scenarios (e.g., aggressive patients, delivering bad news) in a safe learning environment.

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High-tech simulators

High-tech simulators provide students with realistic, immersive, and safe learning environments through advanced devices and software for simulating complex clinical scenarios.

- **Mechanical simulators:** These simulators are primarily utilized to develop advanced skills in surgical and invasive procedures. Applications include laparoscopic and robotic surgeries, endoscopic procedures, angiography, obstetric simulators for practicing childbirth processes, and other interventional techniques.
- **Computer-based simulations:** These simulations enable the creation of virtual clinical scenarios, helping students improve diagnostic skills, treatment planning, and clinical decision-making. Examples include analyzing symptoms in virtual patients, evaluating laboratory test results, simulating diagnostic processes, practicing rapid and effective decision-making in acute conditions (e.g., sepsis, cardiac arrest), and learning medical protocols and algorithms.
- **Virtual reality (VR) and augmented reality (AR):** VR and AR technologies are increasingly employed in medical education, offering students the opportunity to experience complex clinical situations. Examples include simulations for trauma management, emergency interventions, and surgical procedures; anatomy education (allowing students to explore the human body in 3D); and interactive scenarios for real-time patient management.

High-tech simulators are vital tools in medical education, complementing traditional methods and enriching the learning experience. These technologies enable students to acquire advanced skills, understand complex clinical scenarios, and practice procedures while prioritizing patient safety. With ongoing technological advancements, the increasing availability and accessibility of these tools will continue to enhance the quality of medical education (Demirbilek, 2016).

Online Education and Distance Learning

Although medical education traditionally relies on face-to-face communication and hands-on learning, advancements in technology have increasingly integrated online education and distance learning into medical curricula. This trend was significantly accelerated by the COVID-19 pandemic, which compelled medical education institutions to effectively adopt online platforms (Celen, 2011).

The concepts of online education and distance learning are complementary:

- **Online education:** An education model where course content is delivered entirely in digital environments, encompassing synchronous (real-time) or asynchronous (self-paced) learning methods.
- **Distance learning:** A system where students and instructors, located in different physical locations, communicate and conduct the learning process through internet-based platforms (Celen, 2011).

Modern online tools not only facilitate information transfer but also provide interactive learning experiences for students. Commonly used online tools in medical education are briefly described below (Demirtaş et al., 2020):

Virtual Classrooms

Platforms such as Zoom, Microsoft Teams, and Google Meet allow synchronous online classes by creating real-time virtual classroom environments.

Learning Management Systems (LMS)

Examples include Moodle, Blackboard, and Canvas. These platforms enable sharing of course materials, assignments, and assessments while supporting both synchronous and asynchronous learning processes.

Video-Based Content

Platforms like Khan Academy Medicine and YouTube Medical Education provide asynchronous learning opportunities, allowing students to understand complex medical concepts through visual explanations.

Virtual Laboratory and Simulation Software

Digital tools designed for anatomy, physiology, and clinical practices include virtual microscopes and simulated surgical procedures. These resources offer practical training opportunities in a digital format.

Web 2.0 Tools

Web 2.0 tools are extensively used in medical education, particularly for assessment and evaluation. Assessments are critical for evaluating students' cognitive, affective, and behavioral skills. Examples of platforms include Google Forms, Microsoft Forms, Quizizz, Kahoot, Socrative, Mahara, PebblePad, and Google Sites.

By integrating these tools, online education and distance learning in medical education provide diverse, flexible, and interactive learning opportunities, paving the way for innovation in medical training.

Advantages and Challenges of Digitalization in Medical Education

Digitalization represents a transformative shift in medical education, fundamentally altering teaching methods and learning processes. Technological advancements have improved the accessibility of educational content, enriched learning experiences, and introduced innovative approaches in assessment and evaluation. However, challenges posed by digitalization may limit the effective implementation of these processes (Demirtaş et al., 2020).

Advantages of digitalization

Digital tools provide students and educators with access to a vast network of information. Online medical libraries, e-books, and open-access articles enable rapid acquisition of up-to-date scientific knowledge. Additionally, webinars and online courses facilitate global knowledge-exchange.

Digital platforms allow students to learn independently of time and location. Asynchronous learning methods, in particular, enable students to progress at their own pace, offering significant benefits to medical students with demanding clinical schedules.

Artificial intelligence (AI)-powered platforms can analyze a student's knowledge level and offer tailored learning content and feedback. This personalization enhances students' strengths while addressing their weaknesses effectively.

Virtual simulations and augmented reality (AR) technologies provide medical students with a secure space to develop clinical skills. These tools are particularly valuable in high-risk areas such as surgery and emergency interventions, minimizing real-world errors.

Online platforms enable students to collaborate with peers from different geographic regions. Digital study groups provide an effective framework for case analysis and joint projects.

Challenges of digitalization

Effective use of digital tools requires a robust internet connection and suitable hardware. However, inadequate infrastructure in some regions may create a digital divide among students.

Successful integration of digital tools necessitates that educators possess adequate technical skills. Some instructors may struggle to adapt to these technologies, limiting their impact on education.

Storing students' personal and academic data on digital platforms raises concerns about data security. Protecting such information from unauthorized access is imperative.

Online education may decrease direct interaction between students and instructors. This reduction can negatively affect learning quality in areas such as patient communication and clinical skills that require interpersonal engagement.

Digital learning demands high levels of self-discipline and time management. Students lacking these skills may struggle to navigate their learning processes effectively.

Digitalization offers unparalleled opportunities to transform and enhance learning processes in medical education. However, addressing challenges such as technological infrastructure deficiencies, data security risks, and diminished face-to-face interaction is crucial. A successful digitalization process requires robust infrastructure, increased digital competencies among educators, and the integration of technological tools aligned with pedagogical principles.

Web 2.0 Tools in Medical Education

Web 2.0 represents the second generation of internet technologies, offering an interactive and collaborative environment where users not only consume content but also contribute as producers. This concept encompasses dynamic and user-centered websites, social media platforms, collaboration tools, and various digital applications. Web 2.0 tools provide innovative features that facilitate information sharing and enrich learning experiences, particularly in the field of education.

Web 2.0 tools enable internet users to create, edit, share content, and interact with other users through digital platforms and applications. Unlike the static nature of Web 1.0, Web 2.0 offers a dynamic user experience, enhancing accessibility, sharing, and opportunities for collaboration (Karadağ, 2019).

These tools are widely used in education to ease access to information, make learning interactive, and support collaboration. Tools such as blogging, online discussion boards, simulations, and game-based learning applications make learning processes more dynamic and engaging. They find applicability across diverse fields, from medical education to social sciences, offering effective

solutions, especially in areas like assessment, collaborative learning, and student motivation.

Web 1.0 and Web 2.0 tools represent different approaches used to support information access and learning processes in medical education. While Web 1.0 tools primarily focus on providing static information, Web 2.0 tools aim to deliver an interactive and collaborative learning experience. The fundamental differences between these two groups of tools are highlighted in Table 1 (Hamlı & Hamlı, 2021; Kapan & Üncel, 2020).

Table 1. Comparison of Web 1.0 and Web 2.0 Tools

Usage Area	Web 1.0 Tools	Web 2.0 Tools
Access to and Use of Information	Provides static, one-way information. Users are passive information consumers. Examples: Static websites, e-books, PDF format.	Dynamic and interactive. Users can generate and share information. Examples: Blogs, wiki platforms, social media tools.
Interaction and Engagement	No or limited interaction. Communication between users is generally not possible.	Provides high-level interaction. Students and instructors can communicate via social media, forums, and other platforms.
Collaboration and Group Work	Collaboration is not supported. Each student works individually.	Collaboration and group work are encouraged. Examples: Google Docs, Padlet, Trello.
Personalization of the Learning Experience	Provides fixed and standard content. Cannot be adapted to individual needs.	Offers personalized learning. Content is recommended based on individual performance via LMS platforms.
Feedback and Assessment	Feedback processes are limited. No automatic assessment features.	Provides real-time feedback and assessment. Examples: Tools like Kahoot, Quizizz can quickly measure student performance.
Access and Mobility	Mostly dependent on desktop computers. Mobile compatibility is limited, offline access is generally not possible.	Mobile-compatible and cloud-based. Easy access via tablets or smartphones.

"When Table 1 is examined, it is clear that Web 2.0 tools are much more effective for educational purposes compared to Web 1.0 tools. Table 2 presents examples and a comparison of the content and areas of use of Web 2.0 tools that can be used in medical education (Bozkurt, 2013)."

Table 2. Web 2.0 Tools for Use in Medical Education

Tool Name	Category	Content and Areas of Use	Example Use
Google Docs	Collaborative Writing Tools	Students and instructors can work, edit, and comment on documents simultaneously.	Group projects, preparing case analysis reports.
Kahoot	Interactive Assessment	Interactive quizzes can be created to assess students' learning progress.	Short quizzes on clinical information or post-lecture knowledge reinforcement.
Padlet	Digital Boards	Provides a digital board for collecting ideas, brainstorming, and collaboration in group work.	Collecting students' contributions in clinical case analysis.
Quizizz	Educational Games	Provides exams and assessment activities that students can complete at their own pace.	Individual knowledge assessment on topics such as pathophysiology or pharmacology.
YouTube	Video Sharing Platform	Instructors can share video content for clinical procedures and theoretical lessons.	Visual demonstrations of clinical procedures, anatomy lessons.
Twitter	Microblogging	Used for sharing medical updates, conference announcements, and short information.	Following current discussions in medical education via the #MedEd hashtag.
Moodle	Learning Management System	A comprehensive platform for sharing course materials, assignment management, online exams, and discussion forums.	Module-based course management and assessment in medical faculties.
Canva	Design Tools	Students and instructors can design infographics, posters, and visual materials.	Visualizing clinical case summaries, preparing posters for conference presentations.
WikEM	Wiki-based Resource	A wiki platform for sharing information on emergency medicine and other medical topics.	Quick access to information and use as a reference source.
LinkedIn	Professional Networking	Establishing professional connections	Finding professional mentors in medical

		for medical education and career opportunities.	education, sharing medical publications.
Zoom	Video Conferencing Platform	Widely used for synchronous lessons, webinars, and virtual meetings.	Remote lessons and online case discussions.
Edmodo	Educational Social Network	Provides a platform for communication, material sharing, and discussion between instructors and students.	Communication for extracurricular activities and assignment sharing.
Socrative	Assessment Tools	Analyzes students' learning progress with online tests, exams, and surveys.	Short knowledge checks during class or post-lesson surveys.
Prezi	Presentation Tools	A tool used to create dynamic and visually engaging presentations.	Clinical case presentations or visualizing course content.
Flipgrid	Video-based Discussion	Allows students to provide feedback through video recordings.	Sharing students' analyses of clinical scenarios in video format.

In Table 2, the categories, content, and practical applications of Web 2.0 tools that can be used in medical education are summarized. These tools enhance the educational experience by encouraging active participation from students and enriching the learning processes.

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CHAPTER 3

Osteoporosis: Nutritional Approaches and Management for Bone Health

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INTRODUCTION

Osteoporosis is the most common metabolic bone disorder, characterized by a reduction in bone minerals and matrix to levels below normal, which increases bone fragility. Although often associated with women, osteoporosis also affects men, who make up approximately one-fifth of individuals with low bone mineral density or osteoporosis in the U.S. In older adults, it is the leading cause of fractures and is linked with immobility, which can lead to severe complications. Treatment options for osteoporosis include bisphosphonates, receptor activators of nuclear factor kappa-B ligand inhibitors, oestrogen agonists/antagonists, parathyroid hormone analogues, and calcitonin (Tu et al., 2018).

Osteoporosis is a significant health issue, particularly among postmenopausal women, and is influenced by multiple factors that can adversely affect individuals' quality of life. With the aging population increasing globally and, in our country, the prevalence of osteoporosis and its complications is expected to rise, posing a substantial public health risk. Osteoporosis often remains asymptomatic until a fracture occurs, and once a fracture happens, the structural integrity of the bone deteriorates, and its strength is not fully restored. Therefore, early identification of osteoporosis risk factors is crucial for preventive healthcare (Aksu et al., 2005).

Studies indicate that osteoporosis is more prevalent among populations with lower education and socio-cultural levels, underscoring the need to assess societal awareness and disseminate effective information about osteoporosis (Aksu et al., 2005). One study found that individuals who do not live alone have a lower risk of developing osteoporosis, suggesting that mental, physical, and social support from living with others can reduce the risk of the disease (Yu et al., 2020).

The goal of this study is to raise awareness about the nutritional principles associated with osteoporosis. Upon reading this chapter, individuals should gain knowledge about osteoporosis, dietary guidelines for its management, available treatment options, and the prevalence of the condition.

PATHOPHYSIOLOGY OF BONE HEALTH

Bones provide essential structure and protection for the body, serving as reservoirs for minerals like calcium and phosphorus, which are crucial for bone development and stability. Peak bone mass is typically achieved by age 30, after which bone maintenance relies heavily on various factors. While genetics play a significant role in reaching peak bone mass, nutrition, physical activity, disease conditions, and medications also significantly influence bone health (Riancho et al., 2022).

Bone undergoes continuous remodelling throughout life, where old bone tissue is broken down by osteoclasts and replaced by new bone tissue formed by osteoblasts, promoting structural strength and renewal (Riancho et al., 2022). This dynamic process is regulated by various cytokines and hormones, including parathyroid hormone (PTH), vitamin D, calcitonin, and oestrogen. Pro-inflammatory factors such as tumour necrosis factor (TNF) and receptor activator of nuclear factor kappa B (RANK) also stimulate osteoclast activity, increasing bone resorption. Any imbalance between these processes may lead to impaired bone remodelling, which can result in decreased bone density and increased risk of osteoporosis (Yedavally-Yellayi et al., 2019).

Bone is a metabolically active tissue, constantly undergoing a cycle of formation and resorption. Osteoblasts, the primary cells responsible for bone formation, produce osteoid, which facilitates bone mineralization. Once the bone tissue is fully mineralized, osteoblasts become osteocytes, which are less metabolically active but help maintain bone structure. On the other hand, osteoclasts, located in Howship's lacunae, are responsible for bone resorption, ensuring the balance between bone formation and degradation is maintained (Park et al., 2021).

OSTEOPOROSIS

The World Health Organization (WHO) defines osteoporosis based on bone mineral density (BMD), comparing it to that of a young, healthy population. Osteoporosis is characterized by low bone density, compromised bone microarchitecture, and reduced bone strength, leading to an increased risk of fractures. It is often asymptomatic until a low-trauma fracture occurs, commonly in the hip, spine, wrist, or pelvis, which may require hospitalization (Tu et al., 2018).

The disease leads to a reduction in bone mass and deterioration of bone structure, particularly affecting the spine, hip, and wrist. Hip fractures can result in a loss of independence for at least one-third of patients, while vertebral fractures may cause chronic pain and impair daily activities. Globally, over 200 million people are affected by osteoporosis, with approximately 8.9 million fractures occurring each year (Yong & Logan, 2021).

As the global population ages, osteoporosis becomes an increasing concern. According to data from the Turkish Statistical Institute, the elderly population, which made up 9.5% of the total in 2020, is projected to rise to 11.0% by 2025, 12.9% by 2030, 16.3% by 2040, and 25.6% by 2080 (TÜİK, 2021). Additionally, a retrospective study found correlations between abnormal blood cell counts—such as reduced lymphocytes and elevated neutrophils—and low bone mass,

suggesting that these factors may be associated with an increased risk of osteoporosis (Ye et al., 2020).

Osteoporosis Classification

Primary osteoporosis is an age-related condition characterized by decreased bone mass and an increased risk of fractures, without other identifiable causes. It is subdivided into two types: postmenopausal osteoporosis (Type 1) and senile osteoporosis (Type 2). Type 1 osteoporosis is most common in women aged 50 to 75 and is marked by increased osteoclastic activity and rapid bone resorption. It primarily involves trabecular bone loss, which occurs quickly but is typically short-lived. Fractures commonly associated with Type 1 include those of the vertebrae and distal radius. The condition is exacerbated by oestrogen deficiency, along with decreased secretion of calcitonin, impaired parathyroid hormone (PTH) function, and disruptions in vitamin D metabolism (KIŞLAK & Fatma, 2019).

Type 2 osteoporosis, or senile osteoporosis, primarily affects individuals over the age of 75. It is characterized by the loss of both cortical and trabecular bone, coupled with reduced osteoclastic activity. The primary contributing factor is aging, with fractures frequently occurring in the femoral neck, humerus, and hip. Juvenile idiopathic osteoporosis, although rarely seen in adults, occurs in children during periods of rapid growth before puberty and is very uncommon (KIŞLAK & Fatma, 2019).

Secondary osteoporosis occurs due to insufficient development of bone mass during growth or the loss of bone mass in the adult skeleton, usually as a result of disease or injury. In secondary osteoporosis, structural changes in the bones lead to fractures when various etiological factors negatively impact bone development. These factors include reduced mobility, inflammatory cytokines, systemic glucocorticoid use, puberty-related disorders, and low body weight (Khosla & Shane, 2016).

Endocrine-related causes such as glucocorticoids, thyroid hormones, hypogonadism, hyperprolactinemia, diabetes mellitus, and hyperparathyroidism also contribute to secondary osteoporosis. Malignant diseases, such as multiple myeloma, leukemia, lymphoma, and radiotherapy for breast, lung, and prostate metastases, play a significant role. Certain medications, including heparin, ethanol, thyroid hormone, anticonvulsants, and chemotherapeutics, may further exacerbate bone loss (Rizzoli & Biver, 2015).

Additionally, conditions affecting collagen synthesis, such as homocystinuria, Ehlers-Danlos syndrome, and osteogenesis imperfecta, are notable contributors. Other factors such as liver diseases, gastrointestinal disorders (e.g., primary

biliary cirrhosis, hemochromatosis, and subtotal gastrectomy), rheumatoid arthritis, and immobilization can significantly affect bone density and increase the risk of fractures (Kişlak & Fatma, 2019).

OSTEOPOROSIS TREATMENT

The primary goal of osteoporosis treatment is to prevent fractures by enhancing bone strength, improving physical capacity, alleviating symptoms associated with fractures and skeletal deformities, and reducing the incidence of new fractures, as well as related mortality and morbidity. Currently, optimal management of osteoporosis requires a combination of pharmacological and non-pharmacological approaches (Cosman et al., 2014).

The most used medications for osteoporosis include bisphosphonates (such as alendronate, risedronate, ibandronate, and zoledronic acid), raloxifene, calcitonin, parathyroid hormone, strontium ranelate, hormone replacement therapy, and selective oestrogen receptor modulators. While calcium and vitamin D alone are insufficient for treating osteoporosis, they are essential components of therapy and should be used alongside other treatments to promote healthy bone metabolism (Kişlak & Fatma, 2019).

Osteoporosis can be prevented, or its negative effects mitigated, through healthy, adequate, and balanced nutrition combined with regular exercise. Various nutritional therapies, such as the Mediterranean diet, DASH diet, diets with a low inflammatory index, and foods rich in phytoestrogens, have been shown to have positive effects on bone health and help manage osteoporosis (Yilmaz et al.).

Exercise

Regular exercise is the most crucial factor in maintaining bone mass. Weight-bearing (anti-gravity) and muscle-strengthening activities are essential for preventing fractures and reducing the risk of falls. Activities such as walking, dancing, stair climbing, weightlifting, tennis, yoga, and pilates improve bone strength and muscle coordination. For women with osteoporosis, it is recommended to walk for at least 30 minutes three times a week and incorporate back and posture exercises into their daily routine. While swimming offers overall health benefits, it does not have the same positive impact on bone mass as weight-bearing exercises. Engaging in regular physical activity promotes bone health, enhances balance and coordination, and improves functional independence, particularly in older adults (Camacho et al., 2020; Kişlak & Fatma, 2019).

Understanding the Role of Nutrition in Bone Health

Nutrition is crucial for preventing and managing osteoporosis. A balanced diet, rich in calcium and vitamin D, is essential for maintaining peak bone mass and reducing the risk of fractures. Adequate intake of natural plant hormones (phytoestrogens), essential fatty acids, fiber-rich foods, and various vitamins and minerals is crucial for optimal bone health (Kişlak & Fatma, 2019).

Maintaining a diet that limits sugar and saturated fats, while focusing on the intake of Omega-3 fatty acids, polyunsaturated fats, and fiber, supports bone strength. In addition to calcium and vitamin D, other key nutrients such as magnesium, potassium, iron, zinc, copper, and vitamins K, C, and the B complex contribute to bone integrity. Excessive intake of sodium, phosphorus, and manganese should be avoided as they can interfere with calcium absorption and bone health (Cristina & Lucia, 2021; Ortega et al., 2020)

Dairy products, rich in calcium and vitamin D, remain a key component of bone-supporting diets. Moreover, plant-based sources of calcium, such as leafy green vegetables and fortified products, can complement dietary needs. Overall, a nutrient-dense diet, combined with regular physical activity, is essential in mitigating osteoporosis risks and promoting long-term bone health (Cristina & Lucia, 2021).

MACRONUTRIENTS

Carbohydrates

Carbohydrates should constitute around 55-60% of total daily energy intake in a balanced diet. They are found in various forms, with complex carbohydrates, such as whole grains, legumes, and fiber-rich foods, being more beneficial than simple sugars. Complex carbohydrates help regulate blood sugar levels, maintain healthy cholesterol levels, and offer protective effects on bone health through their fiber content. Fiber, in particular, can aid in calcium absorption and improve gut health, which is closely linked to bone metabolism (Baltaci et al.).

Additionally, recent studies suggest that prebiotics, a form of dietary fibre, play a role in enhancing calcium absorption and improving bone density. Prebiotics such as inulin and fructooligosaccharides promote a healthy gut microbiota, which in turn can influence mineral absorption, particularly calcium, thereby supporting bone health (Scholz-Ahrens & Schrezenmeir, 2002).

Fats

It is recommended that 20-35% of an individual's daily energy intake should come from fats. Adhering to this range not only promotes durability but also provides protection against physical injuries. However, beyond the total fat intake, the type and proportion of fatty acids consumed are also crucial. Saturated

and polyunsaturated fats should account for less than 8% of total energy intake, while monounsaturated fatty acids should make up approximately 15%. Additionally, dietary cholesterol should be limited to less than 300 mg per day. For older adults with elevated low-density lipoprotein (LDL) cholesterol levels, diabetes, or cardiovascular disease, this limit should be reduced to 200 mg per day (Baltaci et al.).

A diet rich in essential fatty acids is believed to enhance intestinal calcium absorption, decrease urinary calcium excretion, and promote calcium deposition in bone tissue. Increasing the intake of essential fatty acids can directly help protect against osteoporosis by facilitating calcium absorption. These fatty acids, which are critical components of cell membranes, nerve sheaths, and hormones, cannot be synthesized in sufficient quantities by the body and must therefore be obtained from dietary sources. Unfortunately, deficiencies in essential fatty acids are common due to the prevalence of low-fat diets aimed at improving overall health. It is estimated that at least 80% of individuals are deficient in essential fatty acids. Foods rich in these nutrients include nuts and seeds, dark green leafy vegetables, bread fortified with soybeans and flaxseeds, as well as sunflower and olive oils. Other sources include almonds, corn, sesame seeds, and extra virgin olive oil, along with oily fish such as mackerel, herring, salmon, trout, sardines, and anchovies. Vitamin E plays a crucial role in enhancing the effectiveness of essential fatty acids and helps protect them within the body (Kişlak & Fatma, 2019).

Proteins

Even after growth has ceased, particularly in older adults, protein remains essential for maintaining bodily functions, preserving muscle tissue and mass, supporting cognitive function, and ensuring the proper functioning of the immune system (BALTACI et al.). In Europe, it is recommended that individuals consume 30-40 kcal/kg along with 1.0-1.5 g of protein/kg daily to mitigate the risk of protein-energy malnutrition and frailty. These specific values may vary based on individual health conditions. Similarly, the American Academy of Nutrition and Dietetics suggests a daily protein intake of 1.0 to 1.6 g/kg, advocating for the consumption of 25-30 g of high-quality protein at each meal (Cristina & Lucia, 2021). Research indicates that a high protein intake, exceeding 1.2 g/kg/day, is associated with a reduced risk of frailty among older adults (Baltaci et al.). Additionally, protein intake has been shown to offer protective benefits for bone density in the lumbar spine, compared to lower protein intake (Papadopoulou et al., 2021).

Moreover, recent studies highlight the benefits of plant-based proteins for bone health. Diets rich in plant proteins, such as soy products, lentils, and chickpeas, have been associated with improved bone health due to the presence of phytoestrogens, which mimic estrogen and may reduce bone loss, especially in postmenopausal women (Messina, 2014). Therefore, incorporating both animal and plant-based protein sources is beneficial for long-term bone health.

MICRONUTRIENTS

Vitamin D

Vitamin D is a fat-soluble vitamin that functions similarly to steroid hormones. Unlike many vitamins that must be obtained from external sources, vitamin D can be synthesized within the body. Its primary role is to regulate calcium and phosphorus metabolism, which are critical for maintaining bone health (Sintzel et al.). Vitamin D is essential for calcium (Ca^{2+}) and phosphorus (P) homeostasis, as well as for regulating bone remodeling, cell proliferation, and differentiation. Acting as a hormone, vitamin D promotes calcium absorption in the intestines and its storage in bones. Upon exposure to sunlight, the skin synthesizes vitamin D, which is then converted to its active form through the liver and kidneys.

Dietary sources of vitamin D are relatively limited and include egg yolks, certain mushrooms, and oily fish. The vitamin D content in mushrooms and fish varies based on their exposure to sunlight. Moreover, foods that are not naturally rich in vitamin D, such as cereals and milk, can be fortified to help meet daily intake needs (Akbulut, 2019). A deficiency in vitamin D, known for its immunomodulatory, anti-inflammatory, and antiproliferative properties, can lead to reduced bone density and increased risk of osteoporosis (Jagelavičienė et al., 2018).

Vitamin D deficiency is particularly prevalent among older adults, especially those with comorbidities and polypharmacy. In this demographic, low plasma vitamin D concentrations are linked to conditions such as osteoporosis, osteomalacia, sarcopenia, and myalgia. Reduced kidney function in the elderly affects the conversion of vitamin D to its active form, impairing calcium absorption, and contributing to increased risks of falls, fractures, and delayed bone healing. To mitigate deficiency, elderly individuals are encouraged to sunbathe for 20 minutes daily; however, sunlight exposure alone may not be sufficient due to the diminished synthesis capacity of aging skin (Grant & Holick, 2005).

A study of 107 healthy postmenopausal women found that daily consumption of calcium- and vitamin D-enriched milk significantly improved vitamin D status

and increased bone mineral density in the femur. This dietary intervention also had favourable effects on glucose and lipid profiles(Grant & Holick, 2005). The combination of calcium, proteins, and vitamin D in milk plays a crucial role in reducing osteoporosis risk in the elderly (Reyes-Garcia et al., 2018).

Calcium

Calcium is the most abundant mineral in the human body, with 99% stored in bones and teeth, supporting their structure and function. Vitamin D plays a pivotal role in maintaining calcium homeostasis, regulating serum calcium and phosphorus levels, enhancing intestinal calcium absorption, and stimulating osteoclast activity in bones. These mechanisms aim to increase the body's calcium availability to maintain bone integrity. If dietary calcium intake is insufficient, the body compensates by withdrawing calcium from bones, leading to a gradual decline in bone mineral density and an increased risk of osteoporosis (Akbulut, 2019).

Nutritional sources of calcium include milk and dairy products, soy, sesame, nuts and oilseeds, fish and seafood, as well as vegetables like cabbage, beets, and green leafy vegetables. Fruits such as oranges and figs, along with molasses and legumes, also contribute to calcium intake. The bioavailability of calcium from these food sources is generally high, so emphasis should be placed on the quantity consumed rather than solely on bioavailability (Weaver et al., 2024). However, it is important to note that calcium absorption can be lower when derived from legumes, particularly those rich in oxalic and phytic acids, compared to the absorption of calcium from dairy products (Akbulut, 2019; Mahan & Raymond, 2019).

Calcium intake, adjusted for age and gender, is crucial for achieving peak bone mass and reducing the risk of osteoporosis. Postmenopausal calcium deficiency significantly contributes to the development of osteoporosis. To effectively treat osteoporosis, it is essential to ensure adequate calcium intake and maintain a positive calcium balance. This can be achieved by increasing daily calcium intake to 1000-1200 mg. If vitamin D levels are low, a daily dose of 6000 IU of vitamin D is recommended until normal levels are reached, after which a maintenance dose of 1500 IU can be sufficient (Ortega et al., 2020).

Sodium

Sodium, the primary ion in extracellular fluid, is also found in bones, with about 35% of total body sodium stored in the skeleton (Weaver et al., 2024). While sodium is necessary for maintaining fluid balance and cellular function, excessive sodium intake can pose risks to bone health. High sodium consumption

increases urinary calcium excretion, potentially leading to decreased bone density over time (Mahan & Raymond, 2019).

CONCLUSION

Osteoporosis remains a significant public health challenge, particularly as the global population ages and the incidence of the disease increases. This chapter has comprehensively outlined the underlying mechanisms of bone health, the multifactorial nature of osteoporosis, and the pivotal roles of both pharmacological and lifestyle-based interventions. Key strategies such as weight-bearing exercises, optimal intake of calcium, vitamin D, and other micronutrients, along with the inclusion of phytoestrogens and essential fatty acids in the diet, are fundamental in both the prevention and management of osteoporosis. Furthermore, addressing the societal and educational disparities that contribute to increased risk, as well as promoting early identification and intervention, is essential to mitigating the growing burden of osteoporotic fractures and improving quality of life in aging populations. Moving forward, interdisciplinary research that integrates nutritional science, bone biology, and public health initiatives will be paramount in developing innovative approaches to prevent osteoporosis and enhance bone health across all demographics.

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CHAPTER 4

The Relationship Between Obesity and Oxidative Stress

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INTRODUCTION

Obesity is characterized by an extreme accumulation of adipose tissue and arises from a chronic inequality between caloric consumption and energy expenditure (Hernández Bautista et al., 2019). This energy surplus predisposes individuals to a spectrum of metabolic and cardiovascular disorders (Aaseth et al., 2021). Global prevalence of obesity has nearly tripled since 1975, with projections indicating that by 2030, approximately 51% of the worldwide population may be classified as obese (Ahmed et al., 2021). In Türkiye, the situation is particularly concerning, as 34.6% of adults are overweight and 30.3% are obese, underscoring a significant public health challenge (Pekcan et al., 2017).

Oxidative stress (OS), defined as an imbalance between the generation of reactive oxygen species (ROS) and the body's antioxidant defenses, plays a central role in the development of obesity and its related complications (van der Pol et al., 2019). While physiological levels of ROS play essential roles in cellular signaling and homeostasis, their excessive accumulation can inflict cellular damage, including lipid peroxidation, protein oxidation, and DNA fragmentation (Pérez-Torres et al., 2021). Moreover, elevated ROS levels have been implicated in promoting adipogenesis, adipocyte hypertrophy, and chronic inflammation through the activation of various signaling pathways (van der Pol et al., 2019).

This chapter aims to shed light on the complex relationship between OS and obesity, examining the mechanisms through which ROS contributes to the onset and progression of obesity. Moreover, it seeks to identify potential preventive strategies, focusing on dietary and lifestyle interventions that may help mitigate OS and its harmful effects.

THE RELATIONSHIP BETWEEN OBESITY AND ADIPOSE TISSUES

Obesity is characterized by the excessive accumulation of adipose tissue (Song & Kuang, 2019), a condition that has reached epidemic proportions in both developed and developing countries (Simonson et al., 2020). Adipocytes, the predominant cellular components of adipose tissue, function not only as energy storage units but also as active endocrine organs. They secrete a variety of bioactive molecules, collectively known as adipokines, including adiponectin, leptin, resistin, visfatin, adipsin, apelin, tumor necrosis factor-alpha (TNF-α), and interleukin-6 (IL-6), which play crucial roles in regulating metabolic processes and inflammatory responses (Moreno-Fernandez et al., 2022). The health complications associated with obesity exhibit regional variations. For instance, in countries such as China, Russia, and South Africa, obesity is closely linked to

hypertension, diabetes, and arthritis, whereas in India, hypertension remains the predominant associated condition (Mayoral et al., 2020).

Adipose tissue is classified into two distinct types based on morphology and function: white adipose tissue (WAT) and brown adipose tissue (BAT). WAT, the predominant form, functions as the main energy reservoir by storing excess energy as triglycerides. During periods of caloric surplus, WAT expands by converting free fatty acids into triglycerides, which are stored in lipid droplets surrounded by regulatory proteins (Marcelin et al., 2019).

In humans, white adipose tissue (WAT) is primarily found in two regions: subcutaneous fat, located beneath the skin, and visceral fat, which surrounds internal organs. Excessive visceral fat is strongly associated with an increased risk of cardiometabolic conditions, such as type 2 diabetes mellitus (T2DM), whereas subcutaneous fat is comparatively associated with lower health risks (Marcelin et al., 2019). Despite these differences, the underlying mechanisms that govern the distinct distribution of fat between these depots remain inadequately understood and require further research to be fully elucidated.

Conversely, brown adipose tissue (BAT) is metabolically active and facilitates thermogenesis—the physiological process of heat production. Brown adipocytes are distinguished by their high mitochondrial content and the presence of uncoupling protein 1, which is crucial for heat generation. BAT is primarily found in specific anatomical areas in newborns, though small amounts are also present in adults. Exposure to cold or β3-adrenergic stimulation can induce the "browning" of white adipose tissue, leading to the emergence of beige adipocytes within WAT depots. Emerging evidence indicates that this browning process confers protective effects against obesity and related metabolic disorders (Marcelin et al., 2019).

THE RELATIONSHIP OF OBESITY WITH DIET AND LIFESTYLE

The outcomes of dietary and behavioral interventions for weight loss exhibit significant variability among individuals. This variation stems from multiple factors, including the type of diet, level of physical activity, and psychological influences, all of which affect the success of weight loss strategies (Lopez-Minguez et al., 2019). Nutrition and exercise are fundamental components in the prevention and management of obesity and its associated metabolic complications. However, long-term adherence to these interventions remains a significant challenge, often limiting their efficacy (Zhu et al., 2020). Epidemiological evidence consistently highlights the role of specific dietary patterns and lifestyle behaviors in increasing the risk of obesity, particularly among genetically predisposed individuals. For example, the intake of sugar-

sweetened beverages, frequent consumption of fried foods, and sedentary behaviors, in conjunction with genetic susceptibility, amplify obesity risk (Heianza & Qi, 2017).

