TFSD

Türk Fen ve Sağlık Dergisi

Turkish Journal of Science and Health

September 2025

Abbreviated Title:
Turkish J. Sci. and Health

International Peer Reviewed Journal

Indexed by
Index Copernicus, Directory of Research Journals Indexing, Eurasian Scientific Journal Index, CiteFactor, Academic Research Index, International Scientific Indexing, Acarindex, EuroPub Database, RootIndexing, Asos Indeks, Directory of Open Access Journals, Saji Journals Index, Advanced Scıences Index

Prof. Dr. Mukadder MOLLAOGLU,

Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Nursing, Department of Internal Medicine Nursing, mukadder@cumhuriyet.edu.tr

Prof. Dr. Magfiret KASIKCI,

Atatürk University Faculty of Nursing, Department of Nursing Fundamentals, magfiret@atauni.edu.tr

Prof. Dr. Baki KESKIN,

Sivas Cumhuriyet University, Faculty of Science, Department of Mathematics, Fundamentals of Mathematics and Department of Mathematics Logic, bkeskin@cumhuriyet.edu.tr

Prof. Dr. Ercan BURSAL,

Muş Alparslan University, Faculty of Health Sciences, Department of Nursing, e.bursal@alparslan.edu.tr

Prof. Dr. Ilhan CETIN

Sivas Cumhuriyet University Faculty of Medicine Internal Medicine Department of Public Health, icetin@cumhuriyet.edu.tr

Prof. Dr. Isa GOKCE

Tokat Gaziosmanpaşa University Faculty of Engineering and Natural Sciences, Department of Bioengineering, isa.gokce@gop.edu.tr

Prof. Dr. Serkan AKKOYUN,

Sivas Cumhuriyet University, Faculty of Science, Physics Department, Nuclear Physics Department, serkan.akkoyun@gmail.com

Prof. Dr. Ilhan OTAG,

Sivas Cumhuriyet University Faculty of Medicine, Department of Anatomy, ilhanotag@gmail.com

Prof. Dr. Ugur TUTAR,

Sivas Cumhuriyet University Faculty of Pharmacy, Pharmaceutical Botany, ututar@cumhuriyet.edu.tr

Assoc. Prof. Dr. Mustafa GUZEL,

Istanbul Medipol University International Faculty of Medicine, Department of Medical Pharmacology

Prof. Faik GOKALP,

Kırıkkale University, Faculty of Education, Department of Science Education, akgokalp@gmail.com

Prof. Dr. Gulbahtiyar DEMIREL,

Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Midwifery, gulbahtiyar_doganer@hotmail.com

Assoc. Prof. Dr. Ahmet KARADAG,

Sivas Cumhuriyet University Faculty of Medicine, Department of Internal Medicine, Department of Physical Medicine and Rehabilitation, akaradag@cumhuriyet.edu.tr

Prof. Dr. Fevzi TOPAL,

Gümüşhane University Faculty of Engineering Food Engineering Department of Food Science, ftopal@gumushane.edu.tr

Lecturer Dr. İlknur YILDIZ,

Sivas Cumhuriyet University, Faculty of Health Sciences, Nursing Department, Department of Child Health and Diseases Nursing, ilknuryildiz@yahoo.com.tr

Lecturer Dr. Didem KAYA,

Nuh Naci Yazgan University, Faculty of Health Sciences, Department of Nursing, Department of Obstetrics and Gynecology Nursing, didemkaya86@gmail.com

Lecturer Dr. Onur AVCI,

Sivas Cumhuriyet University Faculty of Medicine, Department of Anesthesiology and Reanimation, dronuravci@gmail.com

Assoc. Dr. Ahmet Kemal FILIZ,

Sivas Cumhuriyet University Faculty of Medicine, Department of Basic Medical Sciences, Department of Physiology, akfiliz@cumhuriyet.edu.tr

Lecturer Dr. Hatice SEN,

Yakın Dogu University Faculty of Nursing, Department of Nursing, Fundamentals of Nursing and Teaching in Nursing / Management, hatice.sen@neu.edu.tr

Lecturer Dr. Burcin ISIK,

Yakın Dogu University Faculty of Nursing, Department of Nursing, Fundamentals of Nursing and Nursing Education / Management, burcin.isik@neu.edu.tr

Lecturer Dr. Nurcan AKGUL GUNDOGDU

Bandırma 17 Eylül University Faculty of Health Sciences, Department of Nursing, Department of Public Health Nursing, nr.akgul@gmail.com

Lecturer Dr. Necmettin IŞCI,

Sivas Cumhuriyet University Faculty of Health Sciences, Department of Nursing, Department of Nursing Management, necmettinisci@cumhuriyet.edu.tr

Lecturer Dr. Keziban AMANAK,

Adnan Menderes University, Faculty of Health Sciences, Department of Midwifery, keziban.amanak@adu.edu.tr

Lecturer Dr. Ghulam Hussain BHATTI,

Department of Chemistry,Cadet College Hasan Abdal Attock, 43730, Pakistan, chemgcu@gmail.com

Lecturer Dr. Omar DAGDAG,

Laboratory of Agroresources, Polymers and Process Engineering (LAPPE), Department of Chemistry, Faculty of Science, Ibn Tofail University, BP 133, 14000 Kenitra, Morocco

Lecturer Dr. Zaki SOLİEMAN SAFİ

Computational Chemistry, Al-Azhar University, Gaza

Türk Fen ve Sağlık Dergisi
Turkish Journal of Science and Health

İÇİNDEKİLER / CONTENTS

The Effect of Scenario-Based Simulation Method on Students' Use of Nursing Diagnoses: A Quasi-Experimental Study

Gülengün Türk [1] [iD], Nihal Taşkıran [1] [iD], Elem Kocaçal [2] [iD], Sercan Özdemir [3]* [iD]

[1]Aydın Adnan Menderes University, Nursing Faculty, Fundemantals of Nursing Department, Aydın, Türkiye
[2]İzmir Demokrasi University, Faculty of Health Sciences, Fundamentals of Nursing, İzmir, Türkiye
[3]Anesthesia Intensive Care Unit, Nazilli State Hospital, Aydın, Türkiye

ABSTRACT:

Purpose: This study was conducted to determine the effect of the scenario-based simulation method on students' use of nursing diagnoses.

Material and Methods: This study was designed as a quasi-experimental research design with control group. The sample of the study consisted of 104 first-year nursing students, including control (n = 52) and experimental (n = 52) groups. A scenario-based simulation method was used for the students in the experimental group in the laboratory practice. The traditional lecturing method and case studies were used in the control group. Data from the study were collected from the care plans that the students had prepared with the data from patients in clinical practice.

Results: The students in the experimental group identified 20 different nursing diagnoses, whereas the students in the control group used 14. A statistically significant difference was found between the experimental and control groups in terms of the total number of nursing diagnoses used (p=0.023, X^2= 19.305).

Conclusion: The scenario-based simulation is an effective method that can be used in teaching nursing diagnoses. Scenario-based simulation has a positive effect on the identification of nursing diagnoses by correctly naming them with the labels and components found as standard in NANDA-I.

Keywords: Nursing diagnosis; simulation training; nursing process; nursing education; nursing students

*Corresponding author: Sercan Özdemir, email: sercanoz15@hotmail.com

INTRODUCTION

The nursing process is a scientific guide used to systematically carry out the care to be given to the patient. This scientific method consists of data collection, diagnosis, planning, implementation, and evaluation stages. The complete collection of the data of individuals in patient care, and the determination of the correct nursing diagnosis are the most basic and critical stages of the nursing process (Erden et al., 2018; Herdman et al., 2021; Kocaçal et al., 2021).

Nursing diagnosis is a clinical judgment of an individual, caregiver, family, group, or community's human response to or sensitivity to health conditions/life processes (Herdman et al., 2021). Determining the nursing diagnosis correctly and in accordance with the priority order is extremely effective in planning, implementing, and evaluating the care to be given to the patient (Herdman et al., 2021; Olmaz and Karakurt, 2019). The use of nursing diagnoses by the students in the clinical practice process of nursing education enables them to analyze the patient's clinical condition, determine his/her needs, and reach care results. However,

nursing students and nurses have difficulty expressing patient problems as a nursing diagnosis (Erden et al., 2018; Herdman et al., 2021; Olmaz and Karakurt, 2019; Türk et al., 2013; Basit, 2020; Çakar and Avşar, 2020; Basit and Korkmaz, 2021; Hsu et al., 2015).

It is the responsibility of nurse academicians to teach nursing diagnoses, which have an important effect on the planning of care, to students. As in the world, NANDA-I diagnoses are widely used in Turkey and comprehensively taught to students in nursing education. NANDA-I Taxonomy II has 13 domains, 47 classes, and 267 approved nursing diagnostic processes (Herdman et al., 2021).

The goal of nursing education programs is to ensure that theoretical information is transferred to practice. Today, with the development of technology, it is necessary to use effective and up-to-date education methods to train them in determining the nursing process and nursing diagnoses for students in nursing education (Ewertsson et al., 2015). In general, simulation has an important place among the effective methods used in nursing education. Simulation is used as a method adopted in the development of students' competencies in patient care management and in gaining competency. With this method, students gain experience with a scenario similar to the real environment before clinical practice; thus, their self-confidence increases and their clinical decision-making skills develop. In the studies conducted, it is stated that the scenario-based simulation method used in nursing education contributes positively to the development of self-confidence through improving critical thinking, clinical decision-making, communication, cooperation, and self-efficacy (Cummings and Connelly, 2016; Haugland and Reime, 2018; Olaussen et al., 2020; Hung et al., 2021; Carpenito, 2023).

Even when the nursing process is taught classically based on examples, it can remain very abstract for students. In this context, scenario-based simulation is very effective in applying the stages of the nursing process in a realistic case by being aware of it. As a more dynamic interactive teaching and learning method, scenario-based teaching focuses on improving students' abilities and skills, including analytical thinking, problem-solving, and team collaboration skills required in today's world. This student-centered teaching strategy also provides students with a great experience by repeating, making mistakes and drawing outcomes from mistakes in a safer learning environment (Haugland and Reime, 2018; Olaussen et al., 2020; Hung et al., 2021).

Determining the correct nursing diagnosis in the planning of care requires the student to think analytically and to be able to make evidence-based clinical decisions. In this direction, the use of cases in "Nursing Process" education has suggested that planned scenario-based education may have an effect on the nursing diagnoses used by students.

This study was conducted to determine the effect of the scenario-based simulation method on students' use of nursing diagnoses. The hypothesis of the study is that the scenario-based simulation has a positive effect on students' skills to use nursing diagnostics. The results of the research will provide more evidence to nursing educators on which method to use in nursing process teaching.

MATERIAL and METHODS

Purpose and Type of the Study

This study was designed as a quasi-experimental research design with control group. This study was conducted to determine the effect of the scenario-based simulation method on students' use of nursing diagnoses.

Variables of the Study

Dependent variables: The dependent variables of the study are the number of nursing diagnoses used. Independent variables: The independent variables of the study are the descriptive characteristics of the students.

Sampling and Participant

The population of the study consisted of 284 first-year nursing students enrolled in the Fundamentals of Nursing Course in the spring semester of the 2021-2022 academic year at a state university in western Turkey. The sample size was determined by G Power. In determining the sample size, the effect size was taken as 0.25, α 0.05, and 1-β 0.95. At total of 104

students, 52 in the experimental group and 52 in the control group consisted the sample of study. Simple random sampling method was used to determine the experimental and control groups. Students whose student numbers ended with an odd number were assigned to the control group and students whose student numbers ended with an even number were assigned to the experimental group. Students who graduated from health vocational high school (26 students) and did not agree to participate (8 students) in the study were excluded from the study.

Procedures

Fundamentals of Nursing course consists of 6 hours of theory, 4 hours of laboratory and 8 hours of clinical practice per week. The course is carried out simultaneously theoretical, laboratory and clinical practice in the spring semester of the first year. Within the scope of this course, the subject of "Nursing Process" is explained to the students in the 4th week of the semester. Following the lecture, students are expected to determine a nursing diagnosis by collecting data from patients in clinical practice, which they continue for 8 hours each week for ten weeks.

The subject of the "Nursing Process" is explained as 6 hours of theoretical explanation (Nursing Process) and 4 hours of practices using with case studies in Fundamental of Nursing course. The theoretical part was the same for both experimental and control groups. For the practical part, a scenario-based simulation method was used in the experimental group in the simulation laboratory. In this study, simulation practices are based on International Nursing Association for Clinical Simulation and Learning standards. In the first stage, the design of the simulation was planned and the framework of the simulation was determined. Student needs were taken into consideration while determining the scenario topics. Scenario topics were identified to fulfil the needs of students to determine nursing diagnoses in a safe environment before clinical practice. Scenarios were created in accordance with this content and learning objectives. Two distinct scenarios were formulated. One of the scenarios addressed the problem-focused nursing diagnosis (nausea), while the other addressed the risk group

nursing diagnosis (risk of falling). Preliminary information was given to orientate the students to the simulation environment and scenario before the simulation. Information was given about simulation aims and goals, roles, characteristics of the patient room and the tools and equipment in pre-briefing. Each scenario lasted an average of 10 minutes. The scenarios were about patient safety and post-op patient care and follow-up. According to the data in the scenarios, it was aimed to determine the needs and problems of the patients and identify the nursing diagnoses by the students. At this stage, students were expected to use critical thinking and problem solving skills by students. After the scenarios, 20-minute debriefing were held with the students. The scenario-based simulation training was completed in the laboratory practice stage of the course. Then, in clinical practice, students were collected data from their patients and prepared a care plan in line with scenario-based simulation training experiences. For the students in the control group, the standard (traditional) method used in teaching the nursing process was used. The practices in this group was made with case studies. Then, the students underwent clinical practice in various departments of a university hospital, including Internal Medicine, General Surgery, Orthopedics, and Cardiology clinics. During their clinical practice, the students compiled care plans that outlined their approach to patient care. In the preparation phase for nursing care, Erdemir and Turk's reference book, which is a translation of Carpenito's Handbook into Turkish, is used (Carpenito, 2021). At the end of the clinical practice, the students gave their care plans for evaluation to the researchers The diagnoses identified by nursing students in their care plans were examined according to NANDA-1 Taxonomy II.

Data Collection Tools

The "Student Introduction Form" and "Care Plan Form" were used to collect the data.

Student Introduction Form: In this form, there are three sociodemographic features including age, gender, and the highest level of formal education of the students.

Care Plan Form: The nursing care plan is a formal process that correctly identifies existing needs and

recognizes potential needs or risks. The form guides students to document the stages of the nursing process which was developed by Ida Jean Orlando in 1958. Nursing process is a systematic guide based on patient-centered care with five steps consisting of assessment, diagnosis, planning, implementation, and evaluation.

The care plan form includes two sections. The first section covered patient data collected by the students based on Gordon's Functional Health Patterns model. Gordon's Functional Health Patterns Model is used by nurses in the nursing process to provide a more comprehensive bio-psychosocial nursing assessment of the patient in a systematic and standardized way. Model consists of 11 functional domains including health perception-health management, nutritional-metabolic, elimination, activity exercise, sleep-rest, cognitive-perceptual, self-perception, role-relationship, sexualityreproductive, coping-stress tolerance, and value-belief. The second part was based on the five steps of the nursing process.

Statistical Analysis

The "Statistical Package for Social Science 25.0 package program" was used to evaluate the data. In the evaluation of the data, number and percentage calculations were used. Chi-square analysis was used to compare the groups. Statistical significance was accepted as $p<0.05$.

Ethical Approval

To conduct the study, approval was obtained from the Non-Interventional Clinical Research Ethics Committee (Approval Number: 2022/05-03) of the Faculty of Health Sciences, and permission was obtained from the institution where the study was conducted and the students participating in the study.

RESULTS

The average age of the students participating in the study was 20.79 ± 1.98 (min=19, max=32), 55.8% were female and 58.7% were Anatolian High School graduates.

The students in the experimental group were determined to have nursing diagnoses in the 8 domains and 140 nursing diagnoses were used (Table 1). The domains of most frequently were used by the experimental group students were "nutrition/metabolism" (74.97%), "health promotion" (61.52%), "self-perception" (38.43%), "perception/cognition", "activity/exercise" (28.82%), and "sleep/rest" (26.92%) (Table 1). The students in the experimental group were used diagnoses were *risk for falls* (50%), *risk for infection* (32.69%), *disturbed sleep pattern* (25%), *fatigue* (23.07%), and *risk for impaired oral mucous membrane integrity* (19.23%). The students did not determine any diagnosis in the domains of "Role/Relationship", "Sexuality/Reproduction", and "Value/Belief" (Table 1).

The students in the control group were determined to have diagnoses in the 8 domains and 132 nursing diagnostic processes were used (Table 1). The domains of most frequently were used by the control group students were "health promotion" (63.44%), "nutrition/metabolism" (61.50%), "activity/exercise" (48.02%), "sleep/rest" (26.92%), and "perception/cognition" (23.06%) (Table 1). The students in the control group were used diagnoses were *risk for falls* (53.84%), *risk for infection* (40.38%), *disturbed sleep pattern* (25%), *acute pain* (17.30%), and *activity intolerance* (13.46%). The students did not determine any diagnosis in the domains of "Role/Relationship", "Coping/Stress tolerance" and "Value/Belief" (Table 1).

When examined in terms of the total number of nursing diagnoses used, it was found that there was a statistically significant difference between the experimental and control groups (p=0.023, X^2= 19.305). In addition, 3 students (5.76%) in the experimental group and 10 students (19.23%) in the control group did not use any nursing diagnosis. Additionally, it was found that the students in the experimental group were able to determine nursing diagnoses with the labels and components that exist as standard in NANDA-I compared to the control group. The number of used nursing diagnoses was compared with the students sociodemographic characteristics, no statistically significant difference was found between the groups (p>0.05), (Table 2).

Table 1. Distribution of Used Nursing Diagnoses (according to NANDA-I Taxonomy II domains)

Nursing Diagnoses*	Experimental group* (n=52)		Control group * (n=52)	
	n	%	n	%
Health promotion				
Risk for disproportionate growth	1	1.92	0	0
Risk for delayed surgical recovery	1	1.92	1	1.92
Obesity	3	5.76	1	1.92
Overweight	0	0	1	1.92
Risk for aspiration	1	1.92	1	1.92
Risk for urinary tract injury	0	0	1	1.92
Risk for falls	**26**	**50.0**	**28**	**53.84**
Total	*32*	*61.52*	*33*	*63.44*
Nutrition/metabolism				
Risk for contamination	1	1.92	0	0
Impaired oral mucous membrane integrity	1	1.92	0	0
Risk for allergy reaction	2	3.84	0	0
Imbalanced nutrition	4	7.69	0	0
Risk for impaired skin integrity	0	0	1	1.92
Risk for dry eye	0	0	1	1.92
Risk for deficient fluid volume	0	0	1	1.92
Deficient fluid volume	2	3.84	1	1.92
Impaired tissue integrity	2	3.84	1	1.92
Impaired skin integrity	0	0	1	1.92
Excess fluid volume	0	0	2	3.84
Risk for impaired oral mucous membrane integrity	**10**	**19.23**	3	5.76
Risk for infection	**17**	**32.69**	**21**	**40.38**
Total	*39*	*74.97*	*32*	*61.50*
Elimination				
Diarrhea	1	1.92	0	0
Chronic functional constipation	1	1.92	0	0
Impaired urinary elimination	2	3.84	1	1.92
Perceived constipation	0	0	2	3.84
Urge urinary incontinence	0	0	3	5.76
Total	*4*	*7.68*	*6*	*11.52*
Activity/exercise				
Risk for ineffective renal perfusion	1	1.92	0	0
Toileting self-care deficit	1	1.92	0	0
Risk for ineffective peripheral tissue perfusion	2	3.84	0	0
Risk for decreased cardiac tissue perfusion	3	5.76	1	1.92
Impaired standing	0	0	1	1.92
Decreased diversional activity engagement	0	0	1	1.92
Wandering	0	0	1	1.92
Impaired physical mobility	2	3.84	1	1.92
Ineffective airway clearance	0	0	1	1.92
Sedentary lifestyle	0	0	1	1.92
Risk for ineffective respiratory function	0	0	2	3.84
Decreased cardiac output	0	0	2	3.84
Ineffective breathing pattern	0	0	2	3.84
Risk for bleeding	0	0	2	3.84
Deficit self-care syndrome	1	1.92	3	5.76
Activity intolerance	5	9.61	**7**	**13.46**
Total	*15*	*28.81*	*25*	*48.02*
Sleep/rest				
Insomnia	1	1.92	1	1.92
Disturbed sleep pattern	**13**	**25.00**	**13**	**25.00**
Total	*14*	*26.92*	*14*	*26.92*
Perception/cognition				
Impaired comfort	2	3.84	0	0
Chronic pain	1	1.92	1	1.92
Nausea	3	5.76	2	3.84
Acute pain	9	17.30	**9**	**17.30**
Total	*15*	*28.82*	*12*	*23.06*

Table 1. (Continued) Distribution of Used Nursing Diagnoses (according to NANDA-I Taxonomy II domains)

Nursing Diagnoses*	Experimental group* (n=52)		Control group * (n=52)	
	n	%	n	%
Self-perception				
Disturbed body image	1	1.92	0	0
Weakness	2	3.84	0	0
Hopelessness	2	3.84	1	1.92
Fear	0	0	1	1.92
Anxiety	3	5.76	3	5.76
Fatigue	**12**	**23.07**	4	7.69
Total	*20*	*38.43*	*9*	*17.29*
Sexuality/reproduction				
Sexual dysfunction	0	0	1	1.92
Total	*0*	*0*	*1*	*1.92*
Coping-stres tolerance				
Impaired mood regulation	1	1.92	0	0
Total	*1*	*1.92*	*0*	*0*
Total number of diagnosis used	140		132	
Total number of diagnosis label used		55		

* Multiple diagnoses were used.

Table 2. Distribution of the Nursing Diagnoses Numbers According to Groups of Students

	Groups				
Number of nursing diagnosis	Control group (n=52)		Experimental group (n=52)		Test and p value
	n	%	n	%	
Zero	10	19.23	3	5.77	
One- Three	23	44.23	39	75.00	**p=0.023**
Four-Six	19	36.54	6	11.54	X^2=19.305
Seven-Ten	0	0	4	7.69	

DISCUSSION

Today, methods such as scenario-based simulation in nursing education are very effective in students' critical thinking skills, especially in complex clinical situations (Adib-Hajbaghery and Sharifi, 2017; Karabacak et al., 2019; Kang et al., 2020). In this study, since clinical decision-making is used extensively in the nursing process, the effect of scenario-based simulation on the nursing process was examined. According to the results, the students in the experimental group used more nursing diagnoses than the group trained with the classical method. This can be interpreted as the scenario-based simulation having a statistically significant effect on nursing students' use of nursing diagnoses. Scenario-based simulation offers students the opportunity to transfer theoretical knowledge into practice in a clinical situation close to reality (Haugland and Reime, 2018; Shinnick et al., 2011;

Maneval et al., 2012). In this way, the use of the nursing process can become more effective. Unless realistic educational methods such as simulation are used, students will have difficulty in making clinical decisions. In fact, Korkut et al. (2021) reported that 31 students encountered difficulties at many stages of the nursing process and that different feedback and messages were given by educators. In this study, the students using scenario-based simulation used more and different nursing diagnoses compared to the students in the control group. In their study, Chang et al. (2021) compared the simulation-based (online interactive animation and a standard patient simulation) method with the case study method in nursing process education. In this study, the success of the students in the group in which simulation was used in preparing the nursing process was found to be better than the group in which only case study was used (Chang et al., 2021).

In studies where scenario-based simulation is not used, it is noteworthy that the ability to determine nursing diagnose is lower. Keskin et al. (2021) found that only 57.6% of the students in their study were able to make the correct nursing diagnoses for an elderly patient in a given case sample. In the same study, the ratio of 21 nursing diagnoses that should be made to the patient in the case, unfortunately, did not exceed 66% (chronic pain nursing diagnosis). Efil (2020) reported that during clinical practice in the scope of an internal medicine nursing course, students used 52 nursing diagnoses under 10 of 13 NANDA-I taxonomy II domains.

After training, students will have a higher ability to determine and apply nursing diagnoses and other stages of the nursing process compared to the groups that do not receive training. Karaca and Aslan (2018) stated that after their training on nursing terminologies and classification systems, students' perception of nursing diagnoses was more positive than those in the group that did not receive training. Although no simulation-based training is provided, the positive perception of the students who receive training is an indication that the training in which the simulation is used will have more superior effects in increasing both the perception of the process and the motivation for learning and practice. Karaca and Aslan (2018) suggested that students should be trained with different teaching methods to comprehensively learn nursing diagnoses, which are the most important step of the nursing process, and to address them correctly. In a study based on four hours of theoretical training and case studies, most of the students (89.6%) were able to make the correct diagnoses (Özkan et al., 2020).

Within the scope of the research, we determined that the most commonly used nursing diagnoses of the students in both the experimental and control groups were "risk for falls", "risk for infection", and "disturbed sleep pattern". Similarly, Özkan et al. (2020) stated in their study that "risk for infection", "acute pain", and "risk for falls" nursing diagnoses are the most commonly used diagnoses by students. While Efil (2020) reported that the first three nursing diagnoses used by students were "activity intolerance", "acute pain", and "disturbed sleep pattern". Keskin et al. (2021) found that "chronic

pain", "imbalanced nutrition", "impaired tissue integrity", "risk for impaired skin integrity", and "risk for infection" were the most commonly used nursing diagnoses. Similar to our study, in another study based on simulated patient use and case study, the most commonly used nursing diagnoses of 70 second-grade students were determined as "oral mucous membrane", "ineffective breathing pattern", "disturbed sleep pattern", "imbalanced nutrition: Less than body requirements", "impaired tissue integrity", "pain" and "risk for infection" (Karadağ et al., 2016). In all the results of this study, there are both similarities and differences in the nursing diagnoses used by the students. The main reason for this is thought to be the difference in the content of the education and cases given to the students in these studies.

In the study, it was determined that the students in the experimental group did not use any diagnoses in the domains of "Role/Relationship", "Sexuality/Reproduction", and "Value/Belief", and similarly, the students in the control group did not use any diagnoses in the domains of "Role/Relationship", "Coping/Stress tolerance", and "Value/Belief". In the studies in the literature, it has been determined that students generally use diagnoses in the areas of sexuality, coping-stress tolerance, self-perception, and role-relationship less (Aydın and Akansel, 2013; Efil, 2020; Haesook et al., 2015; Olğun and Türk, 2022; Türk et al., 2013), and they never use diagnoses in the areas of sexuality-reproduction and value-belief (Taşkın Yılmaz et al., 2015; Uysal et al., 2016). However, it is also stated that students have the most difficulty in collecting patient data in the areas of sexuality (73.4%), value-belief (45.7%), and excretion/elimination (42.4%) (Türk, 2020). In our study, the diagnosis of the students in both groups was mostly focus more on the physiological needs. Furthermore, the fact that these areas are more abstract for the student, the mandatory violation of patient privacy, and the inexperience of the students in this method may cause diagnoses to be used less or not at all in these areas. According to Benner's "From Beginner to Expert" model, the student's ability to understand, comprehend, think critically, adopt a holistic approach and intuition develops through in parallel

with experience (Benner, 1984). The students participating in the study were still at the beginning of their professional training, so their experience was limited, and their cognitive skills, which enable them to assess patients holistically and make clinical decisions based on their intuition, were not yet sufficiently developed. It is hypothesised that these factors may have exerted an influence on the results.

CONCLUSION

The research findings indicate that scenario-based simulation increases the number of diagnoses used by students and is an effective method for teaching nursing diagnoses. This method has been demonstrated to have a positive effect on the identification of nursing diagnoses by naming them correctly with the labels and components that are standard in NANDA-I. In line with the results obtained from the research, it is recommended to use the scenario-based simulation method together with classical education in nursing process teaching and to increase the use of the method by educators by integrating it into the nursing program.

Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

Adib-Hajbaghery, M., Sharifi, N. (2017). Effect of simulation training on the development of nurses and nursing students' critical thinking: A systematic literatüre review. Nurse Education Today, 50:17-24. doi: 10.1016/j.nedt.2016.12.011

Aydın, N., Akansel, N. (2013). Determination of accuracy of nursing diagnoses used by nursing students in their nursing care plans. International Journal of Caring Sciences, 6(2), 252-257.

Basit, G. (2020). Bakımın Rehberi: Hemşirelik Süreci. Genel Sağlık Bilimleri Dergisi, 2(2): 77-90.

Basit, G., Korkmaz, F. (2021). The effect of web-based nursing process teaching on senior nursing students' care planning skills#. International Journal of Nursing Knowledge, 32(1), 4-19. doi:10.1111/2047-3095.12283

Benner, P. (1984). From novice to expert: Excellence and power in clinical nursing practice. Menlo Park, CA: Addison-Wesley.

Carpenito, L. J. (2023). Handbook of Nursing Diagnosis. Jones & Bartlett Learning. (16nd ed.). USA.

Carpenito, L. J. (2021). Hemşirelik Tanıları El Kitabı (Ed: Erdemir F. & Turk G.), (4. Baskı). Nobel Tıp Kitabevi, İstanbul.

Chang H. Y., Wu H. F., Chang Y. C., Tseng Y. S, Wang Y. C. (2021). The effects of a virtual simulation-based, mobile technology application on nursing students' learning achievement and cognitive load: Randomized controlled trial. Int J Nurs Stud., Aug; 120:103948. doi: 10.1016/j.ijnurstu.2021.103948.

Cummings, C. L., Connelly, L. K. (2016). Can nursing students' confidence levels increase with repeated simulation activities? Nurse Education Today, 36, 419-421. doi: 10.1016/j.nedt.2015.11.004

Çakar, S., Avşar, G. (2020). Hemşirelerin hemşirelik süreci kullanımı ile ilgili sorunlarının belirlenmesi. Ebelik ve Sağlık Bilimleri Dergisi, 3(3): 203-213.

Efil, S. (2020). İç Hastalıkları hemşireliği dersi klinik uygulamasında öğrencilerin hazırladıkları bakım planlarının incelenmesi. İstanbul Gelişim Üniversitesi Sağlık Bilimleri Dergisi, 12, 398-414. doi:10.38079/igusabder.748592

Erden, S., Deniz, S., Arslan, S., & Yurtseven, Ş. (2018). Hemşirelik öğrencilerinin cerrahi hastalıkları hemşireliği dersi uygulamalarında hemşirelik tanılarını belirleme düzeylerinin incelenmesi. Van Tıp Dergisi, 25(2): 108-112. doi: 10.48071/sbuhemsirelik.1009334

Ewertsson, M., Allvin, R., Holmström, I. K., Blomberg, K. (2015). Walking the bridge: Nursing students' learning in clinical skill laboratories. Nurse Education in Practice, 15(4), 277-283. doi: 10.1016/j.nepr.2015.03.006

Haesook, H., Jeongeun, P., & Wanju, P. (2015). Usage patterns of nursing diagnoses among student nursesin psychiatric unit: Relation with NANDA and SNOMED CT. J Korean Acad Psychiatr Ment Health Nurs., 24(1), 1-11.

Haugland, V. L., Reime, M. H. (2018). Scenario-based simulation training as a method to increase nursing students' competence in demanding situations in dementia care. A mixed method study. Nurse Education in Practice, 33, 164-171. doi: 10.1016/j.nepr.2018.08.008

Herdman, T. H., Kamitsuru, S., Lopes, C. T. (2021). NANDA International, Nursing Diagnoses Definitions and Classification 2021-2023. (12th ed.) USA: Oxford, Thieme.

Hsu, L. L., Chang, W. H., Hsieh, S. I. (2015). The effects of scenario-based simulation course training on nurses' communication competence and self-efficacy: a randomized controlled trial. Journal of Professional Nursing, 31(1), 37-49. doi: 10.1016/j.profnurs.2014.05.007

Hung, C. C., Kao, H. F. S., Liu, H. C., Liang, H. F., Chu, T. P., Lee, B. O. (2021). Effects of simulation-based learning on nursing students' perceived competence, self-efficacy, and learning satisfaction: A repeat measurement method. Nurse Education Today, 97, 104725. doi: 10.1016 /j.nedt.2020.104725

Kang, S. J., Hong, C. M., Lee, H. (2020). The impact of virtual simulation on critical thinking and self-directed

learning ability of nursing students. Clinical Simulation in Nursing, 49, 66-72. doi: 10.1016/j.ecns.2020.05.008

Karabacak, U., Unver, V., Ugur, E., Kocatepe, V., Ocaktan, N., Ates, E., Uslu, Y. (2019). Examining the effect of simulation based learning on self-efficacy and performance of first-year nursing students. Nurse Education in Practice, 36, 139-143.
doi: 10.1016/j.nepr.2019.03.012

Karaca, T., Aslan, S. (2018). Effect of 'nursing terminologies and classifications' course on nursing students' perception of nursing diagnosis. Nurse Education Today, 67, 114-117.
doi: 10.1016/j.nedt.2018.05.011

Karadağ, M., Çalışkan, N., İşeri, Ö. (2016). Effects of case studies and simulated patients on students' nursing care plan. International Journal of Nursing Studies, 27(2), 87-94. doi: 10.1111 /2047-3095.12080

Keskin, A. Y., Tuna, P. T., Molu, B., Tuna, H. İ. (2021). The skills of nursing first year students to determine the nursing diagnosis related to the case and affecting factors. Journal of Pre-Hospital, 6(1), 69-82.

Kocaçal, E., Aktan, G. G., Eşer, İ. (2021). Tarihsel süreç içinde hemşirelik süreci ve bakım planlarının gelişimi. Anadolu Hemşirelik ve Sağlık Bilimleri Dergisi, 24(2), 284-290. doi:10.17049/ataunihem.528109

Korkut, S., Şahin, S., Ülker, T., Cidem, A. (2021). Nursing students' views of the nursing process and its challenges, and their solutions: a qualitative study. International Journal of Caring Sciences, 14(2), 811-824.

Maneval, R., Fowler, K. A., Kays, J. A., Boyd, T. M., Shuey, J., Harne Britner, S., Mastrine, C. (2012). The effect of high-fidelity patient simulation on the critical thinking and clinical decision-making skillsof new graduate nurses. J Contin Educ Nurs., 43(3), 125-134. doi: 10.3928/00220124-20111101-02

Olaussen, C., Heggdal, K., Tvedt, C. R. (2020). Elements in scenario-based simulation associated with nursing students' self-confidence and satisfaction: A cross-sectional study. Nursing Open, 7(1), 170-179. doi:10.1002/nop2.375

Olğun, S., Türk, G. (2022). Uzaktan Eğitim Sürecinde İntörn Öğrencilerin Hemşirelik Tanılarını Kullanma Durumları. Kırşehir Ahi Evran Üniversitesi Sağlık Bilimleri Dergisi, 6(2), 91-97.

Olmaz, D., Karakurt, P. (2019). Hemşirelerin bakım verirken hemşirelik sürecini bilme ve uygulama durumları. Dokuz Eylül Üniversitesi Hemşirelik Fakültesi Elektronik Dergisi, 12(1): 3-14.

Özkan, Ç. G., Kurt, Y., Bayram, Ş. B., Bayrak, B., Kılınç, K. Ö. (2020). The effect of group case studies on NANDA-I nursing diagnosis identification and perception of nursing students. Clinical and si Health Sciences, 10, 256-264.

Shinnick, M., Woo, M., Horwich, T., Steadman, R. (2011). Debriefing: the most important component in simulation? Clin. Simul. Nurs., 7(3), e105-e111. doi:10.1016/j.ecns.2010.11.005.

Taşkın Yılmaz, F., Sabancıoğulları, S., Aldemir, K. (2015).

The opinions of nursing students regarding the nursing process and their levels of proficiency in Turkey. International Journal of Caring Sciences, 4(4), 265-275.

Türk, G. (2020). Hemşirelik birinci sınıf öğrencilerinin veri toplama sürecinde karşılaştıkları güçlüklerin belirlenmesi. Hemşirelik Bilimi Dergisi, 3(3), 9–13.

Türk, G., Tuğrul, E., Şahbaz, M. (2013). Determination of nursing diagnoses used by students in the first clinical practice. International Journal of Nursing Knowledge, 24(3), 129-133.
doi:10.1111/j.2047-3095.2013.01243.x

Uysal, N., Arslan, G. G., Yılmaz, İ., & Alp, F. Y. (2016). Hemşirelik ikinci sınıf öğrencilerinin bakım planlarındaki hemşirelik tanıları ve verilerin analizi. Celal Bayar Üniversitesi Sağlık Bilimleri Enstitüsü Dergisi, 3(1), 139-143.

Investigation of Anger Expression Styles in Patients with Schizophrenia and Their Clinical and Demographic Predictors

Ertan Türe [1] iD **, Meral Kelleci** [2]* iD

[1]Sivas Cumhuriyet University Health Services Research and Practice Hospital, Cardiovascular Surgery Service, Sivas, Türkiye
[2]Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Nursing, Department of Psychiatric Nursing, Sivas, Türkiye

ABSTRACT:

Purpose: This study aimed to investigate the anger expression styles of individuals diagnosed with schizophrenia and to identify the clinical and sociodemographic factors influencing these styles.