Among dietary factors, the excessive consumption of fried foods significantly contributes to increased caloric intake and the development of both overall and abdominal obesity. Diets high in saturated fats are also genetically linked to elevated body mass index (BMI) (Heianza & Qi, 2017). Modern fast-food culture exacerbates this issue, as eating quickly is associated with overeating. Junk foods, characterized by high caloric density and elevated levels of carbohydrates and fats, lead to excessive energy intake. Children, in particular, are vulnerable, consuming approximately 20% more calories when consuming junk foods compared to other meal types (Nicolaidis, 2019).

Physical activity plays a crucial role in reducing the risk of diseases such as hypertension, diabetes, and obesity, while sedentary behaviors significantly increase the likelihood of weight gain (Yuksel et al., 2020). Exercise promotes weight loss, enhances lipid profiles by increasing HDL cholesterol and reducing triglycerides, and improves insulin sensitivity, which is among its most notable benefits (Myers et al., 2019). When combined with a low-calorie diet, physical activity creates a negative energy balance, facilitating weight loss (Bilski et al., 2022). For example, hypocaloric diets alone can induce short-term weight loss, but the addition of physical activity is essential for improving body composition, particularly in women with obesity. Moderate exercise, coupled with a hypocaloric diet, reduces body fat, while high-intensity exercise is most effective in preserving muscle mass during weight loss (Hernández-Reyes et al., 2019).

Genomic factors also significantly influence the interaction between diet, lifestyle, and obesity at both individual and ethnic levels. Obesity prevalence is shaped by the interplay of genetic predispositions, environmental exposures, and lifestyle behaviors. Understanding these interactions is crucial for addressing intergenerational obesity transmission (Nicolaidis, 2019). Studies examining the relationships between genetics, physical activity, and obesity suggest that exercise mitigates the genetic predisposition to obesity, while sedentary behaviors, such as prolonged television viewing, exacerbate genetic risk (Heianza & Qi, 2017).

The debate regarding the most effective dietary approach for weight loss remains ongoing. Meta-analyses indicate substantial weight loss can be achieved with both low-carbohydrate and low-fat diets. Genetic variations may influence the effectiveness of these interventions; for instance, individuals with the CC genotype of IRS1 rs2943641 respond better to low-fat diets, whereas those carrying the T allele of PPM1K rs1440581 benefit more from low-carbohydrate

diets (Heianza & Qi, 2017). Family and twin studies suggest that genetic factors account for 40–70% of the variability in obesity susceptibility, despite recent increases in prevalence being largely attributed to environmental changes (Lin & Li, 2021). ariatric surgery is considered one of the most effective interventions for achieving sustained weight loss and improving obesity-related comorbidities (Ciobârcă et al., 2020). Genetic factors are known to influence outcomes following procedures such as Roux-en-Y gastric bypass (RYGB). However, further research is needed to elucidate the genetic mechanisms underlying post-surgical results (Heianza & Qi, 2017). Despite the significant weight loss and comorbidity management associated with bariatric surgery, its widespread adoption is hindered by high costs and potential complications, including anemia and the need for additional surgical procedures (Cerdó et al., 2019).

Given the global rise in obesity rates and the limitations of single-focus interventions, comprehensive, multilevel approaches are gaining traction. Multicomponent strategies—integrating culturally tailored elements such as health education, dietary adjustments, physical activity, reduced screen time, behavioral skills training, and motivational support—have demonstrated greater effectiveness in improving obesity-related health behavior (Lee et al., 2017).

OXIDATIVE STRESS MECHANISM

The term "oxidative stress," introduced by Helmut Sies, refers to an imbalance between the production of oxidants and the efficacy of the body's antioxidant defenses, resulting in potential damage to biological systems (Forman & Zhang, 2021). This phenomenon occurs when antioxidant mechanisms fail to neutralize the overproduction of ROS, which are highly reactive, unstable, and short-lived molecules (Hussain et al., 2021). Factors such as sedentary behavior, excess body weight, and poor nutrition further aggravate ROS production, leading to persistent OS (Poblete-Aro et al., 2018).

This state of imbalance is implicated in the development of several health conditions, including obesity, polycystic ovary syndrome (PCOS), T2DM, and cardiovascular diseases (Dubey et al., 2021; Tan & Norhaizan, 2019). In the context of obesity, increased adipose tissue promotes a pro-inflammatory environment characterized by elevated ROS production (Rezzani & Franco, 2021). Both ROS and reactive nitrogen species (RNS) are consistently generated in the body during oxidative metabolism and mitochondrial energy production. The excessive accumulation of these reactive molecules can damage critical macromolecules, such as DNA, proteins, and lipids, contributing to neuronal cell death and dysfunction across various organ systems (Tan & Norhaizan, 2019).

ROS and RNS are produced through several cellular pathways, encompassing mitochondria, the endoplasmic reticulum, peroxisomes, NAD(P)H oxidases, and monoamine oxidases. Maintaining a balance between ROS production and antioxidant defenses is crucial for preserving cellular integrity. Disruption of this equilibrium results in oxidative damage to cellular macromolecules, which can induce necrotic or apoptotic cell death (Senoner & Dichtl, 2019; Yu & Xiao, 2021).

ROS can be classified into two categories: free radicals and non-radical species. Free radicals are particularly reactive and more abundant; however, both types are generated under normal physiological conditions and influenced by external factors such as drugs, radiation, and environmental toxins. Molecular oxygen, which inherently acts as a free radical, undergoes sequential reduction in various chemical reactions. Examples of ROS include superoxide anions, hydrogen peroxide, nitric oxide, peroxynitrite anions, and hydroxyl radicals. While ROS are natural byproducts of cellular processes, they can also arise from interactions with harmful external agents. Although mitochondria are the predominant source of ROS, other contributors include enzymes such as xanthine oxidase, flavin oxidases, and cytochrome P450 (Dumitrescu et al., 2018).

THE RELATIONSHIP OF NUTRIENTS WITH OXIDATIVE STRESS

OS is significantly influenced by factors such as infections, inflammation, and tobacco smoking, all of which promote oxidative damage in tissues and cells (Kim & Kim, 2018). It plays a pivotal role in the etiology of numerous diseases. For example, postprandial OS, which occurs transiently after meals, can activate inflammatory pathways mediated by nuclear factor-kappa B (NF-κB). Chronic overnutrition exacerbates this process by fostering the growth of white adipose tissue, which secretes pro-inflammatory mediators (Tan et al., 2018). Carbohydrates, including glucose, fructose, and galactose, serve as primary dietary sources of energy and contribute to OS through various enzymatic pathways. ROS are generated via mitochondrial respiratory chain enzymes, xanthine oxidases, lipoxygenases, cyclooxygenases, nitric oxide synthases, and peroxidases (Umbayev et al., 2020).

Oxidative Stress and Antioxidants

OS, largely mediated by free radicals, is well-recognized for its detrimental effects on human health, including its role in the progression of cardiovascular diseases (CVD) and cancer. The body combats free radical damage through enzymatic and non-enzymatic antioxidants, as well as exogenous antioxidants derived from dietary sources(Pizzino et al., 2017).

Nutrient deficiencies can amplify inflammation and OS, impairing immune function. Diets rich in fructose, saturated fats, trans fats, cholesterol, and iron, paired with inadequate copper intake, exacerbate OS. Conversely, dietary antioxidants such as vitamin C, vitamin E, carotenoids, and polyphenols mitigate these effects(Iddir et al., 2020; Yang et al., 2019). For instance, vitamin C acts as a potent water-soluble antioxidant, neutralizing ROS and transforming into a weakly reactive radical, thereby reducing OS and cancer risk. Polyphenols, can contribute to OS under certain conditions by interacting with transition metals, triggering hydroxyl radical formation through Fenton-like reactions. However, polyphenols also enhance antioxidant defense by chelating trace elements and inhibiting ROS synthesis (Pizzino et al., 2017).

Zinc plays a crucial role in modulating metabolic health by regulating cytokine production, reducing inflammation, and activating antioxidant enzymes. Additionally, zinc supports lipid and glucose metabolism, with evidence suggesting that supplementation improves blood pressure, glucose levels, and LDL cholesterol(Olechnowicz et al., 2018).

Recent research highlights the regulatory effects of dietary fats, particularly omega-3 polyunsaturated fatty acids on metabolism. These fatty acids influence antioxidant signaling pathways and modulate inflammatory responses, demonstrating their potential as metabolic regulators (Djuricic & Calder, 2021; Yuan et al., 2021).

The relationship between OS and metabolic disorders has been investigated using both whole-body and tissue-specific models in rodents. Studies involving knockout and overexpression of antioxidant enzymes have provided valuable insights into the causal link between OS and metabolic conditions. These findings suggest that targeting OS in specific tissues may hold promise for preventing metabolic diseases, although further translational research is required to refine these approaches (Hauck et al., 2019).

THE RELATIONSHIP BETWEEN OXIDATIVE STRESS AND OBESITY

Substantial evidence underscores that OS in obesity arises from a combination of factors, including elevated blood glucose levels, increased leptin concentrations, and weakened antioxidant defenses (Di Domenico et al., 2019). High-fat diets amplify OS and inflammation by promoting mitochondrial β-oxidation, which leads to an overproduction of ROS and depletion of antioxidant stores (Li et al., 2023). This oxidative imbalance damages cellular components, including DNA, and disrupts repair mechanisms, thereby fostering tumor growth

and resistance to programmed cell death, which ultimately heightens cancer risk (Furukawa et al., 2017).

Hyperglycemia associated with obesity increases intracellular glucose, intensifying glycolysis and the Krebs cycle. This cascade results in elevated levels of NADH and $FADH_2$, enhancing oxidative phosphorylation and superoxide generation. In obese individuals, adipose tissue contributes significantly to ROS production due to heightened Nicotinamide adenine dinucleotide phosphate oxidase activity and diminished antioxidant enzyme expression (Keaney Jr et al., 2003). Weight reduction has been shown to improve antioxidant enzyme functionality, whereas insufficient intake of essential micronutrients exacerbates oxidative vulnerability. Higher body mass index (BMI) correlates with lower concentrations of vital antioxidants such as carotenoids, vitamin C, and vitamin E (Di Domenico et al., 2019; Furukawa et al., 2017).

The persistent low-grade inflammation observed in obesity is another critical driver of OS. Pro-inflammatory cytokines such as TNF-α, interleukin -6, interleukin -8, and interleukin -1 are overproduced in obesity, activating Nicotinamide adenine dinucleotide phosphate oxidases (NOXs) and further increasing systemic OS (Vincent & Taylor, 2006). Leptin, an adipokine that regulates appetite and energy balance, also impacts vascular health. Elevated leptin levels in obese individuals stimulate ROS production and upregulate monocyte chemoattractant protein-1 (MCP1) expression in endothelial cells, contributing to vascular dysfunction (49).

Moreover, leptin-driven fatty acid oxidation via protein kinase A activation has been implicated in increasing endothelial OS by elevating ROS levels (Zhou et al., 2021).

Obesity is also linked to reduced mechanical efficiency during physical activities, resulting in higher energy expenditure. Increased mitochondrial respiration in obese individuals produces more lipid hydroperoxides and activates Nicotinamide adenine dinucleotide phosphate oxidases, leading to vascular OS through mechanisms involving hydrogen peroxide (H_2O_2). Excess energy substrates in obesity further impair mitochondrial efficiency, disrupting fatty acid oxidation, glucose regulation, and adipokine secretion while intensifying ROS production. Additionally, inadequate dietary intake of antioxidants such as β-carotene, vitamins E and C, zinc, and selenium exacerbates oxidative damage in individuals with obesity(Di Domenico et al., 2019).

Enzymatic antioxidants play a vital role in mitigating ROS levels and preserving cellular homeostasis. Key enzymes such as superoxide dismutase (SOD), catalase, glutathione peroxidase (GPx), heme oxygenase (HO), and

peroxiredoxins (Prxs) are crucial in neutralizing ROS. For example, catalase reduces hydrogen peroxide levels, while HO-1, an inducible variant of heme oxygenase, enhances adipocyte function and insulin sensitivity by regulating adiponectin levels and curbing inflammation (Furukawa et al., 2017). Overexpression of these antioxidant enzymes or targeted antioxidant therapies has shown potential in alleviating metabolic disorders associated with obesity (Zhou et al., 2021).

OS emerges when ROS production surpasses the body's antioxidant defense capacity, leading to cellular damage and metabolic imbalance. Obesity is closely linked to elevated OS levels, with adipose tissue serving as a significant ROS source. In this tissue, ROS are generated through mechanisms involving Nicotinamide adenine dinucleotide phosphate oxidase, xanthine oxidase, and mitochondrial oxidative phosphorylation (Vincent & Taylor, 2006). The excessive ROS production observed in obesity contributes to metabolic dysfunctions, including insulin resistance, dysregulated adipokine secretion, chronic inflammation, and protein carbonylation. Additionally, ROS can modulate adipose tissue dynamics by stimulating adipocyte differentiation and promoting thermogenesis in brown adipose tissue (BAT)(Furukawa et al., 2017). Several enzymatic antioxidants play crucial roles in mitigating ROS levels and preserving cellular integrity within adipose tissue. Key enzymes include superoxide dismutase (SOD), catalase, glutathione peroxidases (GPx), heme oxygenase (HO), and peroxiredoxins (Prxs). These enzymes collectively act to neutralize ROS, thereby maintaining oxidative balance and protecting tissue function (Keaney Jr et al., 2003). Several enzymatic antioxidants play crucial roles in mitigating ROS levels and preserving cellular integrity within adipose tissue. Key enzymes include superoxide dismutase (SOD), catalase, glutathione peroxidases (GPx), heme oxygenase (HO), and peroxiredoxins (Prxs). These enzymes collectively act to neutralize ROS, thereby maintaining oxidative balance and protecting tissue function (Zhou et al., 2021).

CONCLUSION

The complex interplay between OS and obesity is well-documented, illustrating a bidirectional relationship. Obesity amplifies OS through excessive adipose tissue and suboptimal dietary habits, causing cellular damage and chronic inflammation that exacerbate obesity-related complications. Conversely, OS actively contributes to the development and progression of obesity by disrupting cellular processes and metabolic homeostasis. Adopting a balanced diet rich in antioxidants, such as fruits, vegetables, whole grains, and oilseeds, is essential for mitigating oxidative damage. Nutritional supplements, including vitamin C, vitamin E, beta-carotene, zinc, and selenium, also demonstrate potential in reducing OS and its associated risks. In conclusion, addressing the interconnected challenges of OS and obesity requires a focus on preventive strategies, including dietary modifications and healthy lifestyle practices. Such measures can mitigate oxidative damage, improve metabolic health, and reduce the burden of obesity-related complications.

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CHAPTER 5

Oral Manifestations Of Covid-19

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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is an extremely infectious zoonotic virus that emerged in Wuhan, China, in December 2019. Millions of people have been diagnosed with SARS-CoV-2 worldwide and mortality rates range from 3% to 12%. Coronavirus disease 19 (COVID-19) rapidly progresses across the globe. As a result, the disease has been declared as global health emergency, by the World Health Organization (WHO, 20 & 30 Jan 2020) (WHO, 11 March 2020). Since the disease concerns people worldwide, knowing the symptoms and multiorgan manifestations is even more crucial for healthcare providers in multiple specialties, including dentistry.

1. ACTION OF MECHANISM OF SARS-CoV-2

The genome of SARS-CoV-2 was sequenced by Chinese researchers, who determined the virus to be the seventh member of the coronavirus family (Wu et al., 2020). SARS-CoV-2 consists of a linear single-stranded RNA genome including 14 open reading frames that are responsible for encoding various proteins (Yan et al., 2022). One of these proteins is spike protein (S) and the function of viral infectivity is provided by this protein, which is also responsible for the affinity of the virus to host cells. This S protein is critical for receptor binding and viral invasion of host cells, which is an action mechanism of the Coronavirus disease. Factors facilitating SARS-CoV-2 entrance, especially in the oral cavity, include angiotensin-converting enzyme 2 (ACE2), transmembrane protease serine 2 (TMPRSS2), and others. ACE2 is the principal receptor enabling the entrance of SARS-CoV-2 into the cells that are hosts (Jackson et al., 2022).

The fact that ACE2 serves as the principal receptor for viral entry, it is essential to know which sites of the oral cavity consist of these receptors. ACE2 is exists on the tongue, lips, gingiva, buccal mucosa, soft palate, tonsils and blood vessels of the oral cavity (Weiming et al., 2003).

2. GENERAL SIGNS AND SYMPTOMS OF SARS-CoV-2

The SARS-CoV-2 mainly affects the respiratory, gastrointestinal and central nervous system. The transmission ways of the virus are respiratory droplets, aerosols, contact and fomites (Maier et al., 2015). Common symptoms are fever, dyspnea, myalgia and dry cough while less common symptoms are sputum production, hemoptysis, diarrhea and headache. Furthermore computed tomography reveals ground-glass opacities on bilateral lungs of patients diagnosed with Covid-19 (Backer et al., 2020; Jiang et al., 2020).

3. ORAL MANIFESTATIONS OF SARS-CoV-2

Besides the general symptoms the SARS-CoV-2 can give rise to other manifestations including oral cavity. The first oral manifestation associated with the COVID-19 patients was identified by Chaux-Bodard et al. which was an irregular ulcer on the dorsal surface of the tongue (Chaux-Bodard et al.,2020).

Data indicate that the majority of patients exhibit at least one oral symptom (El Kady et al., 2021), whereas one-third show dysgeusia as their initial symptom (Biadsee et al., 2020). The predominant common oral symptoms are dysgeusia, xerostomia and oral mucosal lesions (Amorim dos Santos et al., 2021a). Even though they have been not widely documented, there are other symptoms that are not as common as these three, such as Melkersson-Rosenthal syndrome, trigeminal neuralgia, temporomandibular joint anomalies, macroglossia, masticatory muscle pain and swelling, and facial paralysis (Amorim dos Santos et al., 2021b; El Kady et al., 2021; Farid et al., 2022; Sharma et al., 2022).

A study analyzed the incidence of mucocutaneous presentations in 666 patients diagnosed with COVID-19. The study revealed that about half of patients presented with one or more mucocutaneous manifestations. One-fourth of the patients had oral cavity findings. Burning sensation with taste impairment was also reported in patients (Nuno-Gonzales et al., 2021).

Moreover, oral manifestations can also be seen as a COVID-19 aftereffects since the majority of patients have oral symptoms 3 months after their treatment (Gherlone et al., 2021).

3.1. GUSTATORY DYSFUNCTION

Dysgeusia (altered taste), hypogeusia (reduced taste sensation) and ageusia (complete loss of taste) were the most frequently reported oral symptoms in the literature (Hockova et al., 2021; Eghbali &Pegah, 2021; Ganesan et al., 2022; Farid et al., 2022; Gupta et al.,2023; Abd-Elmonsif & Gamal, 2023; Al-Magsoosi et al., 2023; Alhamed & Aljohani, 2023; Fernandes et al., 2023; Saraf et al., 2023)

A prevalent gustatory impairment among patients diagnosed with COVID-19 is dysgeusia (Garg et al., 2020). Since SARS-CoV-2 needs a receptor to fuse to the host cell, ACE2 is a keystone as a receptor for SARS-CoV-2, which is expressed in some brain regions, indicating the central nervous system as a potential target organ for SARS-CoV-2 (Baig et al., 2020; Generoso et al., 2021) besides that, SARS-CoV-2 is a neurotropic virus that can directly affect the cranial nerves associated with taste impairment (Lozada-Nur et al., 2020).

3.2. XEROSTOMIA

Since the salivary glands express ACE2, SARS-CoV-2 has the ability to infect the salivary glands and cause sialadenitis. As a result, the salivary glands can repair themselves by fibrous connective tissue formation. Nevertheless, it may also cause fibrosis of acinar cells and salivary gland ducts, which obstructs the salivary ducts and causes a decrease in salivary secretion (Wang C. et al., 2020).

3.3. ORAL MUCOSAL LESIONS

According to a study, about one-fifth of patients diagnosed with COVID-19, have oral mucosal lesions (Amorim dos Santos et al., 2021b). Moreoever, if the patient is older, unhygienic, long-term hospitalized or diabetic, they are prone to have oral mucosal lesions and which tend to be more severe, long-lasting and wide-ranging (Iranmanesh et al., 2021). There are also several studies have been described that aphthous-like lesions, herpes simplex virus (HSV) reactivation-related ulcers, oral herpes zoster, oral candidiasis, petechiae, Kawasaki-like disease, gingivitis, and bleeding gums are frequently observed (Amorim dos Santos et al., 2021a; Iranmanesh et al., 2021; Orilisi et al., 2021; Sharma et al., 2022). For comparing the frequencies of these lesions, aphthous-like lesions are observed most (Brandão et al., 2021).

3.3.1 Aphthous-like Lesions

Aphthous-like lesions manifested as several shallow ulcers with erythematous halos and yellow-white pseudomemberanes on the both keratinized and nonkeratinized mucosae. Some individuals had oral lesions concurrently with systemic symptoms, while others presented oral lesions 2–10 days subsequent to systemic symptoms. In addition, one patient suffered from recurrent aphthous stomatitis, and two patients diagnosed with positive herpes simplex virus have been reported (Amorim dos Santos et al., 2020; Putra et al., 2020; Diaz Rodriguez et al., 2020; Brandao et al., 2020; Malih et al., 2020; Dominguez-Santas et al., 2020). Aphthous-like lesions observed with or without necrosis and/or hemorrhagic crusts depended on patients age, severity of the infection, and the degree of immunosuppression. Recovery of oral lesions took 5-15 days and had positive correlation between improvement of systemic disease (Brandao et al., 2020).

The etiology of aphthous-like lesions could depend on chemotaxis of neutrophils to the mucosa of the oral cavity as a result of elevated levels of tumor necrosis factor- α. In addition, as a result of infection, immunosuppression and increased stress levels could be etilogical factors for aphthous-like lesions (Amorim dos Santos et al., 2020).

3.3.2. Herpetiform/Zosteriform Lesions

Herpetiform lesions manifested as several painful, unilateral round ulcers with a yellowish-gray appearance and an erythematous border, affecting both keratinized and non-keratinized mucosal surfaces. The occurrence of these lesions was noted to either precede, coincide with, or follow systemic symptoms. In one reported case, a geographic tongue emerged subsequent to the resolution of herpetiform lesions. It was suggested that the immunosuppression and stress associated with COVID-19 contributed to the emergence of secondary herpetic gingivostomatitis (Amorim dos Santos et al., 2020; Aghazadeh et al., 2020; Indu, 2020; Kämmerer et al., 2020; Martín Carreras-Presas et al., 2021).

A different study evaluated the Herpes Zoster as an indicator of latent COVID-19 infection. The study suggests that since SARS-CoV-2 could directly infect lymphocytes, which eventually leads to lymphopenia and decreased antiviral responses, then latent Varicella Zoster can be reactivated (Zeng et al., 2022). So the study stated that patients with Herpes Zoster symptoms should be evaluated as an alarming sign of a recent unsymptomatic SARS-CoV-2 infection (Elsaie et al.,2020).

3.3.3. Oral Candidiasis

Recent research has shown that candidal infections were one of the most commonly observed oral lesions in patients hospitalized due to COVID-19 (Alhamed & Aljohani, 2023). Oral candidiasis may occur concurrently with a coronavirus infection or shortly after the initial recovery phase (Horzov et al., 2021) and is associated with hyposalivation, corticosteroids, antibiotics (Scully, 2008), general health impairment, and poor oral hygiene. Oral candidiasis may occur as either white or red lesions. Pseudomembranous candidiasis (thrush) can be seen as white patches or plaques on the dorsum or lateral borders of the tongue, palatinal mucosa, or buccal mucosa; erythematous candidiasis occurs as a flat red lesion on the dorsum of the tongue or palatal mucosa in patients with COVID-19 (Scully, 2008; Iranmanesh et al., 2021).

3.3.4. Petechiae

Several studies have reported the presence of petechiae on the lower lip, palate, and oropharyngeal mucosa. Thrombocytopenia, either resulting from the COVID-19 infection or as a adverse effect of medications prescribed, has been proposed as a potential cause of these petechiae (Cebeci & Çaşkurlu, 2009; Corchuelo & Ulloa, 2020; Jimenez-Cauhe et al., 2020a; Jimenez-Cauhe et al., 2020b).

3.3.5. Pigmentation of Oral Mucosa

A previous case report revealed a pigmentation in the attached and interpapillary gingiva of a patient with a COVID-19 diagnosis. This post-inflammatory pigmentation could be caused by elevated levels of inflammatory cytokines, such as interleukin-1 (IL-1) and tumor necrosis factor (TNF), as well as arachidonic acid metabolites like prostaglandins, which are produced by the basal layer keratinocytes through the synthesis of basic fibroblast growth factor (bFGF) and stem cell factor (SCF) (Corchuelo & Ulloa, 2020).

3.3.6.Angular Cheilitis

A recent study reported angular cheilitis in two patients with coronavirus disease (Díaz Rodríguez et al., 2020). Another study revealed that more than half of the patients with COVID-19 had unilateral reddish swollen patches on the left commissure, and some of the patients had on the right commissure, or bilateral commissures. In addition to angular cheilitis, some of the patients had generalized cheilitis. Age and gender showed no significant correlation with angular cheilitis. The patients complained of pain and were administered symptomatic treatment, which included mouthwash of Chlorhexidine Gluconate 0.3% and antifungal ointment of Nystatin to alleviate their pain (Riad et al., 2022).

The etiology of angular cheilitis may arise from the increased salivation reported by patients, as the enzymes in saliva can irritate the skin at the corners of the mouth, leading to maceration and subsequent tissue degradation (Park et al., 2011).

3.3.7. Kawasaki-like Syndrome

A study of 59 laboratory-confirmed COVID-19 cases indicated that the predominant oral manifestation, observed in about half of the patients, is Kawasaki-like syndrome characterized by oral mucosal abnormalities such as cracked and/or dry lips, and cheilitis with or without erythema of the oral mucosa. The patient with Kawasaki-like syndrome is also noted to frequently experience severe COVID-19 or necessitate hospitalization (Erbaş et al., 2022).

3.3.8. Erythema Multiforme

Erythema multiforme is an acute cutaneous eruption frequently correlated with infections and, less commonly, to pharmaceuticals. A previous study has described erythema multiforme as a rare symptom of COVID-19. The study considers 70 patients who were diagnosed with COVID-19. These cases with erythema multiforme are categorized in three groups, the virus-related juvenile type, the virus-related older type and the drug-induced type mainly due to

hydroxychloroquine which is as drug using for COVID-19 treatment (Bennardo et al., 2021). Yet, a recent research study that conducted 36 patients with erythema multiforme revealed no cases due to COVID-19 (Gungor et al., 2024).

3.3.9. Melkersson-Rosenthal syndrome

A case report described a patient who presented with unilateral lip swelling, right facial paralysis, fissured tongue, and malaise. The patient had been diagnosed with Melkersson-Rosenthal syndrome four years prior and had experienced spontaneous recovery. In this instance, it was suggested that COVID-19 may have induced a recurrence of Melkersson-Rosenthal syndrome; yet, the patient achieved complete recovery following treatment for the COVID-19 infection (Taşlıdere et al., 2020).

3.3.10. Angina bullosa-like lesions

In two confirmed cases of COVID-19, angina bullosa-like lesions occurred as erythematous-purple blisters on the tongue and hard palate, without any symptoms or spontaneous bleeding (Cruz Tapia et al., 2020).

3.3.11. Atypical sweet syndrome

Previous case report about COVID-19 diagnosed patients with symptoms such as arthralgia, myalgia, fatigue, fever, several erythematous nodules on the body, and minor aphthous ulcers on the hard palate and buccal mucosa. Histopathologic examination of skin revealed diffuse neutrophilic and granulomatous infiltration areas which was consistent with erythema nodosum-like Sweet syndrome (Taşkın et al., 2020).

3.3.12. Hairy Tongue

Black hairy tongue has been frequently observed in studies related to COVID-19. The coloration can range from yellow-brown to black, and it primarily affects the anterior and middle thirds of the dorsum of the tongue. This condition is thought to result from a desquamation of epithelial cells and the overgrowth of chromogenic microorganisms (Scully, 2008). Individuals who smoke, maintain poor oral hygiene, or experience reduced saliva production are more prone to developing black hairy tongue. Additionally, several underlying factors have been identified that could contribute to its occurrence, including the use of NSAIDs, certain antibiotics such as tetracycline, amoxicillin, bismuth, and linezolid, as well as psychotropic medications like phenothiazines, olanzapine, and tricyclic antidepressants. (Scully, 2008; Mohseni Afshar et al., 2022).

3.3.13. Necrotizing Periodontal Disease

There has been an increase reported in the incidince of acute periodontal lesions, particularly necrotizing periodontal disease, corresponding with the rise in confirmed COVID-19 cases. The development of necrotizing periodontal disease may be linked to bacterial co-infections present in the oral cavity of patients with COVID-19. Individuals infected with SARS-CoV-2 often reveal significantly elevated levels of bacterial presence, particularly Prevotella intermedia, which is recognized as a key bacterial species responsible for necrotizing periodontal disease (Herrera et al., 2018; Chakraborty, 2020).

4. CONCLUSION

The most common oral manifestations of COVID-19 are gustatory dysfunction, xerostomia, and oral mucosal lesions. There are studies about whether these manifestations are a sign of the disease or secondary manifestations due to the treatment of the disease or from a former systemic condition. Either way, dentists should be aware of the oral manifestations of the disease and should have adequate knowledge about the initial symptoms of the disease seen in the oral cavity before the diagnosis of patients with COVID-19 to refer the patient to the physician on time.

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CHAPTER 6

Strategic Partners Of Public Health Nurses in Preventing Youth Substance Use; Religious Leaders

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Abstract

The problem of substance addiction is a serious security problem that harms young generations and threatens the future of society. The increasing prevalence of substance addiction all over the world and the difficult and long treatment process of addicts after addiction develops have caused prevention programs to gain increasing importance all over the world. Prevention programs aim to prevent the harm that the use of addictive substances will cause to the physiological, psychological and social life of the person and the negative effects on the society. In addition, the information and awareness-raising activities carried out for the society to develop healthy behaviors are also included in the scope of prevention studies. In this respect, the focus of the roles undertaken by public health nurses is on health promotion and preventive services. Public health nurses have many roles within the scope of public health promotion and preventive services. Inter-institutional cooperation is of great importance in the prevention of substance addiction. Religious leaders are one of the most important stakeholders and strategic partners of the multidisciplinary team in the studies to be carried out on developing healthy habits, adopting a healthy lifestyle, preventing addiction and combating substance addiction in terms of their characteristics such as public speaking, oratory, effective communication, religious knowledge and having trust-based relationships with the society. In this respect, the inclusion of religious leaders in the prevention activities and joint efforts will make a great contribution to the efforts to prevent substance use among young people.

Keywords: Religious Leaders; Public health; Substance Addiction; Struggle

Gençlerin Madde Kullanımını Önlemede Halk Sağlığı Hemşirelerinin Stratejik Ortakları; Dini Liderler

ÖZET

Madde bağımlılığı sorunu genç nesillere zarar veren ve toplumun geleceğini tehdit eden ciddi bir güvenlik problemidir. Madde bağımlılığının tüm dünyada giderek artması, bağımlılık geliştikten sonra bağımlı kişilerin tedavi sürecinin zor ve uzun bir süreci kapsaması, önleme programlarının tüm dünyada giderek önem kazanmasına sebep olmuştur. Önleme programları, bağımlılık yapıcı maddelerin kullanımının kişinin fizyolojik, psikolojik ve sosyal yaşantısına vereceği zararları ve toplum üzerindeki olumsuz etkilerini engellemeyi amaçlamaktadır. Ayrıca toplumun sağlıklı davranışlar geliştirmesi yönünde yapılan bilgilendirme ve farkındalık oluşturma çalışmalarıda önleme çalışmaları kapsamında yer almaktadır. Bu açıdan halk sağlığı hemşirelerinin üstlendiği rollerin odağında sağlığı geliştirici ve koruyucu hizmetler bulunmaktadır. Toplum sağlığını geliştirici ve koruyucu hizmetler kapsamında halk sağlığı hemşiresinin birçok rolü vardır. Madde bağımlılığının önlenmesinde kurumlar arası işbirliği büyük öneme sahiptir. Topluluk önünde konuşma, hitabet, etkili iletişim, dini bilgi ve toplum ile güvene dayalı ilişkilere sahip olma özellikleri açısından dini liderler, sağlıklı alışkanlıklar geliştirme, sağlıklı bir yaşam tarzının benimsenmesi, bağımlılığın önlenmesi ve madde bağımlılığıyla mücadele ile ilgili yapılacak çalışmalardaki multidisipliner ekibin en önemli paydaşlarından ve stratejik ortaklarından biridir. Bu açıdan yapılacak önleme faaliyetlerinde dini liderlerin çalışmalara dahil edilmesi, ortak çalışmalar yapılması gençlerde madde kullanımını önleme çalışmalarına büyük katkı sunacaktır.

Anahtar kelimeler: Dini Liderler; Halk Sağlığı; Madde Bağımlılığı; Mücadele

1. Introduction

In recent years, one of the most important factors threatening public health is substance addiction. (Demirel, et al., 2015; Gövebakan and Duyan, 2015, Işık, 2018; Ögel, 2018; Aktürk, et al., 2019; Eryılmaz and Deniz, 2019). In addition to the problems it causes in individual dimensions such as the physical and mental health of the user, economic status, and career success, substance addiction also negatively affects the individual's social relations in society, family, and social environment to which he or she belongs (Karataşoğlu, 2013; Köroğlu, 2016; Adıbelli, et al., 2017; Taylan and Genç, 2017; Çalışkan, 2018; Uzbay, 2018; Ögel, 2018; Aktürk, et al., 2019; Eryılmaz and Deniz, 2019). There are many negative aspects of addiction that are reflected in society from the beginning to its treatment. As a result of the social and economic difficulties brought about by addiction, addicted individuals can commit illegal actions and crimes (Çalışkan, 2018; Atlam and Kaylı, 2019; Epsoylu and Nehir, 2019; Topçuoğlu, 2020). While substance addiction causes an increase in crime rates on the one hand, it also causes various material and moral damages economically. For this reason, it is not possible to keep addiction separate from the social structure (Taylan and Genç, 2017; Çalışkan, 2018; Örselli and Babahanoğlu, 2019; Aktürk, et al., 2019; Dağlı, 2019; Epsoylu and Nehir, 2019; Eryılmaz and Deniz, 2019; Topçuoğlu, 2020).

Although addiction is quite difficult, laborious, costly and time-consuming to treat and recover after it develops; it is a brain disease with a very low recovery rate and a high risk of relapse (Uzbay, 2015; Tırışkan, et al., 2015; Özbay, et al., 2018; Tarhan and Nurmedov, 2018; Dağlı, 2019; Kariper and Metin, 2020). The cost of long-term treatments for addiction is quite high for society. In addition, despite all the improvements made, one of the most common problems in the treatment of substance use disorders is the problem of re-using substances and relapse during the follow-up period, despite the fact that patients benefit greatly from treatments in the acute phase (Kargın and Hiçdurmaz, 2018; Sevin and Erbay, 2019; Kulaksizoğlu, et al., 2020).

The increasing prevalence of substance addiction all over the world and the difficult and long treatment process of addicts after addiction develops have caused prevention programs to gain increasing importance all over the world (Ögel, 2018). In recent years, since access to substances has become much easier, rather than preventing the person from accessing the substance, ensuring that they recognize and accept the substance when they come across it and protect themselves from the substance has gained importance and has been included in the scope of prevention studies (Özbay, et al., 2018). Preventive struggle methods are of great importance in delaying the age of starting to use cigarettes, alcohol

and drugs, making it difficult to try and use other substances, and preventing the occurrence of diseases and deaths related to these substances (Botvin and Griffin, 2004; Ögel, et al., 2004; Siyez and Palabıyık, 2009; Özbay, et al., 2018; Dağlı, 2019). It has been observed that the cost of all preventive services provided for prevention is lower than the cost of interventions for treatment. It has been shown that every dollar spent on prevention saves up to $10 on treatment for alcohol or other substance abuse (NIDA, 2003; UNODC, 2015; 2018; Ögel, 2018).

Prevention programs have a very important place in the fight against substance addiction because they protect society from the negative consequences of substance use and benefit from the positive aspects of not using substances (Siyez and Palabıyık, 2009; Akbaş and Mutlu, 2016; Ögel, 2018). The general objectives of the programs to be implemented for prevention are; Preventing substance use and new onset in young people and other age groups, preventing the development of addiction, preventing individual and social problems created by these substances, ensuring the development of healthy behaviors in society, providing information about substances that cause addiction, introducing risk factors, gaining and increasing the sense of responsibility and decision-making skills, developing the skills of saying no to substances, providing behavioral change, increasing communication and social skills, gaining skills to cope with substance cravings, raising young people who are healthy, independent, creative, productive and qualified in terms of physical, mental, emotional and social aspects (Şimşek, 2010; Kesgin, 2012; Kostak, et al., 2014; Arabacı, et al., 2017; 2018; Kabasakal and Çelik, 2017; Ögel, 2018; Yılmaz and Sözer, 2018; Ulu, 2018; Kariper and Metin, 2020; Yoldaş and Demircioğlu, 2020). Raising young people as useful individuals who contribute to society is not only about public health, but also about economic efficiency (Ulu, 2018). The youth becoming more productive by not using substances will also accelerate social and economic development. Therefore, with prevention, society will be protected from the negative consequences of substance use, and the positive aspects of not using substances will be utilized (Ögel, 2018; Ulu, 2018). One of the most important preventive activities is the identification of young people at risk of becoming addicted to substances. At this stage, the aim is to get to the bottom of the problem, reach young people with the potential to become addicted, identify problems before the problem becomes more complicated, and implement solution suggestions. In this respect, the basis of preventive activities is to provide training according to the relevant age range. Activities should be carried out to raise awareness among the identified risky young people, their families, these groups, as well as the general society, about substance addiction, the effects of narcotic and stimulant substances, and methods of protection from this risk. Both the creation of

awareness in the society in general and the effective use of visual and written publication tools in the awareness-raising phase can increase the functionality of the protective dimension (Asan, 2015). Considering all these risks, education/prevention studies constitute one of the important pillars of the fight against drugs (TUBİM, 2023). The aim of prevention/education studies is to raise awareness and protect all segments of society.In this respect, preventive studies are becoming increasingly important among the studies carried out in the fight against substance addiction. (Ögel, 2018; TUBİM, 2020).

Preventing drug use and drug-related problems among young people is an important goal for European national drug strategies and covers a wide range of approaches (EMCDDA, 2019). The World Drug Report (2020) stated that the aim of preventing drug use is to prevent the onset of drug use and to prevent or delay the transition to drug use disorders, and that professional training is important for the successful implementation of prevention approaches (UNODC, 2020). In addition, the World Drug Report for 2024 emphasized that much more investment should be made in prevention due to the increasing use of drugs (UNODC, 2024).

Inter-institutional cooperation is of great importance in preventing substance addiction. Since the fight against substance addiction is a problem that concerns the whole society, it is not only the duty of institutions consisting of state bodies but also of all institutions, civil society organizations and all citizens within the scope of social responsibility. Therefore, in the fight against substance addiction, all institutions that concern people, such as schools, mosques, hospitals, universities, police and media, should cooperate, especially the family (Mutlu, 2013; Işık, 2018). The most appropriate method is to fight together in every area of life, such as guidance counselors in schools, academicians in universities, religious officials in mosques and experts in the media. If cooperation between institutions can be ensured in the fight against substance addiction and a coordinated fight can be carried out, success can be achieved.(Eryılmaz and Deniz, 2019; TUBIM, 2023; BMYK, 2024).

2. The Role of The Publıc Health Nurse In Fıghtıng Agaınst Substance Addıctıon

The World Health Organization has defined public health nursing as a special branch of nursing that works to improve the health of individuals, families and communities, to make the physical and social environment positive and to protect communities from disease and disability, and that includes public health and social assistance (WHO, 2001). The American Public Health Association (APHA, 2013), the Canadian Public Health Association (CPHA, 2010) and the

International Council of Nurses (ICN, 2014) have defined public health nursing as the practice of protecting and developing the health of communities using the knowledge of nursing, social sciences and public health. Public health nursing is a special field of practice within nursing and public health that deals with the multiple determinants of health and focuses on the development of community health by emphasizing prevention. The service target of public health nursing is stated as "healthy population" and the service area is stated as "every place where this population lives" (APHA, 2013; Özsoy & Koca, 2015; Daghan, 2017; Rosa, 2017).

The roles undertaken by public health nurses focus on health promotion and preventive services. Public health nurses have many roles within the scope of community health promotion and preventive services. Within the scope of the educational role, public health nurses carry out planned trainings using different educational methods to provide healthy lifestyle behaviors to the whole society, especially to young people, and to protect and develop health. Within the scope of the spokesperson role, public health nurses sensitize the society to existing or potential problems in the society and work as the public spokesperson on the issues that the society needs. Individuals and families in the society sometimes encounter problems that they have difficulty solving. Especially in terms of addiction, families have problems about what to do to protect their children and prevent them from becoming addicted, or how to behave after their children become addicted. In such cases, within the scope of the counseling role, the public health nurse provides consultancy in solving these health problems that disturb the individual and the family (Taylan, et al., 2012; Allender, et al., 2014; Erci, 2016; Stanhope and Lancaster, 2016; Gedük, 2018; Gövebakan and Duyan, 2015). In addition, public health nurses use their collaborative role to meet the needs of addicted individuals, their families and the society and to providedeveloping positive health behaviorscooperates with other health professionals and authorized institutions and organizations on behalf ofmobilizes them.Guides and supports individuals with mental disorders to use social support resources. It carries out and takes part in programs to combat community mental health beliefs, attitudes and stigma. All people at risk of mental health problems, such as children, adolescents, women, the elderly, the unemployed and the disabled, living in areas with low socio-economic levels, at risk of substance abuse,mgroups play a role in protecting and maintaining mental healthr and supportivecreates programs. Risky behaviors that may occur during adolescence (smoking, alcohol and substance addiction),(e.g. suicide, violent behavior, risky sexual behavior, etc.) moreperforms. In this context, with the role of education and counseling to the adolescent, family and societyprovides consultancy.

Organizes community support systems to assist individuals and families.Collaborates with religious leaders to meet the need for spiritual counseling and guidance (Albayrak and Balci, 2014; Terzi and Alkaya, 2017). Religious leaders, in terms of their characteristics of public speaking, oratory, effective communication, religious knowledge and trust-based relationships with society, are one of the most important stakeholders of the multidisciplinary team in the studies to be carried out on developing healthy habits, adopting a healthy lifestyle, preventing addiction and combating substance abuse (Anshel and Smith, 2013; Topuz, 2015; Dagli, 2019)

3. The Role of The Relıgıous Leader In Fıghtıng Agaınst Substance Addıctıon

In the fight against addiction, the faith-based approach has been expressed as a new approach that should be used in recent years (Kızmaz and Çevik, 2016). A study has shown that religious orientations can solve problems related to meaninglessness such as suicide, unhappiness, insecurity, and alienation and contribute to individuals living more meaningful and peaceful lives (Gürses and Kuruçay, 2018). In some studies, it has been determined that religious belief-based approaches contribute to the solution of many chronic illnesses and mental health problems, and that as religious belief increases, conditions such as depression, suicide, anger, anxiety, and panic disorder decrease (Korkmaz, 2010; Dein and Kimter; 2014; Hökelekli, 2015; Dağlı, 2019; Gürsu, 2017; 2018; 2020). The most important effect of religion in terms of psychological health is the explanations it brings about worldly life and the values it reveals, as well as the meaning it gives to human life. The religion-psychological health relationship is also valid for the religion-addiction relationship (Gürsu, 2020). Studies examining the relationship between spirituality and health generally reveal that spiritual feelings prevent people's bad habits and encourage people to live healthy, eat healthy and live a planned life (Al-Omari, et al., 2014; Moscati and Mezuk, 2014; Boztilki and Ardıç, 2017; Gürsu, 2020). In this respect, spirituality is shown as a protective/preventive factor against substance addiction (Giordano, et al., 2015; Gürsu, 2020). Spirituality has a preventive role in solving people's addiction problems, staying away from addictive substances and not using them (Giordano, et al., 2016; Boztilki and Ardıç, 2017).

In addition to all belief systems characterizing actions such as alcohol and substance use, theft, and harming people as crimes or sins, religion also has a reducing effect on the tendency to commit crimes as it contributes to the development of a positive cognitive state in individuals (Anshel and Smith, 2013; Çoban, 2016). When the studies are examined, it is seen that the factor of

spirituality and faith has a decisive role in reducing the tendency of the individual to substance use (Anshel and Smith, 2013; Al-Omari, et al., 2014; Moscati and Mezuk, 2014; Drabble, et al., 2016; Giordano, et al., 2016; Gürsu, 2018; Akıncı and Kesgin, 2018; Noegroho, et al. 2018). Alcoholics Anonymous, an institution in the United States that treats alcohol addicts, has helped many people recover from substance addiction with its 12-step program based on religion (Walton-Moss, et al., 2013; Gürsu, 2018). The services implemented by these programs are referred to as "Clinical Spiritual Support Services". When the content of these services is examined, it includes different activities such as various religious rituals, ceremonies, prayer, meditation, reading the Bible and other holy books (Longshore, et al., 2009; Akıncı and Kesgin, 2018). A spiritual perspective on life increases the ability of individuals to overcome a number of traumatic events. (Çoban, 2016).

In England, community ministry units have been established in approximately 12 centers including Wales to help solve the health problems of prisoners released from prisons and to treat former prisoners who are addicted to substances (Çoban, 2016). In a study titled The Role of the Church in Adolescent Drug Education, it was determined that the church is an important tool for drug education and that drug education provided by the church leads to improvement in substance use behaviors when adolescents are highly involved in church activities and attach importance to the church activities they are involved in (Kutter and McDermott, 1997). Gerald et al. (2007) conducted a study based on Christian belief titled "A Faith-Based Practice for Black Women Addicted to Cocaine". The study included homeless, cocaine-addicted and mother-aged black women. It was determined that those who participated in spirituality-based practices recovered 75% faster than those who did not participate, accelerated the treatment process and contributed to the recovery process (Gerald et al., 2007). BeitT'shuvah Synagogue is a rehabilitation center based on Jewish beliefs. Rehabilitation, therapy and counseling practices operate through meditations, joint prayers and different group activities within the framework of Jewish teachings. The 12-Step Therapy Model is shaped and implemented in this center according to the Jewish belief (Loewenthal, 2014; BeitT'shuvah, 2021). Chabad Residantial Treatment Center, which operates according to the principles of the Jewish faith and focuses on the Torah, the holy book of the Jews, has been providing services since 1972. When we look at the programs implemented by the center, there are optional sports activities such as nature climbing, morning walks, fitness practices, as well as spiritual rituals, group therapies and religious rituals such as Shabbat (Akıncı & Kesgin, 2018; Chabad Residential Treatment Center, 2021).

The following is stated about addictive substances in the Islamic faith; In the verse 90-91 of the Surah Al-Maidah of the Holy Quran, it is stated as follows: “O you who believe! Intoxicants, gambling, idols and divining arrows are abominations from Satan. Avoid them so that you may be successful. Indeed, Satan wants to stir up enmity and hatred among you through intoxicants and gambling and to hinder you from the remembrance of Allah and from prayer. So will you not desist? (Al-Maidah, 5: 90-91). According to what is narrated from Ibn Omar, the Prophet Muhammad (pbuh) said: “Everything that intoxicates is intoxicants and everything that intoxicates is forbidden (Muslim, Eşribe, 74).” Jabir b. According to what is narrated from Abdullah, the Prophet Muhammad (pbuh) said: “What intoxicates in large quantities, a little of it is also forbidden (Tirmizi, Eşribe, 3; Abu Dawud, Eşribe, 5). When we look at the verses in the Holy Quran and the statements of the Prophet Muhammad (pbuh), according to the Islamic belief, the use of all addictive substances is strictly forbidden because they are harmful to health.

Considering the respect and trust felt towards religious leaders in Turkish society; it is possible to say that the integration of religion into the social service counseling mechanism will yield very positive results (Çoban, 2016). Religious leaders have a strong influence on the behavior of others, especially regarding healthy behavioral changes (Anshel and Smith, 2013). In addition, religious leaders, who are leaders in informing the society about religion, have been the consultants that people have consulted throughout history to find solutions to their problems (Karasakal, 2014; Topuz, 2014). When we look at the studies, it is seen that people apply to religion and religious officials, which they see as a source of spiritual peace and relaxation, in order to find solutions to their problems, to solve their psychological, family, etc. problems, and they receive help from religious officials to solve the problems they perceive or experience (Altaş, 2000; Topuz, 2014; 2015). In the study conducted by Dağlı (2019) on the role of religious officials in the fight against addiction policy; It was determined that 41.4% of the religious officials had met an addict before, 76.5% thought they could help an addict, 30.1% had helped someone addicted before, 94.5% thought that helping an addict was a moral responsibility, 90.2% would support programs to solve addiction if possible in order to fulfill their responsibility, and 94.2% thought that they should deal with addiction among their duties.

Considering that religious leaders have the duty to counsel and guide people and that there is a mosque or masjid in every district, neighborhood and settlement, it is seen that they can reach more individuals and families in the field. In this context, it is understood that religious leaders' effective role in providing young people with healthy lifestyle behaviors, protecting them from substance

addiction and directing addicts to treatment will make a great contribution to the efforts to prevent substance addiction (Topuz, 2015; Dağlı, 2019). In the Working Principles and Procedures on Addiction Combat Services of the Presidency of Religious Affairs of Turkey (2017); it is stated as; to cooperate with the relevant institutions, organizations and civil society organizations in addiction combating efforts through the provincial mufti, deputy provincial mufti, district mufti or coordinator, to organize sermons, sermons, special guidance programs, training, conferences, panels, socio-cultural events etc. within the scope of combating addiction, to work for the presidency personnel to receive the necessary training within the scope of combating addiction.

In order to prevent addiction and achieve success in the fight against it, multidisciplinary studies should be conducted. In order to ensure the sustainability of protective and preventive programs so that they can be carried out effectively and comprehensively, all stakeholders, practitioners, politicians, non-governmental organizations, relevant institutions, youth representatives and researchers should be included and cooperation should be established (Bernhardt, et al., 2014; Ögel, 2018). In this context, religious leaders and public health nurses who have a common working area within the framework of the fight against substance addiction will progress faster and more effectively in this fight with a multidisciplinary work in cooperation. Religious leaders are in a unique position to run a health behavior program because they have communication skills, knowledge of religious texts and trust-based relationships with people (Anshel and Smith, 2013; Schoenberg and Swanson, 2017; Demir, 2020). In addition, educational programs aimed at preventing substance use and addiction conducted in the world and in Turkey; It includes skill trainings aimed at informing young people, parents, schools and society about the substance use and addiction process in children and adolescents and providing effective coping strategies to combat these situations. The target audience in these training programs is generally young people between the ages of 13-25, who need the guidance and support of adults (Yoldaş and Demircioğlu, 2020). In a study, it was stated that religious officials working in mosques answer an average of more than 100 questions a year on various occasions on religious and moral issues (Onay, 2006). In another study, it was determined that 36% of people consulted the mufti, assistant muftis, religious officials working in the mufti's office, 24.6% consulted the mosque religious officials and 18.9% consulted the Quran Course instructors about their religious questions or problems (Topuz, 2014). In a study conducted with religious officials, when the areas of counseling were examined; It was determined that 76% of them provided consultancy on family communication (domestic violence, divorce, marriage, relationships between spouses, child

education, etc.), 70% on psychological problems, and 32% on substance addiction. In another study conducted with religious officials, it was stated that the number of questions asked to mosque religious officials increased depending on the population density (Topuz, 2015).

4. Conclusıon

The most basic work carried out to protect and improve health, which is one of the primary duties of the public health nurse, is education. Expanding education activities and reaching more young people is very important for preventing substance addiction within the scope of protecting and developing health. In this context, it is seen that religious leaders can contact more individuals and families in the field since there is a mosque or masjid in every district, neighborhood and settlement. The services and activities of religious leaders are not limited to the mosque community, but are aimed at all segments of society. In addition, religious leaders have the duty of counseling and guiding people. It is an inevitable fact that religious leaders will make a great contribution to the fight against substance addiction by informing young people and families and taking part in prevention activities and also by directing them to the necessary institutions and organizations for treatment. (Topuz, 2015; Dağlı, 2019). On the other hand, the symbolic value of the mosque has a central importance in the society. Similarly, it is a fact that religious leaders have respect and reliability in the community due to the duty they carry out (Onay, 2006). In this respect, when we look at the community leaders who need to cooperate in preventing substance abuse among young people, we see that religious leaders have a very important role and are a strategic partner in preventing substance abuse. In this respect, the inclusion of religious leaders in the prevention activities and joint work will greatly contribute to the efforts to prevent substance abuse among young people.

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CHAPTER 7

Enhancing Upper Limb Function in Stroke Rehabilitation

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ABSTRACT

This paper focuses on the evaluation and treatment of upper extremity impairments following stroke, with an emphasis on functional recovery and improving motor performance. Stroke often results in a wide range of motor deficits, with upper limb weakness and spasticity being common challenges. Addressing these issues early in rehabilitation is crucial for enhancing functional independence and quality of life. A variety of assessment tools, including goniometers, hand-held dynamometers, the Tardieu Scale, and functional tests like the Action Research Arm Test (ARAT), are employed to evaluate motor function, strength, and spasticity. Based on these evaluations, a personalized treatment program is designed, typically incorporating task-specific repetitive training, strengthening exercises, and strategies to manage spasticity, such as stretching exercises, orthotics, and transcutaneous electrical nerve stimulation (TENS).

Key rehabilitation strategies include providing external feedback to improve motor learning, using task-specific exercises to enhance cortical reorganization, and incorporating both group and home exercises to foster patient engagement and long-term recovery. The use of mental practice in combination with physical exercises has been shown to facilitate motor function improvements. Additionally, reassessment and adjustment of treatment goals based on progress are vital for optimizing outcomes. This comprehensive approach, combining various therapeutic modalities and outcome measures, aims to improve upper limb function, reduce spasticity, and ultimately increase the patient's independence and quality of life following a stroke.

Keywords *– Stroke; upper extremity; evaluation; treatment; motor function*

INTRODUCTION

Stroke is widely recognized as a neurological condition resulting from an acute focal injury to the central nervous system (CNS), primarily caused by vascular events such as cerebral infarction, intracerebral hemorrhage (ICH), or subarachnoid hemorrhage (SAH). It is a significant global health concern, representing one of the leading causes of disability and mortality worldwide (Sacco et al., 2013). According to the World Health Organization (WHO), stroke was the second most common cause of death between 2002 and 2012, with approximately 6.7 million deaths attributed to stroke in 2012 alone (WHO, 2014). In England, data from the National Health Service (NHS) indicates that roughly 110,000 people experience a stroke each year, making it the third most frequent cause of death after heart disease and cancer. Furthermore, stroke-related brain injuries account for a substantial portion of disabilities in the UK (Choices, 2014).

While advancements in medical interventions have improved survival rates following cerebrovascular accidents, the aftermath often imposes profound and enduring challenges for individuals and their families. The long-term consequences frequently include severe disabilities and functional impairments, which significantly impact quality of life (Langhorne et al., 2009). Numerous studies have reported that 50–70% of stroke survivors experience persistent motor deficits in the upper extremities, leading to reduced functionality and limited participation in daily activities (Michielsen et al., 2012). Lum et al. (2009) further highlighted that approximately 65% of individuals with stroke struggle to integrate the hemiparetic upper limb into meaningful activities.

The underlying factors contributing to upper limb non-use often stem from a combination of motor impairments and biomechanical challenges. At the shoulder and elbow, these include diminished muscle strength, abnormal neural synergies that restrict movement patterns, loss of range of motion, impaired interjoint coordination, reduced movement fluidity, and a lack of synchronization between reaching and grasping. In the hand and fingers, impairments such as heightened muscle tone in finger flexors, disrupted voluntary activation of muscle groups, and difficulty in independently activating flexors and extensors exacerbate functional limitations.

To address these challenges, a wide array of physiotherapy interventions has been developed to facilitate upper limb recovery in stroke rehabilitation. Langhorne et al. (2009) conducted a comprehensive literature review, incorporating systematic reviews and randomized controlled trials, to evaluate the efficacy of various physiotherapy approaches. Commonly employed

methods include mixed approaches, motor learning principles, neurophysiological techniques, bilateral training, biofeedback, electrical stimulation, constraint-induced movement therapy (CIMT), high-intensity therapy, mental practice combined with motor imagery, repetitive task training, robotic-assisted therapy, and the use of splints or orthoses. Each method demonstrates varying degrees of effectiveness, offering valuable insights and recommendations for clinicians.

This paper aims to explore the kinematics of upper limb movements in individuals with stroke, identifying common problems and their potential causes. A targeted treatment plan will be proposed, focusing on one specific impairment to enhance functional ability and promote independence. Goals will be established for both the short and long term, and evidence-based physiotherapy interventions will be selected based on a thorough review of the literature. By emphasizing a structured and personalized approach, this discussion seeks to contribute to the growing body of knowledge in stroke rehabilitation, offering practical guidance for optimizing upper limb recovery.

ANALYSIS OF KINEMATICS

The analysis of upper limb kinematics during functional tasks, such as reaching, grasping, and object manipulation, provides valuable insights into motor performance. Video-based motion analysis is a widely used method to examine movement patterns, allowing for the identification of typical (invariant) kinematic features and deviations from normative movement profiles. Such deviations are often indicative of underlying impairments in motor control and coordination.

Table 1 outlines common kinematic features, potential deviations, and their associated causes. This structured approach facilitates the identification of biomechanical and neurological challenges that can affect task performance. Recognizing these issues is essential for designing targeted therapeutic interventions.

A thorough understanding of kinematic deviations and their potential etiologies enables clinicians and researchers to develop evidence-based strategies aimed at restoring functional abilities. By integrating advanced assessment techniques with clinical reasoning, the rehabilitation process can be tailored to address specific impairments effectively, thereby improving overall outcomes.

Kinematic analysis often highlights compensatory strategies adopted during reaching and placing tasks. Commonly observed compensatory mechanisms include excessive shoulder abduction, trunk lateral flexion, and trunk rotation.

These adaptations are frequently associated with deficits in specific movement components, such as reduced elbow extension. It is hypothesized that improving elbow extension can significantly reduce reliance on these compensatory strategies. Enhancing elbow extension is expected to decrease biomechanical stress on the shoulder and trunk, thereby promoting more efficient and coordinated movement patterns during functional activities.

This approach emphasizes the importance of targeting specific impairments to minimize compensatory behaviours and optimize overall upper limb function.

Table 1. Common kinematic features, poteantial deviations, and causes

Invariant Kinematic Features	Kinematic Deviations	Causes for Deviations
Scapula *Reduced scapula movements **Shoulder** *Reduced flexion *Reduced external rotation *Reduced horizontal adduction **Elbow** *Reduced extension **Wrist** *Reduced flexion *Reduced extension **Distal Joints** *Reduced MCP extension *Reduced MCP flexion *Reduced finger extension *Reduced finger flexion *Absence of pre shaping *Absence of thumb abduction	Trunk flexion Trunk lateral flexion Trunk rotation Excessive shoulder abduction Use of non-affected hand Increased movement duration	Tightness of biceps muscle Spasticity in biceps muscle Weakness of rotator cuff muscles Paretic or paralytic triceps Weakness of triceps Weakness of flexor carpi radialis Weakness of flexor carpi ulnaris Weakness of extensor carpi radialis longus and brevis Weakness of extensor carpi ulnaris Weakness of extensor digitorum Paretic or paralytic abductor pollicis brevis Paretic or paralytic flexor pollicis brevis Weakness of opponens pollicis Weakness of lumbricals

ASSESSMENT AND OUTCOME MEASURES

1. Assessment of Spasticity

Spasticity, a hallmark of the upper motor neuron (UMN) syndrome, has been the subject of evolving definitions and debates. Lance (1980) described spasticity as "a motor disorder characterized by a velocity-dependent increase in tonic stretch reflexes (muscle tone) with exaggerated tendon jerks, resulting from hyper-excitability of the stretch reflexes." However, later studies suggested that increased muscle tone often results from intrinsic changes within the muscles themselves (Dietz et al., 1991; O'Dwyer et al., 1996).

Building upon these insights, a revised definition emerged in 2005, characterizing spasticity as "disordered motor control, associated with UMN syndrome, presenting as intermittent or sustained involuntary activation of muscles" (Pandyan et al., 2005). This perspective reflects a broader understanding of the condition's complexity. Epidemiological data indicate that spasticity affects approximately 26% of patients with acute hemiparetic stroke and 28% of those with strokes occurring three months prior (Sommerfeld et al., 2004).

The assessment of spasticity remains a contentious issue, as debates about its definition extend to its measurement. Among the most commonly used tools, the Ashworth Scale has been criticized for its poor reliability and questionable validity (Bohannon and Smith, 1987; Sehgal and McGuire, 1998; Ansari et al., 2006). Research indicates that the scale often fails to differentiate between spasticity and contractures, leading some experts to recommend against its use for clinical spasticity assessment (Fleuren et al., 2010; Patrick and Ada, 2006).

In contrast, the Tardieu Scale has emerged as a more robust tool. By incorporating assessments at varying velocities, it effectively distinguishes spasticity from contractures. Furthermore, when used with a goniometer, the Tardieu Scale demonstrates excellent test-retest reliability (ICC of 0.89) (Paulis et al., 2011). This scale has shown greater validity and reliability in clinical practice, making it a preferred choice for spasticity evaluation (Morris, 2013).

The ongoing refinement of tools and methodologies for spasticity assessment underscores the importance of evidence-based practices in clinical and research settings. Accurate evaluation is essential for tailoring interventions and improving outcomes for individuals experiencing UMN-related motor disorders.

2. Assessment of Length of Muscles and Range of Motion

Reduced range of motion (ROM) is a frequently observed issue following neurological conditions. Lowenthal and Tobis (1957) were among the first to highlight this challenge, emphasizing its prevalence and impact on function. Later research has further substantiated these findings, with Borisova and Bohannon (2009) summarizing numerous studies (e.g., Bohannon et al., 1986; Andrews and Bohannon, 1989; Pandyan et al., 2003) that demonstrate how ROM limitations can emerge early after a neurological event, such as a stroke, and progressively worsen over time.

This progressive decline in ROM not only hampers functional recovery but also presents opportunities for early intervention. Research suggests that ROM measurements taken soon after a stroke can provide valuable predictive insights regarding upper limb functionality at three months post-stroke (Beebe and Lang, 2009). Such predictive data is critical for designing tailored and efficient rehabilitation programs for subacute stroke patients, ensuring that interventions target the most pressing deficits and maximize recovery potential.

Accurate and reliable measurement tools are essential for evaluating ROM. Goniometry, for instance, is widely recognized for its precision and reliability in assessing both active and passive shoulder ROM. Studies have reported high intra-observer and inter-observer reliability for goniometric measurements, with intraclass correlation coefficients (ICCs) as high as 0.89 (Marx et al., 1999). Additionally, research indicates that goniometric assessments maintain a high degree of reliability when performed in clinical settings, further supporting their utility in routine practice (Rothstein et al., 1983).

Beyond its technical reliability, goniometry offers practical advantages in clinical contexts. It provides a standardized, cost-effective, and non-invasive means of assessing joint mobility, making it a cornerstone of physical assessment for individuals recovering from neurological conditions. This reliability and accessibility ensure that goniometry remains an indispensable tool for clinicians seeking to evaluate ROM accurately and implement evidence-based rehabilitation strategies.

By recognizing and addressing ROM limitations early in the rehabilitation process, healthcare providers can better support patients in regaining functional independence and improving quality of life. Such efforts underscore the importance of integrating precise measurement tools and predictive data into the development of individualized treatment plans.

3. Assessment of Muscular Strength

Upper extremity muscle weakness is a prevalent issue both in the acute and chronic stages of recovery following a stroke (Wagner et al., 2007; Harris & Eng, 2010a). Therefore, assessing the muscular strength of the upper limbs is a critical component in the development of rehabilitation plans. Various techniques, including gross muscle strength testing, electromyography (EMG), and dynamometry, can be employed to evaluate muscle strength.

Among these, the hand-held dynamometer is commonly used to assess upper limb muscle strength. Research has shown that measurements using a hand-held dynamometer are highly reliable, especially when applied to individuals with brain injuries (Riddle et al., 1989). Additionally, studies demonstrate excellent test-retest reliability (ICC = 0.84-0.99) when used to assess individuals with neurological impairments (Agre et al., 1987). Recent systematic reviews have further supported the reliability and validity of the hand-held dynamometer in clinical settings. For instance, a study by Stark et al. (2011) concluded that due to its ease of use, portability, affordability, and compact size, the hand-held dynamometer can be regarded as a valid and reliable tool for assessing muscle strength, especially when compared to more complex isokinetic devices.

In clinical practice, these findings suggest that hand-held dynamometers are a feasible and efficient alternative for evaluating muscular strength, offering significant advantages in terms of accessibility and cost-effectiveness. Moreover, the consistent reliability of this tool across a range of patient populations underscores its broad applicability for both neurological and musculoskeletal rehabilitation. Given these attributes, the hand-held dynamometer remains an essential instrument for clinicians assessing muscle strength, particularly in settings where other methods may be impractical.

4. Pain Assessment

The issue of pain in subacute stroke patients is rarely addressed in the literature, as noted by Stark et al. (2011) and Boomkamp-Koppen et al. (2005). However, numerous studies have investigated pain in stroke survivors. In particular, de Jong et al. (2006) reviewed several studies and identified hemiplegic shoulder pain as one of the most common complications following a stroke. As a result, it is crucial to assess pain in individuals recovering from a stroke.

Pain is inherently a subjective experience, making it challenging to measure objectively. Although the Visual Analogue Scale (VAS) is widely used for pain assessment, there is ongoing debate among healthcare professionals regarding its reliability. In a randomized controlled trial by Kemp et al. (2012) with forty

healthy participants, thermal laser stimulations were used to evoke pain, and somatosensory evoked potentials (SEP) were recorded. When comparing VAS scores to SEP results, the study concluded that VAS may be an unreliable measure of experimental pain.

Despite these concerns, numerous studies across various disciplines have affirmed the reliability and validity of the VAS. For example, DeLoach et al. (1998), Bijur et al. (2001), Ahlers et al. (2008), and Lati et al. (2010) all found that the VAS is a dependable and valid tool for pain assessment. Furthermore, the Special Interest Group on Neuropathic Pain has issued guidelines for neuropathic pain evaluation, recommending the use of either the Numeric Rating Scale (NRS) or VAS to measure pain intensity and the effects of treatment (Haanpää et al., 2011).

These findings suggest that, despite some limitations, the VAS remains a widely accepted and valuable tool for pain measurement in clinical practice. Its simplicity, ease of use, and strong validity across different patient populations ensure its continued role in both research and patient care, particularly in managing conditions such as post-stroke pain. As the field evolves, further studies may address these reliability concerns and offer refinements to pain measurement methodologies in stroke rehabilitation.

5. Assessment of Upper Limb Function

At least 27 different assessments have been documented in the literature to evaluate the functionality and dexterity of the affected upper extremity in individuals post-stroke (Wagenaar et al., 1990). Among these, the Action Research Arm Test (ARAT) is one of the most commonly used assessments, frequently featured in research (van der Lee et al., 2001). ARAT is widely applicable in the rehabilitation of hemiplegic patients (Lyle, 1981). It is not only useful for monitoring progress throughout treatment, but can also serve as a tool to evaluate the effectiveness of the intervention itself (ibid). The ARAT consists of four subscales—grasp, grip, pinch, and gross arm movement—and includes a total of 19 items to assess. Each item is scored on a 4-point ordinal scale, where 0 indicates that the patient cannot perform any part of the test, and 3 denotes normal performance.