Methods: A total of 70 inpatients diagnosed with schizophrenia participated in this descriptive and correlational study. Data were collected using the Personal Information Form, the Trait Anger and Anger Expression Inventory, and the Scale for the Assessment of Positive Symptoms (SAPS) and Scale for the Assessment of Negative Symptoms (SANS). Data were analyzed using nonparametric statistical methods including the Kruskal-Wallis test, Mann-Whitney U test, and Spearman correlation analysis.

Results: Anger control scores were significantly lower among male patients, unemployed individuals, and those residing in extended families. Patients with a history of violence and those who were non-adherent to medication demonstrated markedly elevated levels of trait anger (M = 27.01, p = 0.003) and outward-directed anger (M = 22.60, p = 0.003), alongside significantly reduced anger control scores (M = 16.86, p = 0.003) compared to their counterparts. Furthermore, outward-directed anger was positively correlated with the severity of positive formal thought disorder (r = .286, p = 0.016), while anger control showed a negative correlation with hallucination severity (r = –.276, p = 0.021).

Conclusion: The findings indicate that anger expression in individuals with schizophrenia is significantly influenced by both clinical symptoms and sociodemographic variables. The integration of anger assessment into routine psychiatric evaluations may enhance individualized treatment planning, contributing to improved symptom control, emotion regulation, and psychosocial functioning.

Keywords: *Schizophrenia; anger; anger expression style; positive symptoms; negative symptoms*

*Corresponding author: Meral Kelleci, email: meralkelleci@yaho.com

INTRODUCTION

Schizophrenia is a chronic and severe psychiatric disorder that significantly affects individuals, families, and society. Typically emerging in late adolescence or early adulthood, it is characterized by disruptions in thought processes, emotional regulation, and behavior. These impairments often lead to social withdrawal, distorted reality perception, and difficulties in maintaining interpersonal relationships (Ozturk & Ulusahin, 2023). Individuals with schizophrenia frequently experience communication difficulties, self-care deficits, disorganized behavior, sleep disturbances, and cognitive impairments (Gulec et al., 2022; Lee et al., 2023; Yildiz & Cerit, 2021). Among the many challenges associated with schizophrenia, difficulties in anger regulation and aggression are particularly critical. These emotional responses are closely linked to the presence and severity of positive symptoms such as delusions and hallucinations (Ringer & Lysaker, 2023). Inadequate management of anger can increase the risk of self-harm and interpersonal

violence, thereby compromising patient safety, treatment adherence, and long-term prognosis (Reddy, 2023; Ringer & Lysaker, 2023). Anger is a fundamental human emotion triggered by perceived threats, injustice, or frustration, and may range from mild irritation to intense rage (Ruocco et al., 2023). Evidence suggests that individuals with schizophrenia, especially those with prominent positive symptoms, are more prone to experiencing and expressing anger in maladaptive ways (Engin et al., 2022; Kassinove & Tafrate, 2023; Modestin, 2023). A recent meta-analysis involving over 45,000 individuals with psychotic disorders highlighted the significant roles of delusions, hallucinations, and poor insight in the development of violent behaviors. In addition, elevated anxiety and panic attacks have been associated with both internalized and externalized anger expression among individuals with chronic schizophrenia (Gadea et al., 2023). Unregulated anger may serve as a precursor to self-injurious and aggressive behaviors, which hinder recovery and disrupt the therapeutic environment. Such behaviors not only pose safety concerns but also burden caregivers and contribute to institutional challenges (Bo et al., 2023; Fassino et al., 2023). Although the relationship between schizophrenia and aggression has been widely studied, there remains a notable gap in understanding how anger is expressed—specifically in terms of its inward or outward direction—and what demographic, clinical, and psychosocial factors influence these patterns (Modestin, 2023; Song & Min, 2023). In light of these considerations, the present study aims to examine anger expression styles and the associated demographic and clinical predictors in individuals with schizophrenia who are hospitalized in a psychiatric unit. A better understanding of anger expression dynamics may contribute to more accurate clinical assessments and the development of individualized intervention strategies to enhance emotional regulation and reduce potential risks.

MATERIAL AND METHODS
Purpose and Type of Study
This study aimed to examine the anger expression styles of individuals diagnosed with schizophrenia and to identify the clinical and sociodemographic variables that predict these styles. Additionally, the study sought to explore the relationship between anger dimensions and the severity of positive and negative symptoms.

A descriptive and correlational research design with a cross-sectional approach was adopted.

Sampling and Participants
The study population consisted of all patients diagnosed with schizophrenia according to DSM-5 criteria who were hospitalized in the psychiatry clinic of a university hospital between July 3, 2019, and January 3, 2020. During this period, a total of 80 patients met the diagnostic criteria. From this population, *70 inpatients* (51 males and 19 females) were included in the study through purposive sampling, based on predefined inclusion and exclusion criteria.The inclusion criteria were as follows:(1) diagnosis of schizophrenia according to DSM-5 criteria for at least six months,(2) being in a clinically stable phase as evaluated by the attending psychiatrist—defined as the seventh day of hospitalization when acute symptoms had begun to subside, and (3) voluntary participation with informed consent.

Exclusion criteria included the presence of comorbid neurological or severe physical illnesses, substance use disorders, intellectual disabilities, or acute agitation that impaired communication. A post hoc power analysis was also conducted to evaluate the adequacy of the sample size. Based on a medium effect size (Cohen's d = 0.50), a significance level of 0.05, and a desired statistical power of 0.90, the minimum required sample size was calculated to be approximately 44 participants. Since the study included 70 inpatients, the sample size was considered sufficient to detect statistically meaningful effects with high power.

Data Collection Tools
1. Personal Information Form: This researcher-developed form consisted of 20 items assessing sociodemographic variables (e.g., age, gender, marital status, education level, employment status, family structure) and clinical characteristics (e.g., age at onset,

illness duration, medication adherence, history of violent behavior, and hospitalization history). Content validity was evaluated by three experts in psychiatric nursing and psychiatry.

2. State-Trait Anger Expression Inventory (STAXI): Originally developed by Spielberger (1988) and adapted into Turkish by Özer (1994), this 34-item scale measures four dimensions: trait anger, anger-in, anger-out, and anger control. Higher scores indicate greater levels of each construct. In the present study, Cronbach's alpha was 0.76, indicating acceptable internal consistency. Exploratory factor analysis supported a three-factor structure, with item loadings exceeding 0.40.

3. Scale for the Assessment of Positive Symptoms (SAPS): Originally developed by Nancy Andreasen and adapted into Turkish by Erkoç et al. (1991), this 35-item clinician-administered scale assesses the severity of positive symptoms in schizophrenia. It includes subdomains such as hallucinations, delusions, bizarre behavior, formal thought disorder, and inappropriate affect. In the current study, the internal consistency of the scale was found to be high (Cronbach's alpha = 0.87).

4. Scale for the Assessment of Negative Symptoms (SANS): Also developed by Andreasen and validated in Turkish by Erkoç et al. (1991), this 24-item scale measures the severity of negative symptoms across five domains: affective flattening, alogia, avolition, anhedonia/social withdrawal, and attention impairment. The internal consistency in the present study was excellent (Cronbach's alpha = 0.96), and the factor structure was supported by exploratory factor analysis.

Data was collected through structured, face-to-face interviews conducted in private rooms within the psychiatric unit. Each interview lasted approximately 30 minutes and was carried out by trained psychiatric nurses who were instructed in the standardized administration of the instruments. Participants were informed about the study procedures and assured of confidentiality and anonymity.

Statistical Analysis

Data was analyzed using non-parametric statistical methods, consistent with the ordinal nature of the scale scores and the non-normal distribution observed in preliminary analyses. The Mann–Whitney U test was employed for binary group comparisons (e.g., gender, employment status), and the Kruskal–Wallis H test was used for comparisons involving more than two groups (e.g., age of onset, family type, illness duration), as presented in Tables 2 and 3.Where significant differences were detected in Kruskal–Wallis tests, appropriate non-parametric post hoc comparisons were conducted using pairwise Mann–Whitney U tests with Bonferroni correction to adjust for multiple testing.Correlational relationships between subdimensions of anger expression and symptom severity scores (SAPS and SANS) were examined using Spearman's rank correlation coefficient, as shown in Table 5.Although the inclusion of effect sizes (e.g., Cohen's d, Spearman's r) was considered to enhance interpretability, these metrics were omitted from the results tables due to space constraints. Missing data was minimal (<5%) and handled using pairwise deletion. The level of statistical significance was set at $p < 0.05$.

Ethical Approval

This study received ethical approval from the Non-Interventional Clinical Research Ethics Committee of Sivas Cumhuriyet University (Approval No: 2019/28, Date: 17.04.2019). All participants were informed about the objectives of the study and provided written informed consent prior to data collection. The study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Table 1 summarizes the demographic and clinical characteristics of the 70 participants. The mean age was 38.86 ± 5.46 years (range: 23–70), and the majority were male (72.9%). Over half of the

participants had completed only primary education (51.4%) and most were unemployed (78.6%) and of low socioeconomic status (75.7%). Regarding clinical features, 40% had been diagnosed with schizophrenia for less than 10 years, and 42.9% had been in remission for up to 12 months. A significant proportion reported a history of violence (72.9%)

and non-adherence to medication (82.9%).

Table 2 presents the comparison of mean scores on trait anger and anger expression subscales according to sociodemographic characteristics. Female participants had significantly higher anger-in scores than males (z = 7.188, p = 0.009), indicating a greater tendency to internalize anger.

Table 1. Demographic and Clinical Characteristics

Characteristics	Number	Percent
Age (38.86±5.46;23-70)		
Gender (Male)	51	72.9
Education (Primary school)	36	51.4
Employment Status (Unemployed)	55	78.6
Socioeconomic Status (Low)	53	75.7
Marital Status (Single)	37	52.8
Duration of Illness		
Less than 10 years	28	40.0
11-20 years	31	44.3
21 years and above	11	15.7
Duration in Remission		
1-12 months	30	42.9
13-36 months	24	34.2
37 months and above	16	22.9
History of Violence (Present)	51	72.9
Medication Adherence (Non-adherent)	58	82.9

Table 2. Comparison of Mean Scores on Trait Anger and Anger Expression Subscales by Sociodemographic Characteristics in Patients with Schizophrenia

Variables	Trait Anger ($\bar{X}$±SD)	Anger-In ($\bar{X}$±SD)	Anger-Out ($\bar{X}$±SD)	Anger Control ($\bar{X}$±SD)	Test/p
Age (30 and below)	26.07±6.67	21.67±3.64	22.33±5.90	17.07±5.04	
31–40 years	25.52±5.26	20.28±2.70	20.60±5.72	18.48±3.45	
Gender (Female)	26.21±4.90	22.47±2.58	22.63±5.19	17.10±3.12	z = 7.188; p = 0.009
Male	25.76±5.56	20.56±2.66	21.03±5.30	17.78±4.11	
Employment (Employed)	24.06±5.29	21.06±2.78	19.33±4.99	18.80±4.44	z = 4.222; p = 0.044
Unemployed	26.38±5.32	21.09±2.77	22.05±5.25	17.27±3.66	
Family (Extended)	29.00±4.62	21.87±2.74	26.00±3.54	15.62±2.66	KW = 3.819; p = 0.027
Nuclear	25.25±5.31	21.03±2.92	20.69±5.33	18.13±4.00	

Unemployed individuals exhibited significantly higher anger-out scores compared to employed participants (z = 4.222, p = 0.044), suggesting increased externalized anger. Additionally, participants from extended families had significantly higher anger-out scores than those from nuclear families (KW = 3.819, p = 0.027), as revealed by follow-up pairwise comparisons. No statistically significant differences were observed in trait anger or anger control scores based on other

sociodemographic variables (e.g., age, marital status, education level, or income).

Table 3 examines the relationship between clinical variables and anger expression scores. A significant difference was found in anger-in scores according to the duration of illness (KW = 3.581, p = 0.033), with patients ill for less than 10 years reporting higher scores. Patients with a history of violence exhibited significantly higher trait anger ($\bar{X}$ = 27.01) and anger-out ($\bar{X}$ = 22.60) scores, and lower anger control

scores (X̄ = 16.86), compared to those without such a history (p < 0.01). Non-adherent patients demonstrated higher trait anger (X̄ = 26.77) and anger-out (X̄ = 22.18) scores, and lower anger control scores (X̄ = 17.06), relative to adherent participants (p < 0.01). No significant differences were observed based on age at onset, remission duration, or reason for hospitalization (p > 0.05).

Table 4 presents significant correlations between anger expression scores and positive symptom domains. Anger-out was positively correlated with positive formal thought disorder (r = .286, p = .016), while anger control was negatively correlated with hallucinations (r = −.276, p = .021).

Table 3. Comparison of Mean Scores for the State-Trait Anger Expression Inventory and Its Subscales According to the Disease Characteristics of the Patients

Variables	Trait Anger (X̄ ± SD)	Anger-In (X̄ ± SD)	Anger-Out (X̄ ± SD)	Anger Control (X̄ ± SD)	Test/p
Age of Onset of Disease					
Under 20 years	26.41 ± 5.74	21.00 ± 3.36	21.66 ± 5.79	17.54 ± 4.46	
21–30 years	25.53 ± 5.51	20.50 ± 2.76	21.00 ± 5.33	17.57 ± 3.90	KW = 0.180; p = 0.836
31 years and above	25.70 ± 4.88	21.95 ± 1.63	21.85 ± 4.79	17.70 ± 3.16	
Duration of Disease					
Less than 10 years	26.07 ± 4.94	22.00 ± 2.35	21.78 ± 4.75	17.21 ± 2.99	
11–20 years	25.51 ± 6.25	20.16 ± 3.12	21.12 ± 6.07	18.45 ± 4.58	KW = 3.581; p = 0.033
21 years and above	26.45 ± 3.77	21.36 ± 1.80	21.63 ± 4.52	16.18 ± 3.31	
Duration of Remission					
1–12 months	24.96 ± 5.03	21.06 ± 3.12	21.33 ± 5.36	17.83 ± 4.04	
13–36 months	27.29 ± 4.58	21.41 ± 1.83	22.00 ± 4.58	17.04 ± 2.54	KW = 1.318; p = 0.274
37 months and above	25.50 ± 6.79	20.62 ± 3.24	21.12 ± 6.32	18.00 ± 5.12	
History of Violence					
Present	27.01 ± 4.87	20.86 ± 2.78	22.60 ± 4.91	16.86 ± 3.44	z = 9.422; p = 0.003
Absent	22.84 ± 5.56	21.68 ± 2.66	18.42 ± 5.02	19.57 ± 4.31	
Medication Adherence					
Present	21.58 ± 5.85	20.00 ± 3.66	18.00 ± 6.17	20.16 ± 4.87	z = 10.617; p = 0.002
Absent	26.77 ± 4.84	21.31 ± 2.51	22.18 ± 4.83	17.06 ± 3.43	

Table 4. Significant Correlations Between Anger Dimensions and Symptom Domains

Variables	Significant Correlations
Anger-Out	Positive Formal Thought (r = .286, p = .016)
Anger Control	Hallucinations (r = −.276, p = .021)
Total Anger Expression Score	Positive Formal Thought (r = .259, p = .030)

Table 5. Effect Sizes (Cohen's d) for Differences in Anger Expression by History of Violence

Variable	Cohen's d	Effect Size Magnitude
Trait Anger	0.820	Large
Anger-In	-0.301	Medium
Anger-Out	0.841	Large
Anger Control	-0.686	Medium

Note: Cohen's d values were calculated to evaluate the magnitude of differences in anger expression variables between patients with and without a history of violence. Values of 0.2, 0.5, and 0.8 are typically interpreted as small, medium, and large effect sizes, respectively.

Additionally, the total anger expression score (sum of trait anger, anger-in, anger-out, and anger control subscales) was positively correlated with positive formal thought disorder (r = .259, p = .030). No significant correlations were found between anger dimensions and negative symptom domains.

These findings underscore the relevance of sociodemographic and clinical variables in shaping anger expression in patients with schizophrenia. The association between externalized anger and positive psychotic symptoms, as well as the impact of violence history and medication adherence on anger profiles, suggests potential intervention points for clinical management. Incorporating anger assessment into routine psychiatric evaluation may support personalized care strategies aimed at improving emotional regulation and reducing risk behaviors.

This table presents the effect sizes (Cohen's d) for differences in trait anger, anger-in, anger-out, and anger control between patients with and without a history of violence. Cohen's d values of 0.2, 0.5, and 0.8 are conventionally interpreted as small, medium, and large effect sizes, respectively. The results indicate that trait anger and anger-out demonstrated large effect sizes, while anger control and anger-in showed medium effects.

DISCUSSION

This study provides a multidimensional evaluation of anger expression styles among individuals with schizophrenia. In addition to statistically significant group differences, the inclusion of effect size analyses has allowed for a deeper understanding of the clinical relevance of these findings. Most notably, patients with a history of violence demonstrated markedly higher levels of trait anger and anger-out behaviors compared to those without such history. These differences were not only statistically significant but also clinically meaningful, as evidenced by large effect sizes (d = 0.82 and d = 0.84, respectively). This suggests that trait anger and outward-directed anger are key emotional patterns in individuals prone to violent behavior, consistent with previous studies linking anger dysregulation to aggression in schizophrenia (Gadea et al., 2023; Kristof et al., 2018). The elevated levels of trait anger

in this group may reflect a stable vulnerability toward perceiving interpersonal situations as threatening or unjust, while high anger-out scores may indicate reactive, externally directed coping mechanisms.

Anger control, which exhibited a medium effect size (d = –0.69), was lower in the same group, suggesting diminished ability to manage or suppress anger impulses. This aligns with findings from Rzewuska (2002) and Tani et al. (2018), who identified poor anger control as a key factor in impulsivity and aggression among non-adherent patients. Although the difference in anger-in scores showed only a medium effect (d = –0.30) and was not statistically significant, it still warrants attention given its association with emotional suppression and risk for depressive comorbidity (Yılmaz et al., 2023). From a clinical perspective, these findings highlight the importance of not only identifying statistically significant differences, but also interpreting their real-world impact through effect size estimates. The large effect sizes in key domains suggest that anger regulation difficulties are not incidental, but central to the emotional and behavioral profile of high-risk patients with schizophrenia.

Sociodemographic variables also played a significant role in shaping anger expression. Unemployed patients and those living in extended families had higher anger-out scores, potentially due to increased psychosocial stress, reduced autonomy, and interpersonal conflict (Ergin et al., 2006; Fassino et al., 2023). These contextual stressors may interact with illness-related vulnerabilities to produce maladaptive emotional responses. Gender differences were again pronounced: while men were more likely to externalize anger (anger-out), women internalized it (anger-in), consistent with culturally embedded patterns of gendered emotion regulation (Kaya et al., 2007; Özmen et al., 2016). Each subdimension of anger expression has distinct implications for clinical risk and treatment planning. Anger-out is often observable and may be managed through behavioral techniques and de-escalation strategies. In contrast, anger-in may go unnoticed but still exert a deleterious effect on the patient's internal psychological state, requiring therapeutic exploration. Trait anger and impaired anger control

are transdiagnostic markers of emotional dysregulation and should be routinely screened in patients with schizophrenia. Taken together, these findings highlight the need for anger expression styles to be conceptualized not as a unitary construct but as a multidimensional emotional process influenced by illness severity, cognitive disorganization, treatment engagement, and sociocultural context. Integration of anger-focused assessment and intervention into psychiatric care may improve emotional resilience, reduce the risk of aggression or self-harm, and enhance overall clinical outcomes.

Limitations

Several limitations should be considered in interpreting the findings of this study. First, the sample size was relatively small (n = 70), which may limit statistical power and the generalizability of the results. Future studies should consider conducting power analyses to determine adequate sample size. Second, the study was conducted with inpatients from a single clinical setting, limiting external validity. Comparative studies with community-based samples would allow for broader clinical inferences. Third, although appropriate non-parametric tests were used, effect size metrics (e.g., r, Cohen's d) were not systematically reported in previous literature, though included here. Future work should continue to integrate these metrics to enhance interpretability.

CONCLUSION

This study demonstrates that anger expression styles in patients with schizophrenia are significantly influenced by both clinical and sociodemographic factors. Positive symptoms such as hallucinations and formal thought disorder are associated with higher levels of outward-directed anger and diminished anger control. Additionally, patients with a history of violence or poor medication adherence tend to experience more difficulties in regulating anger. Sociodemographic variables such as gender, employment status, and family structure also affect how anger is expressed. These results highlight the importance of routinely assessing anger expression patterns in psychiatric practice. Implementing

targeted psychosocial interventions—including emotion regulation training and medication adherence support—may help improve clinical outcomes by promoting healthier anger management and reducing the risk of aggression or self-harm among individuals with schizophrenia.

Conflict of Interest

The authors declare that they have no conflict of interest.

REFERENCES

Bo, S., Abu-Akel, A., & Bertelsen, A. (2023). Violence in patients with schizophrenia: The role of anger and psychotic symptoms. Psychiatry Research, 315, 114789. https://doi.org/10.1016/j.psychres.2022.114789

Engin, E., Özgür, G., & Kurçer, M. A. (2022). Trait anger and anger expression styles in patients with schizophrenia. Archives of Psychiatric Nursing, 36, 92–98. https://doi.org/10.1016/j.apnu.2021.10.005

Ergin, T., Yıldız, M., & Öztürk, F. (2006). Relationship between unemployment and aggression in psychiatric patients. Anadolu Psikiyatri Dergisi, 7(3), 143–150.

Fassino, S., Amianto, F., & Ferrero, A. (2023). Family dynamics and externalized anger in schizophrenia. Journal of Nervous and Mental Disease, 211(1), 43–49. https://doi.org/10.1097/NMD.0000000000001550

Gadea, M., Espert, R., & Salvador, A. (2023). Panic, anxiety, and anger regulation in schizophrenia. Comprehensive Psychiatry, 120, 152345. https://doi.org/10.1016/j.comppsych.2022.152345

Gulec, M. Y., Ustun, B., & Arikan, K. (2022). Clinical challenges in schizophrenia management. Turkish Journal of Psychiatry, 33(2), 120–127.

Kaya, B., Gençöz, T., & Savaşır, I. (2007). Gender differences in anger expression among Turkish adults. Turkish Journal of Psychology, 22(60), 25–34.

Kassinove, H., & Tafrate, R. C. (2023). Anger-related aggression in clinical populations: Assessment and treatment. Journal of Clinical Psychology, 79(2), 150–163. https://doi.org/10.1002/jclp.23375

Köşger, F., Demir, S., & Ertekin, H. (2014). Social withdrawal and delusion in schizophrenia: Their effect on anger expression. Türk Psikiyatri Dergisi, 25(3), 157–164.

Kristof, M., Bauer, J., & Seifert, D. (2018). Aggression in schizophrenia: The impact of positive symptoms. Journal of Psychiatric Research, 103, 129–134. https://doi.org/10.1016/j.jpsychires.2018.05.011

Lee, M. H., Kim, J. S., & Choi, H. J. (2023). The relationship between social functioning and symptom profiles in schizophrenia. Asian Journal of Psychiatry, 81, 103463. https://doi.org/10.1016/j.ajp.2023.103463

Modestin, J. (2023). Positive symptoms and violence in schizophrenia: A review. Current Psychiatry Reports, 25(4), 203–210. https://doi.org/10.1007/s11920-023-

01447-6

Ozturk, M. O., & Ulusahin, A. (2023). Ruh sağlığı ve hastalıkları. Ankara: Nobel Tıp Kitabevleri.

Özmen, D., Erbay, F., & Arıkan, N. (2016). Gender and aggression in Turkish psychiatric settings. Cinsiyet ve Davranış Dergisi, 12(2), 85–92.

Reddy, M. S. (2023). Managing aggression in schizophrenia: Clinical strategies. Indian Journal of Psychiatry, 65(2), 101–105. https://doi.org/10.4103/ijp.ijp_831_22

Ringer, J. M., & Lysaker, P. H. (2023). Anger regulation in schizophrenia: Implications for functioning. Schizophrenia Bulletin, 49(1), 33–41. https://doi.org/10.1093/schbul/sbac112

Ruocco, A. C., Amirthavasagam, S., & Zakzanis, K. K. (2023). Anger experience and expression in clinical populations. Aggression and Violent Behavior, 64, 101792. https://doi.org/10.1016/j.avb.2022.101792

Rzewuska, M. (2002). Nonadherence to treatment in schizophrenia: Causes and consequences. European Psychiatry, 17(7), 330–337.

Schwabe, T., Junger, J., & Weber, H. (2022). Anger suppression and emotional stagnation in chronic psychiatric disorders. Journal of Affective Disorders, 298, 341–349. https://doi.org/10.1016/j.jad.2021.10.057

Song, J. Y., & Min, S. K. (2023). Violence in schizophrenia: Symptom severity and social predictors. Psychiatry Investigation, 20(1), 44–52. https://doi.org/10.30773/pi.2022.0201

Tani, P., Lindberg, N., & Appelberg, B. (2018). Medication adherence and aggression in schizophrenia: A follow-up study. Nordic Journal of Psychiatry, 72(3), 211–218. https://doi.org/10.1080/08039488.2017.1412107

Toth, A., Horvath, L., & Farkas, P. (2024). Positive symptoms and externalized anger: A predictive model in schizophrenia. Journal of Psychiatric and Mental Health Nursing, 31(1), e12560. https://doi.org/10.1111/jpm.12560

Yildiz, M., & Cerit, C. (2021). Interpersonal functioning in schizophrenia and impact on quality of life. Clinical Psychopharmacology and Neuroscience, 19(3), 450–458. https://doi.org/10.9758/cpn.2021.19.3.450

Yılmaz, D., Aydın, N., & Sezer, H. (2023). Internalized anger in patients with schizophrenia and comorbid depression. Psychiatry and Clinical Neurosciences, 77(2), 88–95. https://doi.org/10.1111/pcn.13447

Yöndem, Z., & Bıçak, B. (2008). Gender differences in anger expression: A Turkish perspective. International Journal of Psychology, 43(5), 321–329. https://doi.org/10.1080/00207590701700503

Türk Fen ve Sağlık Dergisi

Turkish Journal of Science and Health

Bibliometric Analysis of Nursing Studies Related to Breastfeeding in Newborns

Nurcan Karamercimek [1]* , Gülay Demir [2] , İlknur Yıldız [3]

[1]Sivas Cumhuriyet University, Institute of Health Sciences, Sivas, Türkiye
[2]Sivas Cumhuriyet University, Vocational School of Health Services, Department of Medical Services and Techniques, Sivas, Türkiye
[3]Sivas Cumhuriyet University Faculty of Health Sciences, Department of Nursing, Sivas, Türkiye

ABSTRACT:

Purpose: This study aims to comprehensively examine nursing research on newborn breastfeeding and identify prominent topics via bibliometric analysis.

Material and Methods: In this study, detailed bibliometric analysis was executed utilizing the Biblioshiny application from the bibliometrix package, alongside RStudio and VOSviewer tools. A search within the Scopus database, employing the keywords "neonatal," "neonatal health," "breastfeeding," and "nurse," identified 317 articles published across 145 journals between 2014-01-01 and 2024-01-01. The analysis encompassed variables such as the annual publication rate, three-parameter analysis, journal publication count, author influence, keyword analysis, thematic assessment, factor analysis, and the status of countries and organizations.

Results: "Spatz DL" was the most prolific author, and *Breastfeeding Medicine* ranked highest in publication volume. The most cited study was **"Effectiveness of a Nurse-Led Intensive Home-Visitation Programme for First-Time Teenage Mothers (Building Blocks): A Pragmatic Randomised Controlled Trial"** by Robling et al. International collaboration rate was 15.77%, with the UK and USA leading both in partnerships and publication output. "Cardiff University" and "University of Sydney" showed strong research productivity. Frequently used keywords included "breastfeeding," "human milk," "infant," and "breastfeeding support."

Conclusion: This study offers a comprehensive insight into breastfeeding in newborns and the nurse's role in its management, highlighting its global significance. By identifying key trends, international collaborations, and research gaps, it provides a strategic foundation for future studies. Understanding these patterns will strengthen evidence-based nursing practices and support relevant health policy development.

Keywords: Newborn; newborn health; breastfeeding; nurse; bibliometric analysis

INTRODUCTION

Breast milk is the primary source of nutrition that supports the growth and development of the newborn and contains all the nutrients they need, and it is easy to digest. Breast milk meets the physical and mental needs of infants in the first six months of life alone, while it can meet at least 50% of the daily energy that 6-12-month-old babies need, and approximately 33% of the daily energy that they need from one year to two years of age alone. Breast milk, which is beneficial for both the newborn and the mother in many physical, mental and social areas, has also been used as a source of nutrition in historical processes. In the historical inscriptions of the Ebers Papyrus (Ancient Egypt 1550 BC), it is stated that breast milk should be used as a source of

nutrition for the newborn, especially up to the age of three. The intensive study of breast milk and breastfeeding in academic studies since the 1970s shows that the importance of this issue is still current. Article 24 of the Convention on the Rights of the Child (1989) explicitly refers to the benefits of breastfeeding, emphasizing the importance of informing and supporting families in this regard (Convention on the Rights of the Child, 1989; Samur, 2008; Sinha et al., 2021; Tanrıkulu et al., 2012; Victoria et al., 2016; WHO, 2023). Breastfeeding also supports the mental development of the newborn, reduces infant mortality by protecting them from non-communicable diseases and many infections such as meningitis and urinary tract infection. It also supports the immune system. It is also known to protect the mother from breast and ovarian cancers, asthma and obesity-like chronic diseases. Therefore, the role of the nurse is important because the nurse is the first health professional consulted just before breastfeeding (Barutçu et al., 2020; Ip et al., 2007; Kartal and Gürsoy, 2020; Tiryaki and Altınkaynak, 2021; WHO, 2023). In cases where the newborn baby does not suck effectively, does not want to suck, has digestive problems, and mothers do not have sufficient knowledge and experience, which will negatively affect breastfeeding, nurses, especially when counseling mothers, support mothers' self-confidence and increase their self-efficacy, ensuring that unwanted situations are prevented with the correct breastfeeding technique. Nurses take their place as health professionals who explain in which positions they should breastfeed, how long the average breastfeeding period is, and the storage conditions of expressed milk, by using their roles of providing care, education and counseling (Aluş Tokat and Okumuş, 2013; Conk et al., 2018; Çerçer and Nazik, 2023; Özkara et al., 2016; Sinha et al., 2021; Törüner and Büyükgönenç, 2023; Yenal et al., 2013). According to UNICEF (2023) data, the rate of starting breastfeeding in the first hour after birth is 46% in the world, and those who only receive breast milk in the first 2 days after birth is 67%. While the Southern Africa region has the lowest breastfeeding rate in the world with 39% in the first 60 minutes, East Asia and Pacific countries have the lowest breastfeeding rate in the world with 59% in 48 hours (UNICEF, 2023).

When the World Health Organization 2025 Global Nutrition Goals are examined, it is aimed to reach at least 50% of breastfeeding in the first 6 months of life. Although access to breast milk increased by 10% between 2012 and 2024, reaching 48%, this goal has still not been achieved due to various problems (UNICEF, 2024; WHO, 2014). When breastfeeding rates up to the 9th month in Türkiye are examined, according to 2018 TNSA data, it was determined as 20.8% in 2003, 41.6% in 2008, 30.1% in 2013 and 40.7% in 2018. Considering the benefits of breastfeeding, it is seen that breastfeeding rates are low. When the obstacles to achieving the desired level of breastfeeding rates in the world and in Türkiye are investigated, it is determined that the share of nurses is quite high. Because breastfeeding is a skill acquired through knowledge and experience, the nurse is a key point in increasing breastfeeding rates with her roles such as care giving, defending patient rights, and providing education in the pre- and post-natal periods. The study conducted by Onbaşı and her colleagues in 2011 reveals that even just providing breastfeeding education increases breastfeeding and feeding rates, which will support the health of the mother and newborn. In a randomised controlled trial conducted by Şimşek Çetinkaya and colleagues in 2024, a breastfeeding education programme was implemented for mothers through an online counselling system led by nurses. The results of the programme showed that mothers' positive attitudes towards breastfeeding had increased. This finding suggests that breastfeeding education programmes can also have positive effects on attitudes that directly influence breastfeeding. In a study conducted in South India, it was determined that 28.3% of mothers breastfeed in an inappropriate position. In other words, almost one third of mothers breastfeed in an inappropriate position (Çerçer and Nazik, 2023; Health Statistics Yearbook, 2022; İşbay and Gerçek, 2019; Nancy et al., 2022; Onbaşı et al., 2011; Şimşek Çetinkaya et al.,2024; Tiryaki and Altınkaynak, 2021). Considering the rates of breastfeeding and ineffective breastfeeding in the world, the importance of nurses' roles in providing care, education and counseling cannot be ignored. Especially the fact that mothers who give birth for

the first time or after cesarean delivery are more worried while performing the breastfeeding act gives the nurse, who will provide counseling on this issue, some duties. The use of factors such as setting realistic goals while fulfilling duties such as education, counseling and care giving, starting breastfeeding early, using technological devices while providing education, and preferring up-to-date training materials positively affects breastfeeding. It is also very important for the nurse to have sufficient knowledge and equipment in the face of these duties (Annagür and Annagür, 2012; Farrag et al., 2019; Nancy et al., 2022; Şensoy and Yüksel Koçak, 2021; Yanıkkerem et al., 2014). In a study conducted by Maastrup and colleagues in 2021, it was found that breastfeeding education programmes for nurses increased breastfeeding rates (Maastrup et al., 2021). Therefore, not only education provided to mothers but also nurses being more knowledgeable in this area has a positive effect on breastfeeding rates. Bibliometric analysis stands out as a central analysis technique in the analysis of academic studies by making systematic reviews. It is used to reveal the importance of the subject and to be a source of light for science by examining the interactions of publications studied on the subject and the complex scientific literature network with different analyses such as publication production level, analysis of citations, efficiency of authors, usage trend of key concepts, utility level of institutions, distribution of geographical regions in activity (Demir et al., 2024a; Demir et al., 2024b). When the literature is examined, considering the number of publications and many factors, the role of nurses in the management of the breastfeeding process, which will primarily affect the health of the newborn, takes its place as a current issue. There is no bibliometric analysis on this subject. This study is the first bibliometric analysis aimed at filling this gap in literature.

MATERIAL and METHODS

In this study, the relationships between scientific studies are examined using the bibliometric analysis method. In line with the study, the keywords "newborn, newborn health, breastfeeding, nurse" were scanned in the Scopus database. The findings obtained from the literature review systematically reveal the activity analysis and scientific orientation analysis methods through RStudio software. In the analysis process, the distinct trends in the literature are examined in detail using a holistic approach, the most effective research areas, authors, academic journals and institutions. Keyword analysis was applied using VOSviewer software to visualize the relationships between keywords and reveal conceptual structures. The bibliometric metrics used in this study consist of annual publication count, total citation count, average citation count, author productivity level, country collaboration rate, keyword co-occurrence analysis, three-parameter analysis, and thematic mapping. Since the main objective of the research is to reveal scientific production trends, international collaboration networks, and research themes in the field under investigation, indicators such as the h-index, g-index, and m-index, which measure author or journal impact levels, have not been included in the analysis. This choice stems from the need to prioritise the content dimension and conceptual relationships in the bibliometric analysis, in line with the study's objective. Scopus was the only data source used in this study. This choice was made because Scopus's broad scope, detailed citation data, and advanced filtering capabilities were appropriate for the purpose of the study. However, the use of a single database limits the scope of the study, as publications not included in Scopus are excluded from the analysis. The population of this research consists of 1024 articles obtained by scanning the keywords "newborn", "newborn health", "breastfeeding" and "nurse" in the Scopus database. However, when limited by inclusion factors such as document type, publication language and publication year, 317 articles were used as a sample.

Research Gaps

This study examines the development and research trends of scientific literature on the nursing factor in newborn health and newborn breastfeeding. The study aims to seek answers to the research questions below:

1. What are the roles and responsibilities of nurses in increasing breastfeeding rates

among newborns?

2. How do the education and counselling services provided by nurses before and after birth affect the breastfeeding process?

3. Who is the author with the most publications in the field of breastfeeding in newborns?

4. Which is the journal, article, university and country that publishes the most in the field of breastfeeding in newborns?

5. What are the most trending topics in the field of breastfeeding in newborns?

6. Which countries cooperate in the field of breastfeeding in newborns?

7. What are the main research points and thematic researches in this field?

The data obtained aims to provide a comprehensive perspective in this field by revealing the productivity in the scientific field about the importance of breastfeeding and nursing that support newborn health, and by revealing the effective research areas and its place in the historical process.