Numerous studies have investigated the reliability and validity of the ARAT as a measure of upper limb function after stroke. For example, Hsieh et al. (1998) conducted a study with 50 stroke patients to assess the reliability and validity of ARAT. Their findings confirmed that ARAT is a valuable outcome measure for evaluating the recovery of arm and hand function in stroke patients. In another study, Rabadi and Rabadi (2006) compared the ARAT with the Fugl-

Meyer Assessment to measure upper limb motor weakness after stroke. They found that both tests had similar sensitivity and could be effectively used in acute stroke settings to assess the recovery of upper limb motor function. Furthermore, studies have demonstrated that ARAT exhibits excellent test-retest reliability (ICC = 0.963) (Platz et al., 2005), as well as strong interrater and intrarater reliability (van der Lee et al., 2002; Platz et al., 2005; Nijland et al., 2010).

Given these robust psychometric properties, the ARAT is considered a reliable and valid tool for assessing motor function in individuals post-stroke. Its comprehensive nature, ease of administration, and proven reliability make it an essential instrument in both clinical practice and research aimed at evaluating functional recovery in stroke rehabilitation. The ARAT's versatility in measuring both recovery and treatment effectiveness underscores its value in the long-term management of stroke rehabilitation programs.

6. Assessment of Quality of Life

Health-related quality of life (HRQoL) is an important outcome measure in stroke rehabilitation, particularly after hemiplegia, as it helps to capture the overall recovery process in stroke survivors (Nichols-Larsen et al., 2005). Therefore, assessing the quality of life of stroke patients is essential in both clinical practice and research. A variety of instruments are available in the literature for measuring quality of life, and for this case study, the Stroke Impact Scale (SIS) has been chosen.

The Stroke Impact Scale has demonstrated adequate to excellent test-retest reliability across most of its domains, except for the emotional domain, with reliability coefficients (ICC) ranging from 0.70 to 0.92 (Duncan et al., 2003; Edwards & O'Connell, 2003). Furthermore, the SIS has shown excellent interrater reliability in assessing hand function (ICC = 0.82) and mobility (ICC = 0.80), adequate reliability for strength (ICC = 0.61), activities of daily living (ADL) and instrumental activities of daily living (IADL) (ICC = 0.74), and memory and thinking (ICC = 0.43). However, it has shown poor interrater reliability for communication (ICC = 0.39), emotion (ICC = 0.17), and social participation (ICC = 0.29) (Carod-Artal et al., 2009). These findings indicate that while SIS is a reliable tool for many aspects of stroke recovery, certain domains, particularly related to emotional and social functioning, exhibit lower reliability.

Despite these results, there is a gap in the literature regarding the test-retest reliability and the inter- and intrarater reliability of the SIS specifically in subacute stroke patient populations. This limitation highlights the need for

further research to validate the tool in this specific cohort. Nevertheless, the SIS remains a valuable instrument for assessing HRQoL in stroke survivors, providing comprehensive insights into multiple dimensions of recovery, including physical, cognitive, emotional, and social aspects. The variability in reliability across domains also suggests that certain areas may benefit from additional measures or refinement to enhance assessment accuracy in clinical settings.

AIMS OF THE THERAPY

It is widely believed that establishing treatment goals in collaboration with the patient enhances the effectiveness of rehabilitation. From a clinical perspective, the primary focus of the treatment will be to improve the patient's elbow extension and strengthen the triceps muscle. These objectives are crucial for restoring functional movement and enhancing the patient's overall physical capabilities.

From a functional standpoint, the goal is to maximize the patient's independence, particularly for this young individual. Regaining the ability to engage in activities he enjoys, such as participating in sports, living without relying on his parents, or driving again, will be significant milestones. These functional goals align with the patient's personal aspirations, making the therapy more meaningful and motivating.

As the patient progresses, the therapeutic goals can be adjusted and expanded to reflect his evolving needs and capabilities. More specific goals can be set as his recovery advances, ensuring that the treatment remains aligned with his functional improvements. Additionally, involving the patient's family, particularly the parents, plays an important role in the rehabilitation process. By providing them with appropriate guidance and training on home exercises, they can become active participants in the patient's recovery. This involvement will help ensure consistency and reinforce the patient’s commitment to his rehabilitation, especially when performing exercises at home.

TRAINING OF ACTIONS IN UPPER LIMB FUNCTION

Table 2 outlines the expected movements of the upper limb during each phase of upper limb function. By carefully considering these key components of upper limb movements, clinicians can create a more targeted and effective treatment plan for patients. This approach helps ensure that the treatment addresses the specific needs and limitations at each stage of recovery, facilitating a more structured and personalized rehabilitation process. Recognizing the distinct phases of movement in the upper limb allows for better

tracking of progress and adjustment of therapy goals as the patient advances through different stages of recovery.

Table 2. Upper Limb Functions and Expected Movements

ACTION	MOVEMENT
Reaching	Forward: flexion at GH joint Sideways: abduction at GH joint Backward: extension at GH joint with -elevation of shoulder girdle -external rotation at GH joint -extension of elbow -supination and pronation of forearm -extension at wrist
Grasping	Extension of wrist and fingers, with abduction and conjunct rotation ('opposition') of the CMC joint of the thumb and 5th finger Flexion of fingers and thumb around object
Releasing	Extension at wrist Extension at MCP joint of fingers Abduction and extension at CMC joint of thumb
Manipulation	Flexion and extension of MCP joints of fingers with wrist in extension Palmar abduction and conjunct rotation of CMC joint of thumb Combined flexion and conjunct rotation at CMC joints of 5th finger and thumb (e.g. cupping) Independent finger flexion and extension (e.g. tapping) Key grasp configurations, for example thumb-index; thumb-5th finger; 4th, 5th finger into palm; thumb + flexed MCP, extended interphalangeal joints of fingers (paper holding grasp)

Source: Carr and Shepherd, c2003.

TRAINING PROTOCOL

In patients with upper limb dysfunction, a primary focus is often on activating the triceps muscle, managing potential biceps muscle spasticity, and strengthening the elbow extensors. These goals are essential for improving the ability to perform reaching and manipulation activities, which are critical for daily functional tasks.

The literature offers a wide range of treatment protocols in terms of intensity and duration, with most programs consisting of 2 to 5 sessions per week over a period of 4 to 12 weeks. For optimal outcomes, treatment programs are typically planned for three sessions per week over a duration of 8 weeks. This frequency allows for consistent muscle engagement while offering sufficient recovery time between sessions.

Task-specific training is a key component of this approach, focusing on activities that simulate real-life functional tasks. These activities aim to target the muscle groups involved in elbow extension and address any functional impairments caused by spasticity. Task-specific training is crucial for improving not just strength but also coordination, precision, and functional movement, all of which are vital for enhancing long-term mobility and independence. As progress is made, the training protocol can be adjusted to incorporate more challenging tasks, further boosting muscle strength and functional performance.

1. Management of Spasticity and Range of Motion

Spasticity is a common condition in stroke patients, affecting 20-40% of individuals (van Kuijk et al., 2007). It is often the underlying cause of basic arm and hand movement difficulties, such as reaching and grasping, as well as many more complex daily activities (ibid). Additionally, spasticity is a major contributor to the development of contractures following a stroke, as noted by Ada et al. (2006). Given its impact on functional recovery, managing spasticity is a crucial aspect of stroke rehabilitation and should be prioritized in the treatment plan.

Orthotics, such as splints and casts, are frequently used to manage spasticity and improve range of motion. A randomized controlled trial involving 26 stroke patients compared two groups: one receiving serial casting (24-hour stretch) and the other a positioning program (1 hour of stretching per day). After 4 weeks, the serial casting group demonstrated a significant increase in passive elbow extension (Moseley et al., 2008). In contrast, a study involving 63 patients with subacute stroke found no significant improvement in the group that received splints or positioning for 9 to 12 hours overnight over 4 weeks (Lannin et al., 2007). This suggests that while orthotics and splints are widely used, their overall effectiveness remains inconclusive.

Stretching exercises are another common method for managing spasticity, particularly in the upper limbs. However, the evidence regarding the effectiveness of upper limb stretching for stroke-related spasticity is mixed. Some studies have found positive effects of stretching on spasticity and range of

motion (Carey, 1990; Hummelsheim et al., 1994; Al-Zamil et al., 1995; Suzuki et al., 2003), while others report no significant improvements (Turton & Britton, 2005; Harvey et al., 2006; Katalinic et al., 2011). This inconsistency in findings highlights the need for further research to better understand the impact of stretching exercises and determine the most effective methods for spasticity management in stroke rehabilitation.

In summary, while several approaches, including orthotics and stretching exercises, are commonly used in spasticity management, their effectiveness is still debated. Continued exploration and individualized treatment plans are essential for optimizing outcomes and improving the range of motion for stroke patients.

2. Pain Management

Reducing pain is crucial for enhancing a patient's willingness to engage in rehabilitation exercises, which can ultimately improve their quality of life. Key modalities used to decrease pain include electrical stimulation, and the application of orthotics and splints. These approaches aim to alleviate discomfort, making it easier for the patient to participate in therapy and progress in their recovery.

Transcutaneous Electrical Nerve Stimulation (TENS) is one of the most widely recommended and commonly used modalities for pain reduction following a stroke. Numerous studies support the use of TENS as an effective pain management tool (Leandri et al., 1989; Cruccu et al., 2007; Murie-Fernández et al., 2012). The general recommendation for TENS application is 5 days a week for 6 weeks, with a frequency range of 35-50 Hz (Paci et al., 2005). This treatment is thought to help manage pain by stimulating sensory nerves, which can interfere with pain signals and promote the release of endorphins, improving overall comfort during rehabilitation.

Another common method for pain reduction post-stroke is the use of splints and orthotics. While the effectiveness of these devices remains a topic of debate, they are often incorporated into treatment plans. A randomized controlled study investigating the use of orthotics in stroke patients divided participants into two groups. The experimental group wore orthotics for 7 to 16 hours daily over a 13-week period. The results indicated a significant decrease in pain in the intervention group (Bürge et al., 2008). Furthermore, the National Institute for Health and Care Excellence (NICE) recommends the use of splints and orthotics in its updated stroke rehabilitation pathway, highlighting their potential benefits in managing pain and improving functional outcomes (NICE, 2014).

In summary, pain management strategies such as TENS and the use of orthotics and splints play a critical role in stroke rehabilitation. While the effectiveness of these treatments can vary, they are widely used to reduce pain, which in turn supports the patient's ability to engage in therapy and improve their quality of life.

3. Strengthening

One of the primary goals in stroke rehabilitation is strengthening weak muscles, particularly to facilitate elbow extension and improve overall upper limb function. Several methods are commonly used for muscle strengthening, including electrical stimulation, biofeedback, muscle re-education, and progressive resistance training. These interventions aim to improve muscle strength, restore movement patterns, and enhance functional independence.

A systematic review conducted in 2004 examined the impact of physical therapy on functional outcomes after stroke. The review concluded that there was insufficient evidence to support the effectiveness of any physiotherapy approach in improving the strength of the paretic upper extremity and activities of daily living (Van Peppen et al., 2004). However, more recent research has provided a clearer picture. A systematic review categorized stroke patients into four groups based on their condition: (i) acute, very weak, (ii) acute, weak, (iii) chronic, very weak, and (iv) chronic, weak. For patients in the acute phase (ranging from 2 weeks to 4.5 months post-stroke), strengthening interventions were found to have a positive effect not only on muscle strength but also on functional abilities in daily life activities. The review suggested that strengthening exercises should be incorporated into rehabilitation programs, particularly within the first six months after stroke onset (Ada et al., 2006).

Further evidence supporting the role of strengthening interventions comes from a meta-analysis of randomized controlled trials conducted between 1950 and 2009. This analysis indicated that strength training programs are effective in improving the strength of the affected upper extremity without exacerbating spasticity or pain (Harris and Eng, 2010b). These findings emphasize the importance of including strengthening exercises as part of post-stroke rehabilitation, particularly for improving muscle strength and supporting functional recovery.

In summary, while early systematic reviews questioned the effectiveness of strengthening interventions for stroke patients, more recent studies demonstrate the value of these interventions, particularly in the acute phase of recovery. Strengthening exercises, when appropriately implemented, can improve muscle

strength and contribute to better functional outcomes without increasing the risk of spasticity or pain.

4. Task-Specific Repetitive Training

Repetitive exercises are an essential component of stroke rehabilitation, particularly for promoting neuroplasticity and sustaining changes in the brain's structure and function. These exercises serve to challenge the brain and encourage it to adapt and reorganize, leading to recovery of function. However, it has been found that simply repeating tasks or movements is unlikely to induce significant cortical changes unless the tasks are meaningful and relevant to the patient's functional needs (Nestor et al., 2005). In other words, while repetition plays a role in neural recovery, the quality and purpose of the tasks performed are crucial in facilitating meaningful brain reorganization and functional recovery.

Research emphasizes that task-specific training, where the exercises are designed to reflect the activities and movements the patient aims to improve, is essential for effective rehabilitation. These task-specific exercises help the patient engage more deeply in the rehabilitation process by targeting the functional abilities required for daily life. This approach has been shown to induce cortical reorganization—where the brain forms new connections in response to specific, repeated tasks—and lead to improvements in both motor function and overall quality of life (Nestor et al., 2005). The more closely rehabilitation exercises mirror the real-world tasks the patient needs to perform, the more likely these tasks will lead to connected, purposeful improvements in motor control.

A randomized controlled trial examined the effectiveness of incorporating additional task-specific training into standard rehabilitation during the early stages of stroke recovery. In this study, both groups received the usual interdisciplinary rehabilitation, which included one hour of physiotherapy, five days a week. The experimental group, however, received an additional hour of task-related therapy for 4 weeks. This additional task-specific training involved exercises directly related to the upper limb functions that the participants needed to recover. The results demonstrated that adding task-related therapy to inpatient rehabilitation resulted in significant gains in upper limb function for patients with subacute stroke. This reinforces the idea that incorporating task-specific training into traditional rehabilitation methods can enhance the effectiveness of recovery programs (Blennerhassett and Dite, 2004).

Another study further explored the relative effectiveness of task-specific training by comparing it with traditional rehabilitation approaches of varying

intensity. The study found that task-specific methods, even when less intense, could be more beneficial for patients than traditional motor rehabilitation techniques that focus on high intensity. The task-specific approach emphasizes quality over quantity, focusing on repetitive, meaningful practice of functional tasks rather than sheer exercise volume. The research concluded that less-intensive, task-specific training could yield greater functional benefits, particularly in the context of improving motor control and recovery in stroke patients (Page, 2003). This suggests that the focus should not necessarily be on increasing the intensity of rehabilitation exercises but on ensuring that exercises are directly relevant to the patient's personal goals and functional needs.

Task-specific training also contributes to the psychological aspect of rehabilitation. When patients engage in exercises that mimic real-life tasks they find meaningful, such as reaching for objects or engaging in activities of daily living, it enhances motivation and adherence to rehabilitation programs. This approach encourages patients to feel more involved in their own recovery, fostering a sense of agency and promoting long-term participation in therapy.

In summary, task-specific repetitive training is a key approach in stroke rehabilitation, aiming not only to stimulate cortical changes but also to promote practical, functional improvements in the patient's daily life. By focusing on tasks that are meaningful and relevant to the patient, task-specific training helps ensure that the exercises lead to significant and lasting improvements in motor function. This approach is particularly effective when integrated with traditional rehabilitation programs, as it addresses both the physical and psychological aspects of recovery. Furthermore, research suggests that task-specific training, even when less intensive, can be more beneficial than traditional high-intensity approaches, making it a valuable strategy in stroke rehabilitation programs.

5. Feedback

Feedback plays a crucial role in motor learning, serving as the information a performer gathers about the quality of their action or performance (Carr and Shepherd, 2003). The timing and type of feedback provided can significantly influence the learning process and subsequent performance. Appropriate feedback, particularly when given at the right moment during practice, fosters enhanced motor learning, helping individuals develop more effective and accurate movement patterns. In the rehabilitation of stroke patients, providing effective feedback is essential to promote motor recovery and skill acquisition.

In the context of motor learning, research has shown that the type of feedback can have varying effects on performance. Specifically, a distinction is often made between "internal" and "external" focus of attention. An internal

focus refers to directing attention to the movements or body parts involved in performing the action, while an external focus involves directing attention to the effects of the movement or the outcome of the action. Studies in healthy participants have consistently demonstrated that an external focus of attention is more effective in improving motor performance and learning than an internal focus (Wulf et al., 1999; Wulf et al., 2002; McNevin et al., 2003). This is because an external focus allows the performer to be more attuned to the task goal, promoting a more automatic and fluid movement pattern, while an internal focus may interfere with the natural coordination of movement.

Similar findings have been observed in stroke rehabilitation, where a study investigating the impact of internal versus external focus in stroke patients found that external focus instructions led to better performance on a reaching task (Fasoli et al., 2002). Stroke patients who were given instructions to focus on the target of the reaching movement, rather than on their own limb or movement, demonstrated significantly better results. Not only did they perform better in terms of reaching accuracy, but they also showed a reduction in movement time, indicating more efficient task execution. This underscores the importance of directing stroke patients' attention to the outcomes of their movements rather than the movements themselves.

Moreover, feedback types can also be categorized into two broad categories: knowledge of results (KR) and knowledge of performance (KP). KR provides feedback about the outcome of a task, such as whether a target was reached, while KP provides information about the quality or technique of the movement itself, such as whether the reaching movement was executed correctly. In a study examining the effects of these types of feedback on motor performance in stroke patients, participants were randomly assigned to KR, KP, or control groups and asked to perform repetitive reaching tasks (Cirstea et al., 2006). The results indicated that the KP group showed greater motor performance improvements, suggesting that feedback regarding the movement's quality, rather than just the outcome, can enhance motor learning in stroke patients. This finding highlights the value of providing more detailed, task-specific feedback during rehabilitation, which can guide patients in refining their movement patterns and improving functional outcomes.

In summary, feedback, both in terms of the type and timing, is an essential element in promoting motor learning and recovery in stroke rehabilitation. External focus of attention has been shown to be more effective than internal focus in improving task performance, especially for patients recovering from stroke. Additionally, providing knowledge of performance feedback can enhance motor outcomes by guiding stroke patients in refining their movement

technique. Thus, careful consideration of feedback strategies—incorporating external focus and knowledge of performance—can lead to more efficient and effective rehabilitation, helping patients regain function and improve quality of life.

6. Group Exercises

Incorporating group exercise activities into rehabilitation programs has been shown to have several benefits for stroke patients. Group-based therapies can create a supportive and motivating environment, where patients are not only working on their own recovery but are also encouraged by the presence and progress of others. For some patients, the social aspect of group exercises can serve as a form of competition or camaraderie, leading them to push themselves harder and perform better. This sense of community and shared experience often helps individuals feel more motivated and engaged in their rehabilitation process.

Research in stroke rehabilitation has provided strong evidence supporting the positive impact of group exercises on motor outcomes and quality of life. Studies have demonstrated that engaging in group-based therapy can lead to improvements in physical function, as well as psychological and social benefits. Pang et al. (2006), English and Hillier (2010), Langhorne et al. (2011), and van de Port et al. (2012) all found that group exercise programs contributed significantly to enhancing motor function in stroke patients. These studies suggest that group exercises can be more effective than individual sessions in improving a variety of outcomes, including muscle strength, mobility, and overall functional independence.

The key advantage of group exercises is not just the physical benefits but also the emotional and psychological support patients receive from interacting with others who are going through similar experiences. Patients in group settings often experience a sense of belonging, which can reduce feelings of isolation or depression that are common following a stroke. The social support that group exercises provide is essential in helping individuals stay motivated and maintain consistency in their rehabilitation efforts. Moreover, the inclusion of friendly competition can stimulate greater effort and persistence, which is often associated with better recovery outcomes.

Additionally, group exercises can be tailored to meet the needs of patients with varying levels of disability, ensuring that each participant can engage in meaningful activity. The presence of a therapist or facilitator ensures that exercises are done safely and correctly while also allowing patients to benefit from observing and learning from each other. This interaction can provide

valuable feedback and reinforce learning in a way that individual therapy sessions may not.

Given the positive outcomes reported in the literature, it is reasonable to consider incorporating group exercises into the rehabilitation process for stroke patients. This approach not only enhances motor recovery but also improves quality of life by providing social interaction and emotional support. For the patient in question, participating in group exercises could serve as an additional motivation to perform well, encourage consistent effort, and offer a sense of progress and achievement alongside peers.

7. Home Exercises

Incorporating a home exercise program into stroke rehabilitation can play a crucial role in maximizing recovery outcomes. One of the most effective strategies for ensuring the success of a home exercise regimen is involving both the patient and their carers in the planning process. By collaborating with the patient and their caregivers, the program can be personalized to fit the patient's specific needs, goals, and capabilities, which increases the likelihood of adherence. This collaborative approach also empowers patients, making them feel more responsible for their recovery, which can lead to better results.

To monitor the patient’s progress and ensure exercises are being performed correctly, regular check-ins are essential. It is suggested to assess the patient’s performance at intervals, such as every week or two weeks, to offer guidance, correct any mistakes, and provide ongoing encouragement. These follow-up sessions also serve as a way to adjust the exercises as needed, ensuring that they continue to challenge the patient without causing frustration or injury.

There are several types of exercises that can be safely performed at home, one of which is mental practice. Mental practice involves the individual imagining or visualizing the movements or actions they want to improve, which has been shown to stimulate brain areas similar to those activated during actual physical movements. Research has shown that mental practice can have a positive impact on motor learning and recovery, particularly when combined with physical practice (Page, 2001; Crosbie et al., 2004). For stroke patients, this approach is valuable because it can engage neural pathways related to motor function even when physical movement is difficult or limited.

Furthermore, studies have indicated that mental practice can be especially beneficial when used in conjunction with physical exercises, helping to reinforce the motor patterns being developed. In the context of stroke rehabilitation, combining mental and physical practice has been shown to improve upper limb motor function in patients during the subacute phase of

recovery (Page et al., 2001). This dual approach is thought to enhance cortical reorganization and promote the retention of new motor skills, supporting a more comprehensive recovery.

A well-structured home exercise program that includes mental practice, along with regular monitoring and adjustments, can significantly enhance the patient's rehabilitation process. It allows the patient to continue their recovery outside of formal therapy sessions and can be a critical component of their long-term progress. Engaging the patient and their carers in this process creates a sense of partnership, improving both motivation and the potential for greater functional gains.

Future Directions for Therapy

While improving elbow extension was the primary focus of this treatment plan, it is important to recognize that stroke rehabilitation often involves addressing multiple areas of impairment. In this case, elbow extension was a key component in minimizing compensatory trunk movements, but there are other aspects of upper limb function that need attention for a comprehensive rehabilitation approach.

Future therapeutic goals should include the improvement of wrist movements and thumb function, which are essential for grasping and manipulating objects in daily activities. Additionally, enhancing the overall quality of life for the patient remains a central focus. This may involve not only physical improvements but also psychological and social aspects, as functional independence and emotional well-being are closely linked in stroke recovery.

To guide future therapy effectively, a reassessment of the patient's biomechanical performance will be essential. Regular biomechanical analyses will help to identify specific deficits and areas for improvement, ensuring that the rehabilitation program is continually adapted to meet the patient's evolving needs. By evaluating both the physical capabilities and limitations of the patient's upper limb movements, therapists can adjust interventions to target areas that require more intensive focus, such as wrist flexion or thumb opposition, and provide more tailored, individualized exercises.

Incorporating advanced technologies, such as robotic rehabilitation devices or virtual reality, may offer promising new avenues for improving hand and wrist function. These tools can provide precise, task-specific training with real-time feedback, which has been shown to enhance motor learning and neuroplasticity. Additionally, exploring the use of functional electrical stimulation (FES) or brain-computer interface systems may provide novel

approaches to stimulating muscle activation and enhancing motor recovery, particularly for patients with severe impairments.

Psychosocial factors should also be considered in future therapy. Increasing patient engagement in meaningful, goal-oriented activities can enhance motivation and accelerate recovery. This can involve collaborative goal setting, where the patient is actively involved in determining their rehabilitation objectives, including returning to work, participating in hobbies, or regaining independence in daily activities.

In summary, while elbow extension remains a foundational goal, future directions for therapy should involve a broader approach, addressing wrist and thumb function, quality of life improvements, and integrating new technological tools to enhance recovery. Regular reassessment and personalized adjustments will be critical in ensuring that the rehabilitation program is effective and responsive to the patient's progress.

CONCLUSION

The kinematic movements of the upper limb can be assessed using video recordings, which help identify key impairments during tasks such as reach, grasp, and manipulation. One of the main impairments in such tasks is reduced elbow extension, which can significantly impact functional performance. Several potential causes for reduced elbow extension include spasticity in the biceps, weakness in the triceps, pain, and contractures. To evaluate these factors, various outcome measures such as the Tardieu Scale, Visual Analogue Scale (VAS), Goniometer, Hand-held Dynamometry, Action Research Arm Test (ARAT), and Stroke Impact Scale (SIS) are commonly used.

A comprehensive treatment program can be scheduled three times a week for eight weeks, focusing on task-specific repetitive training as the primary rehabilitation approach. Complementary techniques such as stretching exercises, orthotics, splints, Transcutaneous Electrical Nerve Stimulation (TENS), and strengthening methods (e.g., electrical stimulation, progressive resistance training) can be incorporated to enhance recovery. Utilizing external focus of attention, along with a combination of knowledge of results (KR) and knowledge of performance (KP), has been shown to improve motor learning and performance outcomes.

Incorporating home exercise programs can promote continued improvement, while group exercises can enhance motivation and foster social interaction. Regular reassessment every two weeks helps track progress and adapt therapeutic goals based on the patient's evolving needs.

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CHAPTER 8

The Relationship Between Self-Efficacy Levels and Gender Perceptionsof Married Women In Turkey

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Abstract

Aim: This research was conducted to determine the relationship between the self-efficacy level of married women and their perception of gender.

Material and Method: The population of this descriptive study consisted of married women aged 18 and overliving in Ordu. The women who agreed to fill out the online questionnaire were included in the sample without making a sample selection. The research sample consists of 315 married. Personal Information Form, General Self-Efficacy Scale and Gender Perception Scale were used as data collection tools.

Results: The fact that married women are primary school graduates affected the GSES score averages, married women had a postgraduate affected their GPS score averages.

Conclusion: In this study, it was determined that the general self-efficacy levels and gender perceptions of married women were high and there was no significant relationship between them.

Keywords: Married Women, Self-Efficacy, Gender Perception.

Introduction

The perception of gender, which is defined as the personality traits, gender-specific attitudes and behaviors attributed to women and men by the society, precedes the perception of biological gender (Erbay, 2019) and society wants men and women to stick to their assigned roles. Until adolescence, boys and girls study and play together. After adolescence, young girls have been labeled as married women or mothers (Erbay, 2019). Thus, gender inequality emerges.

As a result of the Modern Women's Rights Movement that started in the middle of the 19th century and the greater participation of women in the workforce; Some concrete changes have occurred, such as women playing an active role in a place other than their home, and the increase in women's education levels (wikipedia.org). In the traditional understanding of society, the roles, duties and responsibilities assigned to men and women, such as men who make a living in the house, women do the housework and take care of children, have started to change gradually.

A change was made in the 186/II. article of the Turkish Civil Code, which entered into force in 2002 in Turkey regarding gender. This change agent is “The head of the big union.” The provision of "Spouses govern the union together." arrangement has been made. In addition to women's rights, regulations based on the equality of spouses have been made with the change of social structure (Günay et al., 2018).

With the participation of women in social fields such as management, politics, economy and education, the psychological need of creating their own identities is increasing day by day. In this way, women realize their own potential and skills, tend to develop them at the highest level and to tendency to self-actualize by enjoying life. This change in the status of women positively affects their self-efficacy and gender perceptions (Özpulat, 2016).

Self-efficacy is defined as the ability to organize and apply the cognitive, behavioral or social skills necessary for the successful performance of a task (Khorasani et al., 2017). Self-efficacy reflects confidence in one's ability to control one's own motivation, behavior and social environment. In addition, self-efficacy is greatly influenced by the social environment and can vary from one experience to another depending on social inputs (Mueller and Dato-On, 2008).

According to Bandura (1989), there is a relationship between personal factors including marital status, environmental factors and behavioral characteristics such as self-efficacy. A study conducted in Nigeria by Adio and Popoola (2010) reported a statistically significant relationship between marital status and self-efficacy. Therefore, the self-efficacy levels of married people are higher than unmarried people (10). Parlar and Yazıcı (2017) found that marital status does

not affect general self-efficacy. According to the results of the same study, the general self-efficacy level of men is higher than that of women.

Studies on self-efficacy in Turkey have generally not found a significant relationship with sex (Özpulat and Bahar Özvarış, 2018; Erol and Avcı-Temizer,2016; Siti Salva et al., 2013; Uysal, 2013). In some studies, it has been reported that the general self-efficacy level of men is higher than that of women (Kodan Çetinkaya, 2013).

Gender is the emergence of biological sex by taking shape with social and cultural structures (Altınova and Duyan, 2013). Gender is defined as making discriminatory behaviors together with negative attitudes towards women in male-dominated societies and keeping women in a lower status compared to men in social, economic, cultural and political fields (Küçükali, 2013). Gender is related to the roles, duties and responsibilities imposed on individuals by the society, the framework in which the society sees the individual, how it perceives it, and what its expectations are (Terzioğlu and Taşkın, 2008; Üner, 2008).

In studies on gender, a great inequality persists, in which women are often less valued than men in all areas of economic and social life. This causes significant differences between women and men in vital areas such as family, profession, marriage and education (Kızıldağ and Cin, 2018; Saraç, 2013). Gender perception (GP) was found to be higher because women's attitudes towards gender roles are more egalitarian (Özpulat and Bahar Özvarış, 2018; Kodan Çetinkaya, 2013). Bilgiz Ozturk et al. (2021), it was emphasized that the egalitarian gender role is an important variable on self-efficacy belief.

In a study conducted with university students, individuals with high self-efficacy levels have a higher perception of gender (Özpulat, 2016), while some studies argue that there is no relationship between gender perception and self-efficacy (Aygör and Çayır, 2020; Özpulat and Bahar Özvarış, 2018; Siti Salva et al., 2013). In the literature, there are studies on gender perception and self-efficacy, mostly conducted with university students, but there are not enough studies that try to explain the self-efficacy level of married women and gender perception together. In this study, it was tried to determine the self-efficacy level and gender perception of married women, to investigate whether there is any relationship between them and to raise awareness about the subject.

Materials and Methods

Design and Sample

The population of this descriptive study looking for a relationship consisted of married women aged 18 and over living in Ordu. The women who agreed to fill out the online questionnaire were included in the sample without making a

sample selection. A 315 women who were literate, not visually and hearing impaired, who filled out the data collection forms completely and volunteered to participate in the research were included in the scope of the study.

It was aimed to reach the research group with the snowball sampling method. In the research, it was planned to reach the participants by making announcements on their social media accounts and by sending e-mails. Research data were collected with an online form created via Google Form. Participants were asked to fill in the form and share it with the appropriate people for the research.

Data Collection

- The data of the study were collected with the "Personal Information Form" prepared as a result of the literature review, "General Self-Efficacy Scale (GSES)" and "Gender Perception Scale (GPS)".
- *Personal Information Form:* In the Personal Information Form, there are introductory questions such as the age of married women, educational status, employment status, number of children, place of residence, and how many years they have been married.
- *General Self-Efficacy Scale (GSES):* The German version of the General Self-Efficacy Scale (GSES) was developed by Jerusalem and Schwarzer in 1979. It originally consisted of 20 items. It was reduced to 10 items in 1981 and later adapted into 28 languages. Scoring is done by summing the answers given to 10 items. The single-item scale is in a four-point Likert type (completely false=1-completely true=4). The Cronbach Alpha coefficient of the scale is .83. The total score obtained from the scale varies between 10 and 40, with a high score indicating high self-efficacy belief (Aypay, 2010; 2001 Family Report, 2002). In this study, the Cronbach Alpha coefficient of the General Self-Efficacy Scale was calculated as .901.
- *Gender Perception Scale (GPS):* The validity and reliability studies, which developed the Gender Perception Scale, were carried out by Altınova and Duyan (2013). It is a scale developed especially for adults. The scale has the ability to measure individuals' attitudes towards how they perceive gender roles in different areas. The scale consists of 25 items in total. Each item is scored between 1 and 5 by choosing one of the options: Strongly agree, Agree, Undecided, Disagree, Strongly Disagree.
- When calculating the total score of the scale, some items are scored in reverse (2, 4, 6, 9, 10, 12, 15, 16, 17, 18, 19, 20, 21, 24 and 25 are reverse scored). While the lowest score from the scale is 25, the highest score is 125. A high score indicates a high perception of gender, and a low score indicates a low

perception of gender. The Cronbach's Alpha internal consistency coefficient of the scale is .872 (Altınova and Duyan, 2013). In this study, the Cronbach Alpha coefficient of the Gender Perception Scale was found to be .805.

Data Analysis

The data obtained from the study were evaluated with the SPSS package program. Kolmogrov-Smirnov normality test was used for descriptive statistics and normal distribution of the data in the analysis of the data. Independent two-sample t-test was used to compare two groups for normally distributed variables, and one-way analysis of variance (One-Way ANOVA) was used to compare more than two means. Relationships between variables were evaluated with Pearson correlation analysis. A value of 0.05 was used as the significance level while interpreting the results.

Ethical Consideration

The ethics committee approval of the research was obtained with the Decision-No. 2020-484 dated 26.08.2020 from the Social and Human Sciences Ethics Committee of Ondokuz Mayıs University. Before collecting the data, permission to use the General Self-Efficacy Scale and Gender Perception Scale, which was used in the study, was obtained via e-mail from the owners who conducted the Turkish validity and reliability studies. The individuals participating in the study were informed about the purpose of the research and they were given written and verbal consent. It was explained that the information provided by the individuals would be kept confidential and would not be used outside of this research.

Findings

The findings of the research conducted to examine the relationship between the general self-efficacy levels of married women and their perception of gender are given below.