Data Collection

This study examines the development and research trends of scientific literature on the nursing factor in newborn health and breastfeeding through bibliometric analysis. The analysis steps to be followed while performing bibliometric analysis were also taken into account in this study. The analysis processes of this research are summarized in Figure 1. In the first step of the study, keywords were scanned in the Scopus database in the form of "newborn", "newborn health", "breastfeeding" and "nurse". When the publication year is limited to 2014–2024, the publication language is English, and the document type is a published article, 317 articles are included, while articles for 2025, other publication languages, book chapters, reviews, proceedings, survey studies, and editorial publications are excluded from the scope of the study (Figure 1). The data collection process was carried out between February 15, 2025, and June 5, 2025. A total of 317 articles published between 2014 and 2024 have focused on various aspects of breastfeeding and the promotion of breast milk feeding. These studies have explored the experiences, attitudes, and challenges faced by both mothers and healthcare professionals during the breastfeeding process. They have also evaluated the impact of breastfeeding education, counseling services, and healthcare policies. Overall, the findings emphasize that knowledge, support, and professional guidance play a crucial role in sustaining successful breastfeeding practices.

Analysis of Findings

In the diagram showing the steps of the research, while the number of publications, author contribution analysis, the effectiveness and cooperation networks of the countries, journal and document types, thematic and factor analysis studies are carried out through RStudio (biblioshiny) and VOSviewer programs; In the 3rd step, the data obtained were interpreted and evaluated. The detailed results of the analysis are also included in the findings section.

Ethical Approval

In this study, there is no need for ethics committee approval since no direct intervention was performed on any human or animal subjects and only previously published studies were used as a data source. The study was carried out within the framework of ethical principles and in accordance with the Helsinki Declaration.

RESULTS

Performance Analysis

317 articles were accessed in 145 journals between 2014-2024 with the Scopus database. 1450 authors have studied with the keywords 'newborn', 'newborn health', 'breastfeeding', 'nurse'. 28 authors have contributed to the literature alone. International authors' cooperation is 15.77% and the average age of a work is 6.4 years (Figure 2).

Distribution of Studies by Years

Although the number of publications varies between 18-39 depending on the years of the articles, the number of publications has fluctuated over the years. Especially 2017 and 2018 are the years with the highest increase. The average number of

citations per article based on publication year varies between 0.77-34.92, and the average was determined as 13.93 (Table 1).

Three-Parameter Analysis

Three-parameter analysis examines three factors such as country, author, and keyword. Three-parameter analysis is a finding obtained only by using Biblioshiny software.8 The most important factors of this analysis are the country "Italy", the author "Mosca F", and the keyword "breastfeeding" (Figure 3).
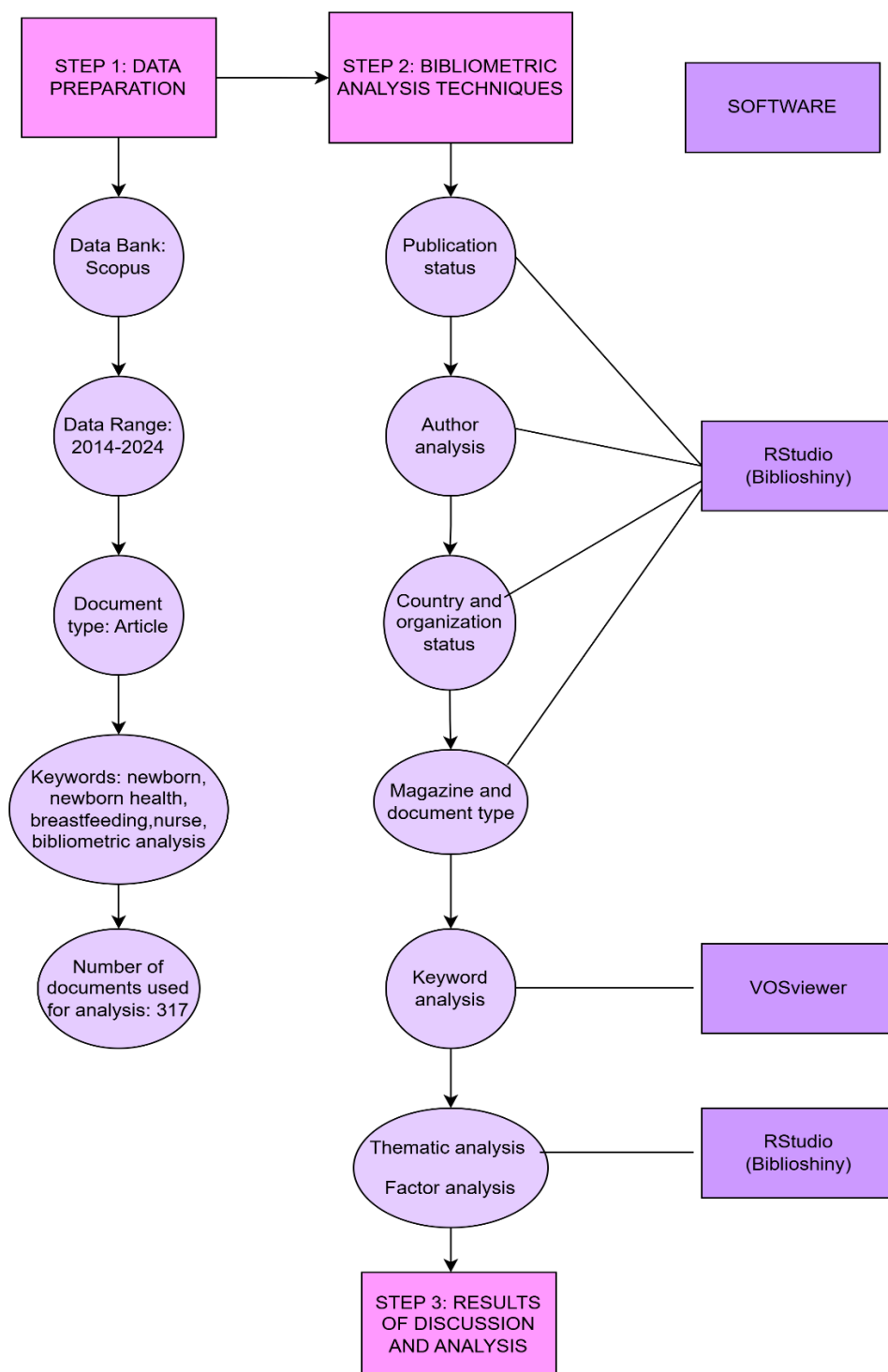
Figure 1. Flow diagram of bibliometric analysis

Figure 2. Performance analysis

Table 1. Status of publications and citations by year

Year of publication	Number of articles	Average number of citations per article
2024	30	0,77
2023	18	3,22
2022	23	4,83
2021	23	6,26
2020	28	11,18
2019	30	16,67
2018	39	21,59
2017	33	17,73
2016	25	34,92
2015	29	22,10
Total	278	Average 13,93
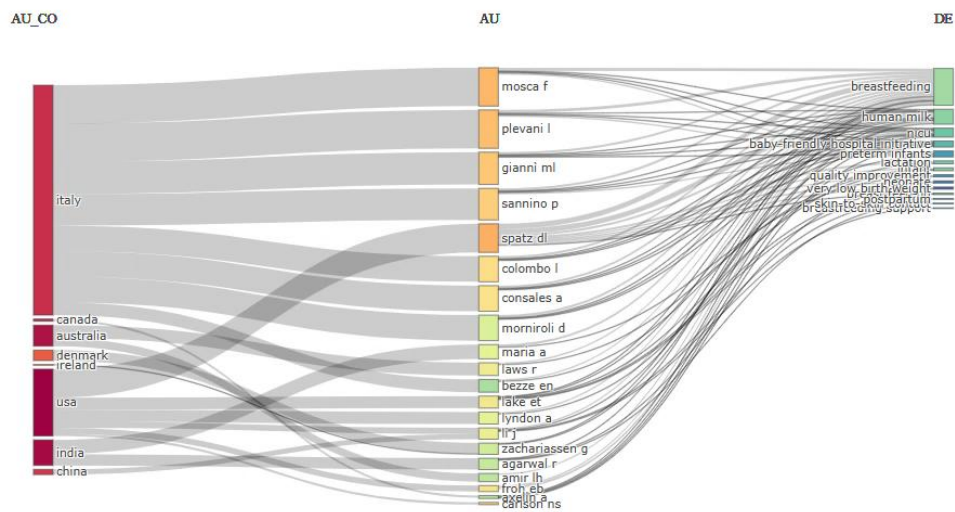
Figure 3. Three-Parameter Analysis

Effectiveness and organization status of countries

When analyzing countries, when the effectiveness of countries in the academic field is examined, countries painted in dark blue are the countries that have contributed the most publications to the literature, while countries painted in blue are countries that publish less, and countries painted in gray are countries that have not contributed any publications to the literature (Demir et al., 2024b; Demir et al., 2024c). When analyzing countries in the field of newborn health, breastfeeding, and nursing, the USA was determined as the country that contributed the most to the literature with 457 publications (Figure 4).

In the international cooperation map, thick brown lines indicate that the number of collaborations between countries is high, while thin brown lines indicate that the number of collaborations is low (Demir et al., 2024a). The United Kingdom and America are world leaders in cooperation. The United Kingdom and Kenya cooperated 3 times, America and Canada 3 times, America and Kenya 3 times, America and the United Kingdom 3 times, and India and Norway 2 times (Figure 5).

Country Scientific Production

| Country	Freq
USA	457
INDIA	125
AUSTRALIA	110
UK	97
CANADA	68
ITALY	61
CHINA	47
BRAZIL	39
KENYA	34
TURKEY	25
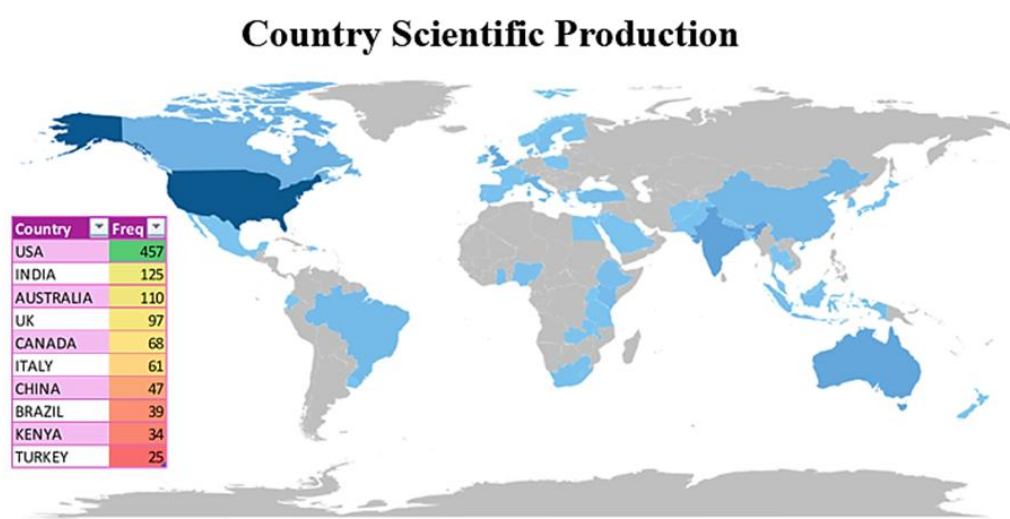
Figure 4. The most productive countries in the scientific process

Country Collaboration Map

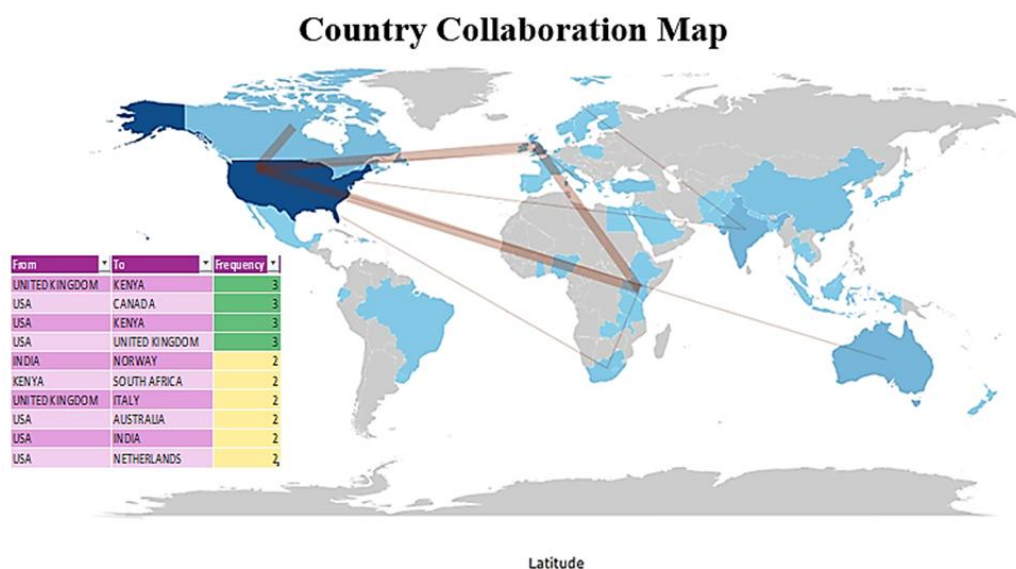| From	To	Frequency
UNITED KINGDOM	KENYA	3
USA	CANADA	3
USA	KENYA	3
USA	UNITED KINGDOM	3
INDIA	NORWAY	2
KENYA	SOUTH AFRICA	2
UNITED KINGDOM	ITALY	2
USA	AUSTRALIA	2
USA	INDIA	2
USA	NETHERLANDS	2

Latitude

Figure 5. Map of countries' cooperation

Systematic Analysis of the Article

The journal "Breastfeeding Medicine" (n=19) ranks first in the world in terms of the number of publications, while "Cardiff University" and "Sydney University" (n=21) are the most active universities in terms of publication productivity. Spatz DL (n=7) is the most productive author. The article "Effectiveness of a nurse-led intensive home-visitation programme for first-time teenage mothers (Building Blocks): a pragmatic randomised controlled trial" written by Robling et al. is the most noticed and cited study by other authors (n=216) (Table 2).

Qualified Modeling Analysis

Qualified Modeling analysis; It is the application of calculation techniques in a holistic way with the method of analyzing and modeling scientific and technical studies by visualizing them (Demir et al., 2024c).

Table 2. Systematic Analysis of Articles (author, citation count, institution, and journal)

Authors	Number of publications	Institutions	Number of publications
SPATZ DL	14	CARDIFF UNIVERSITY	21
MOSCA F	5	UNIVERSITY OF SYDNEY	21
PLEVANI L	5	UNIVERSITY OF HEALTH AND ALLIED SCIENCES	18
GIANNÌ ML	4	UNIVERSITY OF MILAN	18
SANNINO P	4	UNIVERSITY OF WASHINGTON	17
CARLSON NS	3	NOTREPORTED	16
COLOMBO L	3	DEAKIN UNIVERSITY	15
CONSALES A	3	ELIZABETH GLASER PEDIATRIC AIDS FOUNDATION	15
FROH EB	3	UNIVERSITY OF PENNSYLVANIA	14
LAKE ET	3	FONDAZIONE IRCCS CA' GRANDA OSPEDALE MAGGIORE POLICLINICO	13

Article title	DOI	Total citations
ROBLING M, 2016, LANCET	10.1016/S0140-6736(15)00392-X	216
SAVAGE JS, 2016, JAMA PEDIATR	10.1001/jamapediatrics.2016.0445	203
VEDAM S, 2018, PLOS ONE	10.1371/journal.pone.0192523	176
MILLER TR, 2015, PREV SCI	10.1007/s11121-015-0572-9	91
FORD SL, 2019, AM J CLIN NUTR	10.1093/ajcn/nqz006	88
KIEFFER MP, 2014, J ACQUIRED IMMUNE DEFIC SYNDR	10.1097/QAI.0000000000000372	81
ENWERONU-LARYEA C, 2015, BMC PREGNANCY CHILDBIRTH	10.1186/1471-2393-15-S2-S4	78
AKSEER N, 2016, LANCET GLOBAL HEALTH	10.1016/S2214-109X(16)30002-X	76
MORRISON AH, 2019, MCN AM J MATER CHILD NURS	10.1097/NMC.0000000000000566	75
GEPHART SM, 2014, ADV NEONATAL CARE	10.1097/ANC.0000000000000052	72

Magazines	Number of publications
BREASTFEEDING MEDICINE	19
JOGNN - JOURNAL OF OBSTETRIC, GYNECOLOGIC, AND NEONATAL NURSING	17
ADVANCES IN NEONATAL CARE	14
NURSING FOR WOMEN'S HEALTH	14
MIDWIFERY	11
MCN THE AMERICAN JOURNAL OF MATERNAL/CHILD NURSING	10
BMC PREGNANCY AND CHILDBIRTH	9
INTERNATIONAL BREASTFEEDING JOURNAL	9
JOURNAL OF HUMAN LACTATION	9
PLOS ONE	9

Factor analysis, which is grouped into three clusters using keywords, provides convenience when interpreting keywords (Demir et al., 2024a). The large red cluster includes the words "Procedures, infant, newborn, mother, adult, education, male, nurse, breastfeeding, midwife, human experiment, breastfeeding education, organization and management, controlled study, child", the second large cluster includes "Breast milk, milk human, neonatal intensive care unit, neonatal", and the third large cluster includes the words "health knowledge, attitudes practice, psychology, surveys and questionnaires, cross sectional studies" (Figure 6). When the thematic map is examined, it is seen that the keywords are mostly among the themes. Topics such as "human, newborn, breastfeeding, female, humans" are included between the motor theme and the basic theme. Topics that have not been studied sufficiently such as "controlled study, child, major clinical study, newborn care, child health" are included between the motor and niche themes.

Topics such as "prematurity, neonatal intensive care unit, intensive care units, neonatal, infant, premature, milk, human" are available among emerging or declining themes (Figure 7).

The word cloud shows the most used words in the literature. Breastfeeding 562, female 547, human 312, adult 292, newborn 291, humans 288, infant 284, infant newborn 273, pregnancy 245 are the most used words in the literature (Figure 8).

According to VOSviewer program data, when keywords are examined, a total of 178 concepts, 17 clusters, 803 links, and 1,029 total link strength were determined. "breastfeeding" (cluster 17), "exclusive breastfeeding" (cluster 6), "breastfeeding support" (cluster 1), "infant" (cluster 11), "neonatal mortality" (cluster 7), and "very low birth weight" (cluster 4) are the six most important clusters. The most important keywords in cluster 17 (breastfeeding), which is brown, are "knowledge, human milk, preterm, home visitation".
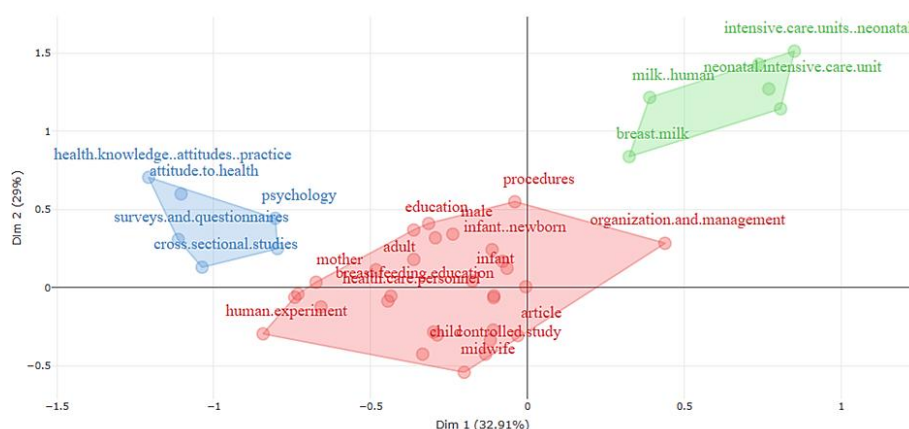

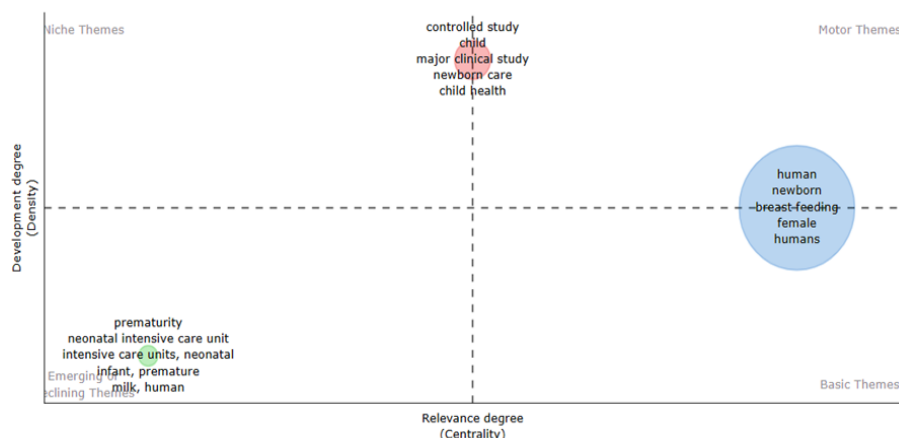**Figure 6.** Three-cluster factor analysis

Figure 7. Thematic Map

Figure 8. Word Cloud

The words "motherhood, baby friendly, preterm birth" are in cluster 6 (exclusive breastfeeding), which is blue. The words "nurses, child health, breastfeeding duration" are in cluster 1 (breastfeeding support), which is red. While the words "mothers, nursing, qualitative study, primary health care, midwives" are in cluster 11 (infant), which is green, the words "nurse education, newborn care, human milk feeding" are in cluster 7 (neonatal mortality), which is orange, and the keywords "randomized controlled trial, pregnant, covid-19" are in cluster 4 (very low birth weight), which is yellow (Figure 9).

The colors navy blue, blue, dark green, light green, and yellow on the timeline indicate the keywords used from 2017 to 2021 (Demir et al., 2024b). The keywords "policy", "neonatal intensive care unit", "very low birth weight", and "breastfeeding education" in navy blue were studied between 2017 and 2018. The keywords "human milk", "formula feeding", "self efficacy", and "primary care" in blue were studied between 2018 and 2019. The keywords "breastfeeding", "infant", and "breastfeeding support" in dark green were studied between 2019 and 2020. The keywords "quality improvement", "nurses", and "kangaroo mother care" in light green were studied between 2020 and 2021. The keywords "education", "counseling", "maternal health", "pregnancy", "pediatrics", "breastfeeding barriers", "maternal education", and "education" in yellow are still used in the literature (Figure 10).
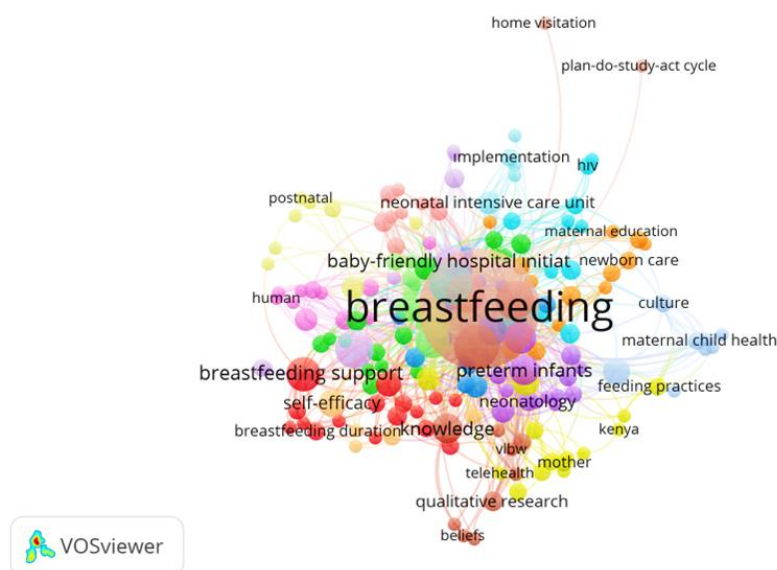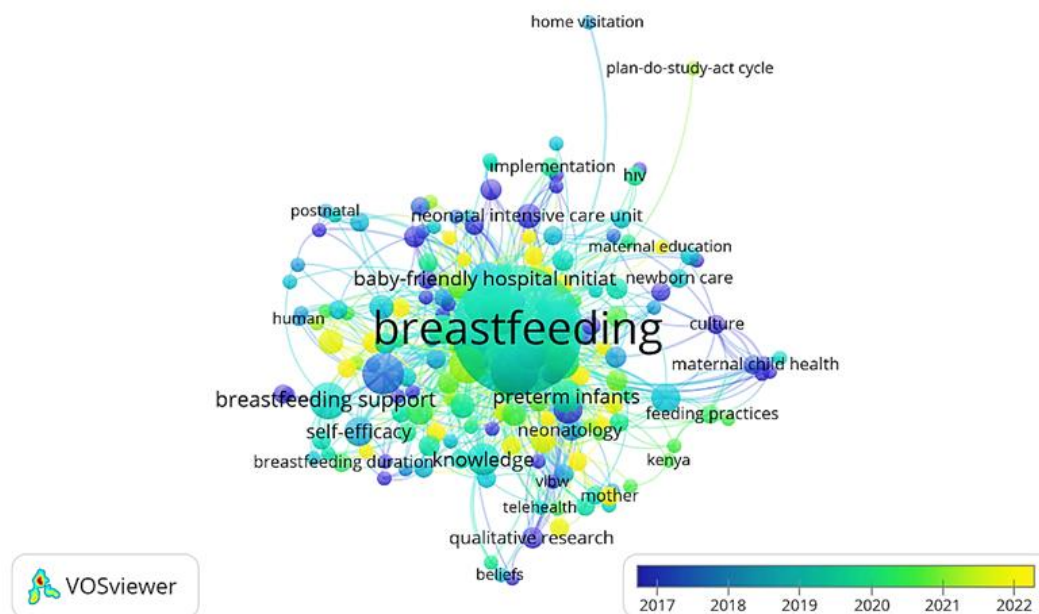

Figure 9. Keyword network map

Figure 10. Timeline of keywords

DISCUSSION

Considering the findings of the study, although there have been fluctuations in the number of publications in the fields of breastfeeding and neonatal nursing over the past decade, the increase in the number of publications, author collaboration, and international collaboration indicates that joint studies are being conducted in the field of breastfeeding in newborns and that researchers around the world are coordinating scientific publications and projects. This highlights the importance of the field, but despite the extent of collaboration, the rates remain low. When examining the reasons for the low rate of international collaboration, differences in research infrastructure and funding opportunities, language and communication barriers, and incompatibilities in data sharing and ethical regulations are identified. Additionally, the fact that field studies such as breastfeeding and newborn care are dependent on local conditions limits international partnerships. This situation necessitates the development of strategies to overcome existing barriers in order to increase collaboration in the field. In addition, the continued widespread use of keywords such as 'education,' 'counselling,' 'maternal health,' 'pregnancy,' 'paediatrics,' 'breastfeeding barriers,' 'maternal education,' and 'nurses' in the literature indicates that the educational and counselling roles of nurses in supporting breastfeeding, as well as the importance of factors that hinder breastfeeding, remain an ongoing research topic. The themes that emerge from the keyword analysis support the critical role of breastfeeding in health outcomes and the intensity of research on the importance of breastfeeding in particular. Nurses' ability to provide direct support to mothers and newborns at both the hospital and community levels clearly demonstrates their importance in promoting breastfeeding. In addition, nurses play a critical role in promoting and sustaining breastfeeding that supports newborn health by using innovative and up-to-date methods in breastfeeding education (Galvão and Silva, 2024; Temizkan Sekizler and Ünsal Atan, 2023). Furthermore, the findings of the study show that academic research on breastfeeding and newborn care has progressed not only in terms of quantity but also in terms of quality and collaboration. At the same time, it serves as a guiding light for future research for student nurses, academics, and nurses working in the field. It is anticipated that bibliometric analysis will guide nurses' trends in this area by determining the status of studies in the field, establishing their relevance in line with the importance of the subject, and determining their place on an international scale.

CONCLUSION

The data obtained revealed that although the issue of breastfeeding has an important place in the field of health, it has not been sufficiently examined, especially with bibliometric analysis methods. While the majority of publications on breastfeeding in the literature are in the form of clinical studies, reviews and case studies; it has been determined that bibliometric studies evaluating publication trends, author collaborations, citation patterns and country contributions are quite limited. This situation shows that the issue of breastfeeding needs to be addressed in a more comprehensive and systematic way. With this study, an important start has been made to understand the roles of nurses in the breastfeeding process and the structure of related scientific production, and the ground has been prepared for future, more comprehensive analyses. In light of the data obtained in this study, it is evident that while breastfeeding, which affects newborn health, holds a significant place in the field of healthcare, a study specifically employing the bibliometric analysis method has not yet been featured in the literature. It has been determined that the studies contributed to the literature are mostly in the form of clinical research, reviews, and case presentations; bibliometric studies evaluating publication trends, international collaborations, and the contributions of authors and countries by looking at publication and citation statuses over the years are limited. This situation reveals the importance of nurses in breastfeeding and its impact on newborn health, highlighting the need for a more comprehensive and systematic approach. This study fills an important gap in the literature by shedding light on the roles of nurses in the breastfeeding process and the structural characteristics of scientific studies conducted in this field; it is also predicted to contribute to the literature in this field by forming a basis for more comprehensive bibliometric analyses to be carried out in the future. Based on these findings, it is recommended to expand modules on breastfeeding counseling within nursing curricula to better prepare nurses for their supportive roles throughout the breastfeeding process. Furthermore, the establishment of international collaboration platforms for researchers and practitioners is advised to enhance knowledge exchange, encourage joint projects, and accelerate advancements in the field. In addition, conducting comparative bibliometric analyses with similar studies in other health disciplines may provide a broader perspective on the development of the field and contribute valuable insights to the literature.

Conflict of Interest

The authors who conducted this study do not have any affiliation with a board, connection with board members, consultancy, employment at a firm, shareholding, or any similar situation that could create a conflict of interest.

REFERENCES

Aluş Tokat, M., Okumuş, H. (2013). The effect of antenatal education based on strengthening breastfeeding self-efficacy perception on breastfeeding self-efficacy perception and breastfeeding success. Journal of Nursing Education and Research, 10(1), 21–29.

Annagür, B. B., Annagür, A. (2012). The relationship between postpartum mood and breastfeeding. Current Approaches in Psychiatry, 4(3), 279–292. https://doi.org/10.5455/cap.20120417.

Barutçu, Çiftçi, A. Ç., Şahin, A. S. (2020). Current approaches in newborn, well child and social pediatrics (pp. 140–200). Academic Bookstore.

Conk, Z., Başbakkal, Z., Bal Yılmaz, H. et al. (2018). Pediatric nursing (2nd ed., pp. 310–314). Academic Bookstore.

Çerçer, Z., Nazik, E. (2023). Breastfeeding Problems and Nurses' Roles. Sakarya University Journal of Holistic Health, 6(2), 353-365. https://doi.org/10.54803/sauhsd.1267125.

United Nations Convention on the Rights of the Child. (1989). Available from https://www.unicef.org/turkiye/%C3%A7ocuk-haklar%C4%B1na-dair-s%C3%B6zle%C5%9Fme (Access date: 2025-04-20).

Demir, G., Chatterjee, P., Kadry, S. et al. (2024c). Measurement of Alternatives and Ranking according to Compromise Solution (MARCOS) method: A comprehensive bibliometric analysis. Decision Making: Applications in Management and Engineering, 7(2), 313–336. http://doi.org/10.31181/dmame7220241137.

Demir, G., Chatterjee, P., Pamučar, D. (2024b). Sensitivity analysis in multi-criteria decision making: A state-of-the-art research perspective using bibliometric analysis. Expert Systems with Applications, 237, 121660. https://doi.org/10.1016/j.eswa.2023.121660.

Demir, G., Chatterjee, P., Zakeri, S. et al. (2024a). Mapping the evolution of multi-attributive border approximation area comparison (MABAC) method: A

bibliometric analysis. Decision Making: Applications in Management and Engineering, 7(1), 290–314. http://doi.org/10.31181/dmame7120241037.

Farrag, N. S., Abdelsalam, S. A., Laimon, W. et al. (2019). Pediatric nurses' knowledge of and self-efficacy in breastfeeding counseling. American Journal of Perinatology, 36(11), 1120–1126. https://doi.org/10.1055/s-0038-1676486.

Galvão, D., Silva, E. (2024). The Nurse's Role In Promotıng Breastfeedıng: Integratıve Revıew. RIIS: Revista de Investigação and Inovação em Saúde, 7(1).

Ip, S., Chung, M., Raman, G. et al. (2007). Breastfeeding and maternal and infant health outcomes in developed countries (Evidence Report/Technology Assessment No. 153; AHRQ Publication No. 07-E007). Agency for Healthcare Research and Quality. https://archive.ahrq.gov/downloads/pub/evidence/pdf/brfout/brfout.pdf

İşbay, B., Gerçek, E. (2019). The importance of breast milk and the effect of grandmothers and fathers on breastfeeding behavior. Turkey Clinics Journal of Pediatrics, 28(2), 87–96. https://doi.org/10.5336/pediatr.2018-62695.

Kartal, T., Gürsoy, E. (2020). The Importance of Breastfeeding in Sustainable Development Goals (2015-2030) and the Duties of Nurses in Light of the Current Situation in Turkey. Mersin University Faculty of Medicine Lokman Hekim Journal of History of Medicine and Folkloric Medicine, 10(2), 147-153. https://doi.org/10.31020/mutftd.676389.

Maastrup, R., Rom, A. L., Walloee, S. et al. (2021). Improved exclusive breastfeeding rates in preterm infants after a neonatal nurse training program focusing on six breastfeeding-supportive clinical practices. Plos One, 16(2), e0245273. https://doi.org/10.1371/journal.pone.0245273

Ministry of Health of the Republic of Turkey. (2022). Health statistics yearbook 2022. Available from https://dosyasb.saglik.gov.tr/Eklenti/48054/0/siy202205042024pdf.pdf. (Access date: 20 April 2025)

Nancy, S., Sindhuri, R., Arunagirinathan, A. et al. (2022). Breastfeeding positioning and attachment among postnatal mothers: A mixed methods study in a tertiary care hospital in Puducherry, South India. Indian Journal of Community Medicine, 47(1), 120–124. https://doi.org/10.4103/ijcm.ijcm_859_21.

Onbaşı, Ş., Duran, R., Çiftdemir, N. A. et al. (2011). The effect of breastfeeding and breast milk education given to expectant mothers before birth on breastfeeding behaviors. Türk Pediatri Arşivi, 46(1), 75-80. https://doi.org/10.4274/tpa.46.13.

Özkara, H., Eren Fidancı, B., Yıldız, D. et al. (2016). Breastfeeding counseling. TAF Preventive Medicine Bulletin. https://doi.org/10.5455/pmb.1-1436701913.

Robling, M., Bekkers, M. J., Bell, K. et al. (2016). Effectiveness of a nurse-led intensive home-visitation programme for first-time teenage mothers (Building Blocks): A pragmatic randomised controlled trial. The Lancet, 387(10014), 146–155.

https://doi.org/10.1016/S0140-6736(15)00392-X

Samur, G. (2008). Breast milk (pp. 1–24). Klasmat Printing House.

Sinha, S., Miall, L., Jardine, L. (2021). Basic newborn (pp. 1–65). Wiley Blackwell.

Sensoy, F., Kocak, D.Y. (2021). Current Approaches in Breastfeeding Consultancy. Ordu University Journal of Nursing Studies, 4(3), 427-435. https://doi.org/10.38108/ouhcd.844447.

Şimşek Çetinkaya, Ş., Gümüş Çalış, G., Kıbrıs, Ş. (2024). Effect of breastfeeding education program and nurse-led breastfeeding online counseling system (BMUM) for mothers: A randomized controlled study. Journal of Human Lactation, 40(1), 101–112. https://doi.org/10.1177/08903344231210813.

Tanrıkulu, P.Ç., Ersoy, N., Ersoy, G. (2012). Examination of the Knowledge Levels of Mothers with Babies Aged 6-24 Months Regarding Breastfeeding, Breastfeeding Periods, and the Factors Affecting These. Journal of Nutrition and Dietetics 2012, 40(2): 120-127.

Temizkan Sekizler, E., Ünsal Atan, Ş. (2023). Innovative Approaches and the Use of Technology in Breastfeeding Counseling. Journal of Women's Health Nursing, 9(Special Issue-1), 44–48.

Tiryaki, Ö., Altınkaynak, S. (2021). The role of the nurse in breastfeeding counseling. STED, 30(3), 1–7. https://doi.org/10.17942/sted.627192.

Törüner, E. K., Büyükgönenç, L. (2023). Basic nursing approaches to child health (pp. 252–258). Ankara: Nobel Medical Bookstores.

UNICEF (2023). Too few children benefit from recommended breastfeeding practices. Available from https://data.unicef.org/topic/nutrition/breastfeeding/. (Accessed date: 2025-04-20).

UNICEF (2024). UNICEF and WHO call for access to breastfeeding support. Available from https://www.unicefturk.org/yazi/emzirme-destegine-esit-erisim?utm_source=google&utm_medium=cpc&utm_campaign=DSA&utm_term=&utm_content=text-ad&gad_source=1&gbraid=0AAAAADdL-pldFVPqxW2StfOf3Sl2nvwfe&gclid=Cj0KCQjwtpLABhC7ARIsALBOCVqpscaL2tdMQIUoI5BsGSlwL_N99lWqMFfTUckXt0GPmqL1DJNffWQaAgIrEALw_wcB (Accessed date: 2025-04-20).

Victora, C. G., Bahl, R., Barros, A. J. D. et al. (2016). Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. The Lancet, 387, 475–490. https://doi.org/10.1016/S0140-6736(15)01024-7

WHO (2014). Global Nutrition Targets 2025: Policy Brief Series. Available from https://iris.who.int/handle/10665/149018?utm_source=chatgpt.com. (Accessed date: 2025-04-20).

WHO (2023). Infant and Young Child Feeding. Available from https://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding. (Accessed date: 2025-04-20).

Yanıkkerem, E., Ay, S., Göker, A. (2016). Breastfeeding

attitudes and concerns of primiparous and multiparous pregnant women. Van Medical Journal, 21(1), 6–16.

Yenal, K., Aluş Tokat, M., Durgun Ozan, Y. et al. (2013). Examination of the relationship between mothers' breastfeeding self-efficacy perceptions and breastfeeding success. Journal of Nursing Education and Research, 10(2), 14–19.

Virtual Reality Applications in Children with Down Syndrome: A Traditional Review

Emine Nacar [1]* [ID], Merve Karakurt [2] [ID], Selvin Balki [3] [ID]

[1]İnönü University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Malatya, Türkiye
[2]Sivas Cumhuriyet University, Institute of Health Sciences, Department of Physiotherapy and Rehabilitation, Sivas, Türkiye
[3]Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Sivas, Türkiye

ABSTRACT:

Down syndrome is a genetic disorder caused by trisomy of the 21st chromosome. Children with down syndrome may have balance and coordination disorders, abnormal movement patterns, decreased muscle tone and delays in motor development compared to typically developing peers. Various rehabilitation methods such as sensory integration, neurodevelopmental therapy and vestibular stimulation are used to treat these motor skill problems. However, one of the most important difficulties in the rehabilitation process is the lack of motivation, which negatively affects the process.

In recent years, virtual reality-based rehabilitation approaches have been increasingly used to increase children's participation and make therapy more engaging. Their interactive and game-based structure strengthens intrinsic motivation in children, makes the process of achieving therapeutic goals more enjoyable, and supports long-term engagement. The literature has shown that virtual reality applications have positive effects on numerous parameters, such as muscle strength, range of motion, coordination, attention span, problem-solving skills, and motor control. Furthermore, virtual reality applications simulate daily tasks, enabling high-repetition functional movements, thus contributing to the motor learning process. The app's usability in the home environment provides a significant advantage in maintaining therapy continuity. All these features of virtual reality offer a potential contribution to the participation and development of children with down syndrome in therapy.

However, although the use of virtual reality technology has been proposed during the therapeutic management of children with down syndrome, studies have generally focused on other neurological disorders such as autism spectrum disorder, attention deficit and hyperactivity disorder, and cerebral palsy. In this review study, the aims of using virtual reality therapies in children with down syndrome were discussed and their effects on gross motor functions such as balance, coordination, speed, agility as well as fine motor functions based on upper extremity skills were evaluated.

Keywords: Down syndrome; virtual reality; augmented reality; motor skills

*Corresponding author: Emine Nacar, email: emine.nacar@inonu.edu.tr

INTRODUCTION

Down syndrome (DS) is a genetic condition caused by chromosomal abnormalities and occurs in approximately 1 in 700 to 1 in 1,000 live births. This condition is one of the most common genetic causes of intellectual disability (Oster-Granite et al., 2011). Cytogenetically, it is divided into three main groups: trisomy 21, translocation, and mosaic type (Bull, 2020). Trisomy 21 is the most common type, seen in approximately 95% of individuals with DS. It occurs due to an error in cell division known as nondisjunction during meiosis I. Translocation accounts for 5% of affected individuals. Mosaic type DS is the least common type, occurring in ~2% of all individuals with DS (Antonarakis, 1998; Morris et al., 2012). As a result of a chromosomal abnormality, neurodevelopmental delays are often accompanied by vision and hearing problems, cognitive problems, obesity, heart and respiratory system problems (Pikora et al., 2014). Children with DS have impaired

balance and coordination, abnormal movement patterns, decreased muscle tone and delayed motor development compared to typically developing children (Lauteslager, 2004). Decreased postural tone, inadequate postural reaction, joint hypermobility and sensory problems play an important role in delayed motor development (das Neves Cardoso et al., 2015). In addition, these problems may cause delay in mental, emotional and social development (Wang et al., 1995). For this reason, as soon as DS is diagnosed, a comprehensive evaluation process should be initiated in all developmental areas, appropriate intervention methods should be determined and lifelong rehabilitation processes should be followed (Määttä et al., 2011). Exercise and traditional rehabilitation interventions have been shown to aid motor skill development in children and adults with DS, and even improve the quality of motor responses after intervention (SILVA & Ferreira, 2001). Motor coordination is considered the interaction of the musculoskeletal, nervous, and sensory systems to produce accurate and balanced dynamic movements (Balaban et al., 2009). The higher the level of coordination complexity of a particular motor skill, the higher the level of coordination required for effective performance (Gallahue et al., 2013; Kiphard, 1974).

Children with DS are more dependent on feedback on motor responses than their typically developing peers. They often take longer to perform the movement because they need more time to process the feedback (Martins et al., 2013). In a study, it was reported that individuals with DS had low movement speed and slow reaction times (Sacks & Buckley, 2003). It has been observed that reaction time and movement speed can be improved with regular training. Sensory integration, neurodevelopmental therapy and vestibular stimulation are some effective rehabilitation methods for treating problems in gross and fine motor skills in children with DS (Uyanik et al., 2003). Nevertheless, one of the most significant challenges in the DS rehabilitation process is the lack of motivation, which negatively impacts the rehabilitation process. Virtual Reality-based (VR-based) therapy is one of the most promising developments in rehabilitation

technology that can be used clinically to improve strength, range of motion, coordination, attention span, problem solving, decision making, balance and postüre (Snider et al., 2010). VR-based rehabilitation applications have been proven to be effective in increasing children's motivation and self-efficacy (Reid, 2002). VR systems integrate computer software and hardware into a user-computer interface, promoting multi-sensory stimulation and user interaction, thereby creating real-time simulations (Perez-Marcos, 2018). It also provides sensory-motor training by providing feedback about the body and activating the motor and perceptual areas of the brain (Adamovich et al., 2009). VR systems allow the user to practice high-quality movements and high repetitions by simulating a real-life task. In order to achieve motor learning, VR systems can help target functional movements of the whole body or a single extremity. The implementation of these activities is promising as they may increase the child's motivation during therapy and can be used as part of the child's home therapy programs (Ghafar & Abdelraouf, 2017). Although VR technology has been recommended for educational and rehabilitative purposes for children with DS, most existing studies have investigated its application for children with neurodevelopmental disorders such as cerebral palsy, autism spectrum disorder and attention deficit hyperactivity disorder (Pinar-Lara, 2024). Research specifically examining the utilization of VR for the rehabilitation of children with DS remains scarce in the current literature. In this review, the purposes of using VR therapies in children with DS were reviewed. The effects of VR on fine motor function based on gross motor function and upper extremity skills such as balance, coordination, speed, agility in children with DS were described.

Virtual Reality Applications for Gross Motor Function in Children with Down Syndrome

Motor control and balance problems are common physical disorders in individuals with DS. One of the main contributing factors is muscle hypotonia, and the inadequate strengthening of muscles negatively affects both motor control and balance. This decrease in muscle tone causes movements to be

less controlled and slower, which makes motor coordination difficult (Umar et al., 2021). In addition, ligamentous laxity leads to decreased joint stability, making balance even more difficult. This laxity prevents the development of motor skills, especially walking and standing (Finbråten et al., 2015). At a neurological level, myelination delays in individuals with DS slow down the speed of signals sent to brain structures that control motor skills and balance. This leads to delays in motor planning and execution, making it difficult to maintain balance (Wu & Li, 2020). In individuals with DS, the vestibular and proprioceptive systems may also be negatively affected. This leads to inadequate access to proprioceptive and vestibular information critical for maintaining balance, which may result in over-reliance on visual cues (Uyanik & Kayihan, 2010). In addition, motor learning processes develop more slowly in individuals with DS. Learning and implementing new movements and developing motor planning strategies may take time. This may hinder independence in daily life activities and the development of motor skills (Valentini et al., 2021). All these factors are fundamental factors affecting motor coordination and balance in individuals with DS and play an important role in understanding the physical development processes of these individuals. Traditional rehabilitation approaches have been used to address these problems in DS. However, the integration of innovative and engaging interventions may further improve treatment outcomes (Shelton & Malow, 2021).

VR is utilized as a tool to enhance motor coordination and balance abilities in children with DS. Although research on this subject is limited, existing studies suggest that VR training can positively influence motor functions in these children. In the study by Wuang et al., A total of 105 children with Down syndrome, aged between 7–12 years, were randomly assigned to standard occupational therapy (SOT), Wii-based virtual reality interventions (VRWii), or a control group. Both intervention groups showed significant improvements in sensorimotor functions compared to controls, with the VRWii group achieving greater gains in motor skills, visual-motor integration, and sensory integration. The results of this study show that virtual reality using Wii game technology is beneficial in developing the sensory-motor functions of children with DS (Wuang et al., 2011). The study indicated that VR training helped children become more independent in their daily life activities by improving their balance skills. It was emphasized that such interventions could yield more successful results when used in addition to traditional rehabilitation methods. In a study conducted by Gómez-Alvárez et al., the effects of VR-based therapy in children with DS were examined in the context of an unblinded randomized controlled trial conducted in a special education school. The participants were children aged between 6–12 years. In the study, one group exercised with the Nintendo Wii Fit Balance Board and sports video games (Snowboard, Penguin Slide, Super Hula Hoop, Heading Soccer ve Ski Jumping) for 10 sessions (5 weeks, twice a week, 20 minutes each session), while the control group continued their daily routine. (Gómez Álvarez et al., 2018). As a result of the study, they found statistically significant results in static balance in the VR group in closed-eye assessments. Another advantage of VR is that it provides sensory-motor activation. VR environments provide children with various motor tasks, allowing them to receive more sensory and motor feedback in completing these tasks. Yunus et al. conducted a randomized controlled trial with 20 children with Down syndrome, aged 9–18 years, who were randomly assigned to treatment and control groups. The treatment group received sensory-motor virtual reality therapy twice a week for four weeks, while the control group did not receive any intervention. Following the intervention, the treatment group demonstrated significant improvements in Pediatric Balance Scale and Timed Up and Go Test (TUG) scores. Sensory integration was achieved through VR games designed to simultaneously stimulate visual, auditory, and proprioceptive systems (Yunus, 2024). These games required children to integrate multiple sensory inputs while coordinating their motor responses, thereby improving both static and dynamic balance. Moreover, VR therapy enhances neuroplasticity by providing repetitive, task-specific, and engaging sensory-motor stimulation. Through these enriched environments, children's brains form

new neural pathways and strengthen existing ones, which supports motor learning and promotes long-term improvements in balance and functional independence. The study concludes that VR therapy is an effective method for improving sensory integration and balance training in children with Down syndrome. In a study conducted by Memon et al., it was shown that both VR and traditional exercise interventions had a positive effect on static and dynamic balance in individuals with DS (Memon et al., 2024). However, it was observed that the group receiving the VR intervention showed a more significant improvement in static balance compared to the traditional exercise group. In the study by Suarez-Villadat et al., VR and conventional physical therapy programs were compared in terms of their effects on dynamic balance and muscle endurance in adolescents with DS (19 female and 30 males; average age, 14.19 ± 2.06 years). The VR group engaged in 60-minute sessions, three times per week over 20 weeks, using Nintendo Wii Fit sports video games, totaling 60 sessions. The control group participated in a traditional physical therapy regimen focused on motor and coordination exercises. Dynamic balance was evaluated using the TUG test, while muscle endurance was measured with the 30-Second Chair Stand Test. The findings indicated that VR-based interventions provided greater improvements in both dynamic balance and muscle endurance compared to conventional therapy (Suarez-Villadat et al., 2023). Similarly, Rahman et al. conducted a study examining the effects of VR and traditional physical therapy on functional balance in children with DS, including participants aged 8–12 years from both genders.The VR group received traditional physical therapy exercises combined with three sports video games using the Nintendo Wii Fit Balance Board. The treatment was performed 6 times per week for 6 weeks, for a total of 36 sessions. Each session lasted 60 minutes. The control group received a traditional physical therapy program that included strengthening, walking, and stair climbing exercises. Functional balance was assessed using the Bruininks-Oseretsky Motor Skills Test (BOT-2), and VR was found to be more effective in improving functional balance compared to traditional physical therapy (Rahman & Rahman, 2010). These results

demonstrate the potential of VR as a promising balance training tool for balance problems in individuals with DS. Studies have highlighted that VR application is more effective in improving motor functions and balance, especially when applied as an adjunct to a traditional physical therapy program. Changes in the musculoskeletal system and motor skills in DS affect physical abilities such as speed and agility (Ulrich et al., 2001). Problems such as low muscle tone and loss of muscle strength observed in DS can directly negatively affect the coordination and speed of movements (Connolly & Michael, 1986). Additionally, deficits in abilities such as balance and proprioceptive awareness may limit agility (Zolghadr et al., 2025). These effects result from a combination of both genetic factors and physiological and environmental elements in the individual's developmental process (Giuriato et al., 2025).

Studies on the development of speed and agility skills in individuals with DS using VR show that this technology is an effective tool (Lin & Wuang, 2012; Reis et al., 2017). Lin et al. found that the implementation of strength and agility training with the help of VR improved motor skills in individuals with DS during adolescence. In the study, children aged 13–18 years in the exercise group participated in a strength and agility program using both virtual and traditional methods for 6 weeks. According to the results of this study, it was emphasized that strength and agility performance could be improved more effectively with combined virtual and traditional methods (Lin & Wuang, 2012). Similarly Reis et al. compared the effects of VR and daily care routines on functional balance in children with DS, including participants aged 10–14 years from both genders.The VR group was given 4 sessions per week for 4 weeks, 16 sessions in total, using the river videos games using the Xbox 360 and Kinect sensor. The control group continued their daily care routine. Each session lasted a maximum of 20 minutes. As a result of the study, it was stated that VR-based tools were effective in developing children's balance, coordination and speed skills In this study, participants made visible improvements in their motor performance with VR-supported activities (Reis et al., 2017). Studies in the literature show that

virtual reality plays an important role in the development of motor skills and that VR can contribute to the development of speed, agility and motor skills in individuals with DS. However, it is also emphasized that this technology should be adapted to the specific needs of individuals.

Virtual Reality Applications for Fine Motor Function in Children with Down Syndrome

Individuals with DS show deficits in multiple areas such as physical and motor function. Body composition and muscle strength are vital parameters for children's gross motor, fine motor and functional performance (Beqaj et al., 2018). Upper extremity function is generally associated with motor coordination, dexterity, muscle strength and sensitivity (Padia et al., 2023). Manual dexterity provides the precision, speed, and coordination of upper extremity movements for a task, while grip and pinch strength provide quantitative measures of upper extremity integrity (Choi, 2015). It has been shown that the development of gross and fine motor skills in children with DS is both slower and more impaired than in normally developing children (Volman et al., 2007). In a study conducted by Sinaga et al., scores of 9-12 year old children with DS and typically developing children on the Nintendo Wii game were compared and significant differences were found in fine motor skill scores. It was reported that fine motor skills of children with DS were weaker than those of normal children (Sinaga et al., 2016). Most intervention programs to develop fine motor skills include exercises or activities that use the hands, sensory integration therapy, and neurodevelopmental therapy (Chen et al., 2014; Jobling & Cuskelly, 2006). However, a limited number of studies have shown that VR therapy is effective in upper extremity motor skills in children with DS. In one study, an 8-week intervention was administered to a 12-year-old child with DS using a game system that included Nintendo Wii rehabilitation software (Berg et al., 2012). The child was instructed to use the Nintendo Wii at least four times a week, with each session lasting at least 20 minutes. Assessments were conducted before and after the intervention using the second edition of the BOT-2. The participant showed improvement in hand dexterity and upper extremity coordination scores on the BOT-2.

A study by Wuang et al. compared VRWii with SOT in 7- to 12-year-old children with DS (Wuang et al., 2011). A total of 105 children were randomly allocated to receive either SOT or VRWii, whereas an additional control group comprising 50 participants did not undergo any intervention. Each intervention group participated in one-hour sessions twice a week for 24 weeks. According to the study's results, the VRWii group achieved the greatest improvements in BOT-2 fine motor subtests and the visual-motor integration test compared to the SOT and control groups. It was noted that VRWii could be used in addition to other proven successful rehabilitation interventions in the treatment of children with DS. In another study, 45 children with DS, aged 9 to 14, were divided into three groups: a control group, a motor skills exercise group, and a computer game intervention group (Hashemi & Arabameri, 2019). The intervention groups participated in 40-minute sessions, three days a week for 10 weeks, to monitor the development of fine motor skills. At the end of the study, it was observed that both the computer games and motor skills training programs improved fine motor skills in children with DS. However, no significant difference was found between the two intervention groups. This was attributed to the possibility that virtual interventions could capture children's interest more effectively and that computer games might have a more motivating aspect.

Current studies indicate that VR therapy is an effective intervention for improving upper extremity motor skills in children with DS. VR therapy can be used alongside existing methods to further enhance upper extremity functions in children with DS.

CONCLUSION

In conclusion, VR therapy is an innovative and effective method that can be used to improve the motor skills of children with DS. These therapies provide significant improvements in children's motor coordination, balance, speed, agility and upper extremity motor skills. However, the existing literature suffers from several limitations, including small sample sizes, short intervention periods,

methodological heterogeneity, and the lack of standardized VR protocols specific to children with DS. Furthermore, the lack of long-term follow-up in most studies makes it difficult to assess the sustainability of therapeutic gains. To address these shortcomings, future research should be supported by large-scale randomized controlled trials, develop VR-based gaming models specific to DS, and comprehensively evaluate long-term effects on motor, cognitive, and psychosocial outcomes. Furthermore, exploring how VR applications can be effectively integrated with traditional rehabilitation approaches will provide valuable insights into clinical practice.

Conflict of Interest

No conflict of interest was declared by the authors.

REFERENCES

Adamovich, S. V., Fluet, G. G., Tunik, E., & Merians, A. S. (2009). Sensorimotor training in virtual reality: a review. NeuroRehabilitation, 25(1), 29-44. https://doi.org/10.3233/NRE-2009-0497

Antonarakis, S. E. (1998). 10 Years ofGenomics, Chromosome 21, and Down Syndrome. Genomics, 51(1), 1-16. https://doi.org/10.1006/geno.1998.5335

Balaban, Ö., Nacır, B., Erdem, H., & Karagöz, A. (2009). Denge fonksiyonunun değerlendirilmesi. J Phys Med Rehabil Sci, 12(3), 133-139.

Beqaj, S., Tërshnjaku, E. E., Qorolli, M., & Zivkovic, V. (2018). Contribution of physical and motor characteristics to functional performance in children and adolescents with Down syndrome: A preliminary study. Medical science monitor basic research, 24, 159. https://doi.org/10.12659/MSMBR.910448

Berg, P., Becker, T., Martian, A., Danielle, P. K., & Wingen, J. (2012). Motor control outcomes following Nintendo Wii use by a child with Down syndrome. Pediatric physical therapy, 24(1), 78-84. https://doi.org/10.1097/PEP.0b013e31823e05e6

Bull, M. J. (2020). Down syndrome. New England Journal of Medicine, 382(24), 2344-2352.

Chen, C. C., Ringenbach, S., & Albert, A. (2014). Assisted cycling exercise improves fine manual dexterity in persons with Down's syndrome. Journal of Applied Research in Intellectual Disabilities, 27(3), 264-272. https://doi.org/10.1111/jar.12061

Choi, Y. M. (2015). Comparison of grip and pinch strength in adults with dexterity limitations to normative values. Procedia Manufacturing, 3, 5326-5333. https://doi.org/10.1016/j.promfg.2015.07.637

Connolly, B. H., & Michael, B. T. (1986). Performance of retarded children, with and without Down syndrome, on the Bruininks Oseretsky Test of Motor Proficiency. Physical therapy, 66(3), 344-348.

https://doi.org/10.1093/ptj/66.3.344

das Neves Cardoso, A. C., de Campos, A. C., Dos Santos, M. M., Santos, D. C. C., & Rocha, N. A. C. F. (2015). Motor performance of children with Down syndrome and typical development at 2 to 4 and 26 months. Pediatric physical therapy, 27(2), 135-141. https://doi.org/10.1097/PEP.0000000000000120

Finbråten, A. K., Martins, C., Andersen, G. L., Skranes, J., Brannsether, B., Júlíusson, P. B., Syversen, U., Stevenson, R. D., & Vik, T. (2015). Assessment of body composition in children with cerebral palsy: a cross-sectional study in N orway. Developmental Medicine & Child Neurology, 57(9), 858-864. https://doi.org/10.1111/dmcn.12752

Gallahue, D. L., Ozmun, J. C., & Goodway, J. D. (2013). Compreendendo o desenvolvimento motor-: bebês, crianças, adolescentes e adultos. AMGH Editora.

Ghafar, M. A. A., & Abdelraouf, O. R. (2017). Effect of virtual reality versus traditional physical therapy on functional balance in children with down syndrome: A randomized comparative study. Int. J. Physiother. Res, 5, 2088-2094. https://dx.doi.org/10.16965/ijpr.2017.146

Giuriato, M., Gatti, A., Pellino, V. C., Bianchi, A., Zanelli, S., Pirazzi, A., Cavallo, C., Quatrale, A., Gazzarri, A. A., & Vandoni, M. (2025). A Tele-Coaching Pilot Study: An Innovative Approach to Enhance Motor Skills in Adolescents with Down Syndrome. Journal of Applied Research in Intellectual Disabilities, 38(2), e70036. https://doi.org/10.1111/jar.70036

Gómez Álvarez, N., Venegas Mortecinos, A., Zapata Rodríguez, V., López Fontanilla, M., Maudier Vásquez, M., Pavez-Adasme, G., & Hemández-Mosqueira, C. (2018). Efecto de una intervención basada en realidad virtual sobre las habi lidades motrices básicas y control postural de niños con Síndrome de Down. Revista chilena de pediatría, 89(6), 747-752. http://dx.doi.org/10.4067/S0370-41062018005001202

Hashemi, A., & Arabameri, E. (2019). The Effect of Two Methods of Motor Program and Computer Games on the Fine Motor Skills in Children with Down Syndrome Disorder. International Journal of Motor Control and Learning, 1(1), 53-62. https://dor.isc.ac/dor/20.1001.1.27173283.2019.1.1.3.2

Jobling, A., & Cuskelly, M. (2006). Young people with Down syndrome: A preliminary investigation of health knowledge and associated behaviours. Journal of Intellectual and Developmental Disability, 31(4), 210-218. https://doi.org/10.1080/13668250600999186

Kiphard, E. (1974). Körper-koordinations-test für kinder KTK: manual Von Fridhelm Schilling. Weinhein: Beltz Test.

Lauteslager, P. E. (2004). Children with Down's syndrome: Motor development and intervention. Heeren Loo Zorggroep.

Lin, H.-C., & Wuang, Y.-P. (2012). Strength and agility training in adolescents with Down syndrome: A

randomized controlled trial. Research in developmental disabilities, 33(6), 2236-2244. https://doi.org/10.1016/j.ridd.2012.06.017

Määttä, T., Määttä, J., Tervo-Määttä, T., Taanila, A., Kaski, M., & Iivanainen, M. (2011). Healthcare and guidelines: a population-based survey of recorded medical problems and health surveillance for people with Down syndrome. Journal of Intellectual and Developmental Disability, 36(2), 118-126. https://doi.org/10.1080/13668250.2011.570253

Martins, M. R. I., Fecuri, M. A. B., Arroyo, M. A., & Parisi, M. T. (2013). Avaliação das habilidades funcionais e de auto cuidado de indivíduos com síndrome de Down pertencentes a uma oficina terapêutica. Revista CEFAC, 15, 361-365. https://doi.org/10.1590/S1516-18462012005000088

Memon, A. G., Ali, S., Adnan, Q., & Tahir, S. (2024). Effects of virtual reality on static and dynamic balance among individuals with down syndrome. Journal of Liaquat University of Medical & Health Sciences, 23(02), 116-120. https://doi.org/10.22442/jlumhs.2024.01057

Morris, J. K., Alberman, E., Mutton, D., & Jacobs, P. (2012). Cytogenetic and epidemiological findings in Down syndrome: England and Wales 1989–2009. American journal of medical genetics Part A, 158(5), 1151-1157. https://doi.org/10.1002/ajmg.a.35248

Oster-Granite, M. L., Parisi, M. A., Abbeduto, L., Berlin, D. S., Bodine, C., Bynum, D., Capone, G., Collier, E., Hall, D., & Kaeser, L. (2011). Down syndrome: national conference on patient registries, research databases, and biobanks. Molecular genetics and metabolism, 104(1-2), 13-22. https://doi.org/10.1016/j.ymgme.2011.07.005

Padia, N., Bose, M., & Parab, S. (2023). Determinants of hand function in children and adolescent with Down Syndrome-a scoping review. Journal of Hand Therapy, 36(3), 622-631. https://doi.org/10.1016/j.jht.2022.07.010

Perez-Marcos, D. (2018). Virtual reality experiences, embodiment, videogames and their dimensions in neurorehabilitation. Journal of neuroengineering and rehabilitation, 15, 1-8. https://doi.org/10.1186/s12984-018-0461-0

Pikora, T. J., Bourke, J., Bathgate, K., Foley, K.-R., Lennox, N., & Leonard, H. (2014). Health conditions and their impact among adolescents and young adults with Down syndrome. PloS one, 9(5), e96868. https://doi.org/10.1371/journal.pone.0096868

Rahman, S. A., & Rahman, A. (2010). Efficacy of virtual reality-based therapy on balance in children with Down syndrome. World Applied Sciences Journal, 10(3), 254-261.

Reid, D. T. (2002). Benefits of a virtual play rehabilitation environment for children with cerebral palsy on perceptions of self-efficacy: a pilot study. Pediatric rehabilitation, 5(3), 141-148. https://doi.org/10.1080/1363849021000039344

Reis, J. R. G., Neiva, C. M., Pessoa Filho, D. M., Ciolac, E. G., Verardi, C. E. L., da Cruz Siqueira, L. O., de Freitas Gonçalves, D., da Silva, G. R., Hiraga, C. Y., & Tonello, M. G. M. (2017). Virtual reality therapy: Motor coordination and balance analysis in children and teenagers with Down syndrome. European Journal of Human Movement, 38, 53-67.

Sacks, B., & Buckley, S. (2003). What do we know about the movement abilities of children with Down syndrome? Down Syndrome News and Update, 2(4), 131-141. https://doi.org/10.3104/updates.193

Shelton, A. R., & Malow, B. (2021). Neurodevelopmental disorders commonly presenting with sleep disturbances. Neurotherapeutics, 18(1), 156-169. http://www.elsevier.com/open-access/userlicense/1.0/

SILVA, D. R. d., & Ferreira, J. S. (2001). Intervenções na Educação Física em crianças com Síndrome de Down. Revista da Educação Física/UEM, 12(1), 69-76.

Sinaga, P., Prananta, M. S., & Fadlyana, E. (2016). Score of fine motor skill in children with Down syndrome using Nintendo Wii. Althea Medical Journal, 3(3), 371-375. https://doi.org/10.15850/amj.v3n3.882

Snider, L., Majnemer, A., & Darsaklis, V. (2010). Virtual reality as a therapeutic modality for children with cerebral palsy. Developmental neurorehabilitation, 13(2), 120-128. https://doi.org/10.3109/17518420903357753

Suarez-Villadat, B., Sadarangani, K. P., & Villagra, A. (2023). Effectiveness of exergames programme to modify body composition and health-related physical fitness in adolescents with down syndrome after COVID-19 quarantine. European Journal of Sport Science, 23(11), 2210-2220. https://doi.org/10.1080/17461391.2023.2214805

Ulrich, D. A., Ulrich, B. D., Angulo-Kinzler, R. M., & Yun, J. (2001). Treadmill training of infants with Down syndrome: evidence-based developmental outcomes. Pediatrics, 108(5), e84-e84. https://doi.org/10.1542/peds.108.5.e84

Umar, A. B., Yakasai, A. M., Danazumi, M. S., Shehu, U. T., Badaru, U. M., & Kaka, B. (2021). Assessment of family needs of children with cerebral palsy in Northern-Nigeria: A cross-sectional study. Journal of Pediatric Rehabilitation Medicine, 14(2), 265-274. https://doi.org/10.3233/PRM-200696

Uyanik, M., Bumin, G., & Kayihan, H. (2003). Comparison of different therapy approaches in children with Down syndrome. Pediatrics international, 45(1), 68-73. https://doi.org/10.1046/j.1442-200X.2003.01670.x

Uyanik, M., & Kayihan, H. (2010). Down syndrome: Sensory integration, vestibular stimulation and neurodevelopmental therapy approaches for children. Stone JH, Blouin M. International Encyclopedia of Rehabilitation, 9.

Valentini, D., Di Camillo, C., Mirante, N., Vallogini, G., Olivini, N., Baban, A., Buzzonetti, L., Galeotti, A., Raponi, M., & Villani, A. (2021). Medical conditions of children and young people with Down syndrome. Journal of Intellectual Disability Research, 65(2), 199-209. https://doi.org/10.1111/jir.12804

Volman, M. J., Visser, J. J., & Lensvelt-Mulders, G. J. (2007). Functional status in 5 to 7-year-old children with Down syndrome in relation to motor ability and performance mental ability. Disability and rehabilitation, 29(1), 25-31. https://doi.org/10.1080/09638280600947617

Wang, P. P., Doherty, S., Rourke, S. B., & Bellugi, U. (1995). Unique profile of visuo-perceptual skills in a genetic syndrome. Brain and Cognition, 29(1), 54-65. https://doi.org/10.1006/brcg.1995.1267

Wu, Z., & Li, Y. (2020). New frontiers in probing the dynamics of purinergic transmitters in vivo. Neuroscience research, 152, 35-43. https://doi.org/10.1016/j.neures.2020.01.008

Wuang, Y.-P., Chiang, C.-S., Su, C.-Y., & Wang, C.-C. (2011). Effectiveness of virtual reality using Wii gaming technology in children with Down syndrome. Research in developmental disabilities, 32(1), 312-321. https://doi.org/10.1016/j.ridd.2010.10.002

Yunus, F. T. (2024). The Effect of Sensory-Motor Virtual Reality on Balance in Children with Clinical Down Syndrome. Jurnal Kedokteran Diponegoro (Diponegoro Medical Journal), 13(2). https://doi.org/10.14710/dmj.v13i2.42137

Zolghadr, H., Yahyaei, M., Sedaghati, P., & Ahmadabadi, S. (2025). The impact of exercise interventions on postural control in individuals with Down syndrome: a systematic review and meta-analysis. BMC Sports Science, Medicine and Rehabilitation, 17(1), 35. https://doi.org/10.1186/s13102-025-01096-4

Coping Attitudes of Women with Fibrocystic Breast Changes Towards Anxiety of Getting Cancer and Depression

Ünzile Yıldırım [1]* [ID], **Gülbahtiyar Demirel [2]** [ID]

[1]Espiye State Hospital, Delivery Room, Espiye, Giresun, Türkiye
[2]Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Midwifery, Sivas, Türkiye

ABSTRACT:

Purpose: The present study was conducted to examine coping attitudes of women with fibrocystic breast changes toward anxiety about getting cancer and depression.

Material and Methods: 360 women (control group: 180 people, case group: 180 people) who referred to the Cancer Early Diagnosis Screening and Training Center (CEDSTC) were included in this prospective cohort study with comparative analysis. Data were collected using "Personal Information Form", "Trait Anxiety Inventory (TAI)", "Beck Depression Inventory (BDI)", and "Coping Strategies with Stress (COPE)". The two independent samples t-test, Pearson correlation test, variance analysis for repeated measurements, Bonferroni test, and Chi-square test were used in the evaluation of the data.

Results: According to the research findings, the level of anxiety and depression higher after the first interview and the first and third month interviews in the case group consisting of women with fibrocystic breast changes than in the control group ($p<0.05$). The women in the groups had a moderate coping attitude during the interviews conducted in the first and third months. Breastfeeding women had lower anxiety levels than those who did not breastfeed, and their coping attitude was higher ($p<0.05$). The level of anxiety in women with a breast cancer history in their family was higher than in women without, and the depression level was higher in women with fibrocystic breast changes than in women without ($p<0.05$).

Conclusion: It was determined that the presence of fibrocystic breast disease increased the anxiety and depression levels in women, and their coping attitude remained moderate.

Keywords: Anxiety; cancer; depression; fibrocystic breast; women

Corresponding author: Ünzile Yıldırım, email: yldrm_unzile@hotmail.com

INTRODUCTION

Breast cancer is the most common cancer in women worldwide and the second leading cause of cancer death (Ferlay et al., 2015). Having a benign breast disease (cysts, adenosis, fibrosis, epithelial hyperplasia, etc.) is considered a risk factor in the formation of breast cancer (Smeltzer and Bare, 2010; Cakir et al., 2016; Kolak et al., 2017; Aldemir et al., 2019). The most common benign lesions of the breast are fibrocystic changes. Fibrocystic breast changes increase the risk of breast cancer, and the cancer risk increases exponentially in some special

types (epithelial hyperplasia, atypical proliferative diseases, atypical ductal hyperplasia, and non-atypical diseases) (Parsak et al., 2010; Global Burden of Disease Cancer Collaboration, 2017; Kolak et al., 2017; Aldemir at al., 2018; Haydar and Ozguven, 2022). A study showed that 20-25% of the newly diagnosed breast cancer patients were women with a history of benign breast disease (Keyzer-Dekkera et al., 2012).

The anxiety about the evolution of fibrocystic breast disease into breast cancer in women diagnosed with this disease may cause a complex physical, mental,

and social situation in which both life and femininity are perceived as being under threat (Bayraktar, 2015; Lou et al., 2015; Kolak et al., 2017; Aldemir at al., 2018; Haydar and Ozguven, 2022). The physical problems experienced by women diagnosed with fibrocystic breast disease who are worried about developing breast cancer include pain, infection, tissue perfusion disorders and lymphedema. Psychosocial problems include deterioration in body image, decreased self-esteem, thought of losing femininity, sexual dysfunction, anxiety, depression, hopelessness, guilt and shame, fear of relapse, isolation and fear of death (Bayraktar, 2015; Lou et al., 2015; Ozer, 2015; Aldemir et al., 2018). Studies show that women with fibrocystic breast disease have high levels of anxiety (Eskelinen et al., 2011; Lou et al., 2015; Aldemir et al., 2018), depression (Lou et al., 2015; Aldemir et al., 2018), and stress when compared to those without fibrocystic breast disease (Aldemir et al., 2018).

Protection from psychosocial problems and treatment is of utmost importance in terms of individual and public health. Problems such as depression and anxiety, directly affect the coping attitude of the person , and increase the severity of these existing psychosocial problems (Cetinkaya et al., 2013). When the concerns of women who have anxiety about cancer are resolved, their complaints decrease or disappear (Aldemir et al., 2018). Therefore, doctors, midwives, and nurses, who take part in primary care services and are in constant contact with people, play a key role in solving psychosocial problems and meeting the needs of patients. Midwives and nurses, especially, have important responsibilities in the protection of women's physical and mental health, in providing women with health habits, in developing positive attitudes and behaviors regarding women's health, and in changing the negative ones (Demirel and Golbasi, 2015; Aldemir et al., 2018). Unfortunately, the mental dimension is not adequately addressed by midwives and nurses, in common problems such as fibrocystic breast change (Aldemir et al., 2018). Although it is a critical problem, there are not enough studies examining how women with fibrocystic breast changes cope with their anxiety about getting cancer and with depression.

MATERIAL and METHODS
Purpose and Type of the Study
This study was conducted to examine the coping attitudes of women with fibrocystic breast changes towards anxiety about getting cancer and depression. The population of this prospective cohort study with comparative analysis consisted of women who were referred to CEDSTCs in Sivas (Suşehri Community Health Center CEDSTC-503 people and Ibn-i Sina Community Health Center CEDSTC-548 people) in 2016 due to breast problems.

Sampling and Participant
The 360 women meeting the research inclusion criteria (aged 15-60; volunteering to participate in the study; not having another breast disease other than fibrocystic breast changes; not having a psychiatric disease; and not being in pregnancy, birth, and puerperium periods) and exclusion criteria (having a breast disease other than fibrocystic breast changes, unable to reach in 1st-3rd months, being pregnant) were included in the sample. The power analysis (Gpower 3.1.9.7) was used to determine the sample size of the study. Based on the item scores of the scale related to easy decision making (2.39±0.74, 2.62±0.84) in the reference study (Eskelinen and Ollonen, 2011), at the $\alpha=0.05$ type I error level, $\beta=0.20$ type II error level, 0.80 test power, the number required to be included in each group for the Cohen (d) effect size $=0.30$ calculated for the independent samples t test (two groups) was calculated as n=176. Taking into account possible data losses, a total of 360 individuals, 180 for each group were included in the study. Of the 360 women, 172 were included from the Suşehri Community Health Center CEDSTC, and 188 from the Ibn-i Sina Community Health Center CEDSTC, by weighing according to the ratios representing the population.