79.4% of the married women participating in the research are between the ages of 26-45, 49.8% are undergraduate graduates, and 20% are primary school graduates. It was determined that 47.6% of the women were civil servants, 48.9% lived in the district, 72.1% had children, 85.4% were nuclear families and 32.7% were married for 0-3 years.

The mean scores of the General Self-Efficacy Scale and the Gender Perception Scale are given. The mean GSES score was 3.22±0.58 (Min-Max: 1.50-4.00). The mean GPS score is 4.12±0.60 (Min-Max: 2.24-5.00)(Table 1.).

It shows the scale score averages of married women according to their demographic characteristics. There is a statistically significant difference between the age variable and the mean scores of the GSES and GPS scales ($p<.05$). The mean CSAS scores of married women aged 46 and over, the mean TCAS scores of married women aged 18-25 were found to be the highest (Table 1.).

Comparing the mean scores of the married women's GSES and GPS according to their education level, there is a statistically significant difference ($p<.05$). The mean GSES scores of married women who are primary school graduates and the mean GPS scores of married women who are postgraduate were found to be the highest (Table 2.).

When the mean scores of GSES and GPS of married women are compared according to the occupational variable, there is a statistically significant difference ($p<.05$). The GSES score average of the private sector employees and the GPS average of the civil servants were found to be the highest (Table 2.).

The mean GPS score of married women residing in the province for the longest time and having no children was found to be the highest, and the difference between them was statistically significant ($p<.05$). When the mean scores of GSES and GPS of married women are compared according to the variable of years of marriage, there is a significant difference ($p<.05$) (Table 2.).

When it was examined, no statistically significant relationship was found between GSES and GPS. High self-efficacy belief did not affect gender perception (Table 3.).

There is a weak and positive correlation between GSES and age, and a weak and negative correlation between GSES and educational status. There was a weak and negative correlation between GPS and age, and a positive moderate statistical

relationship between GPS and education status. The increase in educational status has a positive effect on the perception of gender (Table 3.).

Discussion

The findings of this study, which was conducted to reveal the relationship between the general self-efficacy levels of married women and their perception of gender, were discussed within the scope of the literature.

Discussing the Findings Regarding the General Self-Efficacy Levels of Married Women

According to Bandura, self-efficacy is individuals' belief in their ability to mobilize their motivation, cognitive resources, and exert control over a particular event. With this belief, the individual can affect life outcomes and have a greater sense of control over his life (Khorasani et al., 2017). In addition, self-efficacy belief is an important defining factor for marriage. In the study, the general self-efficacy of married women was found to be high. In line with the findings of this study, Janiszewska et al. (2017) and Rogala et al. (2015) stated in their study that they found the general self-efficacy level of married women to be high. In marriage, couples with higher self-efficacy have more motivation and persistence to solve communication problems, put more effort into improving their relationships, and experience better marital satisfaction as a result (Hamidian and Sharif Mousavi, 2015).

The general self-efficacy levels of married women differ statistically according to the age variable ($p<.05$). Literature studies on the subject show parallelism with this study (Janiszewska et al., 2017; Aypay, 2010; 2001 Family Report, 2002). In some studies, contrary to the study, it was found that the age variable did not affect the level of GSE (Erol and Avcı-Temizer, 2016; Turan et al., 2016; Buchanan and Selmon, 2008; Sergek and Sertbaş, 2006).

The general self-efficacy levels of the participants were not affected by the educational status ($p>.05$). As the education level decreases, the perception of general self-efficacy increases. In some studies, it was determined that the higher the education level, the lower the general self-efficacy level (Janiszewska et al., 2017). In parallel with this study, Sergek and Sertbaş (2006), Yanık and Başbakkal(2011), Chodkiewicz and Gruszynska(2013), and Parlar and Yazıcı (2017) found that there is no significant connection between general self-efficacy perception and education level in their studies. It can be thought that with the increase in education level, the awareness of women in society increases, which affects their belief that they can do something.

Statistically significant differences were determined between the years of marriage and DL levels of married women ($p<.05$). The fact that spouses get to

know each other better, support each other and develop problem-solving skills in the face of problems in marriage can explain the relationship between the duration of marriage and general self-efficacy. Since married women are more open to sharing about their marriage and have relationships worth sharing, it can be thought that their general self-efficacy levels are high. In addition, Najafi Zadeh and Mirzajan Tabriz stated that there is a significant relationship between marital satisfaction and self-efficacy.

Discussing the Findings on the Levels of Gender Perception of Married Women

When the gender perception scale scores of married women were examined in this study, it was seen that they generally got high scores from the scale (Table 1). According to the findings of this study, it can be said that the gender perceptions of the participants are positive and they have an egalitarian perspective. Bolzendahl & Myers (2004) state in their study that the increasing presence of women, especially mothers, in the public workforce as a strong movement for gender equality contributes to widespread liberalization. In many studies, it has been stated that an egalitarian perspective is dominant in women's perception of gender (Yıldırım et al., 2017; Alptekin, 2014; Öngen ve Aytaç, 2013; Yılmaz et al., 2009). It can be said that married women have an egalitarian gender perception due to the increase in women's participation in the workforce, the sharing of responsibilities with women working in marriage, and the fact that women come to the forefront in order to realize themselves.

Regarding this study, "Women should not work after marriage (78.7%)", "Women should always be protected by men (37.8%), "Women should not work if her husband does not allow them (57.1%)", "A working woman should give her husband the income she earns (55.9%)". ” and "Woman without a husband is like a home without an owner (57.1%)" shows that married women have more traditional thoughts. The traditional perspective formed by the perception of gender caused women to take a less active role in social life, leading them to move away from success, authority and independence (Turan et al., 2011).

In the study of İlhan et al. (2017), in parallel with the research, as the age of women increases, the level of gender perception decreases. This can be explained by the fact that married women take on the roles and responsibilities that life brings and a more traditional perspective dominates as they get older.

It can be said that as the education level of married women increases, their gender perceptions also increase positively. The results of this research show parallelism with the findings in the literature (Savaş, 2018; İlhan et al., 2017; Yıldırım et al., 2017; Altuntaş and Altınova, 2015; Yılmaz et al., 2009). Getting education at the university level enables women to perceive the gender

perspective more egalitarian and to be less affected by the culture of the society they live in (Kodan Çetinkaya, 2013).

Married women working in civil servant positions can be thought to have a higher perception of gender, as they are aware of both their legal rights and their responsibilities to represent the role of mother in society. In addition, women's positive perception of gender will cause them to both get rid of the traditional perspective and gain more visibility in the public sphere (Günay et al., 2018; Küçükali, 2013).

In the study of Çiçek and Çopur (2018), individuals' attitudes towards the formation of gender roles also vary according to where they live the longest. In some studies, it has been observed that the place where married women live does not affect the general self-efficacy level (Arslan, 2019; İkiz and Yörük, 2013; Sergek and Sertbaş, 2006). It can be said that the differences between cultures in the society in which individuals live are the source of this situation.

As a result of the study conducted by Kodan Çetinkaya and Gençdoğan (2013) with 639 couples, the gender role attitudes and marriage quality of married individuals without children were found to be higher. This may be because childless women have more time to improve their relationships and more resources to devote to their marriage.

According to the results of the study conducted by Kızıldağ and Cin (2018) with 158 married women, the increase in years of marriage causes a decrease in gender awareness. This situation can be explained by the fact that the family grows with the birth of children and over time, the marital adjustment of the spouses puts the perception of gender in the background. In some studies, it is emphasized that the duration of marriage is transformed from the traditional gender perspective of individuals to an egalitarian gender perspective (2001 Family Report, 2002).

In the study, the relationship between the general self-efficacy of married women and their perceptions of gender was examined and it was determined that there was no relationship between them (r=.04, p=.405). In the literature review, there are many studies showing parallelism with this research (Aygör and Çayır, 2020; Özpulat and Bahar Özvarış, 2018; Siti Salwa et al., 2013). Different from this result, Özpulat (2016) found in his study that there is a relationship between students' self-efficacy levels and their perceptions of gender, and that students with high self-efficacy levels have higher gender perceptions (Özpulat, 2016). Some studies support that there is a relationship between self-efficacy and gender perception (Buchanan and Selmon, 2008).

Conclusion

In the study, no statistically significant correlation was found between the General Self-Efficacy Levels (GSES) of married women and the Gender Perception Scale (GPS). Accordingly, the increase in women's self-efficacy levels did not affect their social perception levels.

In this study, the high score obtained from the gender perception scale revealed that married women's perception of gender was positive. In the study, it was found that women's general self-efficacy levels were high.

The high general self-efficacy and gender perceptions of married women indicate that women are one step closer to realizing themselves in society. The generations to be raised by women who develop themselves, have a say in society and believe in their own power are the primary steps in reaching the position of leading countries in social, economic and scientific terms.

In line with the results of the research, the following suggestions can be made:

- Programs can be organized to increase the awareness of married women about the egalitarian gender perspective.
- Policies can be developed to further increase the general self-efficacy levels of married women.
- Based on the findings of this study, increasing the level of education plays a leading role in improving the inequalities arising from gender. Women should be given more place in the society in areas such as education, business and politics. Awareness of gender perception can be increased in social networks such as TV, internet and media.
- Nurses, who are health professionals, have important responsibilities in the success of all these activities and programs and in maintaining and improving the health of the society. It should always be remembered that nurses' being active in the planning, implementation and evaluation stages of the initiatives required to increase the perception of gender will be effective in improving the perception of gender in a positive way.

Limitations of the Research

The research is limited due to the number of nurses who care for elderly patients working in Ordu State Hospital and Ordu Training and Research Hospital in Ordu province and cannot be generalized to all nurses.

Appendix A. Supporting information

This study was presented as an oral presentation at. Latin American Conference on Social & Humanities Universidad Juarez Autonoma de Tabasco; November 5-6, 2021; Mexico.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors

Conflict of Interest statement

There is no other conflict of interest.

Acknowledgement

The authors gratefully acknowledge all participants of this study.

Data Availability Statement

The data that support the findings of this study are available upon reasonable request from the corresponding author.

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CHAPTER 9

Central Nervous System Neuro-Rheumatology Diseases

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Neuro-Rheumatology

Diagnosis of systemic rheumatologic diseases and their neurological manifestations requires detailed examination. Taking a good history of the disease is very important for diagnosis. Neurological syndromes can occur at any time during the course of rheumatologic diseases, including before the onset of systemic symptoms. Even if the onset of neurological symptoms occurs after rheumatological disease, there may be no relationship between them. It has been observed that rheumatic diseases selectively affect certain parts of the nervous system. Despite detailed investigation, the cause of most cases remains unknown. Cranial neuropathies are not specific to rheumatologic or autoimmune diseases. However, involvement of some cranial nerves (e.g. trigeminal) and the simultaneous occurrence of more than one cranial neuropathy are characteristic of systemic autoimmune diseases. Collaboration between rheumatology and neurology is necessary to ensure accurate diagnosis of these complex and often overlapping diseases (1).

More than 100 gene loci have been identified that affect the risk of developing Multiple Sclerosis (MS). The genetic factor thought to be most strongly associated with the development of MS is the polymorphism seen in the HLA-DRB1 locus and especially in the HLA-DRB*1501 haplotype (2). Synthesis of oligoclonal bands (OCB) in the central nervous system (CNS) is now used to diagnose dissemination in time. In all patients with suspected MS, it has been very useful to support the clinical diagnosis of MS and exclude MS mimics (3).

Neuro- Behçet's Disease

CNS involvement in Behçet's disease (BD), commonly referred to as Neuro-Behçet's disease (NBD), is one of the most serious complications of the disease. According to the clinical course of NBD, it is divided into acute type (ANBD) and chronic progressive type (CPNBD) (4). NBD usually occurs five years after the onset of BD and is more common in males. NBD affects both the central and peripheral nervous systems, but tends to affect the CNS more frequently. Headache is the most common symptom of non-parenchymal NBD (NNBD), and pyramidal symptoms are the most common symptoms in parenchymal disease (PNBD). It mainly leads to dural sinus thrombosis and aneurysm formation. The most common clinical findings of NNBD are headache and visual disturbances due to intracranial hypertension (5).

Patients with PNBD often present with ophthalmoparesis, cerebellar and pyramidal findings, cognitive dysfunction, and sphincter abnormalities due to brainstem and mesodiencephalic involvement. Less commonly, patients may present with myelitis, movement disorders (hemichorea, hemiballismus,

hemidystonia), and epilepsy. Spinal cord involvement alone may be seen in 2.5–30% of NBD patients (6). In laboratory tests, HLA-B51 positivity is not among the diagnostic criteria for BD. However, HLA-B51 is frequently tested in patients with suspected BD. Arterial disease most often presents as aneurysms and rarely as thrombotic occlusions (7). The lack of biomarkers for diagnosis in NBD makes diagnosis difficult (8). There is a high risk of relapse in NBD (9). Most of the clinical findings of BD are due to vasculitis (10). Cerebral white matter lesions resembling MS may rarely be observed in BD patients. Due to the diagnostic difficulties between PNBD and MS, it may lead to misdiagnosis. BD patients with MS-like lesions who meet MS diagnostic criteria should be treated as patients with comorbid MS and BD rather than PNBD. The characteristic feature of PNBD is that the lesions are predominantly found in the infratentorial region and basal ganglia. In conclusion, patients with BD who present with MRI lesions and clinical and cerebrospinal fluid features that meet McDonald criteria should be managed with a dual diagnostic and therapeutic approach that takes into account MS and BD (11). However, typical PNBD is not difficult to distinguish from MS because of the prominent brainstem, diencephalic involvement (12). The presence of brainstem atrophy on initial MRI scans in NBD patients suggests that the disease will be progressive (13).

Neuro-Sjogren's Disease

Sjogren syndrome (SS) is a systemic autoimmune disease with lymphocytic infiltration in which immune cells attack and destroy the exocrine glands (14). Diagnosis is made by history of dry mouth and eyes, biopsy of exocrine glands supporting the diagnosis, and detection of anti-SSA and anti-SSB positivity (15). It causes sensory ganglionopathy and trigeminal neuralgia (1).

CNS involvement can be seen in 5% of cases of Neuro-Sjogren syndrome (NSS) and can cause serious and possibly fatal outcomes (16). CNS involvement manifests itself as MS-like lesions in the brain, longitudinally disseminated transverse myelitis (LETM), cranial neuropathies, vasculitis, aseptic meningitis, encephalitis and cerebellar ataxia, optic neuritis, and thrombosis. However, it should not be forgotten that in MS-like conditions, MS disease-modifying treatment should be applied (14, 17).

The relationship between NSS and demyelinating diseases is still not fully understood. In MS patients, anti-nuclear factor (ANA), anti-Ro/SS-A and anti-La/SS-B positivity can be detected, similar to SS. Although the two diseases are in the autoimmune group, the question of whether the relationship between them is coincidental or whether there is a pathogenic connection remains unanswered (18). No association was found between MS and SS in population-based studies.

Therefore, the relationship suggested by previous studies may be subjective interpretation (19). Studies investigating NSS in MS patients have been unsuccessful. Anti-SSA antibodies have been found in up to 7% of MS patients, but most of these patients have negative biopsies. Therefore, the presence of positive anti-SSA and anti-SSB does not mean that there is evidence of NSS (20).

Cerebral Vasculitis

Primary CNS vasculitis (PCNSV) is a rare disease that causes inflammation of the brain and spinal cord blood vessels without evidence of vasculitis outside the CNS. Establishing a definitive diagnosis is difficult because many diagnostic procedures, including MRI and cerebral angiography, can produce false-positive and false-negative results for CNS vasculitis. A brain and/or leptomeningeal biopsy should be performed for definitive diagnosis, but cerebral angiography should be performed for radiological diagnosis (14, 17). Despite a low incidence of 1-2/million/year, this condition causes significant morbidity resulting in mortality and permanent disability in approximately 15% of patients. Due to the low incidence of the disease, its etiology and pathogenesis are not fully understood. Cerebral vasculitis constitutes 1% of vasculitis and is characterized by CNS involvement without systemic findings. In digital subtraction angiography (DSA), it consists of findings consisting of multifocal stenosis or long-segment dilatations among normal vascular structures and seen in at least 2 separate vascular distributions (21). While DSA reveals abnormalities compatible with vasculitis in 79% of cases, magnetic resonance angiography (MRA) shows abnormalities in 65% of cases. PCNSV with small or distal vessel involvement can be diagnosed with biopsy, and those with medium vessel involvement can be diagnosed with angiography (22). Unlike secondary CNS vasculitis, which is usually caused by infections, connective tissue diseases, neoplasms, and drugs, PCNSV is thought to occur without an etiology (23).

1.5 T' MRI is diagnostic for stenoses of the large cerebral arteries. Therefore, DSA is necessary to detect stenoses of medium and small-sized cerebral arteries. On T1-weighted MR images, even in thin sections (3 mm or less), the walls of intracranial cerebral arteries are not visible or are very thin. Contrast enhancement is often seen in the walls of acutely inflamed arteries. Contrast-enhanced T1-weighted images of the affected arteries in MRI and MRA images are particularly valuable in the diagnosis of cerebral vasculitis. In vasculitis of the large cerebral arteries, demonstration of contrast enhancement in the stenotic vessel wall may be a more sensitive test than biopsy for the diagnosis of an inflammatory disease. In medium-sized cerebral vessel vasculitis, 1.5 T MRA is not sufficient to reliably diagnose vascular stenosis, as vascular wall contrast

enhancement is often invisible. However, MRI with diffusion-weighted sequences shows ischemic brain lesions in almost all symptomatic patients. DSA is still necessary for the diagnosis of vasculitis in medium-sized arteries and should be performed in young patients with otherwise unexplained ischemic brain disease. There is currently no reliable imaging test to diagnose small vessel vasculitis without a brain biopsy. MRI sequences should be taken with fat suppression (24).

Therefore, high-resolution T1-weighted images including a fat-suppressed sequence should be the basis of imaging in patients with suspected intracranial vasculitis. These images allow identification of vessel wall contrast enhancement. Currently, this is the only direct imaging sign of vascular wall inflammation. It should always be kept in mind that cerebral angiography is an indirect method of visualizing the vascular wall. It shows the results of thickening and hardening of the vascular wall (25). The main symptoms of cerebral vasculitis are stroke, headache, and encephalopathy. Other symptoms include seizures, cranial nerve palsies, or myelopathies (26).

Discussion

If neurological findings are associated with systemic disease, uncertainties remain regarding the best treatment approach (27). There are no validated criteria for the diagnosis of NBD. The clinical and radiological appearance may mimic a brain tumor (28). Ischemic stroke is rare. Optic neuropathy is rare. Subclinical cranial MRI abnormalities, such as white matter hyperintensities, are more common in periventricular or subcortical areas, and as in the general population, their clinical significance is unclear (29). The diagnosis of BD is made by interpreting the clinical findings as a whole (30).

Anti-neutrophil cytoplasmic antibody (ANCA)-associated vasculitis is a small- and medium-sized vessel vasculitis that affects multiple organ systems, including the central nervous system (17). Sensorineural hearing loss may be observed especially in patients with ANCA-associated vasculitis. Recurrent mouth ulcers may also be seen in patients with systemic lupus erythematosus (SLE), BD, and other vasculitis. Mouth ulcers in SLE are usually painless, whereas in BD they are usually very painful. Venous and arterial thromboses are characteristic of autoimmune diseases, most commonly SLE and antiphospholipid antibody syndrome. Antiphospholipid antibody syndrome is usually treated with anticoagulation (1, 27). Thrombophilia screening should be performed in the case of cerebral venous thrombosis (CVT). Initially published studies reported a high prevalence of antiphospholipid antibodies and factor V Leiden mutations in patients with CVT, but these findings could not be confirmed

in subsequent studies (29). The diagnosis of antiphospholipid antibody syndrome is made by finding positive lupus anticoagulant antibody, anti-cardiolipin antibody, or anti-β2 glycoprotein antibody. In neuro-sarcoidosis, cranial neuropathies and meningitis are the main findings (30).

Conclusion

A detailed history should be taken in cases where central nervous system findings occur together with systemic rheumatological diseases. A definitive diagnosis of systemic diseases must be made. The specific, selective cerebral involvement of the disease should be questioned. In cases of MS-like involvement, Cerebrospinal fluid (CSF) should be examined. The presence of CSF-specific oligoclonal bands allows exclusion of MS-like diseases. It should be noted that antibodies specific to systemic rheumatologic diseases can be detected in MS patients, but this will not provide sufficient support to change the diagnosis. Systemic disease must be supported by radiological and histological evidence. Once a definitive diagnosis of systemic rheumatologic disease is made, it is difficult to answer the question of whether central involvement is caused by that disease. If MS is diagnosed, it should not be forgotten that both diseases can coexist and treatment should be determined accordingly. Once a diagnosis of MS is made, the patient should not be left untreated (1, 5, 13, 20).

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CHAPTER 10

Teeth Whitening Guide: Indications, Contraindications, and Application Methods

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1.DEFINITION, INDICATIONS, AND CONTRAINDICATIONS

What is Teeth Whitening?

Due to its safety, effectiveness, and significant impact on the appearance of patients, teeth whitening is a conservative and popular procedure in modern dentistry. The whitening procedure can be performed using many different techniques. Regardless of the technique chosen, teeth whitening occurs through the chemical breakdown of chromogen pigments found in the tooth structure.

Indications:

- Treatment of discoloration that can occur with aging,
- Treatment of discoloration caused by fluorosis,
- Treatment of discoloration due to the consumption of coffee, tea, cigarettes, and other products,
- Treatment of teeth discolored due to trauma,
- Treatment of existing tooth discoloration before and after restorations,
- Removal of superficial tetracycline discoloration.

Contraindications:

- Teeth with enamel cracks and associated sensitivity,
- Advanced fluorosis and tetracycline discoloration,
- Teeth with exposed root surfaces,
- Pregnant and breastfeeding women,
- Advanced discoloration caused by old amalgam fillings,
- Conditions with advanced enamel loss,
- Patients allergic to whitening agents,
- Patients with communication difficulties.

2. DEFINITION OF STAINING AND DISCOLORATION OF TEETH

Tooth discolorations can have significant effects on an individual's psychological and social life. This condition, which can cause aesthetic challenges for both the patient and the clinician, can develop in varying intensities from mild to severe. The primary causes of discoloration are shaped by both intrinsic and extrinsic factors. In this context, many different treatment methods are available, such as enamel microabrasion, whitening procedures, or porcelain veneers. When choosing a treatment method, the cause and depth of the stain are key determining factors.

Understanding tooth color is critically important in restorative dentistry. Teeth are usually characterized by a combination of different shades, and a color transition from the gumline (gingival) to the incisal edge of the tooth is often observed. The dentin, located near the gumline, appears darker because it

is closer to the underlying enamel. Typically, canines tend to be darker compared to central and lateral incisors.

In individuals, during the primary (milk) dentition period, teeth are light-colored, but as age increases, tooth color darkens. The reasons for this darkening include secondary dentin production, the accumulation of extrinsic stains, and the gradual wear of enamel, revealing the underlying dentin more clearly.

The coronal part of the tooth is composed of three main structures: enamel, dentin, and pulp. Any changes in these structures can affect the tooth's ability to transmit and reflect light, thereby causing changes in the tooth's external appearance. The appearance of tooth color varies depending on the quality of incoming light and how that light is reflected.

Tooth discolorations are generally classified as follows:

1. **Intrinsic Discoloration:** These are discolorations that originate from the structural components of the tooth.
2. **Extrinsic Discoloration:** These are stains that settle on the surface of the tooth due to external factors.
3. **Internalized Discoloration:** External stains are incorporated into the enamel or dentin as a result of developmental defects or trauma. When external stains enter the porous tooth structure of developmental defects, it is categorized as intrinsic discoloration. Acquired tooth defects resulting from function and para-function, dentin caries, and stains from restorative materials, either directly or indirectly, lead to internalized discoloration.

Table 1. Classification of Tooth Discolorations

EXTRINSIC DISCOLORATION	COLOUR
*Direct stains	
*Tea,coffee and other foods	Brown to black
*Cigarettes,cigars	Yellow/brown to black
*Plaque/ poor oral hygiene/ chromogenic bacteria	Yellow/brown/green
*İndirect stains	
*Cationic antiseptics (chlorhexidine etc)	Black,brown
*Copper salts in mouthrinses	Green
INTRINSIC DISCOLORATION	
1)Metabolic causes	
Congenital erythropoietic porphyria	Purple/Brown
Alkaptonuria	
Congenital Hyperbilirubinemia	
2)Inherited causes	
Amelogenesis imperfecta	Yellow-brown
Dentinogenesis imperfekta	Blue-brown

3) Iatrogenic causes	
Tetracycline	**Banding appearence, Clasically yellow, brown, grey,blue or black**
Florozis	**White,yellow,grey or black**
4) Traumatic causes	
Pulpal haemorrhage products.	**Grey-brown to black**
Internal resorption	**Pink**
5) Idiopathic causes	
MIH	**White to yellow or brownish defects**
6) Ageing causes	**Yellow**
INTERNALIZED DISCOLORATION	
Caries	**White spot lesions to orange-brown to black arrested caries**
Restorations	**Brown,grey,black**

3. EVALUATION BEFORE WHITENING TREATMENT

- A detailed medical history should be taken from the patient, and if there are any contraindicating conditions, whitening treatment should not be performed.
- The patient's expectations, treatment compliance, and motivation should be assessed.
- Factors such as the patient’s eating and drinking habits, smoking, history of systemic diseases, medications used, and the fluoride level of the local drinking water should be recorded.
- The teeth to be whitened should be examined for decay, cracks, erosion or abrasion, sensitivity, and any history of trauma.
- The type of stain or discoloration should be determined (intrinsic or extrinsic discolorations). In this way, stains that will not respond to whitening should be excluded from the treatment options.
- The tooth color should be determined using devices such as a shade guide or spectrophotometer, and it should be decided whether the treatment will produce effective results.
- For devital teeth, factors such as the condition of the root canal treatment, amount of tissue loss, and the suitability of the procedure should be evaluated.
- Based on a detailed medical history and clinical-radiographic examination results, if whitening treatment is deemed appropriate, the patient should be informed about the treatment process, possible complications, and the cost of treatment.

4. PREPARATION FOR WHITENING TREATMENT

After the detailed clinical and radiographic examination prior to whitening:

- Photos should be taken for documentation before starting the whitening treatment.
- Tooth color should be determined using devices such as a shade guide or spectrophotometer.

Figure 1. Determining Tooth Color Using a Shade Guide and pectrophotometer

- Oral hygiene should be examined, and if necessary, prophylaxis and polishing procedures should be performed before whitening, along with providing oral hygiene education.
- If caries are detected in the teeth, they should be cleaned, and restorations with glass ionomer or compomer should be performed.
- In patients with exposed root surfaces, appropriate root surface treatment methods should be planned.
- In devital teeth, if retreatment of the endodontic procedure is required or if resorption is present, whitening should only begin after the treatment is completed and the prognosis of the tooth is evaluated.

5. STRUCTURE AND CHARACTERISTICS OF WHITENING AGENTS

The active component of whitening solutions is typically hydrogen peroxide or carbamide peroxide:

- **Hydrogen Peroxide**: In dentistry, it is used in concentrations ranging from 5% to 35%. It is a strong oxidizing agent that cleans stains on teeth by

oxidation. It works quickly but may cause sensitivity for some users. It is a colorless liquid that is slightly more viscous than water and has a molar mass of 34.01 g/mol. Due to its low molecular weight, it can penetrate the dentin layer of the tooth. Once it enters the dentin, it releases free oxygen. This free oxygen helps eliminate stains on teeth by breaking the double bonds of organic and inorganic compounds found in the dentin tubules.

- **Carbamide Peroxide**: A compound that converts into hydrogen peroxide when it comes into contact with water. It is generally a gentler option, provides slower oxygen release, and is commonly used in at-home whitening products. The concentrations of peroxide solutions used in whitening treatments typically range from 10% to 35%. For example, a 10% carbamide peroxide solution breaks down into approximately 3.35% hydrogen peroxide and 6.65% urea. These values are important factors that directly affect the effectiveness of the product and the method of application.

Table 2. Contents of Whitening Agents.

Bleaching Agent	Chemical Formula	Molar Mass	Percentage Range	Mode of Action	Free Radical
Hydrogen Peroksit	H_2O_2	34.01 g/mol	5-40	Oxidation	-OH,-OOH^- ,O_2^-
Carbamide peroksit	$CH_6N_2O_3$	94.07 g/mol	10-35	Oxidation	-OH,-OOH^- ,O_2^-

In addition to active ingredients, whitening products also contain passive (inactive) ingredients. These components improve the product's usability, stability, and application properties. These may include:

1. **Thickeners**: Used to prevent the product from dripping and to facilitate ease of application. Cellulose derivatives or gelling agents are typically used for this purpose.
2. **Carriers**: Used to ensure the active ingredient is applied evenly across the tooth surface.
3. **Surfactants**: Help the product adhere to the teeth and also enhance its cleaning properties.
4. **Pigment Dispersers**: Ensure the product mixes uniformly and prevent color inconsistencies.
5. **Preservatives**: Prevent the product from degrading or becoming contaminated by bacteria during storage.

6. **Flavorings**: Added to mask the chemical taste of peroxide-based products and improve the user experience.

The combination of these active and passive ingredients ensures effective, safe, and comfortable teeth whitening. It also helps the product maintain stability during storage and preserves its effectiveness during application.

6. WHITENING MECHANISM

The compounds that produce color or cause discoloration on a surface are known as "chromophores." The whitening and decolorization of the chromophore can occur through the removal of one or more double bonds in the conjugated chain, breaking the conjugated chain, or oxidation of other chemical groups in the conjugated chain. Hydrogen peroxide is an oxidizing agent, and when it diffuses into the tooth, it decomposes into unstable free radicals such as hydroxyl radicals ($HO\cdot$), perhydroxyl radicals ($HOO\cdot$), perhydroxyl anions (HOO^-), and superoxide anions (OO^-). These radicals attack the organic pigmented molecules between the inorganic salts in the enamel, targeting the double bonds of the chromophore molecules. The change in the conjugation of the double bond leads to the formation of smaller and less pigmented compounds, resulting in a shift in the absorption spectrum of the chromophore molecules. This causes the tooth tissues to whiten.

7. WHITENING OF VITAL TEETH

Vital teeth whitening methods are generally classified into three main categories:

1. **In-Office Methods**: Whitening techniques applied using professional devices or special methods in the dentist's office.
2. **Dentist-Supervised At-Home Methods**: Whitening methods performed at home by the patient but under the supervision of a dentist.
3. **Methods Without Dentist Supervision**: Over-the-counter (OTC) products available in pharmacies and supermarkets that can be purchased without a prescription. These products are sold for individual use, allowing the patient to whiten their teeth without the supervision of a dentist.

These whitening methods can be used individually or in combination, depending on the patient's needs and the whitening goals.

In-Office Whitening Technique: In-office whitening involves the use of whitening gel containing hydrogen peroxide at a high concentration of 35-40%, applied under the supervision of the dentist in the office. The process lasts a total of 45-60 minutes and is usually applied in 15-20 minute intervals. Throughout the process, the patient is under the complete control of the dentist,

who may increase the number of sessions in a limited manner to achieve the desired tooth color tone or may end the treatment early if satisfactory results are achieved.

Table 3. Advantages and Disadvantages of Office Bleaching

Advantages of Office Bleaching	Disadvantages of Office Bleaching
Minimal dependence on patient compliance	High cost
Elimination of complications that could arise from patient-related factors	Time spent in the dental unit
Immediate and noticeable results	Risk of damage to teeth and surrounding tissues due to high hydrogen peroxide concentration

Office-Type Whitening Clinical Application Stages:

1. Color Determination: Before the procedure, the color of the teeth to be whitened is measured using a shade guide or a spectrophotometer.

2. Photography: Photos are taken before and after the procedure to document the condition of the teeth.

3. Cleaning of Tooth Surface: To remove plaque from the surfaces of the teeth to be treated:

- The tooth surface is cleaned using a low-speed micromotor.
- The surface is cleaned with a brush and pumice under water.

4. Protective Measures:

- **Separators** are placed to protect the lips and cheeks.
- **Gingival barrier** is applied to protect the gums from the effects of the high-concentration whitening gel, and the treatment area is isolated with cotton rolls.
- **Saliva isolation** is provided using a saliva ejector.

5. Application of Whitening Gel:

- The gel and activator in the whitening system are mixed according to the manufacturer's instructions.
- The resulting mixture is applied to the targeted area or the entire front surface of the teeth with a thickness of 0.5-1 mm.

6. Application Sessions:

- Each session lasts 20 minutes.
- A maximum of 4 sessions can be applied in total.

- The whitening procedure can be terminated earlier once the desired tooth color is achieved.

7. Post-Procedure Cleaning:

- After the whitening procedure, the applied whitening gel is removed from the tooth surface using cotton pellets.
- The gingival barrier is removed, and the teeth are rinsed with an air-water spray for 1 minute.

These steps should be carefully followed in terms of patient safety and procedure effectiveness.

Home Bleaching Under Dentist Supervision: This is a whitening method where the patient applies the whitening agent at home, following the instructions and prescription provided by the dentist. The treatment is carried out in three stages: the start, evaluation, and final stages.

- In the **start stage**, a custom tray is prepared for the patient, and the treatment procedures, such as how many hours per day the tray should be worn, are decided.
- For home bleaching, the ADA recommends a carbamide peroxide gel concentration of 10%.
- The duration for the patient to wear the tray depends on their habits, diet, and tooth color. It is recommended that the tray be worn for 30 minutes to 2 hours twice a day, or overnight, for a period of 2 to 6 weeks.
- If whitening is planned for both the upper and lower jaws, treatment of one jaw can be completed before moving on to the other to avoid exacerbating temporomandibular joint (TMJ) disorder symptoms.
- Before starting treatment, the patient's tooth color is assessed, pre-treatment photographs are taken, and if necessary, scaling and polishing are performed, followed by oral hygiene education.
- To prepare a custom tray, impressions are taken from both the upper and lower jaws. During the impression, retention areas are closed. Care is taken to ensure that the impression includes the teeth and surrounding soft tissues (1-2 mm). After obtaining the impression, a reservoir for the whitening gel can be prepared on the cast model.