Data Collection Tools
Data were collected using "Personal Information Form", "Trait Anxiety Inventory (TAI)", "Beck Depression Inventory (BDI)" and "Coping Strategies with Stress (COPE)".
Personal Information Form: The form created by the researchers in line with the literature includes 30 questions regarding age, profession, marital status,

breastfeeding status, number of children, breast complaints, and interventions to be done in fibrocystic breast changes (Eskelinen and Ollonen, 2011; Keyzer-Dekkera et al., 2012; Ozer, 2015; Lou et al., 2015; Cakir et al., 2016; Aldemir et al., 2018; Aldemir et al., 2019).

Trait Anxiety Inventory (TAI): The scale was developed by Spielberger et al. (1970) and was adapted into Turkish by Öner and Le Compte (1985). The alpha reliability coefficient of the TAI was between 0.83 and 0.87, and was found to be 0.90 in our study. TAI is a 20-item inventory. There are two types of statements in the scale: these are direct and reversed coded statements. Direct statements express negative feelings, and reversed statements express positive feelings. While this second type of statement is scored, those with a weight value of 1 are changed to 4, and those with a weight value of 4 are changed to 1. The number of reversed statements on the scale is 7. These are the items 1, 6, 7, 10, 13, 16, 19. The total score for direct and reversed statements is calculated. The total score for the reversed statements is subtracted from the total score obtained for direct statements. A predetermined constant value is added to this number. This value is 35 for the TAI. The last value obtained is the anxiety score of the individual.

Beck Depression Inventory (BDI): BDI is a 21-item scale measuring vegetative, emotional, cognitive and motivational symptoms of depression. Each item is scored on a scale ranging from 0 to 3. The depression score is obtained by adding these scores. 0-9 indicates minimal depression, 10-16 mild depression, 17-29 moderate depression, and 30-63 severe depression. It can be applied to adolescents and adults over the age of 15. Validity and reliability studies of the inventory were done by Hisli (1988), Tegin (1987), Aydin and Demir (1989) in Turkey. The Cronbach alpha value of BDI was found to be 0.90, in the study of Arkar and Safak (2004), and 0.88 in our study.

Coping Strategies with Stress (COPE): This self-report questionnaire consists of 60 items and 15 subscales. The sum of the first five scores of these subscales (1, 2, 3, 4, 5, 14, 16, 17, 25, 28, 29, 30, 31, 38, 43, 45, 46, 47, 58, 59) indicates the problem-focused coping score, the second five (6, 7, 8, 9, 10, 18, 20, 22, 24, 27, 36, 37, 40, 41, 48, 49, 50, 51, 57, 60) indicates the emotion-focused coping score, and the sum of the last five subscale scores (11, 12, 13, 15, 19, 21, 23, 26, 32, 33, 34, 35, 39, 42, 44, 52, 53, 54, 55, 56) indicates the non-functional coping score. The Cronbach's alpha value of the questionnaire is 0.79 in the study of Agargun et al. (2005) and 0.76 in our study.

Application of Data Collection Tools

The women giving written consent to participate in the study were taken to a separate room, and the forms were administered by the researcher using the face-to-face interview technique. The results of the examinations were given to women who were referred with a breast complaint within 4 weeks at the latest. Later, women can be called for examination, (clinical breast examination, mammography, etc.) again. Forms (Personal Information Form, TAI, BDI, COPE) were administered to all women (671 people) who came to the CEDSTC unit for the first time due to breast problems and volunteered to participate in the study. Although the 180th person were reached in the case group, women continued to be included in the sample until the 180th person were reached in the control group. 311 women were excluded from the follow-up process in line with the exclusion criteria. The same forms (TAI, BDI, COPE) were reapplied to women in the first and third month after the examination result was announced. The first group (control group: 180 people) were those not diagnosed with any breast disease, and the second group (case group: 180 people) were those diagnosed with fibrocystic breast changes.

Statistical Analysis

In the evaluation of the data, mean and standard deviation values were used for the data obtained by measurement, as it provided a normal distribution. The suitability of the data obtained from the measurement for normal distribution was examined with the Kolmogorov-Smirnov test, and a two independent samples t test was used for comparison. Pearson correlation test was used for the relationship between variables, variance analysis and Bonferroni test were used for repeated

measurements for the difference between variables, and the Chi-square test was used to examine the data obtained by counting. Statistical significance was examined at the 0.05 significance level in the evaluation of the data, and version 23 of SPSS was used.

Ethical Approval

Before starting the study, written permission was obtained from Sivas Public Health Directorate (number 19448395-771) and Cumhuriyet University Non-Interventional Clinical Research Ethics Committee (ethical decision no: 2016-10/08). Women who met the research criteria were informed about the purpose and content of the study, and their written consent was obtained for their participation.

RESULTS

Most of the women in the study had primary education and above, were married, lived in a nuclear family structure, and did not work. The mean age of menarche for women in the control and case groups was 13.20±1.35 and 13.17±1.19; the mean age of first birth was 19.47±2.23 and 19.55±1.55; the mean body mass index (BMI*) was 25.92±4.74 and 24.39±3.30, respectively. Most of the women gave birth to 3 or more children and breastfed their babies for about 1-2 years. Women may usually have a chronic disease such as diabetes or thyroid disease, and they may consume beverages containing caffeine daily, have not experienced an upsetting situation recently, and do not use hormonal family planning methods.

The mean duration of breast complaints in women was 9.13±8.76 and 8.87±4.89 months in the control and case groups, respectively, and the most common complaint was pain. The proportion of women with a relative or family history of fibrocystic breast changes and breast cancer was low. Women emphasized the importance of interventions such as breastfeeding and regular breast checks in the fight against fibrocystic breast changes. After the diagnosis of fibrocystic breast change, professional help was generally not sought. Instead, patients preferred to seek help from the doctor ($p>0.05$) (Table 1).

In the first interview, the trait anxiety scores of the women were higher in the control group. However, by the first month after the test results were learned, the anxiety scores were close to each other, with a slight increase noted. While the anxiety levels of the women in the control group decreased slightly in the interview held in the third month (47.13±2.30), the anxiety levels of the women in the case group increased (56.26±2.56) ($p<0.05$). While depression was mild in the groups in the first interview, minimal depression was seen in the control group in the first and third months (6.22±2.54, 5.60±2.15), and depression was moderate in the case group (17.73±2.97, 24.00±2.89). In terms of cognitive and somatic-affective dimensions of BDI, there was minimal depression in the first interview among the groups. While minimal depression persisted in the control group in terms of cognitive and somatic-affective dimensions during the first and third months, the case group had mild depression ($p<0.05$) (Table 2).

The women in the groups had a moderate coping attitude at the first interview, conducted in the first month, and in the third month. It was observed that women in the case group used slightly more coping strategies than those in the control group during the first and third months ($p<0.05$). It was determined that women also had a moderate attitude in the dimensions of COPE (problem-focused, emotion-focused, non-functional). The problem-focused coping attitude in the case group, while the emotion-focused coping attitude in the control group, were slightly higher after the interviews ($p<0.05$) (Table 3). Although the anxiety level in the case group, which started to increase after the first interview, was 48.37±3.46 in the first month, it reached its highest level, with 56.26±2.56 in the third month. While the trait anxiety scores of the women in the control group were 45.96±3.52 in the first interview, these scores reached the level of 48.05±5.43 with a slight increase in the first month. There was a difference between the measurements, in terms of trait anxiety scores in both groups ($p<0.05$). There was a difference between the first interview, first month, and third month measurements in terms of depression (overall scale, cognitive and somatic-affective dimensions).

Table 1. Distribution of Women's Characteristics Regarding Breast Complaints (n= 360)

Characteristics Regarding Breast Complaints	Control Group (n:180) x̄± SD	Case Group (n:180) x̄± SD	t/p
Breast complaint duration (months)	9.13±8.76	8.87±4.89	2.560/ 0.251
	n (%)	**n (%)**	**X²/p**
Most common breast complaints			
Breast pain	125(69.4)	131(72.8)	5.109/ 0.276
Breast tenderness	43(23.9)	45(25.0)	
Breast lump	12(6.7)	4(2.2)	
Family history of fibrocystic breast change			
Yes	20(11.1)	17(9.4)	0.271/ 0.603
No	160(88.9)	163(90.6)	
Family history of breast cancer			
Yes	39(21.7)	42(23.3)	0.143/ 0.705
No	141(78.3)	138(76.7)	
Interventions to fight with fibrocystic breast changes			
Breastfeeding	19(10.6)	26(14.4)	
Regular breast check	64(35.6)	54(30.0)	
Chronic disease treatment	4(2.2)	3(1.7)	51.485/ 0.091
Avoiding beverages containing caffeine	3(1.7)	10(5.6)	
Low fat diet	5(2.8)	0(0.0)	
Hormone-free family planning method	12(6.7)	10(5.6)	
Having painkiller and wearing fitting size bras	2(1.1)	2(1.1)	
All	71(39.4)	75(41.6)	
Getting professional help after diagnosis			
Yes	24(13.3)	25(13.9)	0.024/ 0.878
No	156(86.7)	155(86.1)	
The person giving professional help after diagnosis			
Doctor	12(50.0)	14(56.0)	0.527/ 0.769
Nurse	3(12.5)	4(16.0)	
Midwife	9(37.5)	7(28.0)	

Two independent sample t tests; Chi-square Test; α: 0.05

Table 2. Anxiety and Depression Mean Scores of Women with Fibrocystic Breast Changes (n= 360)

Scales	Group		t/p
	Control Group (n:180) x̄± SD	Case Group (n:180) x̄± SD	
1TAI (first interview)	45.96±3.52	43.05±5.68	6.553/0.001*
TAI (first month)	48.05±5.43	48.37±3.46	.541/0.131
TAI (third month)	47.13±2.30	56.26±2.56	35.582/0.003*
2BDI (first interview)	14.11±4.75	13.46±3.16	1.541/0.124
BDI (first month)	6.22±2.54	17.73±2.97	44.336/0.001*
BDI (third month)	5.60±2.15	24.00±2.89	62.047/0.004*
BDI Cognitive Dimension (first interview)	6.34±3.00	5.77±2.45	1.999/0.046*
BDI Cognitive Dimension (first month)	2.72±1.59	10.19±2.15	29.404/0.001*
BDI Cognitive Dimension (third month)	3.22±1.67	13.35±2.12	53.739/0.001*
BDI Somatic-Affective Dimension (first interview)	7.77±3.04	7.69±2.00	.287/0.774
BDI Somatic-Affective Dimension (first month)	3.51±2.13	10.54±1.97	33.856/0.001*
BDI Somatic-Affective Dimension (third month)	2.38±1.44	10.65±2.02	32.659/0.001*

1TAI: Trait Anxiety Inventory; 2BDI: Beck Depression Inventory; Two independent sample t tests; α:0.05; *Significant difference

However, there was a mild to moderate depression in the case group and a mild to minimal depression in the control group according to the overall scale. In the cognitive and somatic-affective dimensions of the BDI, minimal to mild depression in the case group and minimally decreasing depression in the control group were found, where the difference within the group was significant in the measurements (p<0.05). The coping attitude, which was initially reported as 158.76±5.49 at the first interview in the case group, increased to 160.29±4.88 in the first month and to 160.74±5.04 in the third month. In the control group,

there was no statistically significant difference between the within-group measurements in terms of COPE and its dimensions (problem-focused, emotion-focused, non-functional) (p>0.05). Considering the measurements within the group, there was a difference between the first interview and the third month interview in the problem-focused coping attitude, and between the first month interview and the third month interview in the emotion-focused coping attitude, in the case group (p<0.05) (Table 4).

Table 3. Coping Strategies Mean Scores of Women with Fibrocystic Breast Changes (n= 360)

Scales	Group		t/p
	Control Group (n:180) x̄± SD	Case Group (n:180) x̄± SD	
1COPE (first interview)	160.86±15.00	158.76±5.49	1.769/0.078
COPE (first month)	158.86±4.71	160.29±4.88	2.838/0.005*
COPE (third month)	159.63±4.66	160.74±5.04	2.172/0.003*
COPE Problem-Focused Coping (first interview)	55.90±3.30	57.89±7.31	3.329/0.001*
COPE Problem-Focused Coping (first month)	55.66±2.67	56.47±2.62	2.910/0.004*
COPE Problem-Focused Coping (third month)	55.29±2.71	55.87±2.61	2.079/0.038*
COPE Emotion-Focused Coping (first interview)	53.17±2.82	52.59±5.04	1.356/0.176
COPE Emotion-Focused Coping (first month)	54.27±2.73	51.53±2.68	9.612/0.001*
COPE Emotion-Focused Coping (third month)	54.09±2.91	53.00±2.68	3.710/0.001*
COPE Non-Functional Coping (first interview)	49.68±3.07	50.38±6.27	1.346/0.179
COPE Non-Functional Coping (first month)	50.37±2.47	50.86±2.81	1.774/0.077
COPE Non-Functional Coping (third month)	51.36±2.67	50.76±3.16	1.946/0.062

1COPE: Coping Strategies with Stress; Two independent sample t tests; α:0.05; *Significant difference

Table 4. Differences Between Measurements of Anxiety, Depression and Coping Attitude of Women with Fibrocystic Breast Changes (n= 360)

Group	Measurements			
	First interview x̄± SD	First month x̄± SD	Third month x̄± SD	F/p
	(1TAI)			
Case Group	43.05±5.68b,c	48.37±3.46a,c	56.26±2.56a,b	742.011/0.001*
Control Group	45.96±3.52b,c	48.05±5.43a,c	47.13±2.30a,b	19.511/0.001*
	(2BDI)			
Case Group	13.46±3.16b,c	17.73±2.97a,c	24.00±2.89a,b	526.025/0.001*
Control Group	14.11±4.75b,c	6.22±2.54a,c	5.60±2.15a,b	369.942/0.001*
	BDI Cognitive Dimension			
Case Group	5.77±2.45b,c	10.19±2.15a,c	13.35±2.12a,b	482.372/0.001*
Control Group	6.34±3.00b,c	2.72±1.59a,c	3.22±1.67a,b	145.650/0.001*
	BDI Somatic-Affective Dimension			
Case Group	7.69±2.00b,c	10.54±1.97a	10.65±2.02a	99.214/0.001*
Control Group	7.77±3.04b,c	3.51±2.13a,c	2.38±1.44b,a	283.448/0.001*
	3COPE			
Case Group	158.76±5.49b,c	160.29±4.88a	160.74±5.04a	7.369/0.001*
Control Group	160.86±15.00	158.86±4.71	159.63±4.66	2.136/0.136
	COPE Problem-Focused Coping Dimension			
Case Group	57.89±7.31c	56.47±2.62	55.87±2.61a	2.326/0.003*
Control Group	55.90±3.30	55.66±2.67	55.29±2.71	1.021/0.578
	COPE Problem-Focused Coping Dimension			
Case Group	52.59±5.04	51.53±2.68c	53.00±2.68b	2.512/0.002*
Control Group	53.17±2.82	54.27±2.73	54.09±2.91	1.817/0.549
	COPE Non-Functional Coping Dimension			
Case Group	50.38±6.27	50.86±2.81	50.76±3.16	1.534/0.183
Control Group	49.68±3.07	50.37±2.47	51.36±2.67	2.732/0.094

1TAI: Trait Anxiety Inventory; 2BDI: Beck Depression Inventory; 3COPE: Coping Strategies With Stress; Analysis of Variance for Repeated Measurements; α:0.05; *significant difference; Bonferroni test; asignificant difference with the first measurement; bsignificant difference with the second measurement; csignificant difference with the third measurement

The difference between the groups in terms of anxiety, depression and coping mean scores was not found statistically significant after the interviews according to breastfeeding status of women with fibrocystic breast changes, family history of fibrocystic breast changes, family history of breast cancer, presence of a chronic disease such as diabetes and thyroid, daily consumption of caffeine containing beverages, using hormonal family planning methods, having breast complaint and duration of breast complaint (*p*>0.05).

DISCUSSION

In the study, homogeneity was achieved in the groups in terms of socio-demographic, obstetric, health-related, and breast complaints characteristics (p>0.05). The homogeneity between these variables in the groups is important to ensure that there is no difference between women's anxiety about getting cancer, depression, and their attitudes to cope with these conditions.

Psychosocial problems are mostly experienced in women with fibrocystic breast disease due to the risk of cancer (Aldemir et al., 2018). In the study, the trait anxiety scores of the women in the first interview were found to be higher in the control group compared to those in the experimental group. However, the anxiety levels of the women in the control group decreased slightly (47.13±2.30) and their anxiety levels in the case group increased (56.26±2.56) after the women learned about the examination results (p<0.05). Studies have reported that women with benign breast disease have higher anxiety levels than those without (Eskelinen and Ollonen, 2011; Balci et al., 2013; Yilmaz et al., 2015). The study findings show that the presence of benign breast disease increases the level of anxiety in women which is similar to other studies conducted on this subject.

Psychological problems such as depression, which is one of the most common problems in societies and has a lifetime prevalence of 14-21% in women (WHO, 2017), are frequently seen in women diagnosed with fibrocystic breast disease due to anxiety about developing cancer (Bayraktar, 2015; Ozer, 2015; Aldemir et al., 2018). Studies have shown that women with fibrocystic breast disease have higher

levels of depression than women without breast disease (Lou et al., 2015; Aldemir et al., 2018). In the study, there was a mild depression in the groups at the first interview. The women in the control group had minimal depression in the first and third months; meanwhile, women in the case group had moderate depression. There was minimal depression in the control group in terms of cognitive and somatic-affective dimensions, and mild depression in the case group in the first and third months after the test results were learned (p<0.05). The study findings are similar to findings from other studies, and the presence of benign breast disease increases the level of depression in women. However, Fairbanks et al. (2017) found that there was no significant difference between depression levels of healthy women without breast disease and women with benign breast disease.

The process of dealing with life-threatening diseases such as breast cancer and its risks is critical (Ollonen et al., 2005). All of the cognitive, emotional and behavioral responses of the individual to resist the events or factors that create stress and to withstand these situations are defined as coping (Cetinkaya et al., 2013). In some studies that the coping attitudes in patients with breast cancer risk or diagnosed with breast cancer were not at the desired level (Ollonen et al., 2005; Aydogan et al., 2012). Women in the groups had a moderate coping strategy, and it was observed that the women in the case group employed slightly more coping strategies than the control group in the first and third months (p<0.05). Coping attitudes of women with breast cancer risk, similar to other studies, are not at the desired level in our study.

Coping has two main functions: problem-focused coping and emotion-focused coping (Ozarslan, 2013). Women make an effort to resolve or change the situation that causes distress by exhibiting problem-focused behaviors about whether they have cancer or not. If women exhibit emotion-focused behaviors, they exhibit thoughts or behaviors that do not change the situation that causes distress, but make them feel good (Agargun et al., 2005). It was found in the studies that taking a walk, chatting, thinking and interpreting the situation from different angles, , praying, and

seeking refuge in God were important factors in feeling the power and support in the process of coping with cancer and the risk of cancer (Cetinkaya et al., 2013; Hicdurmaz and Oz, 2013; Albayrak and Kurt, 2016). The study determined that women had moderate scores in the subscales of COPE (problem-focused, emotion-focused, non-functional), and that problem-focused coping scores in the case group were slightly higher, and emotion-focused coping scores in the control group after the interviews (p<0.05). The findings of the study show that women with benign breast disease who are worried about having breast cancer, use problem-focused and emotion-focused coping attitudes to manage their concerns, although it is not at the desired level.

Not breastfeeding, family history of benign proliferative disease, and history of breast cancer in the family/relatives increase the risk of breast cancer in women (Cakir et al., 2016; Acikgöz and Yildiz, 2017; Aldemir et al., 2019; Haydar and Ozguven, 2022). While a study revealed that not breastfeeding increases the risk of breast cancer (Lee, 2003), studies conducted with women with fibrocystic breast disease or breast cancer have shown that the psychosocial well-being of women having a history of fibrocystic breast changes (Cakir et al., 2016) and breast cancer in their family/relatives, was negatively affected by anxiety about developing breast cancer (April-Sanders et al., 2018; Haydar and Ozguven, 2022). Contrary to other studies, the difference between the groups in terms of these risk factors was found to be statistically insignificant (p>0.05) after the interviews, including the first and third month interviews, in our study. In contrast, it was found to be significant within the group (p<0.05). The lack of difference between the control group and the case group in our study in terms of these risk factors could be attributed to the diagnosis of fibrocystic breast disease only in the case group.

CONCLUSION

In conclusion, the study determined that fibrocystic breast disease increases anxiety and depression in women due to fear of developing breast cancer, and the attitude towards coping with these issues was not at the desired level (moderate). Healthcare professionals are recommended to conduct screening and regular controls for fibrocystic breast disease, to inform women about individual risk perception and accurate assessment, and to provide emotional support.

Conflict of Interest
The authors declare that there are no conflict of interests.

REFERENCES
Acikgoz, A., Yildiz, E. A. (2017). Etiology and risk factors of breast cancer. Journal of Occupational Therapy and Rehabilitation, 5(1), 45-56.

Agargun, M. Y., Besiroglu, L., Kiran, U. K., et al. (2005). The psychometric properties of the COPE inventory in Turkish sample: a preliminary research. Anatolian Journal of Psychiatry, 6, 221-226.

Albayrak, A., Kurt, E. (2016). Relationship between depression levels due to pain and loss of limb (mastectomy) and quality of life and religiosity in patients with breast cancer. DEUİFD Psychology of Religion Special Edition, p. 41-81.

Aldemir, K., Gurkan, A., Taskin Yilmaz, F., et al. (2019). Participation of first-degree relatives of women with breast cancer in screening programs. Preventive Care in Nursing & Midwifery Journal, 9(2), 48-57.

Aldemir, K., Gurkan, A., Yilmaz, F.T., et al. (2018). Psychosocial health level and quality of sexual life in women with fibrocystic breast disease. International Journal of Women's Health and Wellness, 4(1), 69.

April-Sanders, A., Oskar, S., Rachel, C., et al. (2018). Predictors of breast cancer worry in a Hispanic and predominantly immigrant mammography screening population. Women's Health Issues, 27(2), 237–244.

Arkar, H., Safak, C. (2004). Exploring dimensions of the Beck Depression Inventory in a clinical sample. Turkish Journal of Psychology, 19, 117-123.

Aydogan, U., Doganer, Y. C., Borazan, E., et al. (2012). Relationship between depression and anxiety levels and attitudes of coping with disease in cancer patients. Turkish Journal of Family Practice, 16(2), 55-60.

Balci, N., Kantekin, V., Sunay, D., et al. (2013). Mastalgia, anxiety and related factors: case-control study. Turkish Journal of Family Practice, 17(1), 8-12.

Bayraktar, N. (2015). Surgical treatment and care in breast cancer. Türkiye Klinikleri Surg Nurs-Special Topics, 1, 7-12.

Cakir, S., Kafadar, M. T., Arslan, S. N., et al. (2016). Review of risk factors in women diagnosed with breast cancer in the light of current data. Florence Nightingale Journal of Medicine, 2(3), 186-194.

Cetinkaya, S., Vural Ozec, A., Ozdemir, D., et al. (2013).

Coping strategies with depression and anxiety in glaucoma patients. CumhuriyetMedical Journal, 35, 39-50.

Demirel, G., Golbasi, Z. (2015). Current status in screening of women's health. Gümüşhane University Journal of Health Sciences, 4(4), 638-659.

Eskelinen, M., Ollonen, P. (2011). Assessment of general anxiety in patients with breast disease and breast cancer using the Spielberger STAI Self Evaluation Test: a prospective case–control study in Finland. Anticancer Research, 31(5), 1801-1806.

Fairbanks, F., Andres, M. P., Caldeira, P., et al. (2017). Sexual function, anxiety and depression in women with benign breast disease: a case- control study. Rev Assoc Med Bras, 63(10), 876-882.

Ferlay, J., Soerjomataram, I., Dikshit, R., et al. (2015). Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. Int. J. Cancer, 136(5), E359-E386

Global Burden of Disease Cancer Collaboration. (2017). Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disabilityadjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. JAMA Oncol., 3(4), 524-548. https://dx.doi.org/10.1001/jamaoncol.2016.5688

Haydar, F. G., Ozguven, R. (2022). The relationship between fibrocystic change of the breast and breast cancer. Maltepe Medical Journal, 14(2), 32-36. https://dx.doi.org/10.35514/mtd.2022.67

Hicdurmaz, D., Oz, F. (2013). Spirituality as a dimension of coping. Journal of Anatolia Nursing and Health Sciences, 16(1), 1-19.

Keyzer-Dekkera, C. M. G., Vries, J. D., Esch, L., et al. (2012). Anxiety after an abnormal screening mammogram is aserious problem. The Breast, 21, 83-88.

Kolak, A., Kamińska, M., Sygit, K., et al. (2017). Primary and secondary prevention of breast cancer. Ann Agric Environ Med., 24(4), 549–553. https://dx.doi.org/10.26444/aaem/75943

Lee, S. Y., Kim, M. T., Kim, S. W., et al. (2003). Effect of lifetime lactation on breast cancer risk: a Korean women's cohort study. International Journal of Cancer, 105(3), 390-393.

Lou, Z., Li, Y., Yang, Y., et al. (2015). Affects of anxiety and depression on health-related quality of life among patients with benign breast lumps diagnosed via ultrasonography in China. Int. J. Environ. Res. Public Health., 12, 10587-10601. https://dx.doi.org/10.3390/ijerph120910587

Ollonen, P., Lehtonen, J., Eskelinen, M. (2005). Coping and defending as risk factors for breast cancer in patients with breast disease: a prospective case-control study in Kuopio, Finland. Anticancer Research, 25, 4623-4630.

Oner, N., Le Compte, V. A. (1985). State-trait Anxiety Inventory handbook. Bogazici University, Istanbul, Turkey.

Ozarslan, Z., Fistikci, N., Keyvan, A., et al. (2013). Stress coping strategies of depressive patients. Marmara Medical Journal, 26, 130-135.

Ozer, N. (2015). Psychosocial needs of women with breast cancer. Türkiye Klinikleri Surg Nurs-Special Topics, 1, 16-22.

Parsak, C. K., Sakman, G., Akçam, T., et al. (2010). Histopathology of fibroadenoma and fibrocytic disease of the breast. The Journal of Medical Sciences, 2(4), 1-4.

Smeltzer, S. C., Bare, B. G. (2010). Brunner and suddarth. Medical Surgical Nursing, 10th Edition, Philadelphia: Lippincott Williams and Wilkins, p.1445-1484.

World Health Organization. (2017). Global health observatory data, Geneva, Web Address: https://www.who.int/gho/en/

Yilmaz, E. M., Celik, S., Arslan, H., et al. (2015). Relation between mastalgia and anxiety in a region with high frequency of posttraumatic stress disorder. J Breast Health, 11, 72-75.

Effects of Probiotics on Cognitive Functions in Autism Spectrum Disorder

Gözde Yıldız [1] **, Tuba Tekin** [2]*

[1]Sivas Cumhuriyet University, Institute of Health Sciences, Department of Nutritionand Dietetics, Sivas, Türkiye
[2]Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Sivas, Türkiye

ABSTRACT:

Autism spectrum disorder (ASD) is a multifaceted neurodevelopmental condition marked by restricted and repetitive behaviors, as well as challenges in social communication and engagement. The etiology of ASD is influenced by intricate interactions between genetic and environmental factors. The influence of gut microbiota on ASD and the potential benefits of probiotic supplements have attracted growing attention in recent years. The gut-brain axis is crucial in understanding the impact of gut microbiota on cognitive function. The gut microbiota comprises numerous elements that affect individual health and significantly impact the immune system, metabolism, and neurotransmitter synthesis. Probiotics may enhance cognitive performance and behavioral symptoms by increasing gut health. Research indicates that probiotic administration mitigates gastrointestinal symptoms and diminishes behavioral issues in individuals with ASD. Probiotics have the potential to reduce inflammation by supporting the production of neurotransmitters such as Gamma-Aminobutyric Acid (GABA), serotonin, and dopamine. Probiotics may enhance cognitive performance in persons with ASD by fortifying the intestinal barrier and diminishing intestinal inflammation. The impact of probiotics on cognitive function remains constrained, and the existing findings are preliminary. Consequently, extensive, longitudinal research is required to acquire more conclusive and thorough data in this area. Examining the possible advantages of probiotics in enhancing the quality of life for patients with ASD is essential for formulating treatment methods. The utilization of probiotics is emerging as a potential approach for addressing cognitive and behavioral problems.

Keywords: Autism; cognitive dysfuncyion; microbiota; probiotics

Corresponding author: Tuba Tekin, email: tuba.tekin38@gmail.com

INTRODUCTION

Autism spectrum disorder (ASD) is a multifaceted neurodevelopmental condition marked by impairments in social communication and interaction, alongside restricted and repetitive behaviors, interests, or activities (Critchfield et al., 2011). ASD was initially characterized by American child psychologist Leo Kanner, who proposed that it was an inherent characteristic that constrained the socializing capabilities of 11 children exhibiting distinct behavioral patterns. The disorder, previously known as "early infancy ASD" or "Kanner ASD," is now categorized under the more inclusive label ASD, indicating the extensive range in symptom severity

and presentation (Critchfield et al., 2011; Navarro et al., 2016). The US National Institute of Child Health and Human Development defines ASD as "a complex biological disorder that commences prior to the age of three and results in delays or challenges across various developmental domains" (Dlugosz et al., 2025). Data from the Centers for Disease Control and Prevention indicates that 1 in 36 children aged 8 currently has ASD (Maenner et al., 2023). The incidence of ASD has risen by 150% since 2000 (Baio et al., 2018). The World Health Organization indicated that one in every 160 children with ASD was diagnosed in 2023. A meta-analysis and various regional research has shown that ASD risk rates in

Turkey can vary between 0.8% and 1.0% (Kilicaslan and Tufan, 2022). The frequency of ASD in numerous low- and middle-income nations remains undetermined. The rise in the number of children identified in these nations is posited to contribute to the increased incidence of ASD (World Health Organization, 2024).

Autism affects individuals of all ages, contingent upon severity and cognitive capacity. Both genetic and non-genetic risk factors contribute to the etiology of autism. Factors including prenatal and postnatal exposure to environmental elements and pharmaceuticals, autoimmune disorders, microbial infections, dietary influences, gut dysbiosis, and immunological dysregulation contribute to the development of autism. Recent results indicate that the development and severity of autism are influenced by a complex interplay of genetic predisposition and environmental factors (Critchfield et al., 2011). ASD is a significant area of contemporary research due to its unclear cause and treatment, manifesting in early childhood; nonetheless, many psychotherapeutic and dietary interventions have been identified to alleviate its symptoms (Doenyas, 2018). Dietary intervention in individuals with ASD can have beneficial outcomes for overall health and behavior. In recent years, the significance of gut health in dietary interventions for ASD has garnered attention. In this context, probiotic supplementation has demonstrated beneficial effects in individuals with ASD. This review analyzes probiotic supplementation in autism spectrum disorder, the effects of probiotics on the microbiome, and the influence of probiotics on behavior and cognitive functioning.

Gut-Brain Axis and Gastrointestinal System in Autism Spectrum Disorder

Alterations in the composition and quantity of gut bacteria can result in disorders affecting not only the digestive system but also other body systems; research has demonstrated our current understanding of the influence of gut microbiota on digestive health. The gut microbiota is believed to actively contribute to the genesis of other diseases outside intestinal disorders. Research on neuropsychiatric disorders such as autism,

dementia, depression, anxiety disorder, and schizophrenia, which remain incompletely understood, has examined the microbiota-gut-brain axis (Yitik et al., 2019). Autism Spectrum Disorder is defined by enduring challenges in social interaction and communication, accompanied by restricted and repetitive interests and behaviors. The etiopathogenesis of this intricate and diverse illness is linked to early alterations in structural and functional brain development, resulting from interactions among various genetic and environmental factors, many of which are still unexplained. Recent neuroscience research has concentrated on the involvement of the microbiota-brain-gut axis in the etiopathogenesis of neurodevelopmental disorders. The gut microbiota synthesizes neurotransmitters, short-chain fatty acids (SCFAs), vital dietary amino acids, and metabolites. Moreover, the gut microbiota can affect brain function both directly and indirectly by stimulating the immune system via inflammatory cytokines and chemokines, including IL-6 and TNF-α. The gut microbiota affects intestinal barrier permeability, consequently elevating circulating lipopolysaccharide levels. The gut microbiota influences the levels of brain-derived neurotrophic factors, hence altering the functioning of vagal afferents, the enteric nervous system, and neuroendocrine pathways such as the hypothalamic-pituitary-adrenal axis. The brain regulates intestine peristalsis, sensory, and secretory functions through the vagus nerve. Disruptions to the gut microbiota can result in modifications to these pathways, hence facilitating the emergence or phenotypic manifestation of neuropsychiatric and neurodevelopmental diseases (Fattorusso et al., 2019).

Multiple lines of evidence have conceptualized the potential function of gut microbiota in autism. The incidence of gastrointestinal (GI) symptoms is greater in individuals with ASD than in their counterparts. Children with ASD have a notable shift in the stability, variety, composition, and metabolism of the gut microbiota compared to others their age, accompanied by impaired intestinal permeability and systemic and intestinal inflammation (Fattorusso et al., 2019).

Gut and Oral Microbiota in Autism Spectrum Disorder

The microbiota consists of the aggregation of microbial cells within the human body. The gastrointestinal microbiota comprises around 1,000 species. Six bacterial clusters, predominantly Bacteroidetes and Firmicutes, exist within the gut microbiota. Significant bacterial types in the gut microbiota comprise obligate anaerobes, including Bacteroides, Ruminococcus, Eubacterium, Peptococcus, Clostridium, Peptostreptococcus, Bifidobacterium, and Fusobacterium, alongside facultative anaerobes (Tekin et al., 2019). The gut microbiota significantly influences human health, encompassing metabolic functions and immune system effects. Consequently, comprehending the interplay between gut microbiota and the gut-brain axis is believed to facilitate the identification of novel strategies for GI and central nervous system disorders (Fidan and Özkaya, 2024). Dysbiosis emerges when the healthy balance of microorganisms within the gut microbiota is disturbed, leading to a reduction in beneficial bacteria or an augmentation of pathogenic germs. Dysbiosis in the gut microbiota results in negative consequences, including gastrointestinal disorders like Crohn's disease and ulcerative colitis, metabolic abnormalities, and central nervous system disorders. Alongside neurological or mental disorders in individuals with ASD, autistic enterocolitis is linked to severe gastrointestinal distress, including constipation, diarrhea, and bloating. This syndrome is believed to result from microbiota imbalances that disrupt the microbiota-gut-brain axis, contributing to numerous neurological disorders (Shaaban et al., 2018).

Metagenomic investigation of the gut microbiota in patients with autism has revealed mucosal dysbiosis, characterized by reduced levels of Bacteroidetes and elevated Firmicutes. The fecal microbiota of autistic children exhibits elevated levels of Desulfovibrio species and Bacteroides vulgatus in comparison to healthy controls (Adams et al., 2011). A study of the gut microbiota in patients with late-onset autism revealed a significant presence of Clostridium and Ruminococcus species, particularly *Clostridium bolteae* (Song et al., 2004). Research indicates

elevated amounts of *Clostridium hystolyticum* in children with autism in comparison to their healthy counterparts, irrespective of culture. The increasing number of neurotoxin-producing bacteria, contributes to autistic symptoms (Parrocho et al., 2005). A further investigation into the gut microbial composition of children with autism demonstrated diminished levels of Bifidobacterium and Enterococcus, alongside elevated levels of Lactobacillus species. Commensal bacteria, which are neither detrimental nor advantageous have been documented in autistic children (Adams et al., 2011). A pilot study conducted by Kang et al. indicated reduced numbers of carbohydrate-fermenting bacteria, including Prevotella, Coprococcus, and Veillonellaceae, in individuals with autism, an association between the gut microbiome and autism. Pyrosequencing results indicated modified gut microbial diversity in autistic children (Kang et al., 2013). Research indicates that the free amino acids and volatile organic chemicals in the feces of autistic children differ from those in non-autistic children (Yap et al., 2010).

In autism spectrum disorders, a complex interplay between dental health and microbiome, along with a significant association between microbial alterations and ASD clinical manifestations, is emphasized. Individuals with ASD have elevated incidences of self-injurious behaviors, sensory hypersensitivity, and dietary selectivity, which lead to the development of oral diseases such as traumatic lesions, gingivitis, enamel hypoplasia, and imbalances in oral microbiota. Dysbiosis of the oral and gut microbiota is believed to significantly influence the neuroinflammatory mechanisms and behavioral abnormalities associated with ASD. Alterations in SCFA levels, including acetate, propionate, and butyrate, may influence the clinical symptoms of ASD by impacting the gut-brain and oral-brain axes. Therapeutic strategies focused on modulating the microbiota, such as probiotic supplements, are believed to enhance dental health and certain behavioral facets of autism spectrum disorder. Nevertheless, further investigation is required to ascertain the enduring efficacy of these techniques. The findings underscore the significance of comprehensive therapy approaches,

encompassing oral health management, nutritional interventions, and microbiota-targeted medications, to enhance the quality of life for individuals with ASD (D'Angelo et al., 2025).

Autism Spectrum Disorder and Probiotics

Probiotics are non-pathogenic bacteria that, when consumed in sufficient quantities as food or supplements, positively influence the host's health. Probiotic products predominantly comprise lactic acid-producing bacteria, including lactobacilli, lactococci, and bifidobacteria, as well as yeasts like *Saccharomyces boulardii*. The health effects of probiotics varies among selected species and individual bacterial strains, influenced by genetic variations and the characteristics of bacterial-host interactions. Probiotics have been utilized safely in the fermentation of food products for decades (Liang et al., 2024). Studies on probiotics have shown the efficacy of probiotic bacteria across various health issues. Gastrointestinal disorders, including antibiotic-associated diarrhea, acute infectious diarrhea, inflammatory bowel disease (IBD), and irritable bowel syndrome (IBS), have demonstrated responsiveness to probiotics. Moreover, probiotics have exhibited efficacy in modulating the host's immune system. Given the growing studies on probiotics and their essential role in overall health, their incorporation as a complementary treatment may be advantageous for children with autism (Ng et al., 2019; Tiwari et al., 2025). Comprehending the complex connections between the gastrointestinal system and the brain in autism spectrum disorders, along with the therapeutic potential of probiotics, presents exciting opportunities for intervention. Enhancements in both behavioral and gastrointestinal symptoms have been noted in children with ASD subsequent to probiotic therapy. Addressing gastrointestinal disorders is essential for addressing behavioral difficulties associated with ASD to enhance the quality of life in children with ASD. In this context, probiotics may restore gut microbiota balance, mitigate gastrointestinal disorders, and enhance neurobehavioral outcomes (Khanna et al., 2025).

Probiotics increase the population of advantageous microorganisms in the gastrointestinal tract. Their advantages include the removal of acids, competition for nutrients and intestine receptor sites, immunomodulation, and the production of particular antibacterial agents. Probiotic supplements have demonstrated efficacy in reducing symptoms of IBS and gastrointestinal illnesses by modulating the gut microbiota. In this context, it is essential to incorporate probiotics into the therapy regimen for patients with ASD who also experience gastrointestinal disorders (Doenyas 2018). Probiotics have demonstrated the ability to stabilize the intestinal barrier, modulate the immune system, diminish intestinal inflammation, and alleviate gastrointestinal symptoms in models of IBD and pediatric IBD patients. Consequently, it is posited that probiotics may mitigate the inflammatory condition and modulate gastrointestinal and behavioral symptoms in autism. Probiotics diminish intestinal barrier permeability, hence alleviating intestinal inflammation as well as inflammation induced by cytokines and other immunomodulatory effects. Literature indicates that probiotics can stimulate the production of pro-inflammatory cytokines to mitigate intestinal inflammation linked to dysbiosis, as well as promote the production of anti-inflammatory cytokines to sustain homeostatic balance by curtailing excessive inflammatory responses (Abdellatif et al., 2020). Wang et al. demonstrated that the administration of oral probiotics during pregnancy mitigated autism-related symptoms in children by suppressing the synthesis of proinflammatory IL-6 and IL-17 in both maternal blood and fetal brains (Wang et al., 2019). Bidirectional connection has been established among the stomach, immune system, and brain. This communication may occur, for instance, via stress, which can induce alterations in the gut microbiota, or directly between the central nervous system and gut microbes. The infusion of propionic acid, a metabolite generated by gut bacteria, has been demonstrated to modify both brain function and behavior in a manner analogous to symptoms linked to autism. Moreover, the administration of specific probiotics may influence brain activity. A probiotic beverage with *Lactobacillus casei* shown beneficial benefits on mood and cognition in participants (Abdellatif et al., 2020). The beneficial effects of

probiotics as a prospective treatment for autism has been investigated in both animal and human model studies. Liu et al. demonstrated that four human-derived probiotic strains of *Lactobacillus reuteri* alleviated lipopolysaccharide-induced intestinal inflammation in newborn Sprague Dawley rats. Moreover, these strains exhibited advantageous effects on lipopolysaccharide-induced inflammation by diminishing intestinal levels of IL-8 and modulating the production of intestinal inflammatory cytokines and chemokines in neonatal rats (Liu et al., 2019). Lipopolysaccharides reduce intestinal barrier integrity and increase intestinal tight junction leakage. Probiotic supplementation mitigates intestinal histological damage induced by lipopolysaccharides, enhances intestinal permeability, and diminishes the translocation of endotoxins and inflammatory cytokines across the intestinal barrier (He et al., 2023). Probiotics, beneficial bacterial supplements, have surfaced as a possible therapeutic approach owing to their capacity to modulate the gut microbiota. Possible processes that contribute to their effects encompass the restoration of microbial balance, modulation of immunological responses, and synthesis of neuroactive chemicals. Probiotics may mitigate gastrointestinal symptoms and enhance behavioral signs in ASD by altering the composition of the gut flora.

Effect of Probiotic Supplementation on Cognitive Function and Behavior in Autism Spectrum Disorder
Probiotic strains include those recently classified as "psychobiotics." The term psychobiotics has been defined as "living organisms that, when taken in adequate doses, confer health benefits on individuals suffering from psychiatric illnesses." Psychobiotics are characterized as probiotic supplements believed to exert beneficial benefits on mental health through the gut-brain axis. Probiotics are considered an effective therapeutic instrument for modifying brain function by restoring an optimal balance of gut bacteria and regulating tissue neurotransmitter levels. Probiotic bacteria, particularly Lactobacillus and Bifidobacterium species, facilitate the synthesis of neurotransmitters such as GABA, serotonin, and dopamine in the

gastrointestinal tract and enhance the creation of SCFAs, so benefiting both gut health and cognitive function (Darwesh et al., 2024). Consequently, it establishes an adequate basis for the application of probiotics in autism, a topic lately explored by numerous preclinical and clinical investigations. Probiotic supplementation in children with autism may enhance gastrointestinal function and fecal microbiota while also mitigating the severity of autism symptoms. Some research have indicated that probiotics may reduce the severity of autistic symptoms as measured by various behavioral assessments (Abdellatif et al., 2020).

Multiple environmental influences, certain food and pharmacological habits, and antibiotic usage can induce detrimental changes in the gut-brain axis and gut microbiota composition, resulting in severe health conditions. Consequently, therapy modalities, including probiotic supplementation, may be regarded as possible interventions for neurobehavioral symptoms and gastrointestinal dysfunction in patients with ASD. Recent research indicates that probiotic intervention may serve as a successful alternative or complementary treatment for children with ASD (Soleimanpour et al., 2024). An essential component of therapeutic methodologies is the formulation and assessment of interventions aimed at enhancing patients of social competencies. Existing options are confined to social skills training methodologies and programs or the implementation of humanoid robotic technologies. Nonetheless, despite these measures, there are no established pharmacological interventions that can enhance the fundamental characteristics of ASD. Nevertheless, research indicates that therapies with sulforaphane, oxytocin, or arginine-vasopressin can enhance patients of general well-being (Canitone 2014). Research utilizing an animal model indicates that the homeostatic balance of the gut microbiota significantly influences social behavior. The probiotic mixture utilized in the study demonstrates the capacity to reinstate identical antisocial behavior in two distinct animal models, each established through separate ways. This study provides preliminary evidence that the gut microbiome, specifically certain bacterial species, may serve as an effective intervention for improving social conduct

and mitigating antisocial behavior associated with ASD (Mintal et al., 2022). Certain maladaptive behaviors may correlate with gastrointestinal issues in individuals with autism. Parrocho et al. conducted a study assessing children who received probiotics vs those who received a placebo, utilizing the Developmental Behavior Checklist to evaluate social issues, disruptive behavior, communication deficits, egocentrism, and anxiety levels. No differences were observed in the median scores for the five subdomains between children receiving placebo and those receiving probiotics; however, the probiotic group exhibited a significant reduction in scores for disruptive/antisocial behavior, communication, anxiety problems, and selfish behavior from baseline (Parrocho et al., 2010).

Recent research indicate that some gut bacteria may influence cognitive networks related to emotional and social domains. The microbiota-gut-brain axis is recognized for its role in modulating brain development, function, and behavior through numerous mechanisms, including immunological, endocrine, and neurological pathways (Roman et al., 2018). Individuals with autism spectrum disorders encounter numerous difficulties in cognitive functioning and behavior. Cognitive and behavioral deficits in ASD may be associated with disruptions in the gut-brain axis and gut dysbiosis. Recent studies on the gut-brain axis have explored the possible advantages of probiotic and prebiotic supplementation. The association between autism and cognitive deficits is elucidated by the disruption of the gut-brain axis, leading to diminished GABA levels, compromised serotonin signaling, and heightened inflammation. Probiotic supplements can directly influence neurotransmission by modulating the synthesis of neurotransmitters like GABA, dopamine, and serotonin, enhancing the intestinal barrier, and mitigating inflammation (Rodnyy et al., 2024). A randomized controlled research shown that a probiotic mixture positively influenced cognitive and linguistic development as well as brain function in children with ASD (Santocchi et al., 2016). Literature indicates that several strains of lactobacilli, including *Lactobacillus paracasei 37*, *Lactobacillus plantarum 128*, *Lactobacillus reuteri DSM 17938*, and *Bifidobacterium longum*, are

efficacious in addressing neurodevelopmental disorders in children with ASD and attention deficit hyperactivity disorder (ADHD) (Khanna et al., 2022). In a pilot trial, children diagnosed with ASD and ADHD received supplements of *Lactiplantibacillus plantarum* and *Levilactobacillus brevis* or a placebo over a duration of 12 weeks. The research indicated that probiotics administered to children with ASD and/or ADHD may decrease hyperactivity-impulsivity and improve overall quality of life (Marticella et al., 2025). A separate study involving preschool children with ASD revealed significant enhancements in gastrointestinal symptoms, adaptive functions, and sensory profiles among those receiving probiotic supplementation (Santocchi et al., 2020). A study utilizing an animal model investigated the impact of oral probiotics on the progeny of pregnant mice. Oral probiotic supplementation diminished autism-like symptoms in the offspring. It was also observed to elevate IL-6 and IL-17A levels in both maternal serum and fetal brains, inhibit neuronal loss, and prevent the reduction of GABA levels in the prefrontal cortex of adult offspring. The findings indicate that prenatal probiotic treatment may diminish the risk of autism in offspring without affecting neurophysiology during fetal development (Quing et al., 2025). Probiotic supplementation has demonstrated potential advantages for gastrointestinal and certain behavioral symptoms in patients with ASD. Probiotic supplements may have a positive effect on ASD, especially on gastrointestinal and indirect behavioral symptoms. Although mechanisms are complex, neurotransmitter arrangement (GABA, serotonin levels), brain-induced neurotrophic factor levels, SCFA and metabolite effects, immune regulation, and decrease in neuro-inflammation. The impact of probiotics on cognitive function is yet constrained and reliant on initial findings. Consequently, more extensive research are required to yield more conclusive findings.

CONCLUSION

Probiotic supplementation has considerable advantages for enhancing the microbiota, facilitating the production of vital metabolites that positively influence intestinal permeability, immune response,

and cognitive function. Literature indicates the efficacy of probiotics in the management of ASD. Besides gastrointestinal problems and alterations in microbiota, probiotic treatment has demonstrated encouraging outcomes in cognitive performance and behavioral modifications. The research provided supports probiotic supplementation in alleviating gastrointestinal symptoms, enhancing cognitive performance, and influencing behavioral changes in children with autism. Despite advancements in comprehending and addressing the association between the gut microbiome and autistic symptoms, additional study is essential to endorse and utilize probiotics for the management of these symptoms. The ideal types, strains, and duration of probiotic supplementation must be identified, and more tailored therapies based on individual requirements should be investigated.

Conflict of Interest

The authors declare no conflict of interest.

REFERENCES

Adams, J. B., Johansen, L. J., Powell, L. D., Quig, D., & Rubin, R. A. (2011). Gastrointestinal flora and gastrointestinal status in children with autism—comparisons to typical children and correlation with autism severity. BMC Gastroenterology, 11, Article 22. https://doi.org/10.1186/1471-230X-11-22

Baio, J., Wiggins, L., Christensen, D. L., Maenner, M. J., Daniels, J., Warren, Z., et al. (2018). Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years—Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2014. MMWR Surveillance Summaries, 67(6), 1-23. https://doi.org/10.15585/mmwr.mm6766a1

Canitano, R. (2014). New experimental treatments for core social domain in autism spectrum disorders. Frontiers in Pediatrics, 2, 61. https://doi.org/10.3389/fped.2014.0006

Critchfield, J. W., Van Hemert, S., Ash, M., Mulder, L., & Ashwood, P. (2011). The potential role of probiotics in the management of childhood autism spectrum disorders. Gastroenterology Research and Practice, 2011. https://doi.org/10.1155/2011/161358

Darwesh, M. A. K., Bakr, W., Omar, T. E., El-Kholy, M. A., & Azzam, N. F. (2024). Unraveling the relative abundance of psychobiotic bacteria in children with Autism Spectrum Disorder. Scientific Reports, 14(1), 24321. https://doi.org/10.1038/s41598-024-01883-0

D'Angelo, E., Fiori, F., Ferraro, G. A., Tessitore, A., Nazzaro, L., Serpico, R., & Contaldo, M. (2025). Autism Spectrum Disorder, Oral Implications, and Oral Microbiota. Children, 12(3), 368.

https://doi.org/10.3390/children12030368

Długosz, A., Wróblewski, M., Błaszak, B., & Szulc, J. (2025). The role of nutrition, oxidative stress, and trace elements in the pathophysiology of autism spectrum disorders. International Journal of Molecular Sciences, 26(2), 808. https://doi.org/10.3390/ijms26030808

Doenyas, C. (2018). Dietary interventions for autism spectrum disorder: New perspectives from the gut-brain axis. Physiology & Behavior, 194, 577-582. https://doi.org/10.1016/j.physbeh.2018.05.024

Fattorusso, A., Di Genova, L., Dell'Isola, G. B., Mencaroni, E., & Esposito, S. (2019). Autism Spectrum Disorders and the Gut Microbiota. Nutrients, 11(3), 521. https://doi.org/10.3390/nu11030521

Fidan, H. M., & Özkaya, V. (2024). Otizm Spektrum Bozukluğu Olan Çocuklarda Uygulanan Güncel Diyet Yaklaşımları. Gazi Sağlık Bilimleri Dergisi, 9(2), 133-145. https://doi.org/10.35378/gazi.1155126

He, X., Liu, W., Tang, F., Chen, X., & Song, G. (2023). Effects of probiotics on autism spectrum disorder in children: A systematic review and meta-analysis of clinical trials. Nutrients, 15(6), 1415. https://doi.org/10.3390/nu15061415

Kang, D. W., Park, J. G., Ilhan, Z. E., Wallstrom, G., LaBaer, J., Adams, J. B., & Krajmalnik-Brown, R. (2013). Reduced incidence of Prevotella and other fermenters in intestinal microflora of autistic children. PloS One, 8(7), e68322. https://doi.org/10.1371/journal.pone.0068322

Khanna, H. N., Roy, S., Shaikh, A., Chhabra, R., & Uddin, A. (2025). Impact of probiotic supplements on behavioral and gastrointestinal symptoms in children with autism spectrum disorder: A randomized controlled trial. BMJ Paediatrics Open, 9(1), e003045. https://doi.org/10.1136/bmjpo-2024-003045

Khanna, H. N., Roy, S., Shaikh, A., et al. (2022). Emerging Role and Place of Probiotics in the Management of Pediatric Neurodevelopmental Disorders. Euroasian Journal of Hepato-Gastroenterology, 12(2), 102–108. https://doi.org/10.5005/eajhg-12-2-102

Kilicaslan, F., Tufan, A.E. (2022). Autism spectrum disorder: Comorbidity and demographics in a clinical sample. Int J Dev Disabil, 70(2), 241-250. https://doi.org/10.1080/20473869.2022.2074242

Liang, D., Wu, F., Zhou, D., Tan, B., & Chen, T. (2024). Commercial probiotic products in public health: Current status and potential limitations. Critical Reviews in Food Science and Nutrition, 64(19), 6455-6476.

https://doi.org/10.1080/10408398.2023.2231630

Liu, Y., Tian, X., He, B., Hoang, T. K., Taylor, C. M., Blanchard, E., ... & Rhoads, J. M. (2019). Lactobacillus reuteri DSM 17938 feeding of healthy newborn mice regulates immune responses while modulating gut microbiota and boosting beneficial metabolites. American Journal of Physiology-Gastrointestinal and Liver Physiology, 317(6), G824-G838. https://doi.org/10.1152/ajpgi.00247.2019

Maenner, M. J., Shaw, K. A., Bakian, A. V., Bilder, D. A.,

Durkin, M. S., Esler, A., et al. (2023). Prevalence and characteristics of autism spectrum disorder among children aged 8 years - Autism and Developmental Disabilities Monitoring Network, 11 sites, United States, 2020. MMWR Surveillance Summaries, 72(2), 1-14. https://doi.org/10.15585/mmwr.mm722e1

Mintál, K., Tóth, A., Hormay, E., Kovács, A., László, K., Bufa, A., ... & Karádi, Z. (2022). Novel probiotic treatment of autism spectrum disorder associated social behavioral symptoms in two rodent models. Scientific Reports, 12(1), 5399. https://doi.org/10.1038/s41598-022-09191-7

Navarro, F., Liu, Y., & Rhoads, J. M. (2016). Can probiotics benefit children with autism spectrum disorders? World Journal of Gastroenterology, 22(46), 10093. https://doi.org/10.3748/wjg.v22.i46.10093

Parracho, H. M. R. T., Bingham, M. O., Gibson, G. R., & McCartney, A. L. (2005). Differences between the gut microflora of children with autistic spectrum disorders and that of healthy children. Journal of Medical Microbiology, 54(10), 987–991. https://doi.org/10.1099/jmm.0.46101-0

Parracho, H. M., Gibson, G. R., Knott, F., Bosscher, D., Kleerebezem, M., & McCartney, A. L. (2010). A double-blind, placebo-controlled, crossover-designed probiotic feeding study in children diagnosed with autistic spectrum disorders. International Journal of Probiotics & Prebiotics, 5(2), 69.

Qing, L., Qian, X., Zhu, H., Wang, J., Sun, J., Jin, Z., ... & Tian, P. (2025). Maternal-infant probiotic transmission mitigates early-life stress-induced autism in mice. Gut Microbes, 17(1), 2456584. https://doi.org/10.1080/19490976.2025.2456584

Rojo-Marticella, M., Arija, V., & Canals-Sans, J. (2025). Effect of Probiotics on the Symptomatology of Autism Spectrum Disorder and/or Attention Deficit/Hyperactivity Disorder in Children and Adolescents: Pilot Study. Research on Child and Adolescent Psychopathology, 53, 163–178. https://doi.org/10.1007/s10802-024-01278-7

Roman, P., Rueda-Ruzafa, L., Cardona, D., & Cortes-Rodríguez, A. (2018). Gut–brain axis in the executive function of autism spectrum disorder. Behavioural Pharmacology, 29(7), 654-663. https://doi.org/10.1097/FBP.0000000000000426

Santocchi, E., Guiducci, L., Fulceri, F., et al. (2016). Gut to brain interaction in Autism Spectrum Disorders: a randomized controlled trial on the role of probiotics on clinical, biochemical and neurophysiological parameters. BMC Psychiatry, 16, 183. https://doi.org/10.1186/s12888-016-0887-5

Santocchi, E., Guiducci, L., Prosperi, M., Calderoni, S., Gaggini, M., Apicella, F., ... & Muratori, F. (2020). Effects of probiotic supplementation on gastrointestinal, sensory and core symptoms in autism spectrum disorders: a randomized controlled trial. Frontiers in Psychiatry, 11, 550593. https://doi.org/10.3389/fpsyt.2020.550593

Shaaban, S. Y., El Gendy, Y. G., Mehanna, N. S., El-Senousy, W. M., El-Feki, H. S., Saad, K., & El-Asheer, O. M. (2018). The role of probiotics in children with autism spectrum disorder: A prospective, open-label study. Nutritional Neuroscience, 21(9), 676-681. https://doi.org/10.1080/1028415X.2017.1386700

Soleimanpour, S., Abavisani, M., Khoshrou, A., & Sahebkar, A. (2024). Probiotics for autism spectrum disorder: An updated systematic review and meta-analysis of effects on symptoms. Journal of Psychiatric Research, 179, 92-104. https://doi.org/10.1016/j.jpsychires.2024.07.008

Tekin, T., Çiçek, B., & Konyalıgil, N. (2018). İntestinal mikrobiyota ve obezite ilişkisi. Sağlık Bilimleri Dergisi, 27(1), 95-99.

Wang, X., Yang, J., Zhang, H., Yu, J., & Yao, Z. (2019). Oral probiotic administration during pregnancy prevents autism-related behaviors in offspring induced by maternal immune activation via anti-inflammation in mice. Autism Research, 12(4), 576-588. https://doi.org/10.1002/aur.2007

World Health Organization. (2024). Autism spectrum disorders. Available at: https://www.who.int/news-room/fact-sheets/detail/autism-spectrum-disorders. Accessed Feb 3, 2024.

Yap, I. K. S., Angley, M., Veselkov, K. A., Holmes, E., Lindon, J. C., & Nicholson, J. K. (2010). Urinary metabolic phenotyping differentiates children with autism from their unaffected siblings and age-matched controls. Journal of Proteome Research, 9(6), 2996–3004. https://doi.org/10.1021/pr100003s

Yitik, G., Dursun, O. B., Esin, I. S., & Uslu, H. (2019). A study of the relationship between gut microbiota and autism spectrum disorders. Psychiatry and Clinical Psychopharmacology, 29, 105-106. https://doi.org/10.1080/24750573.2019.1591519

Türk Fen ve Sağlık Dergisi
Turkish Journal of Science and Health

Bariatric Surgery in Adolescent Obesity: A Review of Current Evidence

Tuğçe Turhal [1] [ID], Nurcan Bağlam [2]* [ID]

[1]Sivas Cumhuriyet University, Institute of Health Sciences, Department of Nutrition and Dietetics, Sivas, Türkiye
[2]Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Sivas, Türkiye

ABSTRACT:

Obesity is increasingly recognized as a significant health concern affecting not only adults but also younger populations, including children and adolescents. Type 2 diabetes, dyslipidemia, and hypertension, which are common in adults, are becoming increasingly prevalent in the pediatric population. The onset of these comorbidities at an early age will result in a significantly reduced life expectancy. The widespread nature of obesity in the pediatric population has led to the initiation of various treatments, including surgical interventions at an early age. Certain risks and benefits must be considered when considering surgical treatment in adolescents. In the decision-making process for bariatric surgery in adolescents, not only the potential health benefits and risks but also the ethical, psychological, and social dimensions must be carefully considered. While perioperative and postoperative psychological status changes and patient selection differ significantly from those in adult patients, outcomes after bariatric surgery are similar to those in adult patients. Bariatric surgery in adolescence may be considered among treatment options after the implementation of other therapeutic approaches by a multidisciplinary team, taking into account the adolescent's and family's lifestyle as well as long-term health outcomes.

Keywords: Adolescent; bariatric surgery; obesity; pediatric obesity

Corresponding author: Nurcan Bağlam, email: nurcanbaglam@cumhuriyet.edu.tr

INTRODUCTION

Childhood and adolescent obesity has shown a notable upward trend over the past decade in both industrialized and low-to-middle-income countries (Collaborators, 2017). According to the World Health Organization's (WHO) 2022 global health statistics, the prevalence of overweight and obesity among young people has reached alarming levels, with more than 390 million children and adolescents between the ages of 5 and 19 categorized as overweight. Of these, approximately 160 million meet the criteria for obesity, which points to the urgent need for effective public health interventions and preventive strategies targeting this age group. In the United Kingdom, the National Child Obesity Programme reports that 20.1% of children aged 10-

11 are obese (Kovacs et al., 2018). Globally, this prevalence has increased at an alarming rate. Obesity adversely impacts health during youth and has long-term consequences. Overweight and obesity are characterized by abnormal and excessive fat accumulation that can adversely affect health. Body mass index (BMI) is a straightforward formula that relates body weight to height, frequently employed to categorize overweight and obesity. According to the standardized growth charts developed by the Centers for Disease Control and Prevention (CDC), children aged two years and older with a BMI between the 85th and 95th percentiles are classified as overweight, and those above the 95th percentile are classified as obese. Similarly, according to the WHO, in individuals aged 5–19

years, overweight is defined as a BMI-for-age greater than +1 standard deviation (SD), and obesity as greater than +2 SD (Antwi et al., 2013; WHO, 2007; CDC, 2024).

It is well-established that the likelihood of developing non-communicable diseases at an early age increases as the severity of obesity increases (Roebroek et al., 2024). The risk of developing non-communicable diseases, including type 2 diabetes, hypertension, and other cardiovascular conditions, is elevated (Bjerregaard et al., 2018; Owen et al., 2009; Umer et al., 2017). Moreover, obese individuals are prone to hepatic steatosis, gallbladder disease, significant orthopedic issues, pseudotumor cerebri, and sleep apnea (Richards et al., 1985). Obese adolescents will continue to suffer the condition into adulthood, resulting in an elevated risk of mortality and morbidity in later life. Effective weight loss measures are essential to mitigate this risk (Freedman et al., 2001; Harris et al., 2009; Must et al., 1992). The management of pediatric obesity employs a structured care approach. A multidisciplinary lifestyle intervention constitutes the initial phase of treatment (Styne et al., 2017). Medical nutrition therapy is regarded as the fundamental component of any obesity treatment protocol. However, severe obesity limits its efficacy. Although individuals following low-carbohydrate, low-fat, high-protein, and low-glycemic index diets often experience temporary improvements in weight loss, maintaining this weight loss in the long term is quite rare due to issues such as lack of motivation, poor adherence, and social and psychological challenges. (Spieth et al., 2000; Wilfley et al., 2007). While certain studies suggest pharmacotherapy for obese adolescents, no current medicine has proven effective in solely decreasing both BMI and related comorbidities (Mark, 2006; Rogovik et al., 2010). While this approach may achieve weight loss in morbidly obese adolescents, it remains an inadequate treatment option for a significant portion of the population in the long term. When comprehensive treatment fails, more effective treatment options are preferred. The American Heart Association issued a statement detailing existing treatments for this expanding disease. Given the limited efficacy of lifestyle treatments, this statement suggests bariatric surgery for adolescents with extreme obesity and obesity-related comorbidities (Kelly et al., 2013).

The aim of this review is to present a comprehensive overview of current evidence evaluating the effectiveness, safety, and long-term outcomes of bariatric surgery in the treatment of adolescent obesity. Additionally, the review seeks to provide up-to-date information on referral criteria, surgical techniques, and potential complications, thereby offering guidance for clinical practice. In this narrative review, a literature search was conducted to evaluate current scientific evidence regarding bariatric surgery in adolescent obesity. The search was performed using the PubMed, Scopus, Web of Science, and Google Scholar databases. The keywords used in the search included "adolescent obesity," "bariatric surgery," "metabolic surgery," "pediatric obesity treatment," "weight loss surgery in adolescents," and "long-term outcomes of bariatric surgery." The study selection criteria included original research articles, systematic reviews, and meta-analyses published in peer-reviewed journals in English or Turkish, focusing on bariatric surgery in adolescents aged 10 to 19 years. Studies involving adult populations, case reports, opinion papers, letters to the editor, and conference abstracts were excluded. In the initial screening phase, titles and abstracts were reviewed, and full texts of eligible studies were retrieved. The studies included in the final evaluation were assessed in terms of content, methodology, and findings, and the results were synthesized qualitatively.

Bariatric Surgery Methods
Bariatric surgery involves different procedures that change the structure of the digestive system, which reduces the size of the stomach and alters the path of food. To be considered for surgery, patients must have a BMI over 40 kg/m² (140% of the 95th percentile) or a BMI over 35 kg/m² (at least 120% of the 95th percentile) along with other health issues; they must have had long-term obesity and health problems even after following a structured weight loss program (not including medication); they should be at Tanner stage 4 or higher; have reached 95% of their adult height; and be willing to make lifestyle

changes (Chalklin et al., 2021; "IPEG Guidelines for Surgical Treatment of Extremely Obese Adolescents," 2008; Styne et al., 2017). The American Society for Metabolic and Bariatric Surgery (ASMBS) acknowledges bariatric surgery as safe for individuals under the age of 18 (Eisenberg et al., 2023). Bariatric surgery is predominantly practiced among adolescents; however, it has been executed in children as young as 5 years old, demonstrating sustained weight loss and swift alleviation of comorbidities (Alqahtani et al., 2021). Roux-en-Y gastric bypass (RYGB), adjustable gastric banding (AGB), and, more frequently, laparoscopic sleeve gastrectomy (LSG) are the most often performed surgeries in severely obese adolescents. The patient's medical, psychological, and social issues are assessed in order to decide the best course of action (Hsia et al., 2012). Table 1 presents the studies and their key characteristics on bariatric surgery in adolescents, including sample size, age range, surgical methods, and outcomes.

Intragastric Balloon

It can be administered in an outpatient setting without the need for endoscopy or anesthesia. The encapsulated device is intended for ingestion by the patient. Upon verifying stomach placement via fluoroscopy or abdominal X-ray, the balloon is inflated with 550 ml of distilled water in accordance with the device's operational guidelines (Oyola et al., 2024). After approximately four months, the distilled water is released from the balloon and excreted naturally via the gastrointestinal tract (Machytka et al., 2017; Salmi et al., 2020).

Intragastric balloon application was found to be a safe and effective short-term weight loss method for overweight and obese adolescents in a study involving 91 adolescents between the ages of 15 and 17 (Oyola et al., 2024). Reece and colleagues reported that in adolescents who underwent intragastric balloon placement, improved psychosocial health and physical activity levels were maintained for 12 months, along with weight loss (Reece et al., 2017). It has been reported to result in substantial enhancements in obesity-related comorbidities (Sachdev et al., 2016; Thomson et al., 2017).

Laparoscopic Adjustable Gastric Band (LAGB)

LAGB is a weight-loss surgery where a synthetic band that can be adjusted is placed around the upper part of the stomach using small incisions, usually 1 to 2 cm below where the esophagus meets the stomach. The band is placed diagonally across the abdomen and fastened with stitches. The benefits of this treatment include no staple lines, the option to reverse the procedure, and fewer nutritional deficiencies compared to malabsorptive techniques. Patients must be consistently examined for band modifications (Hsia et al., 2012). LAGB offers significant benefits for adolescent patients. A meta-analysis has demonstrated substantial enhancements in BMI, type 2 diabetes, and hypertension among patients receiving LAGB (Treadwell et al., 2008). Following the LAGB intervention in adolescents with severe obesity, a comprehensive lifestyle intervention led to substantial weight reduction and improvements in glucose and lipid metabolism at 12 months (Roebroek et al., 2024). The major consequences of LAGB are band displacement and nutritional deficits. Nevertheless, risks include band erosion, port or tube dysfunction, hiatal hernia, wound infection, and bladder distension (Treadwell et al., 2008).

Roux- en Y Gastric Bypass (RYGB)

RYGB is a procedure that is both restrictive and malabsorptive. Despite the rising prevalence of laparoscopic sleeve gastrectomy procedures, RYGB continues to be the preferred surgical technique for adolescents. During the restrictive segment of the treatment, the proximal stomach is sectioned to form a 15-20 cm³ pouch. The jejunum is segmented roughly 40 cm from the ligament of Treitz. The Roux limb is affixed to the pouch. The biliopancreatic limb is connected to the distal jejunum at a distance of 100-125 cm from the gastric pouch (Treadwell et al., 2008). RYGB has been reported to promote long-term weight loss and improve comorbidities (Pratt et al., 2009). Significant reductions in low-density lipoprotein (LDL) and non-high-density lipoprotein (non-HDL) levels have been observed in adolescents who underwent RYGB (Maffazioli et al., 2016). However, the process is irreversible and results in major changes in the intestine. Nutritional deficits

can emerge if proper eating and required nutritional supplements are not prioritized (Pratt et al., 2009). Complications that might arise following RYGB include pneumonia, malnourishment, pulmonary embolism, deep vein thrombosis, anastomotic obstruction, staple line leakage, jejunojejunal anastomotic blockage, incisional hernias, and wound infections. Examples of long-term consequences include stoma stenosis, the development of a gastrogastric fistula, disruption of the gastric staple line, and internal herniation (Xanthakos et al., 2006).

Table 1. Overview of Studies on Adolescent Bariatric Surgery

Author (Year)	n	Age	Surgery method	Results/Outcomes
Shehata et al. (2025)	63	10-19	LSG	Significant reduction in BMI and comorbidities such as diabetes and hypertension at 7-year follow-up.
Oyola et al. (2024)	91	15–17	Intragastric Baloon	It provided effective and safe weight loss in the short term.
Roebroek et al. (2024)	53	14-16	LAGB	A multidisciplinary lifestyle intervention was found to result in significant weight loss and improvement in glucose and lipid metabolism after 12 months.
Mitchell et al. (2023)	66	13-24	LSG	LSG leads to progressive changes in bone health over 2 years and may cause increased skeletal fragility in adolescents.
Khidir et al. (2018)	91	14-19	LSG	Significant weight loss has been observed in adolescents undergoing LSG, and it has been reported to be effective in the prevention and treatment of diabetes and prediabetes.
Olbers et al. (2017)	100	13-18	RYGB	Significant weight loss was achieved over the 5-year follow-up, and improvements were observed in comorbidities and risk factors. However, nutritional deficiencies were also noted.
Maffazioli et al. (2016)	46	16-21	RYGB	Significant decreases in LDL and non-HDL cholesterol levels.
Inge et al. (2016)	242	<19	RYGB/LSG	Improved cardiometabolic health and quality of life; risks include micronutrient deficiencies and additional abdominal interventions.
Xiao et al. (2015)	28	<20	RYGB/LSG	Subclinical kidney injury persists post-surgery despite weight loss; long-term kidney monitoring recommended.
Xiao et al. (2014)	242	<19	RYGB/LSG	Early kidney dysfunction observed pre-surgery with some severely obese adolescents; future studies needed to assess reversibility after weight loss.
Landau et al. (2011)	7	13-18	LSG	Weight loss, improvement in comorbidities, and success without complications have been reported.
Marceau et al. (2010)	13	15-17	BPD/DS	Significant weight loss and improvement in comorbidities, but risk of serious complications and nutritional deficiencies.
Papadia et. (2007)	78	14-18	BPD	Significant weight loss observed; considered safe with accurate and continuous follow-up.

Laparoscopic Sleeve Gastrectomy (LSG)
Laparoscopic Roux-en Y gastric bypass remains the predominant bariatric surgical surgery; nevertheless, LSG is gaining traction as a viable alternative among both adults and children (English et al., 2018; Li JianFang et al., 2013; Nguyen & Varela, 2017). The procedure involves severing the short gastric vessels and then extirpating the greater curvature of the stomach approximately 6 cm from the pylorus, proximally to the esophagogastric angle. The benefits of this procedure are that it doesn't involve any foreign objects, there are no band adjustments like with LAGB, it has fewer nutritional deficiencies compared to malabsorptive procedures, and it lowers the chance of dumping syndrome because it keeps the vagus nerve safe. One of the drawbacks is irreversibility (Treadwell et al., 2008). A study involving obese adolescents with an average age of 16.2 years indicated substantial weight reduction, enhancement of comorbid conditions, and the

absence of problems (Landau et al., 2011). A notable decrease in BMI and chronic conditions, including diabetes, hypertension, sleep apnea, and dyslipidemia, was recorded in 63 adolescents after 7 years of follow-up post-LSG, as reported in 2025 (Shehata et al., 2025).

Biliopancreatic Diversion with Duodenal Switch (BPD/DS)

The laparoscopic duodenal switch with biliopancreatic diversion is a malabsorptive procedure that preserves the pylorus while excising the Roux segment of the duodenum, located 3–4 cm from the pylorus. This method circumvents the distal ileum by 250 centimeters. Consequently, merely 100 cm of intestine is subjected to both digestive enzymes and food (Treadwell et al., 2008). A study of adolescents receiving biliopancreatic diversion reported substantial weight reduction and marked enhancement in comorbidities (Marceau et al., 2010) (Table 1). Although it is a very effective method for weight loss, its use is not widespread due to increasing nutritional deficiencies (Buchwald & Williams, 2004).