Instructions for the Patient:

- The patient should brush their teeth before placing the tray.
- The patient should place 2-3 drops of the agent in the reservoir areas of the tray, depending on the size of their teeth. The tray should be placed in the mouth as instructed by the dentist. Any excess agent should be removed with a damp cotton ball.

- After the tray is placed, it should not be removed for the duration recommended by the dentist.
- The patient should not consume any food or drink while the tray is in the mouth.
- After removing the tray, it should be cleaned and stored in its case.

Table 4. Advantages and Disadvantages of Home Bleaching

Advantages of Home Bleaching	Disadvantages of Home Bleaching
Self-application by the patient	Requirement for patient cooperation
Fewer side effects	Longer treatment duration
Noticeable results	
Lower cost	
Time-saving	

Whitening Methods Applied Without Dentist Supervision: Whitening products purchased by patients from markets or pharmacies without dentist supervision are defined as 'over-the-counter' (OTC) products. OTC products contain whitening agents in low concentrations (3-6% hydrogen peroxide). Examples of OTC products include 'paint-on' gels applied with a brush, strips, toothpastes, gums, dental floss, and mouthwashes. OTC products should be used twice a day for a maximum of two weeks.

Toothpastes: Whitening toothpastes contain standard toothpaste ingredients like fluoride, as well as active whitening agents such as hydrogen peroxide (HP), carbamide peroxide (CP), or sodium citrate, which chemically whiten enamel. Silica, calcium carbonate, or alumina abrasively remove external stains. Whitening toothpastes can generally lighten tooth color by one or two shades.

Whitening Strips and 'Paint-On' Gels: These strips are plastic bands shaped to adapt to the buccal surfaces of teeth, coated with a thin layer of peroxide gel. 'Paint-on' gels are peroxide-based gels applied directly to the tooth surface with a small brush. Both are used twice daily for 14 days. The strips should remain in contact with the teeth for 60 minutes. Whitening can be seen within a few days, and the teeth can lighten by one or two shades with this method.

Mouthwashes: Whitening mouthwashes contain hydrogen peroxide (1.5%) and sodium hexametaphosphate. Sodium hexametaphosphate is included to

protect tooth surfaces from new stains. Manufacturers claim these products can prevent stains and reduce plaque buildup.

Gums: Whitening gums, containing sodium hexametaphosphate (4.0 - 7.5%), aim to prevent the formation of external tooth stains.

8. WHİTENİNG OF DEVİTAL TEETH

The color change of devital teeth can be caused by various factors. These include dental trauma, necrotic residues in the pulp horns and dentinal tubules, insufficient irrigation, or the filling materials in the pulp chamber or its walls. Intracoronal bleaching is a minimal invasive, protective, relatively simple, effective, and low-cost method for treating discolored endodontically treated teeth. There are three different intracoronal bleaching techniques:

1.Walking-Bleach Technique: In the Walking-Bleach technique, a conservative access cavity is first created to expose the entire pulp chamber. The root canal filling material is checked with a periodontal probe and removed approximately 2-3 mm subgingivally in relation to the clinical crown. The root canal filling is covered with materials like resin-modified glass ionomer cement (RMGIC) or traditional glass ionomer cement (GIC), ensuring at least 2mm thickness to prevent apical leakage. After cleaning the cavity, the bleaching agent is placed so that it contacts all the coronal walls. A cotton pellet or a teflon strip pellet is placed over the bleaching agent, and the cavity is sealed with temporary filling material. The patient is recalled after a few days, the bleaching result is assessed, and if necessary, the bleaching agent is placed again in the cavity.

2. Thermocatalytic Technique (Power Bleaching): The thermocatalytic technique for whitening is based on enhancing the effectiveness of the whitening agent by using heat and light. Typically, oxidative chemical agents like 30-35% hydrogen peroxide are placed into the pulp chamber, and then heat-producing devices such as electric heat tools, light, or both are applied. However, due to side effects from heating the hydrogen peroxide in the pulp chamber, which can lead to excessive whitening and especially external cervical resorption, the thermocatalytic technique is no longer recommended.

3. Inside-Outside Technique: In this technique, both intracoronal whitening and at-home whitening are combined. First, impressions of the patient's teeth are taken, and individual trays are made. The access cavity of the nonvital tooth is typically protected and left open with resin-modified glass ionomer. Then, at-home whitening (home-bleaching) procedures are applied. Alternatively, both intracoronal and vital whitening can be performed in the same session in-office,

which shortens the treatment time. The inside-outside whitening technique is especially useful for treating teeth that are difficult to whiten.

The side effects of devital bleaching are limited but may include:

- Increased fracture risk
- Reduced bonding strength
- External root resorption

To minimize these side effects during devital bleaching, the following precautions can be taken:

- Avoid using high-concentration agents (e.g., 30% Hydrogen Peroxide)
- Avoid using heat and light
- Completely seal the canal filling material with cement in a "saddle" shape
- Allow sufficient time after whitening and ensure a hermetic restoration is placed (It is recommended to leave calcium hydroxide in the cavity for 2 weeks)

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CHAPTER 11

Evaluation of SNPs in PPARA GENES in Turkısh Saanen Goats

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EVALUATION of SNPs in PPARA GENES in TURKISH SAANEN GOATS

ABSTRACT

Saanen goat is one of the most spread goat breed in Türkiye, they are known for their high milk yield and fertility. Agriculturally important traits in goats generally show quantitative inheritance, since quantitative traits regulates by several genes, It is important to find candidate genes that will accelerate selection studies. PPARA (peroxisome proliferator-activated receptor alpha) is one of the candidate genes for milk yield and milk yield characteristics. The PPARA gene is located on chromosome 5 in goats and consists of 9 exons and it is related with fatty acid metabolism. The PPARA gene plays an important role in fatty acid synthesis pathways, thus becoming a candidate gene that may be related to milk yield and milk yield traits.

In the study, detected SNPs in Turkish Saanen goats and DNA sequences of PPARA genes from individuals were used to construct phylogenetic tree. Also, PPARA proteins of PPARA genes in Choromosome 5 in goat genome were analyzed. The results showed total of 24 genes were determined in Chromosome 5 and these genes were named between ChPPARA5-1 and ChPPARA24-1. The lowest protein length was found in ChPPARA5-17 with 427 amino acids, and the highest protein length was found in ChPPARA5-10 and ChPPARA5-11 with 770 amino acids.

Five groups were determined in the phylogenetic tree; it was determined that the PPAR16 gene and PPAR41 genes belonging to the 16th individual, where PPARASNP2 and PPARASNP3 were found, showed a single branch, PPAR6 (PPARSNP3), PPAR24 and PPAR28 genes formed Group IV, the most similar genes in this group were PPAR24 and PPAR28 genes, and Group V consisted of PPAR18 (PPARSNP3) and PPAR29 genes, and these genes were similar to each other.

The aim of the study is to evaluate the detected SNPs in PPARA genes in Turkish Saanen goats, and analysis of PPARA genes and predicted PPARA genes in Chromosome 5 in goat genome.

Keywords: Turkish Saanen goat, PPARA, SNP

INTRODUCTION

Many of the economically important traits in farm animals have quantitative inheritance. Traits based on measurement such as meat, milk, wool, etc. are quantitative traits and are defined by polygenes. In addition to the phenotypic evaluation made according to these traits in the breeding programs applied in farm animals, tools such as protein polymorphism, blood groups, DNA polymorphism have been needed, allowing selection at an early age (Lin et al., 1992).

There are many candidate genes related to growth, reproduction, milk and hair production parameters, which are economic traits (Benjelloun et al., 2015). Candidate genes that can be used in selection include Leptin (LEP), Insulin-like growth factor-I (IGF-I) and Myostatin (MSTN) related to meat yield and quality (Grobet et al., 1998; Ge et al., 2001; Oprzadek et al. ., 2003), Beta lactoglobulin (β-lg), Diacylglycerol acyltransferase 1 related to milk yield (DGAT1) and Prolactin (PRL), (Chung et al., 1996; Spelman et al., 2002; Heidari et al., 2012) and reproductive Progesterone receptor (PRG) and Osteopontin (OPN) (Moura et al., 2012) can be given as examples (Şahin et al., 2013).

It is possible to investigate the relationship between the traits to be examined and the determined locus by molecular biology methods. Thus, genetic variation related to the locus (quantitative trait locus, QTL) can be determined and the relationship between QTL and the yield trait can be determined. The information obtained from the candidate genes can increase the success of the selection studies as well as provide time and cost savings in the breeding studies for the trait in question.

Saanen goats has features that distinguish goat farming from other animal production units include its ability to adapt to different climate and environmental conditions, its resistance to environmental conditions, its ability to benefit from rocky and scrub areas, and its high adaptability. Saanen goats, which are also a common goat breed in our country, stand out with their milk yield and fertility. This breed, which has a high adaptability, is described as robust, short-eared, sometimes with a collar under the neck, white body color and short hair, the udder is well placed between the two legs and has a seat-type glandular breast, and high milk and fertility (Haris and Frederick 1996, Özder 2006).

In recent years, it has been observed that interest in goat milk and its products has increased. Kesenkaş et al. (2010) stated that Saanen goat milk is as valuable as cow milk in terms of chemical composition and also explained that milk components are important for human health. A large number of nutritional contents are required for the human metabolism to function in a certain order. Elements, fats, proteins and vitamins are the most important of these contents. It

is known that elements have a healing effect on diseases such as infections and skin diseases, as well as playing a role in the regulation of immunological reactions and enzyme activities (Selvaraju et al., 2009; Emsley, 2011). People obtain the fats necessary for their metabolism from plant and animal sources. Although goat milk is similar in composition to cow milk, it has become a recommended animal product for the nutrition of infants and the elderly and for those with stomach problems due to the fact that it contains smaller fat globules, is more easily digestible due to structural differences in milk proteins, and is rich in short and medium chain single and multiple fatty acids (Haenlein, 2007).

There are many candidate genes related to growth, reproduction, milk and hair yield parameters in goats (Benjelloun et al., 2015; Işık, 2017, Yakan, 2018). In Turkish Saanen goats, milk yield is the most important trait of economic importance. In addition to the amount of milk, the components such as protein and fat that make up its structure and the number of somatic cells are among the most important quality criteria affecting its processing (Najafi et al., 2009). Detection of candidate genes that can affect milk quality in goat breeding will increase the accuracy of breeding stock selection.

The development of molecular biology methods is closely related to the development of agriculture, including animal husbandry. The identification of genome regions and genes related to important phenotypic traits allows the selection of candidate genes and genetic markers associated with the trait of interest. Marker-assisted selection (MAS) allows the selection of young animals at the early stage of breeding and the selection of the best animals for crossing, allowing to improve the selected trait much faster compared to standard methods. Such an approach allows to increase the financial benefits of livestock production and to accelerate the breeding process.

PPARA (peroxisome proliferator-activated receptor alpha) is a candidate gene; it is a gene that is activated by many fatty acids and fatty acid-derived compounds. PPARA, discovered in the early 1990s, is defined as the chief regulator of hepatic lipid metabolism. Synthetic agonists of PPARA reduce plasma triglycerides and increase plasma HDL cholesterol levels, and are therefore used in the treatment of dyslipidemia. Genetic variants of PPARA are related to the development of dyslipidemia and cardiovascular disease, and the development of Type 3 diabetes (Gorniak, 2014). It was determined that PPARA gene expression increased in the liver tissue of goats fed diets rich in α-linolenic acid (Ebrahimi et al., 2015).

PPARA is a part of the peroxisome proliferator-activated receptor subfamily along with PPARb and PPARG. The PPARA gene is located on chromosome 5 in goats and consists of 9 exons. The PPARA gene, first identified by Stephen

Green in 1990, is a basic transcription factor regulating lipid metabolism in the liver. PPARA activation regulates the uptake, utilization and destruction of fatty acids by regulating genes involved in fatty acid transport, fatty acid binding and activation, and peroxisomal and mitochondrial fatty acid β-oxidation (Kersten 2014). PPARA helps reduce pain and inflammation by inhibiting the release of various proinflammatory and pro-angiogenic enzymes (D'Agostino et al., 2007). In a study conducted on goats; It was determined that PPARA gene expression increased in the liver tissue of goats fed diets rich in α-linolenic acid (Ebrahimi et al., 2015).

The information obtained from candidate genes can increase the success of selection studies and save time and money in breeding studies for the trait in question. In addition, understanding the genetic mechanism in the formation of components such as protein and fat, which also affect the nutritional value of milk, will allow changes such as differentiating the nutritional value and decreasing or increasing organoleptic properties as desired (Paromod et al., 2018).

The aim of the study is to evaluate the detected SNPs in PPARA genes in Turkish Saanen goats, and analysis of PPARA genes and predicted PPARA genes in Chromosome 5 in goat genome.

MATERIAL and METHODS

Material

SNPs obtained for PPARA genes from the research project number FGA-2019-20593 of Ege University Scientific Research Projects Unit were used in the study. In research project total of 41 samples from Turkish Saanen goats were sequenced for PPARA genes. Also, PPARA sequences located on Chromosome 5 in the goat genome were taken from the National Center for Biotechnology Information Database (NCBI) and loaded into the CLC Workbench program and sequence similarities were compared with BLASTP (NCBI, 2023; Qiagen, 2024). Query matches with an expectation value of ≥e-60 and ≥60% similarity were accepted as significant matches.

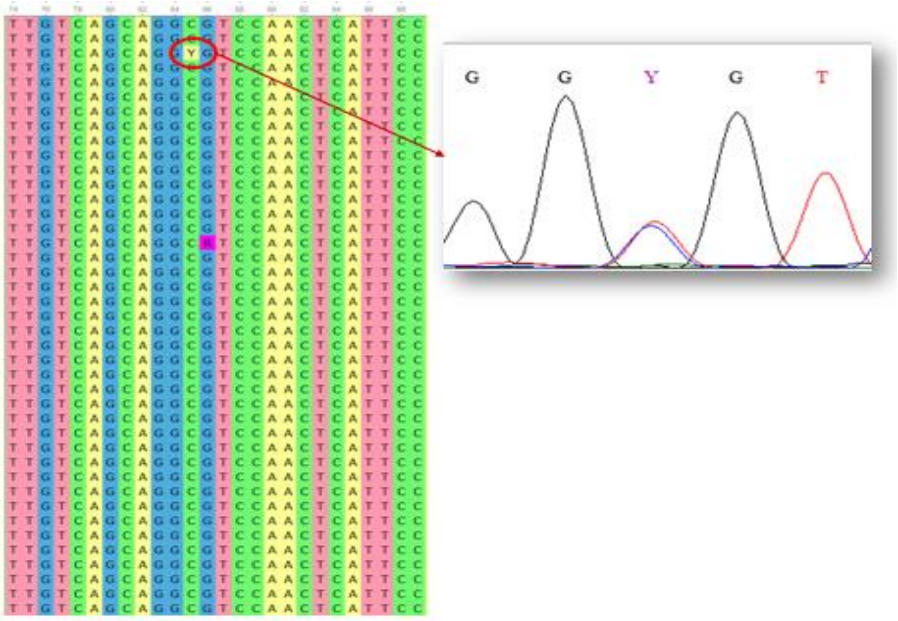
Methods

The predicted PPARA genes on Chromosome 5 were named using chromozomal locations and molecular weights of the proteins (kDa), lengths, pI points, instability of the proteins, alifatic index, GRAVY and subcellular locations were determined using Expasy Protparam tools (Gasteiger et al., 2005).

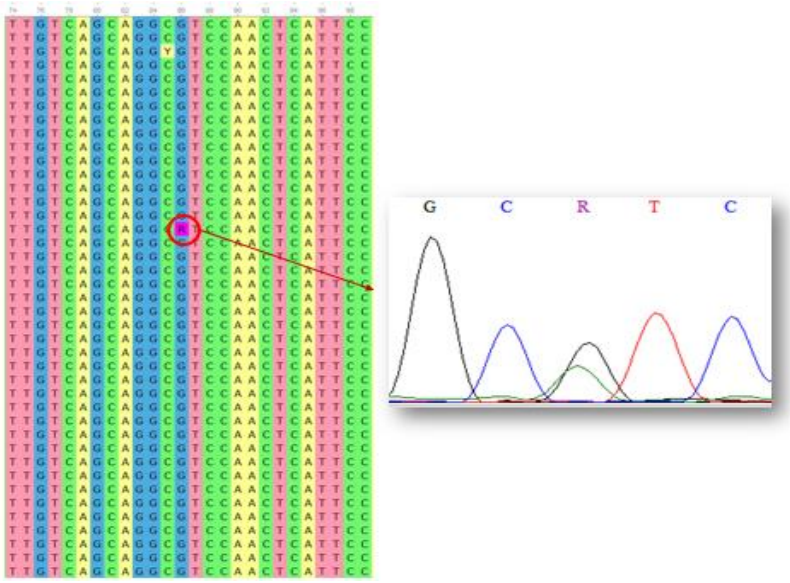
DNA sequences of a total of 41 samples were aligned using the ClustalW algorithm in the MEGA 11 program and phylogenetic tree of gene sequences was created based on the maximum likelihood algorithm (Tamura et al., 2021). Deeploc 2.1 online program was used to estimate the subcellular localization of PPARA proteins (Ødum et al., 2024).

RESULTS and DISCUSSION

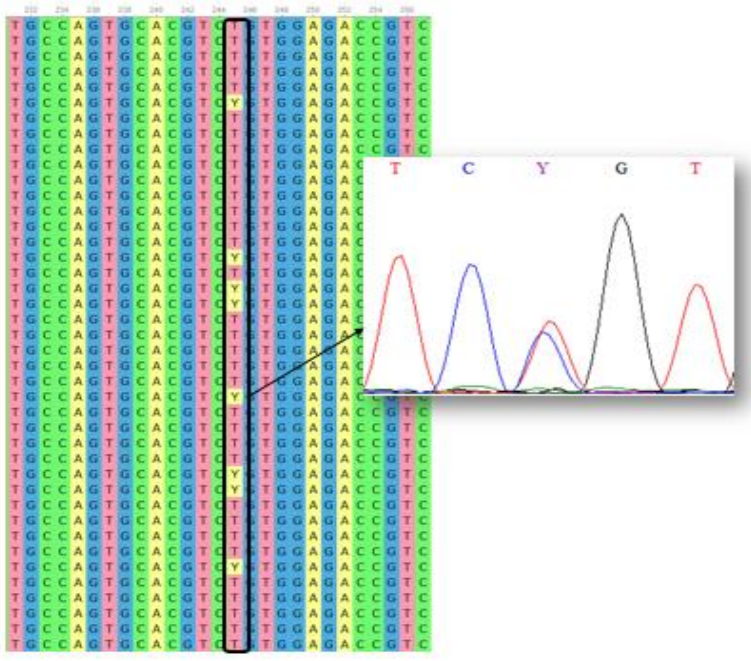
A total of 3 SNPs were detected in the samples taken for the PPARA gene. These SNPs were found in Intron 6-7 (Samples 3 and 16), Exon 7 (Samples 6, 16, 18, 19 ,25, 30, 31 and 36) and Intron 7-8 (Samples 12 and 40). The SNPs located in Intron 6-7 (Sample 3) and Exon 7 (Samples 6, 16, 18, 19 ,25, 30, 31 and 36) were found to be in the databases with the codes rs640787651 and rs665742135, respectively (Gevrekci et al.,2022). These SNPs are visualized in Figure 1, Figure 2, Figure 3 and Figure 4.



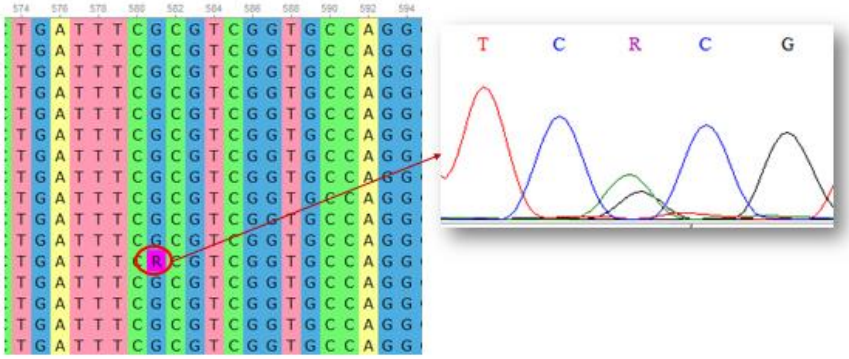
Şekil 1. PPARASNP1 (Intron 6-7, Sample 3)



Şekil 2. PPARASNP2 (Intron 6-7, Sample 16)



Şekil 3. PPARASNP3 Exon 7 (Samples 6, 16, 18, 19 ,25, 30, 31 and 36)



Şekil 4. PPARASNP4 Intron 7-8 (Samples 12 and 40)

PPARA gene sequences located on chromosome 5 in the goat genome and the predicted gene sequences associated with these genes were determined and the parameters of the proteins that are the products of these genes are given in Table 1. A total of 24 genes were determined and these genes were named between ChPPARA5-1 and ChPPARA24-1. The lowest protein length was found in ChPPARA5-17 with 427 amino acids, and the highest protein length was found in ChPPARA5-10 and ChPPARA5-11 with 770 amino acids. Similarly, the lowest and highest molecular weights were determined in ChPPARA5-17 and ChPPARA5-10 and ChPPARA5-11 (48.286 Kda-83.711 Kda). When the isoelectric point was examined, it was seen that the lowest isoelectric point was in ChPPARA5-22 with 5.70 and the highest isoelectric point was in ChPPARA5-16 with 8.78. Instability index varied between 46.99-61.98 and all proteins were found to be unstable. The lowest aliphatic index and GRAVY were found in ChPPARA5-16 (59.79 and -0.361), and the highest aliphatic index and GRAVY were found in ChPPARA5-22 (84.72 and -0.189). According to aliphatic index and GRAVY values, all proteins were found to be hydrophilic and soluble. When the subcellular localizations of the proteins were evaluated, it was determined that ChPPARA5-7, ChPPARA5-8, ChPPARA5-9, ChPPARA5-17, ChPPARA5-18, and ChPPARA5-22 proteins were found both in the nucleus and cytoplasm, while the other proteins were located in the nucleus.

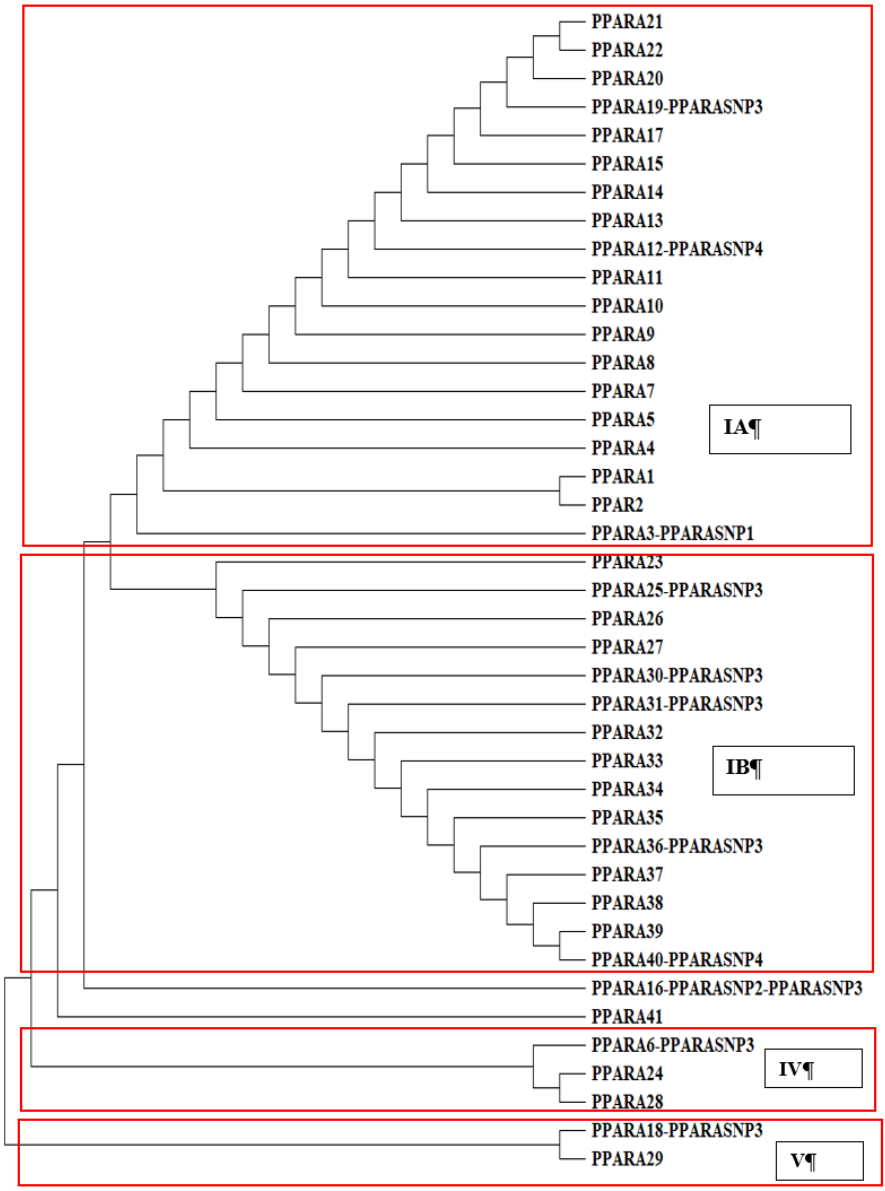
The phylogenetic tree constructed for the sequences of 41 samples on which DNA sequencing was performed for the PPARA gene is given in Figure 5. Five groups were determined in the phylogenetic tree; it was determined that the PPAR16 gene and PPAR41 genes belonging to the 16th individual, where PPARASNP2 and PPARASNP3 were found, showed a single branch, PPAR6 (PPARSNP3), PPAR24 and PPAR28 genes formed Group IV, the most similar genes in this group were PPAR24 and PPAR28 genes, and Group V consisted of

PPAR18 (PPARSNP3) and PPAR29 genes, and these genes were similar to each other.

It was seen that the other genes were in Group I. It was seen that Group I was divided into two subgroups. While PPAR19 (PPARSNP3), PPAR12 (PPARSNP4), PPAR3 (PPARSNP1) were located in IA; PPARA25 (PPARSNP3), PPAR30 (PPARSNP3), PPAR31 (PPARSNP3), PPAR36 (PPARSNP3) and PPAR40 (PPARSNP4) genes were found to be located in group IB. PPARSNP1 and PPARSNP4 were found only in main group I. In IA, PPAR21 and PPAR22, PPARA1 and PPARA2 were the most similar genes to each other, while PPARA3-PPARSNP1 formed a single branch in this group. In IB, the closest genes were observed to be PPAR39 and PPAR40 (PPARSNP4). PPARASNP3 was the most common SNP type.

Table 1. Parameters of PPARA proteins

Gene	NCBI ID	Start position (bp)	End Position (bp)	Protein length (aa)	pI	Molecular weight (Da)	Instability index	Instability	Alifatic Index	GRAVY	Hydropathy	Subcellular Localization
ChPPARA5-1	XP_005679885.1	24.497.247	24.527.467	674	6.02	76060.88	50.35	Unstable	78.74	-0.28	Hydrophilic	Nucleus
ChPPARA5-2	XP_005680558.1	63.093.976	63.145.652	532	6.29	61535.54	56.25	Unstable	74.98	-0.485	Hydrophilic	Nucleus
ChPPARA5-3	XP_005680559.1	63.093.976	63.145.652	528	6.29	61083.01	56.22	Unstable	75.55	-0.487	Hydrophilic	Nucleus
ChPPARA5-4	XP_017903123.1	24.497.247	24.527.467	670	5.95	75587.31	50.59	Unstable	78.63	-0.288	Hydrophilic	Nucleus
ChPPARA5-5	XP_017903124.1	24.497.387	24.527.467	592	6.05	66532.89	50.92	Unstable	74.98	-0.269	Hydrophilic	Nucleus
ChPPARA5-6	XP_017903178.1	26.511.951	26.527.099	513	7.13	57733.85	56.84	Unstable	69.24	-0.438	Hydrophilic	Nucleus
ChPPARA5-7	XP_017903179.1	26.511.951	26.527.099	513	7.13	57733.85	56.84	Unstable	69.24	-0.438	Hydrophilic	Nucleus, Cytoplasm
ChPPARA5-8	XP_017903180.1	26.511.951	26.527.099	513	7.13	57733.85	56.84	Unstable	69.24	-0.438	Hydrophilic	Nucleus, Cytoplasm
ChPPARA5-9	XP_017903181.1	26.518.782	26.527.099	502	7.12	56631.48	61.10	Unstable	69.02	-0.446	Hydrophilic	Nucleus, Cytoplasm
ChPPARA5-10	XP_017903219.1	27.520.423	27.525.562	770	7.69	83711.51	61.98	Unstable	71.01	-0.247	Hydrophilic	Nucleus
ChPPARA5-11	XP_017903220.1	27.520.423	27.525.562	770	7.69	83711.51	61.98	Unstable	71.01	-0.247	Hydrophilic	Nucleus
ChPPARA5-12	XP_017903221.1	27.520.423	27.525.562	706	7.73	75589.29	60.56	Unstable	73.43	-0.216	Hydrophilic	Nucleus
ChPPARA5-13	XP_017903222.1	27.520.423	27.525.562	599	7.21	64549.61	59.64	Unstable	72.05	-0.265	Hydrophilic	Nucleus
ChPPARA5-14	XP_017903223.1	27.520.423	27.525.562	600	6.91	64664.70	59.75	Unstable	71.93	-0.27	Hydrophilic	Nucleus
ChPPARA5-15	XP_017903224.1	27.520.586	27.525.562	592	8.15	62454.69	58.87	Unstable	62.72	-0.330	Hydrophilic	Nucleus
ChPPARA5-16	XP_017903225.1	27.522.994	27.525.562	526	8.78	55520.94	61.73	Unstable	59.79	-0.361	Hydrophilic	Nucleus
ChPPARA5-17	XP_017903361.1	31.982.880	32.012.747	427	5.85	48286.02	51.96	Unstable	77.66	-0.469	Hydrophilic	Nucleus, Cytoplasm
ChPPARA5-18	XP_017903362.1	31.982.880	32.012.747	427	5.85	48286.02	51.96	Unstable	77.66	-0.469	Hydrophilic	Nucleus, Cytoplasm
ChPPARA5-19	XP_017903640.1	63.084.629	63.145.652	478	6.25	54934.14	54.97	Unstable	78.35	-0.497	Hydrophilic	Nucleus
ChPPARA5-20	XP_017903641.1	63.084.629	63.145.652	474	6.25	54481.61	54.93	Unstable	79.01	-0.501	Hydrophilic	Nucleus
ChPPARA5-21	XP_017904393.1	115.425.957	115.447.998	525	6.86	56965.94	48.62	Unstable	74.59	-0.282	Hydrophilic	Nucleus
ChPPARA5-22	XP_017904394.1	115.425.957	115.447.825	509	5.70	56446.94	48.83	Unstable	84.72	-0.189	Hydrophilic	Nucleus, Cytoplasm
ChPPARA5-23	XP_017904395.1	115.426.068	115.447.998	488	7.19	53029.45	46.99	Unstable	73.65	-0.299	Hydrophilic	Nucleus
ChPPARA5-24	XP_017904396.1	115.426.068	115.447.998	488	7.19	53029.45	46.99	Unstable	73.65	-0.299	Hydrophilic	Nucleus



Şekil 5. Phylogenetic tree of sample PPARA genes and SNPs

Studies have reported that PPAR family members play a role in fatty acid synthesis pathways in ruminants. In a study using primary goat mammary epithelial cells, it was suggested that PPARA can stimulate the synthesis of monounsaturated fatty acids, and due to the high levels of mRNAs associated

with these genes, it plays a role in fatty acid synthesis, oxidation, transport, and triacylglycerol synthesis (Mu et al., 2021; Tian et al., 2020).

Ataç et al. (2022) examined the relationship between milk quality traits and yield and SNPs in PPARA and PPARG genes in their study on Turkish Saanen goats, they determined the SNPs in the Turkish Saanen goat genome, and stated that the SNP registered as rs665742135 had a significant effect on the PPARA target value, and that there was a positive correlation between PPARA gene expression and true protein and lactose levels.

Gunawan et al. (2020) reported that the PPAR family was clearly present in the fatty acid synthesis pathway, apart from different metabolism and signaling pathways, as a result of KEGG analysis in their study on sheep, and that they had an important role in the regulation of fatty acid metabolism in the liver. It was also stated that PPARA was involved in blood glucose uptake, as well as being involved in fat metabolism in skeletal muscles and liver.

Chen et al. (2017) reported that two miRNAs, miR-148a and miR-17-5p, control triglyceride synthesis in goat mammary epithelial cells by regulating PPARG coactivator 1 α (PPARGC1A) and peroxisome proliferator-activated receptor α (PPARA) genes. These miRNAs control tryglyceride synthesis and fat droplet accumulation by inhibiting the expression of both genes.

Qin et al. (2015) determined that gene expression in the PPARA signaling pathway is associated with *longissimus dorsi* muscle fatty acid composition in yaks and cattle. They also reported that it controls and regulates intramuscular fatty acid metabolism in yaks and therefore the PPARA gene can be used as a candidate gene in selection studies on fatty acid composition in yaks.

CONCLUSION

The PPARA gene plays an important role in fatty acid synthesis pathways, thus becoming a candidate gene that may be related to milk yield and milk yield traits. By revealing the regulation mechanisms of key genes involved in fatty acid synthesis, it will be possible to accelerate selection studies to improve milk yield and milk yield traits. Therefore, investigating the gene polymorphisms of PPARA and PPAR family members in goats, a farm animal of economic importance, and the relationships of these polymorphisms with milk and meat traits will lead to future breeding studies.

ACKNOWLEDGEMENT: The aouthors would like to thank to Ege University Scientific Research Projects Unit for its support to their project FGA-2019-20593.