Preoperative and Postoperative Nutrition

Patients should undergo a nutritional assessment before any procedure. A comprehensive assessment is necessary, particularly for malabsorptive procedures. The nutritional assessment should include preoperative eating behavior, dietary education, and preoperative weight loss. It should also provide information about food composition, alternatives, and guidance on determining appropriate portion sizes. To prevent the incidence of micronutrient deficiencies and any existing deficiencies in obese adolescents undergoing bariatric surgery, multivitamin use should be initiated preoperatively. A balanced diet containing adequate protein, fruits, vegetables, and whole grains should be recommended preoperatively. These dietary recommendations also support weight stabilization or weight loss (Fullmer et al., 2012). Preoperative low-calorie diets reduce liver volume, increasing the success of the surgical procedure (Els, 2014). In the postoperative period, a clear liquid diet should be planned for the first 24-48 hours, followed by a liquid diet for weeks 2-4, a pureed diet for weeks 4-6, a soft diet for weeks 7-9, and a lifelong standard diet starting at week 9, depending on the patient's tolerance. The primary goal of the postoperative diet is to support weight loss while maintaining lean body mass. Therefore, a high-protein diet limited to high-glycemic carbohydrates, no added sugars, and a moderate fat content of 1.0–1.5 grams per kilogram of ideal body weight is recommended (Fullmer et al., 2012). According to the Turkish Society of Endocrinology and Metabolism (TEMD) Bariatric Surgery Guidelines, there is no evidence-based, standard dietary guide for the preoperative and postoperative nutritional management of patients undergoing bariatric surgery. Personalized nutrition programs should be developed for the individual (Turkish Society of Endocrinology and Metabolism, 2019).

Nutritional & Developmental Outcomes

Evidence suggests that bariatric surgery can serve as an efficacious method for controlling obesity in adolescent individuals. Nevertheless, it presents detrimental effects, such as deficits in vitamins and minerals. Nutritional deficiencies are a major problem in adolescents, necessitating lifelong nutritional monitoring and supplements for those who undergo bariatric surgery (Desai et al., 2016). Common vitamin and mineral deficiencies observed after surgery include iron, thiamine, vitamin D, folic acid, and vitamin B12. Increased nausea and vomiting may exacerbate nutrient deficits (Wasserman & Inge, 2014). Untreated micronutrient deficiencies are linked to various systemic diseases, including autoimmune disorders, cognitive impairment, and increased susceptibility to infections (Brenton et al., 2014; Stevens et al., 2022; Zhang et al., 2022). The American Society for Metabolic and Bariatric Surgery (ASMBS) recommends monitoring specific micronutrients and supplementing as necessary before surgery and at 2 and 6 months post-surgery (Parrott et al., 2017). Due to the reduced intake of both macronutrients and micronutrients in adolescents, which can lead to growth and developmental disorders after bariatric surgery, and the inadequate absorption in the small intestine during procedures that restrict absorption,

attention should be paid to growth parameters. Studies on the long-term effects of bariatric surgery in adolescents are limited. However, when bone mineralization is considered, calcium deficiency increases at an alarming rate. Studies have found a significant loss of bone density in adolescents within 2 years after bariatric surgery (Kaulfers et al., 2011; Mitchell et al., 2023). Further, improvements in metabolic variables (insulin levels, blood lipids, etc.) following bariatric surgery have been linked to improved adolescent growth and development (Järvholm et al., 2024). It has been shown that there is an elevation in testosterone levels in men, enhanced insulin sensitivity in females, and improved menstrual periods accompanied by decreased testosterone and cholesterol levels (Dhindsa et al., 2022; Eid et al., 2014). Data about long-term outcomes exceeding ten years in this domain is inadequate. Consequently, we require more extensive, prospective trials with long-term follow-up data on adolescents receiving bariatric surgery.

The Effect of Bariatric Surgery on Chronic Diseases
The growing obesity epidemic is accompanied by an increase in chronic kidney disease (CKD) (Wahba & Mak, 2007). Studies reveal a potential link between obesity and 24-33% of all renal illnesses. (Wang et al., 2008). The Longitudinal Assessment of Bariatric Surgery in Adolescents (The Teen LABS) study found that some severely obese adolescents having bariatric surgery showed early signs of chronic kidney disease, including protein in their urine and a much lower kidney function before the surgery (Xiao et al., 2014). Xiao et al. indicated that adolescents with severe obesity (mean BMI 48 kg/m²) exhibited elevated urinary excretion of novel kidney damage biomarkers (NGAL, IL-18, and KIM-1) in the absence of microalbuminuria or renal function impairment, and that this subclinical kidney damage persisted one year post significant weight loss following bariatric surgery. This indicates the necessity for vigilant and sustained observation of renal health in these adolescents (Xiao et al., 2015). To assess whether early kidney impairment linked to severe obesity would ameliorate post-bariatric surgery, Edward and colleagues examined 242 individuals

with a mean age of 17 years and noted enhancements in kidney function and albuminuria (Nehus et al., 2017). Bariatric surgery enhances kidney health indicators in individuals with severe obesity; however, the relationship between this improvement and the patient's age at the time of operation remains ambiguous. In a study involving 161 adolescents and 396 adults undergoing Roux-en-Y gastric bypass, adolescents with preoperative type 2 diabetes exhibited a significantly greater prevalence of elevated urinary albumin-to-creatinine ratio (UACR) prior to surgery compared to adults (22.5% vs. 9.0%) and demonstrated a more rapid recovery from elevated UACR levels post-surgery than adults. However, no significant improvement in kidney function was observed after surgery in adolescents and adults without diabetes. These studies demonstrate that bariatric surgery provides significant improvements in markers of obesity-related nephropathy and diabetic kidney disease (DKD), beyond those achieved with current medical therapies. However, the mechanisms by which bariatric surgery alleviates kidney disease are not yet clear. Kidney disease is not specified as a selection criterion for bariatric surgery in international guidelines. However, a growing body of adolescent data supports the inclusion of kidney disease as a comorbidity that would justify surgical consideration (Bjornstad et al., 2020).

Type 2 diabetes is becoming recognized as a major threat to human health in the 21st century and is closely associated with obesity (Kahn, 2003). It is reported that weight loss may contribute to glycemic control by improving insulin sensitivity and beta cell function (Grams & Garvey, 2015). The effects of interdisciplinary lifestyle therapies on weight reduction and the alleviation of obesity-related comorbidities are not enduring. A meta-analysis published in 2019 indicated weight regain between 1 and 12 years and heightened incidences of anemia and iron insufficiency in the long run among adolescents who received bariatric surgery. A consensus regarding the sustainability of bariatric surgery has yet to be established (Ruiz-Cota et al., 2019). Nevertheless, a study in 2023 demonstrated that bariatric surgery was more effective than medical treatments for the treatment of obesity and

glycemic control in adolescents (Zhu et al., 2023). LSG and LRYGB are the primary bariatric surgical techniques employed in the management of type 2 diabetes (Melissas et al., 2017).

Adolescents with severe obesity exhibit a more adverse profile of cardiometabolic risk factors than their healthy counterparts, with early indications of vascular dysfunction and atherosclerosis observed (Freedman et al., 2007). Adolescents who undergo bariatric surgery show significant improvements in cardiovascular risk variables with increased weight loss (Michalsky et al., 2018). Three years after bariatric surgery, Inge et al. found that adolescents who had the treatment had significantly improved dyslipidemia and high blood pressure (Inge et al., 2016). In their research involving 242 adolescents with a mean age of 17 who underwent bariatric surgery, Michalsky and colleagues demonstrated early improvements in cardiometabolic risk factors, including systolic blood pressure, diastolic blood pressure, and triglycerides, along with a reduction in their prevalence (Michalsky et al., 2018). In summary, although significant studies demonstrate the positive effects of bariatric surgery on the improvement of chronic diseases, the existing evidence is limited, and long-term follow-up studies are needed.

Psychological Effects of Bariatric Surgery

Severe obesity is linked to heightened physical health risks as well as compromised mental health, especially during adolescence and young adulthood (Martyn-Nemeth & Penckofer, 2012; Morrison et al., 2015; Onyike et al., 2003). Certain studies indicate a heightened risk of suicide and self-injury in individuals undergoing bariatric surgery (Goueslard et al., 2022; Neovius et al., 2018). In 2018, a meta-analysis found that 0.3% of people who had bariatric surgery also committed suicide (Lim et al., 2018). Many factors can be attributed to these psychological disorders, including insufficient weight loss or subsequent weight regain, changes in peripherally secreted peptides that can increase depression and addiction, both of which can affect mood, and the emergence of eating disorders that increase the risk of disappointment (Conceição et al., 2015; Kubik et al., 2013; Morales-Medina et al.,

2010; Romanova et al., 2004; Yuan et al., 2019). Nonetheless, hormonal alterations associated with weight reduction have been documented in adolescents following bariatric surgery. Research indicates substantial enhancements in anxiety and sadness (Roberts, 2021). This underscores the necessity for long-term investigations to further assess emotional and hormonal fluctuations. Moreover, bariatric surgery is evidently not solely a physical procedure but also involves behavioral, psychological, and societal transformations. Consequently, psychological counseling and support from a psychologist are deemed a crucial element of the surgical process.

Bariatric Surgery and Informed Consent in Adolescent

Obesity has been linked to mental comorbidity, lower cognitive abilities, and language skills in adolescents, as well as an impact on the patient's autonomy and consent (Berdah, 2010; Cawley & Spiess, 2008; Li et al., 2008). The ASMBS guidelines indicate that bariatric surgery for adolescents under 18 necessitates informed consent, parental or legal guardian agreement, and, where feasible, the adolescent's acquiescence. Parents and adolescents must be apprised of the potential risks, benefits, and anticipated long-term outcomes of surgery, including the necessity for lifelong monitoring of vitamin and mineral levels following any metabolic and bariatric procedure, the likelihood of subsequent surgical interventions, the possibility of unanticipated long-term repercussions, and the risk of weight regain and recurrence of comorbidities if weight loss is not achieved (Pratt et al., 2018).

In adolescents with limited decision-making capacity and severe obesity, the most beneficial procedure for the patient should be determined by a multidisciplinary healthcare team, taking into account the adolescent's risk of obesity/comorbidities, as well as their social, cognitive, and emotional status. It is crucial to ensure that the adolescent and parents reach the clearest possible understanding. It is also important to demonstrate that the lifestyle changes necessary for postoperative success can be maintained by the adolescent and caregiver before bariatric surgery

(Bolt & van Summeren, 2014).

In situations where the adolescent has decision-making capacity, extreme caution should be exercised if there is disagreement between the parent(s) and the adolescent. Both the parent's and the adolescent's knowledge and understanding of obesity and bariatric surgery should be comprehensively assessed. The decision to proceed with bariatric surgery in adolescents must be supported by informed consent from the adolescent as well as both parents or legal guardians (Pratt et al., 2018). Currently, no standard ethical framework specifically for bariatric surgery for adolescents exists. Therefore, developing clearer, more inclusive, and more structured ethical approaches for adolescents, including those with special needs, is crucial for patients, their families, and healthcare professionals.

CONCLUSION AND RECOMMENDATIONS

Obesity is becoming increasingly prevalent during childhood and adolescence, reflecting broader changes in lifestyle, diet, and physical activity levels. The sustainability and success of interventions aimed at preventing and treating obesity are limited. Studies conducted to date show that bariatric surgery in adolescence is a reliable treatment option. While bariatric surgery provides significant improvements in obesity and associated comorbidities, it requires significant follow-up in the preoperative and postoperative periods. During adolescence, complications should be addressed in all aspects, while nutrient deficiencies, evaluation of growth and development, the course of chronic diseases, and psychosocial effects should also be considered. In conclusion, bariatric surgery can effectively mitigate obesity-related health risks in adolescents; however, the long-term efficacy of this intervention is influenced not only by the surgical method but also by various factors, including nutritional oversight, psychosocial support, familial engagement, and cultural adaptation. Future extensive and longitudinal investigations will enhance the clinical, ethical, and sociocultural framework for this therapy option.

Conflict of Interest

The authors declare that there is no conflict of interest.

REFERENCES

Alqahtani, A. R., Elahmedi, M., Abdurabu, H. Y., & Alqahtani, S. (2021). Ten-year outcomes of children and adolescents who underwent sleeve gastrectomy: weight loss, comorbidity resolution, adverse events, and growth velocity. Journal of the American College of Surgeons, 233(6), 657-664. https://doi.org/10.1016/j.jamcollsurg.2021.08.678

Antwi, F. A., Fazylova, N., Garcon, M.-C., Lopez, L., Rubiano, R., & Slyer, J. T. (2013). Effectiveness of web-based programs on the reduction of childhood obesity in school-aged children: a systematic review. JBI Evidence Synthesis, 11(6), 1-44. https://doi.org/10.11124/jbisrir-2013-459

Berdah, C. (2010). Obesity and psychiatric disorders. Paper presented at the Annales Medico-Psychologiques. https://doi.org/10.1016/j.amp.2009.03.010

Bjerregaard, L. G., Jensen, B. W., Ängquist, L., Osler, M., Sørensen, T. I., & Baker, J. L. (2018). Change in overweight from childhood to early adulthood and risk of type 2 diabetes. New England Journal of Medicine, 378(14), 1302-1312. https://doi.org/10.1056/nejmoa1713231

Bjornstad, P., Nehus, E., Jenkins, T., Mitsnefes, M., Moxey-Mims, M., Dixon, J. B., & Inge, T. H. (2020). Five-year kidney outcomes of bariatric surgery differ in severely obese adolescents and adults with and without type 2 diabetes. Kidney international, 97(5), 995–1005. https://doi.org/10.1016/j.kint.2020.01.016.

Bolt, I. L., & van Summeren, M. J. (2014). Competence assessment in minors, illustrated by the case of bariatric surgery for morbidly obese children. Best Practice & Research Clinical Gastroenterology, 28(2), 293-302. https://doi.org/10.1016/j.bpg.2014.02.006

Brenton, J. N., Koenig, S., & Goldman, M. D. (2014). Vitamin D status and age of onset of demyelinating disease. Multiple sclerosis and related disorders, 3(6), 684-688. https://doi.org/10.1016/j.msard.2014.07.004

Buchwald, H., & Williams, S. E. (2004). Bariatric surgery worldwide 2003. Obesity Surgery, 14(9), 1157-1164. https://doi.org/10.1381/0960892042387057

Cawley, J., & Spiess, C. K. (2008). Obesity and skill attainment in early childhood. Economics & Human Biology, 6(3), 388-397. https://doi.org/10.1016/j.ehb.2008.06.003

Centers for Disease Control and Prevention. BMI-for-age categories. Retrieved September 5, 2025, from https://www.cdc.gov/bmi/child-teen-calculator/bmi-categories.html

Chalklin, C. G., Ryan Harper, E. G., & Beamish, A. J. (2021). Metabolic and bariatric surgery in adolescents. Current obesity reports, 10, 61-69.

https://doi.org/10.1007/s13679-021-00423-3

Collaborators, G. O. (2017). Health effects of overweight and obesity in 195 countries over 25 years. New England Journal of Medicine, 377(1), 13-27. https://doi.org/10.1056/nejmoa1614362

Conceição, E. M., Utzinger, L. M., & Pisetsky, E. M. (2015). Eating disorders and problematic eating behaviours before and after bariatric surgery: characterization, assessment and association with treatment outcomes. European Eating Disorders Review, 23(6), 417-425. https://doi.org/10.1002/erv.2397

Desai, N. K., Wulkan, M. L., & Inge, T. H. (2016). Update on adolescent bariatric surgery. Endocrinology and Metabolism Clinics, 45(3), 667-676. https://doi.org/10.1016/j.ecl.2016.04.015

Dhindsa, S., Ghanim, H., Jenkins, T., Inge, T. H., Harmon, C. M., Ghoshal, A.,Dandona, P. (2022). High prevalence of subnormal testosterone in obese adolescent males: reversal with bariatric surgery. European Journal of Endocrinology, 186(3), 319-327. https://doi.org/10.1530/eje-21-0545

Eid, G. M., McCloskey, C., Titchner, R., Korytkowski, M., Gross, D., Grabowski, C., & Wilson, M. (2014). Changes in hormones and biomarkers in polycystic ovarian syndrome treated with gastric bypass. Surgery for obesity and related diseases, 10(5), 787-791. https://doi.org/10.1016/j.soard.2014.02.046

Eisenberg, D., Shikora, S. A., Aarts, E., Aminian, A., Angrisani, L., Cohen, R. V.,Haddad, A. (2023). 2022 American Society of Metabolic and Bariatric Surgery (ASMBS) and International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) indications for metabolic and bariatric surgery. In: Springer. https://doi.org/10.1007/s11695-022-06332-1

Els, A. (2014). The preoperative use of restricted energy diets to reduce liver volume and liver fat content and improve postoperative outcome in obese patients scheduled for bariatric surgery: A systematic review and meta-analysis (Master's thesis, University of the Free State). University of the Free State. https://scholar.ufs.ac.za/bitstream/handle/11660/1072/ElsA.pdf?sequence=1&isAllowed=y

English, W. J., DeMaria, E. J., Brethauer, S. A., Mattar, S. G., Rosenthal, R. J., & Morton, J. M. (2018). American Society for Metabolic and Bariatric Surgery estimation of metabolic and bariatric procedures performed in the United States in 2016. Surgery for obesity and related diseases, 14(3), 259-263. https://doi.org/10.1016/j.soard.2017.12.013

Freedman, D. S., Khan, L. K., Dietz, W. H., Srinivasan, S. R., & Berenson, G. S. (2001). Relationship of childhood obesity to coronary heart disease risk factors in adulthood: the Bogalusa Heart Study. Pediatrics, 108(3), 712-718. https://doi.org/10.1542/peds.108.3.712

Freedman, D. S., Mei, Z., Srinivasan, S. R., Berenson, G. S., & Dietz, W. H. (2007). Cardiovascular risk factors and excess adiposity among overweight children and adolescents: the Bogalusa Heart Study. The Journal of pediatrics, 150(1), 12-17. https://doi.org/10.1016/j.jpeds.2006.08.042

Fullmer, M. A., Abrams, S. H., Hrovat, K., Mooney, L., Scheimann, A. O., Hillman, J. B., & Suskind, D. L. (2012). Nutritional strategy for adolescents undergoing bariatric surgery: report of a working group of the Nutrition Committee of NASPGHAN/NACHRI. Journal of pediatric gastroenterology and nutrition, 54(1), 125-135. https://doi.org/10.1097/MPG.0b013e318231db79

Goueslard, K., Jollant, F., Petit, J., & Quantin, C. (2022). Self-harm hospitalization following bariatric surgery in adolescents and young adults. Clinical Nutrition, 41(1), 238-245. https://doi.org/10.1016/j.clnu.2021.11.034

Grams, J., & Garvey, W. T. (2015). Weight loss and the prevention and treatment of type 2 diabetes using lifestyle therapy, pharmacotherapy, and bariatric surgery: mechanisms of action. Current obesity reports, 4, 287-302. https://doi.org/10.1007/s13679-015-0155-x

Harris, K. M., Perreira, K. M., & Lee, D. (2009). Obesity in the transition to adulthood: predictions across race/ethnicity, immigrant generation, and sex. Archives of pediatrics & adolescent medicine, 163(11), 1022-1028. https://doi.org/10.1001/archpediatrics.2009.182

Hsia, D. S., Fallon, S. C., & Brandt, M. L. (2012). Adolescent bariatric surgery. Archives of pediatrics & adolescent medicine, 166(8), 757-766. https://doi.org/10.1001/archpediatrics.2012.1011

Inge, T. H., Courcoulas, A. P., Jenkins, T. M., Michalsky, M. P., Helmrath, M. A., Brandt, M. L.,Xanthakos, S. A. (2016). Weight loss and health status 3 years after bariatric surgery in adolescents. New England Journal of Medicine, 374(2), 113-123. https://doi.org/10.1056/nejmoa1506699

IPEG Guidelines for Surgical Treatment of Extremely Obese Adolescents. (2008). Journal of Laparoendoscopic & Advanced Surgical Techniques, 18(6). https://doi.org/10.1089/lap.2008.9987

Järvholm, K., Janson, A., Henfridsson, P., Neovius, M., Sjögren, L., & Olbers, T. (2024). Metabolic and bariatric surgery for adolescents with severe obesity: Benefits, risks, and specific considerations. Scandinavian Journal of Surgery. https://doi.org/10.1177/14574969241297517

Kahn, S. (2003). The relative contributions of insulin resistance and beta-cell dysfunction to the pathophysiology of Type 2 diabetes. Diabetologia, 46, 3-19. https://doi.org/10.1007/s00125-002-1009-0

Kapiotis, S., Holzer, G., Schaller, G., Haumer, M., Widhalm, H., Weghuber, D.,Widhalm, K. (2006). A proinflammatory state is detectable in obese children and is accompanied by functional and morphological vascular changes. Arteriosclerosis, thrombosis, and vascular biology, 26(11), 2541-2546. https://doi.org/10.1161/01.atv.0000245795.08139.70

Kaulfers, A.-M. D., Bean, J. A., Inge, T. H., Dolan, L. M., & Kalkwarf, H. J. (2011). Bone loss in adolescents after bariatric surgery. Pediatrics, 127(4). https://doi.org/10.1542/peds.2010-0785

Kelly, A. S., Barlow, S. E., Rao, G., Inge, T. H., Hayman, L. L., Steinberger, J.,Daniels, S. R. (2013). Severe obesity in children and adolescents: identification, associated health risks, and treatment approaches: a scientific statement from the American Heart Association. Circulation, 128(15), 1689-1712. https://doi.org/10.1161/cir.0b013e3182a5cfb3

Kelly, A. S., Hebbel, R. P., Solovey, A. N., Schwarzenberg, S. J., Metzig, A. M., Moran, A., Steinberger, J. (2010). Circulating activated endothelial cells in pediatric obesity. The Journal of pediatrics, 157(4), 547-551. https://doi.org/10.1016/j.jpeds.2010.04.069

Khidir, N., El-Matbouly, M. A., Sargsyan, D., Al-Kuwari, M., Bashah, M., & Gagner, M. (2018). Five-year outcomes of laparoscopic sleeve gastrectomy: a comparison between adults and adolescents. Obesity Surgery, 28(7), 2040-2045. https://doi.org/10.1007/s11695-018-3139-6

Kovacs, B. E., Gillison, F. B., & Barnett, J. C. (2018). Is children's weight a public health or a private family issue? A qualitative analysis of online discussion about National Child Measurement Programme feedback in England. BMC Public Health, 18(1), 1295. https://doi.org/10.1186/s12889-018-6214-y

Kubik, J. F., Gill, R. S., Laffin, M., & Karmali, S. (2013). The impact of bariatric surgery on psychological health. Journal of obesity, 2013(1). https://doi.org/10.1155/2013/837989

Landau, Z., Karplus, G., Hanukoglu, A., Abiri, S., Levy, A., & Serour, F. (2011). Laparoscopic sleeve gastrectomy (LSG) in adolescents with morbid obesity. Harefuah, 150(10), 765-768, 816, 815. https://orcid.org/0000-0003-1486-6641

Li JianFang, L. J., Lai DanDan, L. D., Ni Bin, N. B., & Sun KuanXue, S. K. (2013). Comparison of laparoscopic Roux-en-Y gastric bypass with laparoscopic sleeve gastrectomy for morbid obesity or type 2 diabetes mellitus: a meta-analysis of randomized controlled trials. https://doi.org/10.1503/cjs.026912

Li, Y., Dai, Q., Jackson, J. C., & Zhang, J. (2008). Overweight is associated with decreased cognitive functioning among school-age children and adolescents. Obesity, 16(8), 1809-1815. https://doi.org/10.1038/oby.2008.296

Lim, R. B., Zhang, M. W., & Ho, R. C. (2018). Prevalence of all-cause mortality and suicide among bariatric surgery cohorts: a meta-analysis. International Journal of Environmental Research and Public Health, 15(7), 1519. https://doi.org/10.3390/ijerph15071519

Machytka, E., Gaur, S., Chuttani, R., Bojkova, M., Kupka, T., Buzga, M., Levy, S. (2017). Elipse, the first procedureless gastric balloon for weight loss: a prospective, observational, open-label, multicenter study. Endoscopy, 49(02), 154-160. https://doi.org/10.1007/s11695-015-1783-7

Marceau, P., Marceau, S., Biron, S., Hould, F.-S., Lebel, S., Lescelleur, O.,Kral, J. G. (2010). Long-term experience with duodenal switch in adolescents. Obesity Surgery, 20, 1609-1616. https://doi.org/10.1007/s11695-010-0262-4

Mark, A. L. (2006). Dietary therapy for obesity is a failure and pharmacotherapy is the future: a point of view. Clinical and Experimental Pharmacology and Physiology, 33(9), 857-862. https://doi.org/10.1111/j.1440-1681.2006.04454.x

Martyn-Nemeth, P. A., & Penckofer, S. (2012). Psychological vulnerability among overweight/obese minority adolescents. The Journal of School Nursing, 28(4), 291-301. https://doi.org/10.1177/1059840511430508

Maffazioli, G. D., Stanford, F. C., Campoverde Reyes, K. J., Stanley, T. L., Singhal, V., Corey, K. E., ... & Misra, M. (2016). Comparing outcomes of two types of bariatric surgery in an adolescent obese population: Roux-en-Y gastric bypass vs. sleeve gastrectomy. Frontiers in Pediatrics, 4, 78. https://doi.org/10.3389/fped.2016.00078

Melissas, J., Stavroulakis, K., Tzikoulis, V., Peristeri, A., Papadakis, J. A., Pazouki, A.,Kabir, A. (2017). Sleeve Gastrectomy vs roux-en-Y gastric bypass. Data from IFSO-European chapter Center of Excellence Program. Obesity Surgery, 27, 847-855. https://doi.org/10.1007/s11695-016-2395-6

Michalsky, M. P., Inge, T. H., Jenkins, T. M., Xie, C., Courcoulas, A., Helmrath, M., Dixon, J. B. (2018). Cardiovascular risk factors after adolescent bariatric surgery. Pediatrics, 141(2). https://doi.org/10.1542/peds.2017-2485

Mitchell, D. M., Singhal, V., Animashaun, A., Bose, A., Carmine, B., Stanford, F. C., Bouxsein, M. L. (2023). Skeletal effects of sleeve gastrectomy in adolescents and young adults: a 2-year longitudinal study. The Journal of Clinical Endocrinology & Metabolism, 108(4), 847-857. https://doi.org/10.1210/clinem/dgac634

Morales-Medina, J. C., Dumont, Y., & Quirion, R. (2010). A possible role of neuropeptide Y in depression and stress. Brain research, 1314, 194-205. https://doi.org/10.1016/j.brainres.2009.09.077

Morrison, K. M., Shin, S., Tarnopolsky, M., & Taylor, V. H. (2015). Association of depression & health related quality of life with body composition in children and youth with obesity. Journal of affective disorders, 172, 18-23.https://doi.org/10.1016/j.jad.2014.09.014

Must, A., Jacques, P. F., Dallal, G. E., Bajema, C. J., & Dietz, W. H. (1992). Long-term morbidity and mortality of overweight adolescents: a follow-up of the Harvard Growth Study of 1922 to 1935. New England Journal of Medicine, 327(19), 1350-1355. https://doi.org/10.1056/nejm199211053271904

Nehus, E. J., Khoury, J. C., Inge, T. H., Xiao, N., Jenkins, T. M., Moxey-Mims, M. M., & Mitsnefes, M. M. (2017). Kidney outcomes three years after bariatric surgery in severely obese adolescents. Kidney international,

91(2), 451-458.
https://doi.org/10.1016/j.kint.2016.09.031

Neovius, M., Bruze, G., Jacobson, P., Sjöholm, K., Johansson, K., Granath, F., Ottosson, J. (2018). Bariatric surgery & suicide: results from two controlled matched cohort studies. The lancet. Diabetes & endocrinology, 6(3), 197.
https://doi.org/10.1016/s2213-8587(17)30437-0

Nguyen, N. T., & Varela, J. E. (2017). Bariatric surgery for obesity and metabolic disorders: state of the art. Nature reviews Gastroenterology & hepatology, 14(3), 160-169. https://doi.org/10.1038/nrgastro.2016.170

Onyike, C. U., Crum, R. M., Lee, H. B., Lyketsos, C. G., & Eaton, W. W. (2003). Is obesity associated with major depression? Results from the Third National Health and Nutrition Examination Survey. American journal of epidemiology, 158(12), 1139-1147.
https://doi.org/10.1093/aje/kwg275

Olbers, T., Beamish, A. J., Gronowitz, E., Flodmark, C.-E., Dahlgren, J., Bruze, G., . . . Järvholm, K. (2017). Laparoscopic Roux-en-Y gastric bypass in adolescents with severe obesity (AMOS): a prospective, 5-year, Swedish nationwide study. The lancet Diabetes & endocrinology, 5(3), 174-183.
https://doi.org/10.1016/S2213-8587(16)30424-7

Owen, C. G., Whincup, P. H., Orfei, L., Chou, Q.-A., Rudnicka, A. R., Wathern, A. K., Cook, D. G. (2009). Is body mass index before middle age related to coronary heart disease risk in later life? Evidence from observational studies. International Journal of Obesity, 33(8), 866-877. https://doi.org/10.1038/ijo.2009.102

Oyola, C., Berry, M., Salazar, M. A. P., De Abreu, D., Formiga, A., Escalona, A., Ienca, R. (2024). Successful Weight Loss in Adolescents with Overweight or Obesity Using a Swallowable Intragastric Balloon and Nutritional Oversight. Obesity Surgery, 34(10), 3762-3770. https://doi.org/10.1007/s11695-024-07458-0

Parrott, J., Frank, L., Rabena, R., Craggs-Dino, L., Isom, K. A., & Greiman, L. (2017). American Society for Metabolic and Bariatric Surgery integrated health nutritional guidelines for the surgical weight loss patient 2016 update: micronutrients. Surgery for obesity and related diseases, 13(5), 727-741. https://doi.org/10.1016/j.soard.2016.12.018

Papadia, F. S., Adami, G. F., Marinari, G. M., Camerini, G., & Scopinaro, N. (2007). Bariatric surgery in adolescents: a long-term follow-up study. Surgery for obesity and related diseases, 3(4), 465-468.
https://doi.org/10.1016/j.soard.2006.12.010

Pratt, J. S., Browne, A., Browne, N. T., Bruzoni, M., Cohen, M., Desai, A., Michalsky, M. (2018). ASMBS pediatric metabolic and bariatric surgery guidelines, 2018. Surgery for obesity and related diseases, 14(7), 882-901. https://doi.org/10.1016/j.soard.2018.03.019

Pratt, J. S., Lenders, C. M., Dionne, E. A., Hoppin, A. G., Hsu, G. L., Inge, T. H., Rosenblum, J. L. (2009). Best practice updates for pediatric/adolescent weight loss surgery. Obesity, 17(5), 901-910.
https://doi.org/10.1038/oby.2008.577

Reece, L. J., Sachdev, P., Copeland, R. J., Thomson, M., Wales, J. K., & Wright, N. P. (2017). Intra-gastric balloon as an adjunct to lifestyle support in severely obese adolescents; impact on weight, physical activity, cardiorespiratory fitness and psychosocial well-being. International Journal of Obesity, 41(4), 591–597.
https://doi.org/10.1038/ijo.2016.192

Richards, G. E., Cavallo, A., Meyer III, W. J., Prince, M. J., Peters, E. J., Stuart, C. A., & Smith, E. R. (1985). Obesity, acanthosis nigricans, insulin resistance, and hyperandrogenemia: pediatric perspective and natural history. The Journal of pediatrics, 107(6), 893-897.
https://doi.org/10.1016/s0022-3476(85)80182-7

Roberts, C. A. (2021). Physical and psychological effects of bariatric surgery on obese adolescents: A review. Frontiers in pediatrics, 8, 591598.
https://doi.org/10.3389/fped.2020.591598

Roebroek, Y. G., Paulus, G. F., Talib, A., van Mil, E. G., Vreugdenhil, A. C., Winkens, B., Van Heurn, L. E. (2024). Weight Loss and Glycemic Control After Bariatric Surgery in Adolescents With Severe Obesity: A Randomized Controlled Trial. Journal of Adolescent Health, 74(3), 597-604
https://doi.org/10.1016/j.jadohealth.2023.10.024

Rogovik, A. L., Chanoine, J.-P., & Goldman, R. D. (2010). Pharmacotherapy and weight-loss supplements for treatment of paediatric obesity. Drugs, 70, 335-346 https://doi.org/10.2165/11319210-000000000-00000

Romanova, I. V., Ramos, E. J., Xu, Y., Quinn, R., Chen, C., George, Z. M., Meguid, M. M. (2004). Neurobiologic changes in the hypothalamus associated with weight loss after gastric bypass. Journal of the American College of Surgeons, 199(6), 887-895.
https://doi.org/10.1016/j.jamcollsurg.2004.07.013

Ruiz-Cota, P., Bacardí-Gascón, M., & Jiménez-Cruz, A. (2019). Long-term outcomes of metabolic and bariatric surgery in adolescents with severe obesity with a follow-up of at least 5 years: a systematic review. Surgery for obesity and related diseases, 15(1), 133-144. https://doi.org/10.1016/j.soard.2018.10.016

Sachdev, P., Reece, L., Copeland, R., Thomson, M., Natarajan, A., Wales, J., & Wright, N. (2016). Biomedical outcomes of weight loss associated with intragastric balloon therapy supported by a life style programme in severe adolescent obesity. Paper presented at the Endocrine Abstracts.
https://doi.org/10.1530/endoabs.45.oc8.5

Salmi, A., Greco, F., & Belleri, E. (2020). Ultrasound-guided insertion of the elipse® gastric balloon: technical details, learning curve, and perioperative outcome in 36 cases. Journal of Ultrasound, 23, 593-597.
https://doi.org/10.1007/s40477-020-00499-y

Shehata, M., Abosena, W., Elhaddad, A., & El Attar, A. (2025). Seven years follow-up after sleeve gastrectomy in adolescents. Obesity Surgery, 35, 1–9.
https://doi.org/10.1007/s11695-025-07966-7

Spieth, L. E., Harnish, J. D., Lenders, C. M., Raezer, L. B., Pereira, M. A., Hangen, S. J., & Ludwig, D. S. (2000). A

low–glycemic index diet in the treatment of pediatric obesity. Archives of pediatrics & adolescent medicine, 154(9), 947-951. https://doi.org/10.1001/archpedi.154.9.947

Stevens, G. A., Beal, T., Mbuya, M. N., Luo, H., Neufeld, L. M., Addo, O. Y.,Brown, K. H. (2022). Micronutrient deficiencies among preschool-aged children and women of reproductive age worldwide: a pooled analysis of individual-level data from population-representative surveys. The Lancet Global Health, 10(11), e1590-e1599. https://doi.org/10.1016/s2214-109x(22)00367-9

Styne, D. M., Arslanian, S. A., Connor, E. L., Farooqi, I. S., Murad, M. H., Silverstein, J. H., & Yanovski, J. A. (2017). Pediatric obesity—assessment, treatment, and prevention: an Endocrine Society clinical practice guideline. The Journal of Clinical Endocrinology & Metabolism, 102(3), 709-757. https://doi.org/10.1210/jc.2016-2573

Thomson, M., Natarajan, A., Copeland, R., Wales, J., & Wright, N. (2017). Intragastric balloon as an adjunct to lifestyle programme in severely obese adolescents: Impact on biomedical outcomes, and skeletal health. https://doi.org/10.1038/ijo.2017.215

Treadwell, J. R., Sun, F., & Schoelles, K. (2008). Systematic review and meta-analysis of bariatric surgery for pediatric obesity. Annals of surgery, 248(5), 763-776. https://doi.org/10.1097/sla.0b013e31818702f4

Turkish Society of Endocrinology and Metabolism. (2019). Bariatric surgery guideline. Ankara, Turkey. https://file.temd.org.tr/Uploads/publications/guides/documents/201905271603252019tbl_kilavuza1dab037d3.pdf

Umer, A., Kelley, G. A., Cottrell, L. E., Giacobbi, P., Innes, K. E., & Lilly, C. L. (2017). Childhood obesity and adult cardiovascular disease risk factors: a systematic review with meta-analysis. BMC public health, 17, 1-24. https://doi.org/10.1161/circ.135.suppl_1.p145

Wahba, I. M., & Mak, R. H. (2007). Obesity and obesity-initiated metabolic syndrome: mechanistic links to chronic kidney disease. Clinical journal of the American Society of Nephrology, 2(3), 550-562. https://doi.org/10.2215/cjn.04071206

Wang, Y., Chen, X., Song, Y., Caballero, B., & Cheskin, L. (2008). Association between obesity and kidney disease: a systematic review and meta-analysis. Kidney international,73(1),19 33. https://doi.org/10.1038/sj.ki.5002586

Wasserman, H., & Inge, T. H. (2014). Bariatric surgery in obese adolescents: opportunities and challenges. Pediatric annals, 43(9). https://doi.org/10.3928/00904481-20140825-10

Wilfley, D. E., Stein, R. I., Saelens, B. E., Mockus, D. S., Matt, G. E., Hayden-Wade, H. A., Epstein, L. H. (2007). Efficacy of maintenance treatment approaches for childhood overweight: a randomized controlled trial. Jama, 298(14), 1661-1673. https://doi.org/10.1001/jama.298.14.1661

World Health Organization. (2007) Growth Reference Data BMI-for-age (5-19 years). Retrieved September 5, 2025, from https://www.who.int/toolkits/growth-reference-data-for-5to19-years/indicators/bmi-for-age

Xanthakos, S. A., Daniels, S. R., & Inge, T. H. (2006). Bariatric surgery in adolescents: an update. Adolesc Med Clin, 17(3), 589-612. https://doi.org/10.1016/b978-0-323-02842-4.50081-4

Xiao, N., Devarajan, P., Inge, T. H., Jenkins, T. M., Bennett, M., & Mitsnefes, M. M. (2015). Subclinical kidney injury before and 1 year after bariatric surgery among adolescents with severe obesity. Obesity (Silver Spring, Md.), 23(6), 1234–1238. https://doi.org/10.1002/oby.21070

Xiao, N., Jenkins, T. M., Nehus, E., Inge, T. H., Michalsky, M. P., Harmon, C. M.,Moxey-Mims, M. (2014). Kidney function in severely obese adolescents undergoing bariatric surgery. Obesity, 22(11), 2319-2325. https://doi.org/10.1002/oby.20870

Yuan, W., Yu, K.-H., Palmer, N., Stanford, F. C., & Kohane, I. (2019). Evaluation of the association of bariatric surgery with subsequent depression. International Journal of Obesity, 43(12), 2528-2535. https://doi.org/10.1038/s41366-019-0364-6

Zhang, X., Man, K.-W., Li, G. H.-Y., Tan, K. C., Kung, A. W.-C., & Cheung, C.-L. (2022). Osteoporosis is a novel risk factor of infections and sepsis: A cohort study. EClinicalMedicine. https://doi.org/10.1016/j.eclinm.2022.101488

Zhu, X., Zhou, G., Gu, X., Jiang, X., Huang, H., You, S., & Zhang, G. (2023). Comparing bariatric surgery and medical therapy for obese adolescents with type 2 diabetes. Asian journal of surgery, 46(10), 4337-4343. https://doi.org/10.1016/j.asjsur.2022.10.079

Determining the Knowledge Levels of Midwifery Students Regarding Emotional Freedom Technique

Merve Kurt [1]* , Büşra Cesur [1]

[1]Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Midwifery, Sivas, Türkiye

ABSTRACT:

Purpose: The study was conducted to determine the knowledge levels of midwifery students regarding the Emotional Freedom Technique (EFT).