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CHAPTER 12

Effects Of Electromagnetic Field On Male Reproduction

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INTRODUCTION

With today's technological advances, electrical devices have become a commonplace part of our lives. However, in addition to the conveniences these devices offer, it is observed that they also pose threats to our lives. Electromagnetic sensitivity syndrome manifests itself with a variable picture in line with the living spaces and personal differences of individuals (Tamam et al., 2016). The electromagnetic field refers to the empty space under the influence of moving particles with an electric charge. This field is a force field consisting of electric and magnetic components created by electrons in the atom as they rotate around the nucleus and their own axes (Halliday et al., 2001).

Since the mid-20th century, the utilization of radio frequency electromagnetic fields in technology has expanded significantly. These fields are now integral to various domains, including medical practices (e.g., magnetic resonance imaging and therapeutic diathermy), industrial processes (e.g., material heating and welding), everyday devices (e.g., baby monitors and Wi-Fi systems), security and navigation tools (e.g., radar applications), and communication technologies (e.g., broadcasting and mobile networks). As a result, a considerable portion of the global population is currently exposed to radio frequency electromagnetic fields, and this exposure is projected to grow further as technological adoption increases. Concerns regarding the potential health implications of radio frequency electromagnetic fields exposure are intensifying, making it essential to conduct thorough risk assessments. Such evaluations are crucial for enabling policymakers to establish evidence-based regulations and for ensuring the public receives accurate information (Pacchierotti et al., 2021).

Non-ionizing electromagnetic radiation refers to electromagnetic waves consisting of photons that do not reach the energy level required to break the atomic bonds that hold molecules together. These types of radiation include visible light, infrared, ultraviolet, radio frequency waves, microwaves, static fields, and magnetic fields. These fields can cause heat increases in the body depending on various parameters such as exposure time, power, and distance. The relationship between non-ionizing electromagnetic radiation and cancer is addressed in the literature with conflicting results (Ahlbom et al., 2004).

Modern devices generating electromagnetic fields encompass a wide range of technologies, including radars, mobile phones, radio and television transmitters, as well as medical and industrial equipment, high-voltage power lines, microwave ovens, and numerous electrical household appliances (Öngel et al., 2009). Moreover, gadgets such as computers, tablets, hair dryers, and wireless devices contribute to the production of electromagnetic fields. Consequently,

human exposure to electromagnetic fields begins as early as the intrauterine stage and continues to grow throughout life.

PROBLEMS THAT MAY OCCUR DURING EXPOSURE TO ELECTROMAGNETIC FIELD

While the benefits of technological advancements are indisputable, the adverse effects of electromagnetic fields on human health have been linked to severe conditions, including leukemia, infertility, cardiovascular disorders, and neuroendocrine dysfunctions. Analyzing contemporary research on the detrimental impact of electromagnetic waves highlights that this issue has escalated into a significant public health concern (Özgüner and Mollaoglu, 2006). Scientific investigations indicate that electromagnetic fields may disrupt cellular structures and impair functions by elevating oxidative stress and inducing DNA damage (Erdoğan et al., 2019).

Advances in technology (mobile phones, base stations, Wi-Fi and Bluetooth, etc.) have led to the proliferation of devices that emit increasing amounts of electromagnetic radiation into the environment. Beyond their intended use, the widespread and often unconscious reliance on these devices exposes individuals to substantial electromagnetic fields from birth onward (Swerdlow et al., 2011). Low-frequency electromagnetic fields influence not only electrically charged particles but also a wide range of biochemical processes in the human body, from digestion to brain activity. As a result, the potential health implications of electromagnetic fields have sparked societal concerns and debates. These fields are regarded as an invisible environmental pollutant with adverse effects on both human and animal health.

Experimental studies conducted on animals have shown that electromagnetic field exposure causes deterioration in some cellular functions (Lagroye and Poncy, 1998). These studies show that electromagnetic fields can cause adverse results such as cytotoxicity, genotoxicity and hypersensitivity (Singh and Kapoor, 2014). Furthermore, electromagnetic fields have been reported to exert detrimental effects on various biological systems, including the nervous, digestive, endocrine, and cardiovascular systems, as well as reproductive functions. These findings underscore the diverse and widespread negative impacts of electromagnetic fields on physiological processes (Açıkgöz, 2019; Singh and Kapoor, 2014).

Electromagnetic fields can affect certain hormone levels via the hypothalamic-pituitary-gonadal axis by reducing melatonin production in the pituitary gland. This can lead to decreased sexual desire in both men and women. Its effects at the cellular level disrupt the function of germ cells in men, causing

abnormalities in sperm morphology, loss of fertility, increased apoptosis, and decreased intracellular calcium levels (Agarwal et al., 2008; Agarwal et al., 2009; Lui et al., 2014). It can also cause congenital defects in the embryo, disruptions in embryo development, and problems with blastocyst maturation. There is evidence that abnormalities in testicular development and growth and developmental delays may occur in future generations. The adverse effects of electromagnetic fields on biological tissues vary depending on the frequency, intensity (strength) and exposure time of the field (Belyaev et al., 2015; Otto and von Mühlendahl, 2007).

SOME REPORTED STUDIES WİTH ELECTROMAGNETIC FIELD

Testicular tissue plays a vital role in regulating spermatogenesis and is essential for healthy reproductive processes. Wireless networks have a significant effect on testicular sperm production and maturation. Results from studies on some reproductive hormones provide insights into this issue. The sensitivity of this tissue to both ionizing and non-ionizing radiation, especially during wireless internet use on laptops, can alter hormone levels and potentially pose a risk to reproductive health.

Many reported experimental studies suggest that electromagnetic field exposure may negatively affect male reproductive health and cause infertility by causing a decrease in sperm quality and count (Açıkgöz, 2019; Agarwal et al., 2009; Avendaño et al., 2012; La Vignera et al., 2012).

A study was conducted to investigate whether the effects of exposure to extremely low frequency magnetic fields on spermatozoa differ depending on some variables (waveform, magnetic flux density, field frequency and exposure time). The results showed that statistically significant changes in motility and morphology values and reactive oxygen species production in human sperm occurred after two hours of exposure to a 50 Hz magnetic field (Muti et al., 2023).

An experimental study examined the effects of fourth-generation (4G) mobile phone radiation on hematological parameters, including total leukocyte count, total erythrocyte count, and hemoglobin concentration; biochemical markers such as serum creatinine levels; and histopathological changes in the kidney and testicular tissues of Swiss albino mice. The study utilized 30 male Swiss albino mice, each weighing 45–65 grams, divided into three groups. Group A served as the control, Group B was exposed to 40 minutes of daily mobile phone radiation, and Group C underwent exposure to two 4G mobile phones operating at a frequency of 2400 MHz for 60 minutes daily over 60 days. Radiation frequency was measured using an electromagnetic radiation frequency radiometer, with a specific absorption rate (SAR) calculated at 0.087 W/kg. Control mice were kept

under identical conditions without exposure to electromagnetic radiation. Results indicated that radiation-exposed mice exhibited significant reductions in body weight and total erythrocyte count compared to controls, alongside notable increases in total leukocyte count, hemoglobin levels, and serum creatinine concentrations. Histopathological assessments showed prominent interstitial inflammation and mononuclear cell infiltration in the kidneys of mice exposed to 60 minutes of daily radiation. Additionally, testicular tissue analysis revealed irregularly shaped and sized seminiferous tubules, enlarged lumens, and a diminished spermatogenic cell layer. The study concluded that prolonged exposure to 4G mobile phone radiation adversely impacts hematological balance and induces inflammatory changes in kidney and testicular tissues (Hasan et al., 2021).

Research by La Vignera et al. (2012) demonstrated that exposure to electromagnetic frequencies leads to the generation of reactive oxygen species, adversely impacting sperm count and motility. Similarly, an experimental study on rats divided into three groups—those exposed to radiofrequency for 20 hours, those exposed for 8 hours, and a control group—revealed that testicular damage was most pronounced in the group subjected to the longest exposure. These findings suggest a direct correlation between the duration of radiofrequency exposure and the extent of testicular damage (Karaman et al., 2014).

An experimental study evaluated the impact of 900 MHz radiofrequency electromagnetic fields on rat testes using 20 adult male Sprague-Dawley rats weighing 270–320 grams. The rats were divided into two groups: the control group, which was not exposed to the electromagnetic field, and the experimental group, which was exposed to a 900 MHz electromagnetic field for 30 minutes, five days a week, over four weeks. The findings revealed a significant reduction in the seminiferous tubule diameter and the average height of the germinal epithelium in the exposed group. Serum total testosterone levels were also significantly lower in this group, while no significant differences were observed in Follicle-Stimulating Hormone and Luteinizing Hormone levels. Additionally, a statistically significant difference was found in the seminiferous tubule diameters, but no significant changes were detected in Johnsen scoring, germinal epithelium thickness, testicular tissue weight, or the percentage of Leydig cells in the interstitial tissue. These results suggest localized structural and hormonal effects without broader histopathological changes in testicular tissue (Ozguner et al., 2005).

Lary et al. (1982) demonstrated that radiofrequency waves at a frequency of 27.12 MHz exhibited teratogenic effects in rats. Similarly, in a study by Dasdag et al. (1999), rats exposed to mobile phones during active conversations showed

histological changes in their testicles. Additionally, these rats had statistically higher rectal temperatures compared to those not exposed to mobile phone radiation.

In another experimental study, rats exposed to electromagnetic fields at a frequency of 900 MHz for 1 hour per day showed significant reductions in sperm concentration and motility, along with an increase in sperm head abnormalities. Additionally, the rate of DNA damage in the sperm of these rats was found to be higher compared to the control groups. Histopathological examinations revealed degeneration, necrosis, and apoptosis in the testicular tissue of the exposed rats. The study also noted alterations in oxidative stress markers in both blood and semen samples, further indicating the negative impact of electromagnetic field exposure on male reproductive health (Açıkgöz, 2019).

An experimental study was conducted to explore the potential protective effects of melatonin against testicular damage induced by oxidative stress from electromagnetic radiation. Thirty-two rats were divided into four groups: control (A1), sham control (A2), a group exposed to 2.45 GHz electromagnetic radiation alone (B), and a group treated with melatonin along with electromagnetic radiation (C). Groups B and C were exposed to 2.45 GHz radiation for one hour per day over 30 days. The results showed that lipid peroxidation levels were significantly higher in group B compared to groups A1 and A2. Melatonin treatment in group C effectively prevented the radiation-induced increase in lipid peroxidation. Additionally, levels of reduced glutathione and glutathione peroxidase were higher in group C than in group B. While vitamin A and E levels were decreased in group B, melatonin helped prevent the reduction of vitamin E. These findings suggest that melatonin may offer protective effects against oxidative damage caused by electromagnetic radiation exposure (Oksay et al., 2014).

In their study examining the impact of mobile phone usage on sperm quality, Agarwal and colleagues found that sperm quality significantly decreased as the duration of mobile phone usage increased (Agarwal et al., 2008).

Another study investigating the effects of electromagnetic fields on the male reproductive system found a significant association with decreased fertility. In this study, male albino rats exposed to electromagnetic radiation showed reduced sperm count, increased lipid peroxidation damage in sperm cells, alterations in the seminiferous tubules, decreased testicular weight, and increased DNA damage (Kumar et al., 2014).

In another study examining the effects of high-intensity exposure to 50 Hz AC electric fields on the reproductive system of male rats, the findings indicated that the mating and fertility rates of animals exposed to short-term exposure were

lower than those exposed to long-term exposure. Additionally, the body weights of the offspring were reduced by approximately 10% compared to the control group in both exposure conditions (Margonato and Viola, 1982).

A research team examined the effects of radiofrequency electromagnetic fields emitted by mobile phones on free radical metabolism and sperm quality. In this study, 10-12 week old male Wistar rats were exposed daily for 1 hour to a 0.9/1.8 GHz radiofrequency electromagnetic field from an active mobile phone over a period of 28 days. The control group was exposed to a mobile phone without a battery for the same duration. The findings showed a significant reduction in sperm motility in the rats exposed to the electromagnetic fields. Additionally, there was an increase in lipid peroxidation and a decrease in glutathione levels in the epididymis and testes of the exposed rats (Mailankot et al., 2009).

Twenty adult male Sprague-Dawley rats were divided into four equal groups and exposed to a 900 MHz radio frequency electromagnetic field for 1, 2, and 4 hours per day over a period of 30 days. The results showed that Follicle Stimulating Hormone and Luteinizing Hormone levels were significantly higher in the long-term exposure group compared to the sham group. Additionally, serum activin B and prolactin levels were also significantly increased in the long term exposure group. On the 30th day of exposure, Inhibin B levels showed a significant decrease in both the sham and short-term exposure groups. Furthermore, serum testosterone levels were significantly lower in the long-term exposure group compared to the short and medium term exposure groups (Sepehrimanesh et al., 2014).

In a different experimental study, the protective effects of melatonin against oxidative stress-induced damage in testicular tissue caused by prolonged radiation exposure were explored. For this purpose, rats were divided into four groups: a sham group, a melatonin-only treatment group, a 2.45 GHz microwave radiation exposure group, and a group receiving both melatonin treatment and microwave radiation exposure (2 mg/kg). The rats were exposed to electromagnetic radiation for 2 hours per day over 45 days in Plexiglas cages, with a power density of 0.21 mW/cm² and a specific absorption rate (SAR) of 0.14 W/kg. The study assessed biochemical markers indicating oxidative damage in the testicular tissue, including lactate dehydrogenase isoenzyme activity, xanthine oxidase, reactive oxygen species, DNA damage, and malondialdehyde levels. The radiation exposure resulted in a significant increase in lactate dehydrogenase isoenzyme activity in the testicles. However, in the melatonin treatment group, malondialdehyde and reactive oxygen species levels were found to decrease, demonstrating the protective effects of melatonin. Furthermore,

melatonin treatment mitigated the negative impacts of microwave radiation, improving xanthine oxidase activity, reactive oxygen species levels, sperm count, testosterone levels, and reducing DNA damage in testicular cells (Meena et al., 2014).

A research team examined the effects of radiofrequency waves emitted by a base receiver-transmitter station on oxidative stress in testicular tissue and explored the protective role of vitamin C against these effects. The study involved 32 adult male rats, which were randomly assigned to four experimental groups (control, radiofrequency, vitamin C, and radiofrequency + vitamin C) and lasted for 45 days. The vitamin C group received a daily oral dose of 200 mg/kg of L-ascorbic acid. The radiofrequency group was exposed to 900 MHz radiofrequency. The activities of antioxidant enzymes (glutathione peroxidase, superoxide dismutase, and catalase) were measured in the study. It was observed that antioxidant enzyme activity in the radiofrequency group decreased compared to the control group, and malondialdehyde levels were higher. Furthermore, vitamin C supplementation was found to enhance antioxidant enzyme activity and reduce malondialdehyde levels (Jelodar et al., 2013).

An experimental study investigated the impact of electromagnetic fields at a frequency of 2450 MHz on apoptosis and histopathological changes in rat testicular tissue. Twelve-week-old male rats were divided into three groups: a control group, a sham group, and an electromagnetic radiation group. The radiation group was exposed to 2.45 GHz electromagnetic radiation for 60 minutes daily over a period of 28 days. The study found that the Leydig cell count in the radiation-exposed rats was significantly lower compared to the control group. Additionally, a statistically significant difference in the Johnsen testicular biopsy score was observed between the groups (Saygin et al., 2011).

A study was conducted to assess the effects of a 900 MHz electromagnetic field on cortisol and testosterone hormone levels in rats. In this experiment, 20 male rats were divided into two groups: a control group and an electromagnetic field group. The rats in the electromagnetic field group were exposed to a 900 MHz frequency with a power of 1 ± 0.4 mW/cm² for 30 minutes each day, 5 days a week, over a 4-week period. The results revealed that cortisol levels were significantly higher in the electromagnetic field group compared to the control group, while testosterone levels were significantly lower in the electromagnetic field group than in the control group (Koyu et al., 2005).

In their study, two researchers compared sperm exposed to radiofrequency electromagnetic fields with unexposed sperm, finding that sperm viability in the exposed samples was significantly lower than in the control group. Additionally, the levels of reactive oxygen species were higher in the sperm that were exposed

to electromagnetic fields (Wang and Zhang, 2017). This suggests that electromagnetic waves emitted by mobile phones induce oxidative stress in human sperm (Agarwal et al., 2009).

In their experimental study, Yahyazadeh et al. (2020) explored the potential impact of 900 MHz electromagnetic field exposure (60 minutes daily for 28 days) on rat testicular tissue. Histological, stereological, biochemical, and immunohistochemical methods were used to analyze the testicular samples. The findings indicated a significant decrease in the number of primary spermatocytes, spermatids, and Leydig cells in the group exposed to the electromagnetic field compared to the control group. Moreover, the activity of superoxide dismutase was significantly elevated in the exposed group. Additionally, the levels of serum testosterone and the wet weight of the testicles were significantly reduced in the electromagnetic field group when compared to the control group.

In an experimental study, rats were subjected to an electromagnetic field with a power intensity of 3.21 W/kg and a frequency of 2450 MHz for 60 minutes each day, 7 days a week, for a duration of 4 weeks. Upon analyzing the serum hormone levels after the exposure period, no significant alterations were observed in the levels of Follicle Stimulating Hormone or Luteinizing Hormone. However, a notable reduction in total testosterone levels was recorded. Specifically, the group exposed to the 2450 MHz electromagnetic field showed increased sensitivity to magnetic radiation, which was reflected in the decrease in testosterone levels. The study revealed testicular degeneration and adverse effects on sperm development, suggesting that such impacts could potentially affect fertility. The researchers speculated that the electromagnetic field emitted by wireless devices at a frequency of 2450 MHz likely influenced the rats' neuroendocrine system and testicular tissue, possibly due to thermal effects and other stress-related factors (Saygın et al., 2009).

A research team investigated the effects of 2.45 GHz electromagnetic radiation from wireless devices on rat testicles. The experiment involved 48 male Sprague Dawley rats, divided into four groups: a sham group, a group exposed to 3 hours of radiation daily for 30 days, a group treated with 30 mg/kg of gallic acid daily alongside radiation, and a group treated with gallic acid alone. The results showed that the radiation-exposed group had increased malondialdehyde and total oxidant levels, indicating oxidative stress. On the other hand, the gallic acid-treated group had lower oxidant levels and a reduced oxidative stress index. Additionally, the gallic acid treatment reversed the decrease in total antioxidant levels observed in the radiation-exposed group. Although there were decreases in testosterone and vascular endothelial growth factor levels in the radiation group, these changes weren't statistically significant. The group treated with gallic acid

alongside radiation showed an increase in these levels. Moreover, radiation exposure led to higher prostaglandin E2 and calcitonin gene-related peptide levels, but gallic acid treatment significantly reduced these increases. The study also found a reduction in sperm count due to the electromagnetic radiation, with gallic acid treatment positively affecting cell activity in the seminiferous tubules.

CONCLUSION

Today, advances in technology have enabled the diversification of communication tools and their widespread use in our daily lives, thus providing various conveniences. In recent years, with the rapid development of communication technology, electronic devices such as radios, mobile phones and internet networks have become part of our lives. Although these devices make our daily lives easier, they also bring with them some negative effects. These effects are the negative effects of electromagnetic fields, which are often ignored and occur in the long term. Since we cannot remove these devices from our lives, if we can at least reduce the time we are exposed to them, this situation can prevent many negative effects from occurring.

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CHAPTER 13

Spiritual Care and Nursing Approaches In Palliative Care

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1. INTRODUCTION

Palliative care is an essential part of person-centered health care. Palliative care provides services to a wide range of patient profiles, such as cardiovascular diseases, cancer, major organ failure, drug-resistant tuberculosis, severe burns, end-stage chronic diseases, and acute trauma cancer, progressive neurological diseases, AIDS (WHO, 2024; Ünver, 2020). It offers a support system to help patients live as actively as possible until death. In palliative care, these patients' physical, psychological, social, or spiritual symptoms are reduced or eliminated (Veloza-Gomez et al., 2016; Farahaninia et al., 2018; Ünver, 2020).

Treatment and care for palliative care patients include addressing the patient's basic psychosocial needs and providing grief counseling (WHO, 2024). Individuals in palliative care also have spiritual needs brought about by the disease and the disease process. Palliative care includes medical and spiritual care practices provided by a specialized healthcare team for individuals with life-threatening diseases (Cardoso et al., 2013).

2. PALLIATIVE CARE

Palliative care includes medical and spiritual care provided by a specialized healthcare team for individuals with life-threatening diseases. It focuses on reducing the existing disease and its symptoms. The main aim of palliative care is to improve the quality of life of the patient and his/her family. Care and treatment services provided to patients needing palliative care are provided by a specially trained team of doctors, nurses, dieticians, physiotherapists, and other healthcare professionals working together. Palliative care is based on the patient's needs, not on the prognosis of the patient. Addressing pain involves dealing with psychosocial problems in addition to physical symptoms. Therefore, a coordinated team approach is adopted in palliative care to support patients and caregivers. In practice, it includes addressing the basic psychosocial needs of the patient and providing grief counseling. It offers a support system to help patients live as actively as possible until death (Cardoso et al., 2013; WHO, 2024).

3. SPIRITUAL CARE

Patients needing care and treatment should be evaluated holistically during care provision. Patients should be evaluated spiritually as well as physically, socially, and psychologically (Nas, 2018; Arslan & Avcı, 2024; Sucaklı & Koşar, 2016).

In Turkish, the term 'spirituality' is commonly used instead of ‘spirituality’. The Turkish Language Institution defines spirituality as ‘the state of bringing strength to belief and moral attitudes to the difficulties experienced, strength to

endure' (Turkish Language Institution, 2024). Spirituality, a human phenomenon, enables individuals to find meaning in their lives (Nas, 2018), live more hopefully, and continue this journey until the end of their lives. While spiritual care is often linked to religion and God, it has a broader significance. If it were solely associated with religion and God, individuals without religious beliefs or those who do not believe in God would be overlooked in terms of their spiritual needs (Nas, 2018; Dalcalı, 2019; Arslan & Avcı, 2024).

The following headings provide a list of spiritual needs that arise in individuals in relation to the disease (Boztilki & Ardıç, 2017).

- The need to make sense of the disease: There are many anxieties, worries, and sadnesses, such as why the individual is experiencing the disease, the situations awaiting him and his family after this disease, and how this situation will be reflected in his future. They wonder how to overcome the possible consequences of this physical state brought about by the disease process and how they will bear their psychological and spiritual burdens.
- The need for meaning during the course of the illness: During the course of the illness, it is sometimes necessary to reinforce the goals of the illness and the dedication and motivation to overcome the illness. Religious and spiritual beliefs are the most important sources of meaning during this illness.
- The importance of recognizing, respecting, and supporting spiritual beliefs: Patients' spiritual beliefs and values are integral to their well-being. They expect their caregivers and treatment providers to acknowledge and respect these beliefs.
- The need for the mind to concentrate on subjects other than the illness: Individuals in the process of illness want to get away from this mood that causes them to remain in a constant state of negative thoughts, anxiety, and worry caused by the disease. Their most crucial basis in this process is their spiritual beliefs and values.
- The need for feelings of being in control and giving up control: Patients may feel lonely, unclaimed, and marginalized in the hospital and this disease process. Actions such as praying for the patient by the communities to which they feel they belong spiritually, making visits to the patient, and other actions that will make the patient feel valuable will make them feel cared for. This will make the patient think that he/she is loved and valued by the spiritual value they believe in. Accepting and overcoming death: Experiences such as struggling with life-threatening diseases and hospitalization cause the patient to feel that he/she will no longer live. The process of death itself, rather than the death itself, frightens the patient and causes anxiety. During this period, they feel lonely and have no control over their lives. Spiritual values and beliefs in this period are essential

resources in managing situations such as pain, desire to live, and death brought by the disease. They may not feel spiritually ready for death. In this period, they may need specialists who help them feel good and motivate them.

- The need to forgive and be forgiven: For some patients, illness may be perceived as punishment. There may be a need to forgive and be forgiven by this process. Spiritual beliefs and values, religion, being forgiven by others, and forgiving others will be seen as purification and make them feel good.
- The need for gratitude in experiencing the disease: Patients need to be grateful for their health and the human relationships around them. These positive emotions enable the patient to adapt to the treatment and disease process more quickly.
- The need to feel hope: Being hopeful and looking hopeful during the disease process is the most essential energy source of motivation. Spiritual beliefs and values are significant sources of the need for hope in the treatment process.

Healthcare professionals should provide holistic care by addressing the patient's physical, mental, social, and cultural conditions in their care practices, in addition to the treatment and care of the patient's physical problem (Nas, 2018; Arslan & Avcı, 2024).

4. IMPORTANCE OF SPECIALISED CARE IN PALLIATIVE CARE

The fact that the individual in palliative care has a life-threatening disease affects the individual physically, socially, and psychologically (Nas, 2018; Arslan & Avcı, 2024). In particular, anxiety, stress anxiety, hopelessness, and depression, which cause the patient to be affected psychologically and spiritually, go beyond the physical symptoms of the palliative care patient from time to time (Dalcalı, 2019). Since one of the main goals of palliative care is to relieve the patient's physical, psychological, social, and spiritual pain, the importance of spiritual care, which is included in the holistic evaluation of the patient required by the professional approach, should not be ignored and appropriate care should be provided (Dalcalı, 2019; Arslan & Avcı, 2024).

According to the study published by Vachom et al. (2009), the following dimensions emerged in the analysis of the spiritual problems of patients in palliative care;

- Meaning and purpose in life,
- Relationship with God or the transcendent, beliefs, hopes,
- Attitudes towards death,
- Relationship with oneself, evaluation of life, reflection on values,
- The developmental nature of spirituality,

- The openness of consciousness is a sense of unity and togetherness (Vachom et al., 2009).

According to studies, it has been shown that patients with a high level of belief in spiritual values contribute to a decrease in moods such as anxiety, depression, anxiety, stress, a high level of hope (Johnson et al., 2011), a high level of individual competence and a decrease in the risk of suicide, overcoming crises, making sense of life, illness and death (Coyle, 2002).

Healthcare professionals play a crucial role in meeting the health needs of palliative care patients. Their efforts stimulate the importance and value of providing appropriate care to the patient in a holistic and humane manner. This includes interventions that ensure the control of physical, psychosocial, and spiritual symptoms for a dignified end of life (Cardoso et al., 2013).

5. SPECIALISED CARE IN NURSING PRACTICE

Spiritual care in nursing is not just a component, but an integral part of handling the patient with a holistic perspective, intuitively perceiving and establishing a relationship with the patient's existing condition and need, and applying this approach to the patient from a professional perspective (Nas, 2019). It is a practice that values the patient's spiritual well-being as much as their physical health, making nurses an indispensable part of the patient care process.

Therefore, spiritual care and spirituality are new in nursing and need a clear definition. It is not easy to define because it is abstract and concerning feelings. These terms will vary from person to person (Arslan & Avcı, 2024). The importance of spiritual care should increase in nursing practices. The nurse should emphasize the patient's spiritual care as much as physical care. The nurse should evaluate the patient's complexity in the spiritual sense, including individual and social-spiritual problems (Arslan & Avcı, 2024). The nurse's values and beliefs should be considered for effective spiritual care. Meeting the needs of patients should be fulfilled independently of the nurse's values and beliefs (Peres et al., 2007).

In addition to meeting the physical needs of the palliative care patient, the nurse is also confronted with the emotional and spiritual needs of the patient. The palliative care nurse aims to improve the patient's quality of life during the illness as much as possible. For this purpose, the nurse should focus on the needs of the patient because each patient's needs are different (Arslan & Avcı, 2024). Physical changes caused by the disease in the patient will negatively affect the patient in biological, psychological, and social terms, so the nurse should observe the patient and create appropriate support.

Healthy communication must be ensured in order to provide spiritual care. Listening, focusing on the individual, providing opportunities for awareness, and mutual sharing during the provision of physical care help the individual make good sense of life and death and cope spiritually (Edwards, Pang, Shiu, & Chan, 2010).

According to the study of Ramezani et al., spiritual care practices in nursing include the following interventions:

- To help patients develop personal and psychological coping strategies,
- Helping patients to reconnect with themselves, their families, friends, and the supreme being,
- Encouraging patients' self-care,
- Supporting the spiritual and religious practices of patients and family members,
- To emphasize the positive aspects of the patient's condition,
- To take into account the uniqueness and individuality of each patient,
- To respect the personal dignity of each patient,
- Actively listening to patients,
- To create and support trust in the nurse-patient relationship,
- Expressing unconditional love for patients (Ramezani et al., 2014).

What the nurse can do for care practices;

- The questions asked during the preliminary assessment determine the patient's need for spiritual care. Spiritual care is provided by the patient's values, respecting his/her ethnic structure.
- The patient is supported at the point of spiritual practices that the patient can apply on his/her own in situations such as fear, anxiety, and grief, and appropriate counseling should be provided.
- It is the nurse's responsibility to create a conducive environment for spiritual practices such as listening to music and worshipping. This environment, tailored to the patient's spiritual values, enhances the patient's comfort and relaxation.
- While providing spiritual care for patients, the nurse should make a detailed assessment with the cooperation of the entire professional team. It's important for the nurse to have an approach that respects the patient's beliefs and does not impose her/his own spiritual thoughts on the patient.
- The nurse should provide care supporting the patient's search for meaning by establishing a trusting relationship, improving compliance with treatment, and instilling hope. It should contribute to the development of these feelings in the patient.

- If the patient has religious rituals, a suitable environment should be created for him/her to perform these rituals if no factor will adversely affect his/her medical treatment.
- The patient's mood and concerns should be understood and supported. In moments of crisis, the patient will show a change in mood. The nurse should empathize with the patient and provide appropriate spiritual care.
- While providing spiritual care, the patient should be listened to by providing careful, compassionate eye contact in communication with the patient. The patient should feel understood.
- The patient should be encouraged to provide spiritual care, and the relationship with the patient's family should be improved.
- Participation in spiritual care development programs is a key aspect of a nurse's professional growth. It provides opportunities to enhance skills and knowledge, ultimately improving the quality of spiritual care they can offer.
- Spiritual care varies from person to person, and the nurse should have a patient-oriented approach. There is no specific standard. After the patient's spiritual perspective is discovered, spiritual care should be provided by providing a professional relationship with the patient (Çınar & Eti Aslan, 2017; Veloza-Gomez et al., 2016; Farahaninia et al., 2018; Attard et al., 2014; Akın & Yılmaz, 2020).

The process of collecting appropriate data is essential in the spiritual care planning process of nurses. The following questions can be asked for this:

- Is spirituality important to you, and why?
- How do you define spirituality?
- Do you worship in your routine life? Do you have spiritual practices that you repeat often?
- Who or what gives you hope and strength?
- Are your spiritual values a personal strength for you?
- In what ways does spirituality help you in your life as you struggle with the difficulties you face? Do you have certain spiritual beliefs and practices that you use to cope with your problems?
- Are you a member of a group that helps you make sense of life?
- Does your faith community offer resources to help you make sense of life?
- How would you describe your relationship with the Creator or the immaterial?
- What are your views about life?

- What kind of spiritual/religious support do you expect from health professionals?
- What does ‘suffering’ mean to you?
- What does death mean to you?
- What are your spiritual needs?
- How do your spiritual beliefs support you in coping with the illness process?
- How has the disease process changed you and your family's life?
- Can you share with me if there is a belief, a philosophy, or an approach to shaping your thoughts about expressing your current situation?
- Are there any spiritual issues you would like to share with me that would guide your care? (Hodge, 2005; Ergül & Bayık, 2004).

The nurse's practices are essential for the patient to hold on to life and not lose hope. In this context, spiritual care is critical in nursing practices. The importance of spiritual care in nursing practices should increase (Arslan & Avcı, 2024).

6. NURSES’ ATTITUDES TOWARDS SPECIALISED CARE

The nurse's role in spiritual care is crucial, providing patients with a lifeline and a source of hope. The nurse's involvement in spiritual care is significant, as revealed in a multinational study conducted in collaboration with advanced practice nurses in the UK, USA, Switzerland, Austria, and Germany. The study found that approximately 93% of the participants acknowledged the spiritual needs of their patients, and about two-thirds tried to provide spiritual care (Arslan & Avcı, 2024; DeKoninck et al., 2016).

The study published by Borneman et al. showed results of nurse-led training (in four sessions of 25-30 minutes) in physical, psychological, social, and spiritual areas. Providing a prepared training booklet led to positive developments in many areas regarding meeting the patient's and his family's spiritual needs (Borneman et al., 2013). In the study conducted by Kahraman (2020), they examine how spiritual well-being affects the perception of illness: ‘As the level of spiritual well-being of patients increases, their adaptation to treatment, the idea that their disease is curable, and their emotional state also increase’ (Kahraman, 2020). In the study conducted by Ozbasaran et al. (2011) investigating the status of nurses in Turkey regarding spiritual care, it was found that individuals with a highly therapeutic nursing approach have used spiritual care. These are psychiatry and pediatric department nurses. The low spiritual sensitivity of nurses, excessive workload, lack of time, and lack of knowledge are the barriers to spiritual care’ (Ozbasaran et al., 2011). Another study on nurses in Turkey

revealed that their perspectives and attitudes toward spiritual care were often undecided, leading to inadequate care. The study identified factors such as the nurses' level of education, the intensity of their work environment, and the length of their service as key reasons for their negative views on spirituality and spiritual care practices (Ergül & Bayık, 2004). The nurse who cares for the patient during the dying process experiences emotions such as fear, anger, depression, and guilt, which negatively affect the spiritual care provided to the patient. Nurses should receive suitable training in this field and gain awareness and insight into their emotions and behaviors (Ünver, 2020).

In the study published by Ramezani et al: 'There are nurses who do not apply spiritual care in nursing care because they see spiritual care as religious care and there is no clear definition of spirituality' (Ramezani et al., 2014). This underscores the crucial need for a comprehensive guide that demonstrates how nurses can effectively implement spiritual care practices (Meehan, 2012). The review conducted by Galutira et al. (2019) on spiritual care further highlights the significance of a standardized approach: 'The lack of a single standard of spiritual care leads to the inability to provide training on spiritual care, which causes a lack of knowledge in nurses' (Galutira et al., 2019). In another study, it was found that nurses lacked knowledge about spiritual care in palliative care (Tomasso, Beltrame, & Lucchetti, 2011).

7. CONCLUSION

Palliative care is carried out by a specialized health care team where individuals struggling with life-threatening diseases are evaluated in terms of physical, psychological, social, cultural, and spiritual status and provides appropriate medical and spiritual care. Individuals may feel spiritually empty due to the disease state they are in. Palliative care nurses are an essential part of the specialized healthcare team and have a significant place in providing spiritual care. This spiritual care offered to patients by nurses contributes in many ways, such as finding meaning in the patient's life, feeling hopeful, contributing to good interaction with the external environment, and positively affecting the treatment process of patients. In palliative care, nurses' lack of knowledge about spiritual care, lack of awareness, lack of spiritual sensitivity, time limitation, high workload, and lack of a standardized situation that spiritual care cannot be placed in a clear and measurable level in terms of abstract, person-to-person variation, The application of spiritual care in the field of palliative care is minimal due to many reasons such as hesitations in the approach to the patient in the death process and the nurse's anxiety and anxiety states arising from this process together with the patient, and the fact that he/she is affected by this situation.

8. RESOURCES

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CHAPTER 14

Considering Radiation With Male Reproduction

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INTRODUCTION

It is impossible to completely avoid radiation that occurs as a result of the radioactive decay of isotopes found in water, soil, air, plants and other living things on Earth through cosmic rays reaching our Earth from space. This is a phenomenon that occurs independently of human influence and is called "natural radiation". Radioactive isotopes such as potassium-40, carbon-14 and radium-226, which are naturally found in the structure of living organisms, act as a continuous radiation source in the body and cause internal radiation release (Ambarcıoğlu, 2014; Bozbıyık et al., 2002; Çoşkun, 2011; Helvacı, 2011).

Cell phones, televisions, microwave ovens, radio broadcasting systems and wireless communication networks are among the basic tools of today's life. These technologies use radio frequency waves and cause everyone to be exposed to these waves due to their dense presence in our environment. On the other hand, the increase in infertility rates in men is a serious health concern. In particular, it is suggested that long-term and intense non-ionizing radiation can cause genetic problems in the male reproductive system, which can be a factor that increases the risk of cancer (Kaur et al., 2023).

Radiation is basically divided into two main groups: particulate radiation, which moves in the form of particles, is very small in size and has high speed, and electromagnetic (wave) radiation, which propagates at the speed of light and carries energy through vibrations (Balsak, 2014). In addition, a distinction is made between ionizing and non-ionizing radiation, depending on whether the radiation causes ion formation on the substance it comes into contact with. This classification is determined by the gain or loss of electrons by the substance (Şenlik, 2010). It has been reported that radiation is divided into two basic groups depending on its capacity to remove electrons from atoms or molecules in the substance, and these two groups are classified as ionizing radiation and non-ionizing radiation (Öngel et al., 2009).

Briefly, radiation is defined as energy carried by rapidly moving particles or electromagnetic waves (Özalpan, 2001). Testicles, the primary organs of the male reproductive system, are extremely sensitive to gonadotoxic agents such as radiation and chemotherapy drugs (Shetty et al., 2004).

RADIATION AND THE PROBLEMS IT CAUSES

It is very important to understand the difference between non-ionizing radiation and radiation. Very low frequency (50 Hz) electric and magnetic fields originating from electrical networks are in the category of non-ionizing radiation, and such emissions do not involve particle motion. However, high frequency radiation and radiation have an ionizing effect; this can lead to the high energy emitted reaching a level that can break the bonds between atoms and molecules. This poses a risk of creating various biological effects in living cells (Tamam et al., 2016). Radiation is a form of spread in which energy transfer occurs through waves or particles and can penetrate into matter or the human body. Radiation is divided into two main groups according to the substance it affects: ionizing and non-ionizing. Ionizing radiation has the ability to cause ionization by removing electrons from atoms and molecules. In contrast, non-ionizing radiation cannot change atomic structures and break bonds because it does not have sufficient energy (Türkkan and Pala, 2009).

It is no longer possible to live a life completely free of radiation under today's conditions. Radiation is defined as the excess energy carried by high-speed particles and electromagnetic waves emitted by radioactive materials to reach a more stable state. This energy is examined in two basic groups: "ionizing" and "non-ionizing" radiation. Ionizing radiation includes particles such as alpha, beta and neutrons, as well as high-energy waves such as X-rays and gamma rays. It is known that this type of radiation can cause serious health problems in biological structures such as cells and tissues, as well as organ systems, starting at the molecular level. Today, the use of radiation in many areas such as energy production, defense industry, industrial applications, medical diagnosis and treatment, agricultural research and scientific studies has become inevitable. This situation exposes people to the effects of natural or human-induced radiation (Çoşkun, 2011).

It has been stated that the radiation emitted by devices emitting radiofrequency radiation can have harmful effects on various biological systems. This radiation can cause problems such as headaches and sleep disorders in the central nervous system, while it can cause changes in the circulatory system such as increased heart rhythm and blood pressure. It has also been reported that it can cause fertility problems by creating negative effects on the reproductive system in men and women (Durusoy et al., 2017; Jangid et al., 2022; Kesari et al., 2018; Usman et al., 2021).

Ionizing radiation causes various physical, chemical and biological changes at the molecular and cellular levels in living organisms. These effects can be temporary or permanent depending on the type of radiation received,

dosage and duration of exposure. When X and gamma rays, alpha and beta particles and neutrons enter cells, they first affect molecular structures and cause changes. They ionize the atoms and molecules in the cell, stimulate these structures and try to drop to lower energy levels by leaving their excess energy on these structures. These types of ionizing radiation can cause significant adverse effects on living tissues (Coşkun, 2011).

With the advancement of technology, the level of human exposure to electromagnetic frequencies is constantly increasing. Ionizing radiation, ultraviolet rays and microwave radiation are the main factors that create negative biological effects on sperm cells. Studies have shown that even infrared radiation has harmful effects on male reproductive health. In an animal experiment, animals exposed to short-term infrared radiation (900 nm) experienced disruptions in the production processes of steroid hormones, resulting in decreased testosterone levels and decreased fertility rates (Highland et al., 2003).

SOME REPORTED STUDIES ON RADIATION

Radiations are divided into two main categories, ionizing and non-ionizing, according to their ability to penetrate matter and remove electrons from atoms or molecules. Radiofrequency waves, especially those emitted by mobile phones and base stations, have an increasing effect on large masses. The widespread use of this electromagnetic exposure in society requires further investigation of the possible effects on public health (Özgüner and Mollaoğlu, 2006).

Saygın et al. (2009) investigated the effects of 2450 MHz electromagnetic field on reproductive hormones (Follicle Stimulating Hormone, Luteinizing Hormone and testosterone) of rats. In the study, 18 3-month-old Wistar albino male rats were divided into three groups: control, sham and electromagnetic field exposed group. The electromagnetic field was applied for 1 hour every day for 4 weeks with a SAR value of 3.21 W/kg. The findings showed that there was a significant difference between the groups in total testosterone level and it was determined that testosterone levels decreased in the electromagnetic field exposed group. This result suggests that the electromagnetic field may cause hormonal imbalance.

In a recent study, it was reported that radiofrequency electromagnetic fields have a significant effect on the metabolic activity of cells. It was observed that metabolic activity decreased in healthy human fibroblast cells exposed to electromagnetic fields, while cancer cells (PC-3) increased their survival rate with the extension of the incubation period of the radiofrequency electromagnetic field. Based on these findings, it was thought that high-frequency electromagnetic fields could have harmful effects on human cells (Górski et al., 2021).

A research team investigated the effects of microwave radiation on spermatogenetic function in male rats, and the role of different concentrations of Morinda Officinalis on these effects. The study found a slight decrease in body weight and a significant decrease in sperm density in the experimental group of rats compared to the control groups. It was determined that the damage caused by microwave radiation to the testicular tissue was reduced in both treatment groups (Wang et al., 2013).

Shahin and his colleagues investigated the effects of low-level (2.45 GHz frequency) microwave radiation on male mice. According to the research findings, a significant decrease in the diameter of the seminiferous tubules and degeneration of the tubules were observed in mice exposed to microwave radiation. In addition, a significant decrease in sperm count and viability was detected. In the testes, a decrease in 3β-hydroxy steroid dehydrogenase activity and plasma testosterone levels were also observed. The study also determined that inducible nitrite oxide synthase expression increased in the testes (Shahin et al., 2014).

In an experimental study, rats (24) were exposed to electromagnetic radiation (900 MHz frequency) with a specific absorption rate of 0.66 ± 0.01 W/kg for 2 h every day for 50 days. The group exposed to electromagnetic radiation showed a significant increase in the percentage of apoptotic sperm cells by 91.42% compared to the control group. In addition, the concentration of reactive oxygen species decreased by 46.21% and the total antioxidant capacity decreased by 28.01% in this group. While a significant decrease in Bcl-2 protein and mRNA expression occurred under the effect of radiation, an increase in the levels of Bax, cytochrome C and Caspase-3 was observed (Liu et al., 2015).

Odacı et al (2015) investigated the effects of electromagnetic radiation (900 MHz) on rat testicles. The study was conducted by dividing twenty-four adult male rats into three groups as control, sham and electromagnetic radiation groups. Rats in the electromagnetic radiation group were exposed to electromagnetic radiation for 30 days (one hour per day). Morphological changes such as vacuoles, intertubular spaces, disruptions in seminiferous tubules, basement membrane damage and edema were observed in the testicles in this group. In addition, the diameter of the seminiferous tubules and the thickness of the germinal epithelium were found to be lower than in the other groups and the apoptotic index was found to be higher in the electromagnetic radiation group. Significant decreases were detected in malondialdehyde, superoxide dismutase, catalase and glutathione levels in the electromagnetic radiation group compared to the control group (Odacı et al., 2015).

A research team conducted an experimental study to evaluate the short-term and long-term effects of Wi-Fi radiation on male reproductive health. In the study, three-month-old male Wistar rats were exposed to radiation with two wireless antennas operating at a frequency of 2.45 GHz. The experimental groups were divided into three groups: control group, 1-hour exposure group, and 7-hour exposure group. The exposure period continued for two months for both groups. As a result of the analysis, it was determined that there were significant decreases in sperm parameters in both short-term and long-term radiation exposure groups. In addition, it was observed that the apoptosis rate in the seminiferous tubules increased and caspase-3 protein expression increased. In addition, it was determined that seminal vesicle weights decreased significantly in both 1-hour and 7-hour exposure groups compared to the control group (Shokri et al., 2015).

Oksay and colleagues conducted an experimental study to evaluate the damage caused by oxidative stress in testicular tissues caused by electromagnetic radiation (2.45 GHz) and the protective effect of melatonin against this damage. The study was designed by dividing thirty-two rats into four equal groups: control group (A1), sham group (A2), group exposed to electromagnetic radiation alone (B), and group treated with melatonin along with electromagnetic radiation (C). Electromagnetic radiation exposure was applied to groups B and C for 60 minutes every day for 30 days. The results showed that lipid peroxidation levels were significantly increased in group B compared to groups A1 and A2. It was observed that melatonin treatment significantly reduced the increase in lipid peroxidation induced by radiation. In addition, reduced glutathione and glutathione peroxidase levels were higher in group C than in group B. At the same time, it was determined that vitamin A and E levels decreased in group B, but melatonin treatment prevented the decrease in vitamin E levels (Oksay et al., 2014).

In an experimental study, the pathophysiological and ultrastructural effects of electromagnetic radiation (2.45 GHz) emitted by wireless devices on rat testes were evaluated. A total of 48 male Sprague Dawley rats, 6 weeks old, were equally divided into four experimental groups: sham group, electromagnetic radiation only group (3 h per day, 30 days in total), electromagnetic radiation and gallic acid (30 mg/kg/day) treatment group, and gallic acid treatment only group. In the radiation-exposed group, a significant increase in malondialdehyde and total oxidant levels was observed. In contrast, oxidative stress indicators were decreased and total antioxidant capacity was increased in the group treated with gallic acid. Although testosterone and vascular endothelial growth factor levels decreased in the electromagnetic radiation group, this difference was not statistically significant. However, it was determined that these parameters

increased in the gallic acid-treated group compared to the control groups. Prostaglandin E2 and calcitonin gene-related peptide levels increased in the group exposed to electromagnetic radiation, while this increase decreased in the group treated with gallic acid. In addition, a significant decrease in sperm counts was observed in the groups exposed to electromagnetic radiation. The findings revealed that gallic acid treatment together with electromagnetic radiation may play a protective role by increasing mitotic activity in seminiferous tubule cells (Saygin et al., 2016).

Meena and his team investigated testicular damage caused by oxidative stress caused by long-term exposure to microwave radiation and the possible protective effect of melatonin against this damage. The study was conducted by dividing 70-day-old male Wistar rats into four groups: a sham group, a melatonin-only group (2 mg/kg), a group exposed to 2.45 GHz microwave radiation, and a group that received both radiation and melatonin treatment (2 mg/kg). Electromagnetic radiation was applied in Plexiglas cages for 2 hours per day for a total of 45 days at a power density of 0.21 mW/cm² and a SAR of 0.14 W/kg. The biochemical parameters evaluated in the study included testicular lactate dehydrogenase isoenzyme activity, xanthine oxidase, reactive oxygen species, malondialdehyde levels, and DNA damage. Microwave radiation has been found to increase lactate dehydrogenase isoenzyme activity and lead to an increase in oxidative stress indicators. Melatonin treatment reduced these adverse effects by decreasing malondialdehyde and reactive oxygen species levels; it also alleviated the damages on xanthine oxidase activity, sperm count, testosterone level and DNA damage (Meena et al., 2014).

Yue et al (1988) conducted a study by applying microwave radiation at a frequency of 2450 MHz to the unilateral epididymis of mice weighing 300-450 grams for 30 minutes. According to the findings of the study, it was concluded that the effect of microwave radiation on the epididymis may adversely affect the sperm maturation process and sperm storage conditions.

In a study investigating the effects of 2.45 GHz electromagnetic radiation emitted from wireless devices on apoptosis in testicular tissue and the possible protective roles of selenium and L-carnitine, 24 male Wistar albino rats, 12 weeks old, were divided into four equal groups: sham group, electromagnetic radiation group, electromagnetic radiation and L-carnitine (1.5 mg/kg/day)-administered group, and electromagnetic radiation and selenium (1.5 mg/kg/day)-administered group. The findings revealed that Bcl-2, Bax, caspase-3, and caspase-8 levels showed significant differences between the sham and electromagnetic radiation groups. In particular, it was determined that Bcl-2 and Bax levels increased in the electromagnetic radiation group; caspase-8 levels decreased in the selenium-

administered group when the electromagnetic radiation + selenium group was compared with the electromagnetic radiation only group (Saygin et al., 2015).

Cleary and coworkers (1989) exposed mouse spermatozoa to continuous radiofrequency radiation in the range of 0 to 90 W/kg SAR for one hour at frequencies of 27 and 2450 MHz in an isothermal environment (37±0.2 °C) under laboratory conditions. The results of the study showed that radiation at SAR values of 50 W/kg or higher at both frequencies of 27 MHz and 2450 MHz caused a statistically significant decrease in the ability of epididymal spermatozoa to fertilize mouse oocytes in vitro.

In an experimental study, it was observed that the structure of the interstitial connective tissue was generally preserved in the group exposed to radiation, while the Leydig cells maintained their typical morphology. However, it was determined that the regular structure in the seminiferous tubules was disrupted and significant abnormalities occurred. Obvious edema formation and cellular separations were noted among the seminiferous epithelial cells. In addition, a significant shortening in the height of the seminiferous epithelium was recorded, and this finding was found to be statistically significant. It was observed that the number of mature sperm in the lumen decreased significantly. Histological analyses showed that there were changes such as deterioration in the structural integrity of the seminiferous tubules, localized edematous areas, and degeneration of the cells in the group exposed to radiation. The decrease in the height of the epithelium also gave a statistically significant result (Altındağ et al., 2017).

Kowalczuk et al. (1983) exposed the back of adult male hazelnut mice to microwave radiation with a SAR of 44 W/kg at a frequency of 2.45 GHz for 30 minutes. The findings of the study revealed that sperm count decreased and sperm morphology deteriorated. The most pronounced effects on each parameter were observed between 2 and 4 weeks after the application.

In histopathological analyses of an experimental study, significant degeneration in the germinal epithelium of seminiferous tubules, vascular congestion, atrophic tubules, edema in the interstitial region, and shed immature cells in the lumen of some tubules were observed in samples from the radiation group. In the group that received the combination of radiation and ellagic acid, a significant improvement was observed compared to the radiation group. When compared to the control group, it was found that the number of TUNEL positive cells increased in the radiation group, but this increase was not observed in the radiation + ellagic acid group. In addition, a significant increase in malondialdehyde levels and a decrease in superoxide dismutase activity were observed in the radiation group, while it was determined that malondialdehyde

levels decreased and superoxide dismutase activity increased in the radiation + ellagic acid group (Tasdemir et al., 2018).

McRee and his research team (1983) applied microwave radiation at a frequency of 2450 MHz continuously to Japanese quail embryos during the first 12 days of embryogenesis. The findings revealed that there was a significant decrease in the reproductive ability of quails exposed to microwave radiation at a frequency of 2.45 GHz.

A group of researchers conducted an experiment by exposing 242 adult rats to an electric field of 25–100 kV/m intensity and 50 Hz frequency for 280, 440 and 1240 hours. As a result of the study, no significant difference was observed in the plasma Follicle Stimulating Hormone, Luteinizing Hormone and testosterone levels of these three experimental groups when compared to the control group (Margonato et al., 1993).

One study examined male rats exposed to radiofrequency electromagnetic fields at a frequency of 905 MHz for 12 hours every day for 1 to 5 weeks. The results showed that sperm DNA fragmentation was 18% in the first week of exposure, and by the end of the fifth week, there was a significant increase in DNA fragmentation compared to the control or sham exposure groups (Houston et al., 2019). In another study, rats were exposed to radiofrequency fields at a frequency of 1900 MHz for 18 hours a day, and this was reported to cause DNA damage. The researchers associated this damage with the potential of radiofrequency to cause genotoxic effects (Smith-Roe et al., 2020).

Lai and Singh (1997) showed in a study that DNA breaks occurred in the brain cells of rats exposed to radiofrequency waves. Maes et al. (1993) reported in a study they conducted on human peripheral blood lymphocytes that radiofrequency waves at a frequency of 2450 MHz significantly increased the formation of micronuclei and the frequency of chromosomal abnormalities.

In an experimental study, 4G smartphone radiofrequency electromagnetic radiation was applied to the scrotums of rats, and the rats were exposed to a smartphone operating in active talk mode for 6 hours every day. In addition, the device was set to receive 1-minute external calls in 10-minute cycles during this period. The findings revealed that exposure to smartphone radiofrequency electromagnetic radiation for 150 days led to decreased sperm quality and offspring weight, and testicular damage was associated with these effects. However, these adverse effects were not significantly evident in 50 or 100-day exposure conditions. The study showed that long-term exposure to 4G smartphone radiofrequency electromagnetic radiation reduced male reproductive capacity by directly affecting the Spock3-blood-testis barrier-matrix metallopeptidase 2 axis in the testes of adult rats (Yu et al., 2020).

CONCLUSION

The harms of radiation carry extensive risks that can affect not only the health of the individuals exposed, but also the environmental balance and future generations. Long-term and uncontrolled radiation exposure can cause serious health problems by causing damage at the cellular level. Effects such as cancer, genetic mutations and weakening of the immune system pose significant threats both at the individual and societal level. Therefore, it is imperative to act consciously, implement protective measures and turn to sustainable energy alternatives in order to minimize the harms of radiation. Increasing awareness about radiation for a healthy life and a safe environment should be a priority for both individuals and societies.

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CHAPTER 15

Purification Methods of Enzymes and Their Use in Medicine

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ENZYMES

Enzymes are protein molecules that accelerate biochemical reactions in living cells. Like all catalysts, enzymes accelerate the reaction by reducing the interaction energy of the reaction. Enzymes are highly specific, so they do not participate in all chemical reactions, cannot be changed during the reaction, and work quickly. The primary sequence of amino acids that make up their structure is formed in the order determined by the genes.

Enzymes show a three-dimensional structure and the loss of their activity as a result of the deterioration of these structures is called denaturation. The stability of the three-dimensional structures of enzymes and their activity depends on some parameters.

Temperature: While enzymes can show activity at many different temperatures, they denature outside of these temperatures. The temperature value at which an enzyme shows the highest activity is called the optimum temperature value. While the optimum temperature value is observed around 40-60°C in plant-derived enzymes, these values are observed as 30-50°C in animal-derived enzymes.

pH: The pH value at which an enzyme shows the highest activity is called optimum pH. Enzyme activity decreases below and above the optimum pH value. Some enzymes are very sensitive to pH changes, while others can function in a wide pH range.

Substrate: By keeping the amount of an enzyme constant, it is observed that as the concentration of the substrate of that enzyme increases, the reaction rate increases over time, but after a while, when the substrate concentration reaches saturation, the reaction rate does not increase further.

Enzyme Amount: When an environment with sufficient substrate is provided, it is observed that the reaction rate increases linearly with the increase in the amount of enzyme.

Presence of Other Substances Affecting Enzyme Activity: Substances that reduce or completely stop the reaction rate by reducing the interest of enzymes in their substrates, disrupting the enzyme structure or preventing the binding of the enzyme and the substrate are called inhibitors, and chemical substances that increase enzyme activity with various effects are called activators.

Enzymes are classified according to the types of reactions they catalyze. There is a four-digit E.C (Enzyme Commission) number based on the type of reaction catalyzed by each enzyme. This classification system, set by the International Union of Biochemistry and Molecular Biology (IUBMB), divides enzymes into six main classes. Here are these classes and their characteristics:

1. Oxidoreductases

These enzymes catalyze oxidation and reduction reactions. For example, the enzyme pyruvate dehydrogenase catalyzes the oxidation of pyruvate to acetyl coenzyme A.

2. Transferases

Transferases catalyze the transfer of chemical groups from one molecule to another. For example, transaminases transfer an amino group from one molecule to another.

3. Hydrolases

These enzymes catalyze the hydrolysis of chemical bonds by adding water molecules. For example, the enzyme pepsin hydrolyzes peptide bonds in proteins.

4. Lyases

Lyases induce the separation of groups from substrate molecules or the formation of double bonds they catalyze. For example, the enzyme aldolase catalyzes the cleavage of fructose-1,6-bisphosphate into glyceraldehyde-3-phosphate and dihydroxyacetone phosphate

5. Isomerase

Isomerases catalyze the transformation of isomers of a molecule. For example, the enzyme phosphoglukomutase catalyzes the conversion of glucose-1-phosphate to glucose-6-phosphate.

6. Ligases

Ligases catalyze the union of two molecules. For example, the DNA ligase enzyme enables DNA fragments to be assembled.

This classification system is organized according to the functions of enzymes and the types of reactions they catalyze. Each class helps us understand the specific activities of enzymes and their biological roles.

Since they can show the same activity outside the cell as they do inside the cell, many of the enzymes can be separated from the cell and used in different environments. These properties of enzymes allow them to be used in many chemical and industrial processes. Biological detergents, beer industry, dairy industry, starch industry, textile industry, leather industry, medicine and pharmacy are the areas where enzymes are used. purification of enzymes,

High Activity and Efficiency: Purified enzymes show higher activity and efficiency. This allows reactions to occur more quickly and effectively.

Specificity: Pure enzymes behave more specifically towards certain substrates. This minimizes the occurrence of unwanted side reactions and products.

Research and Analysis: In scientific research, the purification of enzymes provides a better understanding of their structural and functional properties. This is critical for determining how enzymes work and under what conditions they perform best.

Industrial Applications: In the food, pharmaceutical and biotechnology industries, safer and more effective products are obtained by using pure enzymes. For example, the purity of enzymes used in food production improves product quality and safety.

It is important for.

The enzymes are in the same solution as the chemicals in the reaction and require lengthy purification processes to separate. For this reason, the use of immobilized enzymes as catalysts in industrial processes has gained great importance in recent times.

ENZYME ACTIVITY UNITS

Molar (Molecular) Activity: It is the unit of activity measured by the number of substrate molecules converted into a product in one minute by a single enzyme molecule under optimal conditions of that enzyme.

International Unit (IU): It is the enzyme activity that catalyzes the conversion of one micromole of substrate into a product in one minute at the optimal temperature, pH and substrate concentrations of the enzyme.

Catal: Enzyme activity, which is defined as the conversion of one mole of substrate into a product in one second, is called catal.

Specific Activity: It is called the number of enzyme units in a milligram of protein. This activity is also used as a measure of enzyme purity. As the purity of the enzyme increases, the amount of enzyme and specific activity in one milligram of protein increases.

PURIFICATION OF ENZYMES

The purification of enzymes involves various methods used to obtain pure and active forms of enzymes. Enzyme purification methods are listed below.

1.Sedimentation: Enzymes can be purified by precipitation with salts such as ammonium sulfate. This method reduces the solubility of enzymes, allowing them to precipitate

2.Chromatography: It is one of the most widely used methods in the purification of enzymes. There are several types of chromatography:

a.Gel Filtration Chromatography: Separates molecules by size

b.Ion Exchange Chromatography: Separates molecules according to their charge

c.Affinity Chromatography: Based on the ability of enzymes to bind to specific ligands

3.Triple Phase Separation : This method precipitates enzymes using t-butanol and ammonium sulfate. Due to its simplicity and low cost, it is more preferred in industrial use.

4.Ultracentrifugation: It allows enzymes to be separated from other components by rotating at high speed.

5.Dialysis: Provides the purification of enzymes using the diffusion of small molecules through a membrane.

These methods preserve the purity and activity of enzymes, allowing them to be used in a variety of applications. Which method to choose depends on the type of enzyme and the purpose of purification. Now let's explain these methods one by one.

1.SEDIMENTATION METHOD

The precipitation method is a widely used technique in the purification of enzymes. This method reduces the solubility of enzymes, allowing them to precipitate, thus facilitating their separation from other components. Here are the details of the precipitation method:

a. Sedimentation with Salt

The salt precipitation method uses high concentrations of salt (usually ammonium sulfate) to reduce the solubility of the enzymes. This method reduces the interaction of enzymes with water molecules, causing them to precipitate.

1. **Ammonium Sulfate Precipitation**: The most commonly used salt is ammonium sulfate. Ammonium sulfate reduces the solubility of proteins, allowing them to precipitate. This process is usually done at low temperatures, and the precipitated enzymes are separated by centrifugation.

b. Sedimentation with Organic Solvent

Precipitation of enzymes can be achieved by using organic solvents (such as ethanol, acetone). This method increases the hydrophobic interactions of enzymes, reducing their solubility.

1. **Ethanol Precipitation**: Ethanol reduces the solubility of proteins, causing them to precipitate. This method is especially suitable for thermolabile enzymes.

c. Sedimentation by pH Change

At pH values close to the isoelectric point (pI) of the enzymes, their solubility decreases and they precipitate. This method provides purification using the sensitivity of enzymes to pH.

d. Sedimentation by Temperature Change

Some enzymes precipitate denatured at certain temperatures. This method can be used in the purification of thermostable enzymes.

Application Steps

1. **Preparation**: The enzyme solution is prepared and mixed with a suitable buffer solution.
2. **Adding Salt**: A salt, such as ammonium sulfate, is slowly added and the mixture is constantly stirred.
3. **Precipitation**: When the enzymes begin to precipitate, the mixture is centrifuged and the precipitated enzymes are separated.
4. **Washing and Dissolving**: The precipitated enzymes are washed with a suitable buffer solution and dissolved again.

Purification of enzymes by precipitation method is widely used due to its simplicity and cost-effectiveness.

2.PRECIPITATION OF ENZYMES BY CHROMATOGRAPHIC METHODS

Chromatography is a widely used technique in the purification of enzymes and other biomolecules. This method allows the separation of enzymes based on their distribution between two phases (stationary phase and mobile phase). There are four different types of chromatography available.

a. Ion Exchange Chromatography

This method allows the separation of molecules according to their charges. The stationary phase contains positively or negatively charged groups and attracts oppositely charged molecules.

1. **Cation Exchange Chromatography**: Binds positively charged ions.
2. **Anion Exchange Chromatography**: Binds negatively charged ions.

b. Gel Filtration Chromatography (Size Exclusion Chromatography)

This method separates molecules based on their size. The stationary phase contains a porous matrix, and small molecules enter these pores, while large molecules elude more quickly.

c. Affinity of Chmatography

This method exploits the high binding affinity of enzymes to certain ligands. The stationary phase contains specific ligands to which the enzyme will bind. Glutathione-S-transferase (GST) proteins bind to a stationary phase coated with glutathione as an example.

d. Hydrophobic Interaction Chromatography

This method uses the interaction of the hydrophobic regions of molecules with the stationary phase. High salt concentrations increase hydrophobic interactions and enable molecules to bind to the stationary phase.

Application Steps

1. **Column Preparation**: The stationary phase is placed in the chromatography column.
2. **Sample Loading**: The enzyme solution is loaded into the column.
3. **Elution**: The mobile phase is passed through the column and the enzymes are separated according to their interaction with the stationary phase.
4. **Aggregation**: The separated fractions are collected and analyzed.

Chromatography is an effective and sensitive method for obtaining enzymes of high purity. Which type of chromatography to use depends on the properties of the enzymes and their purification requirements.

3.TRIPLE PHASE SEPARATION

Triple Phase Separation is an effective and simple method used in the purification of enzymes. This method uses t-butanol and ammonium sulfate for precipitation and purification of enzymes.

Triple Phase Separation is based on the formation of three phases:

1. **Upper Phase**: Contains t-Butanol.
2. **Sub-Phase**: Contains ammonium sulfate solution.
3. **Intermediate Phase**: It is the phase in which enzymes precipitate.

Application Steps

1. **Preparation**: The enzyme solution is prepared and mixed with a suitable buffer solution.
2. **Addition of Ammonium Sulfate**: A certain concentration of ammonium sulfate is added to the enzyme solution.
3. **Addition of t-Butanol**: Add t-butanol to the mixture and shake the mixture well.
4. **Phase Separation**: The mixture is kept for a certain period of time to form three phases.
5. **Collection of the Interphase**: The interphase in which the enzymes precipitate is carefully collected.

Advantages

1. **Simplicity and Speed**: Triple Phase Separation is a fast and easy-to-apply method.
2. **Low Cost**: The cost of the chemicals used is low.
3. **High Efficiency**: It provides purification of enzymes with high efficiency.

Disadvantages

1. **Specificity: It** may not be suitable for every enzyme.
2. **Optimization Requirement**: It may be necessary to determine the optimum conditions for the precipitation of enzymes.

The Triple Phase Separation method is a preferred purification method for the rapid and cost-effective use of enzymes, especially in industrial applications.

4.ULTRACENTRIFUGATION

Ultracentrifugation is a method that enables the separation of enzymes and other biomolecules using high-speed spinning. This technique allows the separation of molecules according to their density and is used to obtain enzymes of particularly high purity. The denser components sink to the bottom of the tube, while the less dense components remain at the top.

Application Steps

1. **Sample Preparation**: The enzyme solution is prepared with a suitable buffer solution.
2. **Insertion into Centrifuge Tube**: The prepared sample is carefully placed in the centrifuge tube.
3. **Balancing: The** centrifuge tubes are placed opposite each other to provide balance.

4. **Centrifugation**: The sample is rotated at a certain speed and time. This speed can usually be 100,000 rpm or higher.
5. **Fraction Collection**: After the centrifugation process is completed, the different fractions formed in the tube are carefully collected and analyzed.

Advantages

1. **High Resolution**: Allows precise separation of molecules according to their density.
2. **High Purity**: It allows enzymes to be obtained with high purity.
3. **Fast Process: It** gives results in a short time.

Disadvantages

1. **High Cost**: Device and operating costs are high.
2. **Technical Requirements**: Requires special training and knowledge to use and maintain.

Ultracentrifugation is a widely used method in biochemistry and molecular biology laboratories and is especially preferred for obtaining sensitive and high-purity enzymes.

5.DIALYSIS

Dialysis is a method used in the purification of enzymes and is based on the diffusion of small molecules through a semi-permeable membrane. This method allows enzymes to be separated from large molecules and small impurities.

In the dialysis method, it uses a semi-permeable membrane to separate small molecules (salts, small metabolites) from large molecules (proteins, enzymes). The membrane only allows the passage of molecules small of a certain size.

Application Steps

1. **Sample Preparation**: The enzyme solution is prepared with a suitable buffer solution.
2. **Placement in a Dialysis Bag**: The enzyme solution is placed in a semi-permeable membrane bag (dialysis bag).
3. **Dialysis**: The dialysis bag is placed in a large volume of buffer solution. Small molecules diffuse out through the membrane, while large molecules remain in the bag.
4. **Buffer Replacement**: During the dialysis process, the buffer solution is changed several times so that small molecules are completely removed.

Advantages

1. **Simplicity**: Easy to apply and does not require special equipment.
2. **Low Cost**: It is a cost-effective method.
3. **High Purity**: Provides effective removal of small molecules.

Disadvantages

1. **Time Taking**: The dialysis process can take a long time.
2. **Optimization Requirement**: Appropriate buffer and conditions may need to be determined to maintain the activity of enzymes.

Dialysis is a widely used method, especially for the removal of enzymes from salts and small impurities. This method is frequently preferred in biochemistry and molecular biology laboratories.

USE OF ENZYME PURIFICATION IN MEDICINE

Enzyme purification has several important applications in medicine.

Diagnosis: Enzymes are used as biomarkers in the diagnosis of diseases. For example, in the diagnosis of a heart attack, the levels of enzymes such as creatine kinase and lactate dehydrogenase are measured. Abnormal levels of these enzymes may indicate the presence of certain diseases.

Treatment: Enzymes are used directly in the treatment of some diseases. Enzyme replacement therapy ensures that missing or insufficient enzymes are replaced. For example, pancreatic enzymes are used to facilitate digestion in patients with pancreatic insufficiency.

Drug Development: Enzymes are used to increase the effectiveness of drugs and reduce their side effects. The ability of enzymes to accelerate specific biochemical reactions ensures that drugs are targeted and effective.

Cancer Treatment: Some enzymes can exert therapeutic effects by targeting cancer cells. For example, certain enzymes can inhibit the growth of cancer cells or destroy these cells.

The use of enzymes in various ways provides us with significant advances in medicine.

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