Materials and Methods: This descriptive study was conducted with students from the Midwifery Department of Sivas Cumhuriyet University, Faculty of Health Sciences, in the spring semester of 2023 (n=329). The data were collected between March 23 and June 25, 2023, using a questionnaire form prepared by the researchers, and analyzed using the SPSS 23 software.

Results: Among the students who participated in the study, 28.3% were in their first year, 23.7% were in their second year, 26.1% were in their third year, and 21.9% were in their fourth year. It was found that opinions of students on EFT (21.816/.000), its usefulness (LR=9.354/.053), the cost of the technique (41.651/.000), the way of applying the technique (LR=23.824/.001), and the place where the technique is applied (LR=16.713/.010) increased as the grade level increased (p<0.05). Although this rate was 12.8% in the 1st grade, it increased to 43.6% in the 4th grade, and this difference was statistically significant. The most commonly used information sources were found to be the internet and social media.

Conclusion: The study is important in terms of evaluating the knowledge and attitudes of midwifery students towards EFT. Although very few of the students were knowledgeable about EFT (12%), the majority exhibited a positive attitude towards the technique; however, it was also found that their information sources were insufficient. These results suggest the need to provide students with more academic and practical training on how EFT can be used in midwifery services. Integrating EFT into midwifery education is important because it will improve the quality of care by providing students with a holistic approach to the anxiety, fear, and psychological difficulties women may experience during pregnancy, birth, and the postpartum period.

Keywords: *Midwifery; Student; Emotional Freedom Technique; Knowledge Level*

Corresponding author: Merve Kurt, email: mervekurt@cumhuriyet.edu.tr

INTRODUCTION

Energy Psychology Approaches, which have become increasingly common in the USA and Europe since the 1980s, are defined as a holistic method that combines traditional psychotherapy with the stimulation of meridians and acupuncture points used in Chinese medicine to support individuals' emotional well-being (Vural, Körpe & Inangil, 2019). Literature data show that Energy Psychology-Based Therapies provide effective change in the short term, and these methods are reported to offer an alternative treatment option for many psychological conditions, such as anxiety disorders. The most widely used method among these approaches is Emotional Freedom Technique (EFT), developed by Craig and Fowlie in 1995 as a simplified form of Thought Field Therapy (Church, 2013). Clinical EFT is defined as a safe and evidence-based practice that

relies on the stimulation of specific acupuncture points in conjunction with cognitive processes. Many studies, including randomized controlled trials, report that EFT provides positive outcomes across a wide range of conditions, including anxiety, stress, anger, grief, and trauma, with no side effects, and can be safely applied to all individuals, including the elderly, pregnant women, and children (Hartmann, 2014).

EFT offers significant potential, particularly during pregnancy and childbirth. Pregnant women might associate the birth experience with previous negative experiences, which can increase anxiety, fear, and stress. EFT applications might help pregnant women release negative emotions and prepare for birth more comfortably and confidently. It has also been reported that EFT reduces fear of childbirth and pain perception, increases satisfaction with the birth experience, and contributes to the postpartum process (Ghamsari & Lavasani, 2015; Mardjan et al., 2018; Vural & Aslan, 2019; Emadi et al., 2024; Okyay & Barut, 2025).

Midwifery is based on a holistic approach to care that encompasses not only physiological but also psychological and emotional processes. For this reason, midwifery students' knowledge of EFT is crucial for them to provide more effective support to women in labor and to manage their own professional stress. However, studies examining midwifery students' knowledge of EFT are limited in the literature. In this context, the current study aimed to determine midwifery students' knowledge of EFT and, therefore, contribute to the development of educational programs and the improvement of the quality of care provided to women's health in the future. Moreover, our study is expected to contribute to the literature by revealing midwifery students' views and attitudes toward EFT and by raising their awareness.

METHOD

The study had a descriptive design, and the population of the study consisted of students continuing their education at the Midwifery Department of Sivas Cumhuriyet University. No sample selection was made. Between March 23 and June 25, 2023, 329 voluntary midwifery students

(80,2%) out of 410 students enrolled in the program participated. Verbal consent was obtained from the students. The data collection tools for the study were a 9-question Personal Information Form covering sociodemographic data such as age, grade, employment, and income status, and a 14-question Emotional Freedom Technique (EFT) Knowledge Level Form, developed by the researchers based on literature data, which were applied via Google Forms. For the implementation of the study, ethical approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Sivas Cumhuriyet University on September 21, 2023, with decision number 2023-09/45.The data obtained from the study were evaluated in a computer environment using the SPSS 23.0 software. The Chi-square test was used for the comparison of numerical data, and a significance level of $p < 0.05$ was accepted for all analyses.

RESULTS

Of the students participating in the study, 28.3% were in the first year, 23.7% in the second year, 26.1% in the third year, and 21.9% in the fourth year. The mean age of the participants was 20.9 years. Among the students, 82.7% lived in a nuclear family, and 79.3% reported a middle-level income. In addition, 96.7% of the participants were not employed in any job, and 99.4% were single. It was found that opinions of students about EFT and its usefulness, the cost of the technique, the way of applying the technique, and the place where the technique is applied increased as the grade level increased (p<0.05). While this rate was 12.8% in 1st grade, it increased to 43.6% in 4th grade. This difference was found to be statistically significant (p=0.009). It was also found that the most used resources were the internet and social media. 38.5% of those who were knowledgeable about EFT stated that they used the therapy/technique to support psychological well-being. This rate was significantly lower among those who had no idea or knowledge about EFT. This difference was statistically significant (p=0.000). Opinions of students on the application of EFT in stress, anxiety, pregnancy, birth, and postpartum processes were not significant according to class level (Table 1).

Table 1. Students' Knowledge and Thoughts on EFT by Grade Level

			Grade 1 (n= 93)	Grade 2 (n=78)	Grade 3 (n=86)	Grade 4 (n=72)	X²/p
Do you have knowledge about Emotional Freedom Technique (EFT)?	Yes		5(12,8)	6(15,4)	11(28,2)	17(43,6)	**16,974/ ,009***
	No	n(%)	62(28,3)	56(25,6)	60(27,4)	41(18,7)	
	No opinion		26(36,6)	16(22,5)	15(21,2)	14(19,7)	
If you have knowledge about Emotional Freedom Technique, how did you access this information?	Social media		30(26,1)	28(24,3)	30(26,1)	27(23,5)	LR=5,316/ ,947
	Course		5(41,7)	3(25,0)	3(25,0)	1(8,3)	
	Internet	n(%)	44(28,4)	40(25,8)	38(24,5)	33(21,3)	
	Scientific research		8(29,6)	4(14,8)	9(33,4)	6(22,2)	
	Healthcare institution		6(30,0)	3(15,0)	6(30,0)	5(25,0)	
I think Emotional Freedom Technique is beneficial.	Yes		21(21,7)	23(23,7)	23(23,7)	30(30,9)	**LR=19,819/ ,003***
	No	n(%)	1(9,1)	0(0,0)	7(63,6)	3(27,3)	
	No opinion		71(32,1)	55(24,9)	56(25,4)	39(17,6)	
I think Emotional Freedom Technique is a practice that involves a cost.	Yes		0(0,0)	5(17,9)	5(17,9)	18(64,3)	**41,651/ ,000***
	No	n(%)	25(36,4)	11(15,5)	24(34,9)	9(13,3)	
	No opinion		68(29,3)	62(26,7)	57(24,6)	45(19,4)	
I think Emotional Freedom Technique can be applied regardless of location.	Yes		30(30,6)	23(23,5)	20(20,4)	25(25,5)	LR=16,713/ ,010*
	No	n(%)	2(13,3)	0(0,0)	10(66,7)	3(20,0)	
	No opinion		61(28,2)	55(25,5)	56(25,9)	44(20,4)	
Emotional Freedom Technique is a practice performed by tapping on specific points of the body.	Yes		8(14,3)	7(12,5)	18(32,1)	23(41,1)	**LR=23,824/ ,001***
	No	n(%)	3(20,0)	5(33,3)	6(40,0)	1(6,7)	
	No opinion		82(31,8)	66(25,6)	62(24,0)	48(18,6)	
Once learned, Emotional Freedom Technique can be practiced individually.	Yes		19(24,4)	13(16,7)	23(29,5)	23(29,5)	LR=12,328/ ,055
	No	n(%)	0(0,0)	2(28,6)	4(57,1)	1(14,3)	
	No opinion		74(30,3)	63(25,8)	59(24,2)	48(19,7)	
I think Emotional Freedom Technique is applied only to individuals with poor mental health.	Yes		9(22,5)	8(20,0)	8(20,0)	15(37,5)	12,132/ ,059
	No	n(%)	31(36,5)	18(21,2)	25(29,4)	11(12,9)	
	No opinion		53(26,0)	52(25,5)	53(26,0)	46(22,5)	
I think Emotional Freedom Technique is effective in reducing stress and anxiety.	Yes		44(32,4)	27(19,9)	38(27,9)	27(19,9)	LR=6,492/ ,370
	No	n(%)	0(0,0)	0(0,0)	0(0,0)	1(100,0)	
	No opinion		49(25,5)	51(26,6)	48(25,0)	44(22,9)	
I think Emotional Freedom Technique provides psychological healing.	Yes		38(29,7)	27(21,1)	36(28,1)	27(21,1)	LR=5,817/ ,444
	No	n(%)	0(0,0)	1(20,0)	3(60,0)	1(20,0)	
	No opinion		55(28,1)	50(25,5)	47(24,0)	44(22,4)	
I think Emotional Freedom Technique can be applied to women during pregnancy and the postpartum period.	Yes		39(30,5)	26(20,3)	37(28,9)	26(20,3)	LR=6,716/ ,348
	No	n(%)	0(0,0)	3(60,0)	1(20,0)	1(20,0)	
	No opinion		54(27,6)	49(25,0)	48(24,5)	45(23,0)	
I think Emotional Freedom Technique is effective in reducing fear of childbirth.	Yes		38(29,9)	27(21,3)	37(29,1)	25(19,7)	LR=4,955/ ,550
	No	n(%)	0(0,0)	1(25,0)	2(50,0)	1(25,0)	
	No opinion		55(27,8)	50(25,3)	47(23,7)	46(23,2)	
I think Emotional Freedom Technique is effective in reducing postpartum depression.	Yes		30(24,6)	28(23,0)	37(30,3)	27(22,1)	LR=7,120/ ,310
	No	n(%)	0(0,0)	1(33,3)	2(66,7)	0(0,0)	
	No opinion		63(30,9)	49(24,0)	47(23,0)	45(22,1)	
I think Emotional Freedom Technique can be used in all areas where midwifery services are provided.	Yes		30(25,0)	29(24,2)	36(30,0)	25(20,8)	LR=2,892/ ,822
	No	n(%)	3(42,9)	2(28,6)	1(14,3)	1(14,3)	
	No opinion		60(29,7)	47(23,3)	49(24,3)	46(22,8)	

LR: Likelihood Ratio (Chi-square test result), *:The difference was statistically significant, p < 0.05, Row percentages were used.

Table 2 shows significant differences in opinions of students regarding EFT's use of techniques/therapies for maintaining psychological well-being, including knowledge and usefulness, cost of the technique, application method, reducing fear of childbirth, postpartum depression, and its use in midwifery (p<0.05). Based on the data obtained, it was found that only a small portion of the participants (12%) had previous knowledge of EFT. Although the majority of the participants had limited knowledge of EFT, they had a positive attitude towards the technique (p<0.05), (Table 2).

Among the students who participated in the study, listening to music (7.3%) and walking (6.1%) were found to be the most preferred coping methods in their daily lives.

Table 2. Comparison of Students' Knowledge and Thoughts on the Use and Benefits of EFT and Their Use of Techniques/Therapies to Maintain Their Psychological Well-Being

			Yes	No	No opinion	X²/p
Do you have knowledge about Emotional Freedom Technique (EFT)?	Yes	n(%)	15(38,5)	24(61,5)	0(0,0)	**21,816/ ,000***
	No		44(20,1)	163(74,4)	12(5,5)	
	No opinion		9(12,7)	50(70,4)	12(16,9)	
If you have knowledge about Emotional Freedom Technique, how did you access this information?	Social media	n(%)	22(19,1)	86(74,8)	7(6,1)	LR=12,309/ ,138
	Course		3(25,0)	8(66,7)	1(8,3)	
	Internet		33(21,3)	113(72,9)	9(5,8)	
	Scientific research		9(33,3)	16(59,3)	2(7,4)	
	Healthcare institution		1(5,0)	14(70,0)	5(25,0)	
I think Emotional Freedom Technique is beneficial.	Yes	n(%)	30(30,9)	61(62,9)	6(6,2)	**LR=9,354/ ,053***
	No		3(27,3)	7(63,6)	1(9,1)	
	No opinion		35(15,8)	169(76,5)	17(7,7)	
I think Emotional Freedom Technique is a practice that involves a cost.	Yes	n(%)	14(50,0)	13(46,4)	1(3,6)	**16,608/ ,002***
	No		12(17,4)	53(76,8)	4(5,8)	
	No opinion		42(18,1)	171(73,7)	19(8,2)	
I think Emotional Freedom Technique can be applied regardless of location.	Yes	n(%)	27(27,6)	65(66,3)	6(6,1)	LR=4,738/ ,315
	No		4(26,7)	10(66,7)	1(6,7)	
	No opinion		37(17,1)	162(75,0)	17(7,9)	
Emotional Freedom Technique is a practice performed by tapping on specific points of the body.	Yes	n(%)	25(44,6)	26(46,5)	5(8,9)	**LR=22,309/ ,000***
	No		2(13,3)	12(80,0)	1(6,7)	
	No opinion		41(15,9)	199(77,1)	18(7,0)	
Once learned, Emotional Freedom Technique can be practiced individually.	Yes	n(%)	24(30,8)	50(64,1)	4(5,1)	LR=7,797/ ,099
	No		2(28,6)	5(71,4)	0(0,0)	
	No opinion		42(17,2)	182(74,6)	20(8,2)	
I think Emotional Freedom Technique is applied only to individuals with poor mental health.	Yes	n(%)	13(32,5)	24(60,0)	3(7,5)	7,553/ ,109
	No		22(25,9)	58(68,2)	5(5,9)	
	No opinion		33(16,2)	155(76,0)	16(7,8)	
I think Emotional Freedom Technique is effective in reducing stress and anxiety.	Yes	n(%)	39(28,7)	88(64,7)	9(6,6)	LR=9,464/ ,050
	No		0(0,0)	1(100,0)	0(0,0)	
	No opinion		29(15,1)	148(77,1)	15(7,8)	
I think Emotional Freedom Technique provides psychological healing.	Yes	n(%)	37(28,9)	83(64,8)	8(6,3)	LR=3,393/ ,052
	No		1(20,0)	4(80,0)	0(0,0)	
	No opinion		30(15,3)	150(76,5)	16(8,2)	
I think Emotional Freedom Technique can be applied to women during pregnancy and the postpartum period.	Yes	n(%)	35(27,3)	85(66,4)	8(6,3)	LR=8,481/ ,075
	No		0(0,0)	5(100,0)	0(0,0)	
	No opinion		33(16,8)	147(75,0)	16(8,2)	
I think Emotional Freedom Technique is effective in reducing fear of childbirth.	Yes	n(%)	38(29,9)	82(64,6)	7(5,5)	**LR=11,763/ ,019***
	No		1(25,0)	3(75,0)	0(0,0)	
	No opinion		29(14,6)	152(76,8)	17(8,6)	
I think Emotional Freedom Technique is effective in reducing postpartum depression.	Yes	n(%)	37(30,3)	78(63,9)	7(5,8)	**LR=11,912/ ,018***
	No		1(33,3)	2(66,7)	0(0,0)	
	No opinion		30(14,7)	157(77,0)	17(8,3)	
I think Emotional Freedom Technique can be used in all areas where midwifery services are provided.	Yes	n(%)	37(30,8)	78(65,0)	5(4,2)	**LR=15,154/ ,004***
	No		2(28,6)	5(71,4)	0(0,0)	
	No opinion		29(14,4)	154(76,2)	19(9,4)	

*LR: Likelihood Ratio (Chi-square test result), *:The difference was statistically significant, p < 0.05, Row percentages were used.*

Only 1.2% of participants who meditated and 1.8% of those who used psychologically based techniques to increase their energy were aware of EFT.

Those who listened to music were more knowledgeable about EFT than those who used other coping methods. Similarly, those who listened to music were more likely to believe that the technique could be used in midwifery (26.7% during pregnancy and postpartum periods), to reduce fear of childbirth (26.4%), and to reduce postpartum depression (24.9%) than those who used other methods. When opinions of participants on the usefulness of EFT were examined, 18.8% of those who listened to music, 12.8% of those who walked, and 6.4% of those who used energy-enhancing techniques stated that they found the method helpful. However, the percentage of participants who responded "I have no idea" was over 40% across

all groups, with the highest rate found among those listening to music (48.6%). In assessing the applicability of EFT, 21.3% of those listening to music, 10.9% of those walking, and 4% of those meditating indicated that the technique could be applied regardless of location. Similarly, the percentage of participants who believed that EFT could be applied independently after learning it was also low (14.6% of those listening to music and 10.3% of those walking). These results suggest that participants had limited opportunities to experience or observe EFT in practice (Table 3).

Table 3. Students' Knowledge and Thoughts on EFT and Their Methods of Coping with Negative Situations

			I listen to music	I do meditation	I take a walk	I try psychology-based techniques to boost my energy	Other
Do you have knowledge about Emotional Freedom Technique (EFT)?	Yes	n(%)	24(7,3)	4(1,2)	20(6,1)	6(1,8)	2(0,6)
	No		152(46,2)	18(5,5)	60(18,2)	38(11,6)	29(8,8)
	No opinion		53(16,1)	3(0,9)	25(7,6)	5(1,5)	5(1,5)
If you have knowledge about Emotional Freedom Technique, how did you access this information?	Social media	n(%)	82(24,9)	10(3,0)	37(11,2)	17(5,2)	15(4,6)
	Course		8(2,4)	0(0,0)	5(1,5)	3(0,9)	1(0,3)
	Internet		110(33,4)	10(3,0)	48(14,6)	20(6,1)	14(4,3)
	Scientific research		15(4,6)	4(1,2)	12(3,6)	6(1,8)	3(0,9)
	Healthcare institution		14(4,3)	1(0,3)	3(0,9)	3(0,9)	3(0,9)
I think Emotional Freedom Technique is beneficial.	Yes	n(%)	62(18,8)	11(3,3)	42(12,8)	21(6,4)	3(0,9)
	No		7(2,1)	0(0,0)	1(0,3)	0(0,0)	3(0,9)
	No opinion		160(48,6)	14(4,3)	62(18,8)	28(8,5)	30(9,1)
I think Emotional Freedom Technique is a practice that involves a cost.	Yes	n(%)	16(4,9)	4(1,2)	12(3,6)	8(2,4)	2(0,6)
	No		52(15,8)	6(1,8)	19(5,8)	5(1,5)	6(1,8)
	No opinion		161(48,9)	15(4,6)	74(22,5)	36(10,9)	28(8,5)
I think Emotional Freedom Technique can be applied regardless of location.	Yes	n(%)	70(21,3)	13(4,0)	36(10,9)	15(4,6)	7(2,1)
	No		9(2,7)	0(0,0)	3(0,9)	1(0,3)	3(0,9)
	No opinion		150(45,6)	12(3,6)	66(20,1)	33(10,0)	26(7,9)
Emotional Freedom Technique is a practice performed by tapping on specific points of the body.	Yes	n(%)	33(10,0)	10(3,0)	26(7,9)	10(3,0)	2(0,6)
	No		11(3,3)	0(0,0)	5(1,5)	4(1,2)	1(0,3)
	No opinion		185(56,2)	15(4,6)	74(22,5)	35(10,6)	33(10,0)
Once learned, Emotional Freedom Technique can be practiced individually.	Yes	n(%)	48(14,6)	10(3,0)	34(10,3)	16(4,9)	5(1,5)
	No		5(1,5)	0(0,0)	3(0,9)	0(0,0)	1(0,3)
	No opinion		176(53,5)	15(4,6)	68(20,7)	33(10,0)	30(9,1)
I think Emotional Freedom Technique is applied only to individuals with poor mental health.	Yes	n(%)	28(8,5)	3(0,9)	12(3,6)	5(1,5)	3(0,9)
	No		55(16,7)	10(3,0)	36(10,9)	16(4,9)	6(1,8)
	No opinion		146(44,4)	12(3,6)	57(17,3)	28(8,5)	27(8,2)
I think Emotional Freedom Technique is effective in reducing stress and anxiety.	Yes	n(%)	88(26,7)	14(4,3)	56(17,0)	22(6,7)	11 (3,3)
	No		0(0,0)	0(0,0)	1(0,3)	0(0,0)	0(0,0)
	No opinion		141(42,9)	11()	48(14,6)	27(8,2)	25(7,6)
I think Emotional Freedom Technique provides psychological healing.	Yes	n(%)	84(25,5)	12(3,6)	54(16,4)	23(7,0)	11(3,3)
	No		2(0,6)	1(0,3)	2(0,6)	0(0,0)	0(0,0)
	No opinion		143(43,5)	12(3,6)	49(14,9)	26(7,9)	25(7,6)
I think Emotional Freedom Technique can be applied to women during pregnancy and the postpartum period.	Yes	n(%)	88(26,7)	11(3,3)	52(15,8)	24(7,3)	11(3,3)
	No		3(0,9)	1(0,3)	1(0,3)	1(0,3)	0(0,0)
	No opinion		138(41,9)	13(4,0)	52(15,8)	24(7,3)	25(7,6)
I think Emotional Freedom Technique is effective in reducing fear of childbirth.	Yes	n(%)	87(26,4)	11(3,3)	51(15,5)	26(7,9)	11 (3,3)
	No		1(0,3)	0(0,0)	2(0,6)	0(0,0)	1(0,3)
	No opinion		141(42,9)	14(4,3)	52(15,8)	23(7,0)	24(7,3)
I think Emotional Freedom Technique is effective in reducing postpartum depression.	Yes	n(%)	82(24,9)	9(2,7)	50(15,2)	25(7,6)	12(3,6)
	No		2(0,6)	0(0,0)	1(0,3)	0(0,0)	0(0,0)
	No opinion		145(44,1)	16(4,9)	54(16,4)	24(7,3)	24(7,3)
I think Emotional Freedom Technique can be used in all areas where midwifery services are provided.	Yes	n(%)	84(25,5)	8(2,4)	46 (14,0)	24(7,3)	10(3,0)
	No		4(1,2)	0(0,0)	4(1,2)	1(0,3)	0(0,0)
	No opinion		141(42,9)	17(5,2)	55(16,7)	24(7,3)	26(7,9)

DISCUSSION

As an effective treatment for a variety of psychological and physiological conditions, EFT has been proven in numerous randomized controlled trials in the literature, and is considered an evidence-based practice that meets APA standards (Church et al., 2022; Clond, 2016; Nelms and Castel, 2016; Sebastian and Nelms, 2017; Seok and Kim, 2024; Stapleton et al., 2023). A growing body of evidence supports its effectiveness in treating psychological symptoms such as anxiety, depression, phobia, and Post-Traumatic Stress Disorder (PTSD), as well as physiological symptoms such as pain, insomnia, and autoimmune disorders such as psoriasis and fibromyalgia (Church et al., 2022; Hodge and Jurgens, 2011; Lee et al., 2013; Stapleton et al., 2025).

The present study examined midwifery students' knowledge and opinions about the Emotional Freedom Technique (EFT). Results from the study revealed that only a small percentage of participants had prior knowledge of EFT (12%), but the majority had a positive attitude toward the technique (p<0.05), which suggests that despite students' low awareness, they tend to understand the potential contributions of EFT to midwifery and individual applications. Among those familiar with EFT, 38.5% reported using the therapy/technique to support psychological well-being.

It was found that students' knowledge of EFT, its usefulness, and positive attitudes towards its application increased as their grade level increased (p<0.05). This result suggests that students are more open to alternative and complementary approaches as their professional experience and theoretical knowledge increase. The literature also shows that EFT is beneficial for different student groups. In a study conducted by Forouzi et al. (2024) on university students studying health in Iran, EFT sessions were administered once a week in six online sessions, each lasting 45 minutes, and a significant decrease in test anxiety was observed in the intervention group. In an Australian study aiming to increase the self-esteem and resilience of high school students and reduce fear of failure and emotional difficulties, EFT was reported to be an effective treatment program in reducing students'

fear of failure (Stapleton et al., 2017). In Korea, a total of six sessions of EFT training given to first-year medical students over three weeks was found to reduce academic stress and negative affect in the students (Lee et al., 2022). Similarly, EFT was used in nursing students, and it was reported that it reduces feelings of stress and anxiety and can offer ways to cope or control their existing anxiety. In addition, students reported feeling calmer and more relaxed after using the technique (Patterson, 2016). In addition to all these studies, a study conducted with 138 students in primary schools in Northern Australia reported that EFT supported social and emotional learning and benefited students and teachers (Lambert et al., 2022). A study conducted on nursing students in Turkiye reported that three EFT sessions applied in a group setting reduced test anxiety and other anxiety symptoms in the students (Vural, Körpe, & İnangil, 2019). In another study conducted in our country, the effect of EFT on premenstrual syndrome and pain in nursing and midwifery students was evaluated. The students in the intervention group received 3 sessions of EFT for 3 months, and as a result of the study, a decrease in pain scores and the "Premenstrual Syndrome Scale" score was found (Yazar et al., 2025).

In the present study, it was found that third-year students, in particular, had higher opinions than other years regarding the use of EFT in reducing fear of childbirth, postpartum depression, and midwifery. This may be related to the fact that students, through their participation in specialized courses such as obstetrics and neonatology, gain a deeper understanding of not only the physiological but also the psychological and social dimensions of pregnancy, birth, and postpartum processes. Also, the reinforcement of the theoretical knowledge acquired in these courses with clinical experience makes them more sensitive to the anxieties and fears of childbirth. Thus, students become more aware of the importance of complementary, non-pharmacological techniques like EFT in addressing the anxieties and difficulties they observe in mothers and in their own professional experiences, and are increasingly interested in these methods. Indeed, the literature shows that EFT provides positive effects on the pregnancy process (Okyay & Uçar,

2023), reduces fear of childbirth (Vural & Aslan, 2019; Limbong, 2024; Zhou et al., 2025), and reduces postpartum anxiety and depression (Robbins, Harvey, & Moller, 2024; Widaningsih, 2023). A study conducted on midwifery students found that fear of childbirth, perception of traumatic birth, and PTSD decreased in the intervention group receiving EFT (Bekmezci, Duran & Karakoç, 2022).

The most common coping methods of participants in a negative situation were listening to music (7.3%) and walking (6.1%), while the proportion of those who used meditation and psychologically based techniques was lower. When the opinions of participants on the usefulness of EFT were examined, 18.8% of those who listened to music, 12.8% of those who walked, and 6.4% of those who used energy-enhancing techniques stated that they found this method useful. Those who listened to music were more likely to think of the technique's use in midwifery (use during pregnancy and postpartum period (26.7%), reducing fear of childbirth (26.4%), and reducing postpartum depression (24.9%)) than those who used other methods. Music contributes to psychological development by creating positive changes in human behavior (Karamızrak, 2019; Mastnak, 2016; Ocebe et al., 2019). However, the fact that students who listen to music find EFT more beneficial and think that it can contribute more to its use in the field of midwifery can be explained by the joint positive effects of music and EFT on psychological development, anxiety level, and cortisol release (Okyay and Uçar, 2023). In an assessment of the applicability of EFT, 21.3% of those listening to music, 10.9% of those walking, and 4% of those meditating reported that the technique could be applied regardless of location. Similarly, in a study of 238 first-year university students, the intervention group received four 90-minute group sessions online, and the EFT group experienced significantly less depression compared to the control group (Church, De Asis, & Brooks, 2012). Church and Brooks (2010) reported that a 2-hour EFT session significantly reduced anxiety, depression, and pain among healthcare professionals, and these benefits persisted for 90 days. These results suggest that EFT can be applied in both face-to-face and online

settings and can be used effectively regardless of location. Studies in the literature demonstrate the usefulness of EFT as a short-term, cost-effective, and effective treatment (Church, De Asis & Brooks, 2012).

In the present study, students' acquisition of EFT information via the internet and social media demonstrates the importance of digital resources in today's educational process. However, this can limit the accuracy and reliability of the information obtained. For this reason, it is recommended that students' access to evidence-based information about complementary techniques like EFT be increased and integrated into course curricula or elective course content. A review of the literature revealed no studies assessing midwifery students' attitudes and views toward EFT. Studies conducted abroad, however, appear to focus primarily on measuring students' stress, anxiety, and depression levels. Based on this perspective, the present study contributes uniquely to the literature by revealing midwifery students' views and attitudes about EFT and raising awareness.

In conclusion, the results suggest that midwifery students, despite their low knowledge of EFT, exhibit positive attitudes toward the technique. The literature indicates that EFT is a short-term, cost-effective, and effective method (Church and Brooks, 2010; Stapleton et al., 2025) and that it can help students cope with significant psychological burdens such as stress, anxiety, and fear of childbirth. Introducing EFT during midwifery education can significantly enhance students' self-efficacy, providing significant benefits for both their personal well-being and their professional practice. Also, we believe that EFT not only contributes to students' individual lives but can also be used as a practical and effective method to support women during pregnancy, birth, and the postpartum period within their professional roles. In this context, EFT is an important tool that can help midwifery students both protect their own emotional well-being and enhance the psychological resilience of the women they care for.

CONCLUSION AND RECOMMENDATIONS
Midwifery students' knowledge of EFT increases with

increasing grades. However, students' knowledge of EFT is largely based on popular media channels such as social media and the internet, which suggests the need to provide students with more academic and practical training on how EFT can be used in midwifery services. It is recommended that courses or elective training modules that introduce or demonstrate EFT in practice be added. Integrating EFT as a complementary method into the care of women during pregnancy, birth, and the postpartum period may be beneficial. Seminars, workshops, and evidence-based resources must be offered at universities to provide students with access to accurate and scientific information about EFT. It is recommended that EFT be incorporated into university-level psychoeducation programs to help students cope with academic and clinical stress. Further qualitative and quantitative research can be conducted to more comprehensively examine its effects on midwifery students. It is recommended that the scientific basis of EFT be strengthened and its integration into educational practices. Studies with larger samples can reveal the long-term effects of EFT on midwifery students and women's health.

REFERENCES

Abdelhafiz, A. S., Mohammed, Z., Ibrahim, M. E., Ziady, H. H., Alorabi, M., Ayyad, M., & Sultan, E. A. (2020). Knowledge, perceptions, and attitude of Egyptians towards the novel coronavirus disease (COVID-19). Journal of community health, 45(5), 881-890.

Austrian, K., Pinchoff, J., Tidwell, J. B., White, C., Abuya, T., Kangwana, B., ... & Ngo, T. D. (2020). COVID-19 related knowledge, attitudes, practices and needs of households in informal settlements in Nairobi, Kenya.

Ayhan Baser, D., Cevik, M., Gümüstakim, Ş., & Basara, E. (2020). Assessment of individuals' attitude, knowledge and anxiety towards COVID-19 at the first period of the outbreak in Turkey: A web-based cross-sectional survey. International Journal of Clinical Practice, 74(12), e13622.

Budak, F., & Korkmaz, Ş. (2020). An overall evaluation for the COVID-19 pandemic process: the case of Turkey. Journal of Social Research and Management, 1(1), 62-79.

Bawazir, A., Al-Mazroo, E., Jradi, H., Ahmed, A., & Badri, M. (2018). MERS-CoV infection: mind the public knowledge gap. Journal of infection and public health, 11(1), 89-93.

Inal Onal, E., Ünal, Y., & Tekeli-Yesil, S. (2021). Differences in the Preferences of Information Sources Between COVID-19 Pandemic and Earthquakes Among Young People in Turkey. Journal of Emergency Management and Disaster Communications, 1-12.

Li, W., Yang, Y., Liu, Z. H., Zhao, Y. J., Zhang, Q., Zhang, L., ... & Xiang, Y. T. (2020). Progression of mental health services during the COVID-19 outbreak in China. International journal of biological sciences, 16(10), 1732.

Turkısh Republic (TR) Ministry of Health (2020). COVID-19 Algoritmalar [online]. Website: https://covid19bilgi.saglik.gov.tr/tr/algoritmalar [accessed 17April 2020].

Muruganandam, P., Neelamegam, S., Menon, V., Alexander, J., & Chaturvedi, S. K. (2020). COVID-19 and severe mental illness: impact on patients and its relation with their awareness about COVID-19. Psychiatry research, 291, 113265.

NIMH Transforming the understanding and treatment of mental illnesses [WWW Document] Ment. Illn. Defin. 2017 https://www.nimh.nih.gov/health/statistics/mental-illness.shtml#:~:text=Serious%20mental%20illness%20(SMI)%20is,or%20more%20major%20life%20activities URL.

Neto, M. L. R., Almeida, H. G., Esmeraldo, J. D. A., Nobre, C. B., Pinheiro, W. R., de Oliveira, C. R. T., ... & da Silva, C. G. L. (2020). When health professionals look death in the eye: the mental health of professionals who deal daily with the 2019 coronavirus outbreak. Psychiatry research, 288, 112972.

Person, B., Sy, F., Holton, K., Govert, B., & Liang, A. (2004). Fear and stigma: the epidemic within the SARS outbreak. Emerging infectious diseases, 10(2), 358.

Sonoda, Y., Ozaki, A., Hori, A., Higuchi, A., Shimada, Y., Yamamoto, K., ... & Tsubokura, M. (2019). Premature death of a schizophrenic patient due to evacuation after a nuclear disaster in Fukushima. Case reports in psychiatry.

Spoorthy, M. S., Pratapa, S. K., & Mahant, S. (2020). Mental health problems faced by healthcare workers due to the COVID-19 pandemic–A review. Asian journal of psychiatry, 51, 102119.

Sukut, O., & Ayhan Balik, C. H. (2021). The impact of COVID-19 pandemic on people with severe mental illness. Perspectives in Psychiatric Care, 57(2), 953-956.

Tao, N. (2003). An analysis on reasons of SARS-induced psychological panic among students. Journal of Anhui Institute of Education, 21(2), 78-9.

Turkish Repuclic (TR) Ministry of Health COVID-19 Information Platform, 2020: https://covid19.saglik.gov.tr/TR-66935/genel-koronavirus-tablosu.html

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R. S., ... & Ho, C. (2020). A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. Brain, behavior, and immunity, 87, 40-48.

Wolf, M. S., Serper, M., Opsasnick, L., O'Conor, R. M., Curtis, L., Benavente, J. Y., ... & Bailey, S. C. (2020). Awareness, attitudes, and actions related to COVID-19

among adults with chronic conditions at the onset of the US outbreak: a cross-sectional survey. Annals of internal medicine, 173(2), 100-109.

World Health Organization. *WHO Director-General's Opening Remarks at the Media Briefing on COVID-19 - 18 March 2020*. Geneva, Switzerland: World Health Organization; 2020. https://www.who.int/dg/speeches/detail/who-director-general-   s-opening-remarks-at-the-media-briefing-on-COVID-19---18-   march-2020. Accessed March 27, 2020.)

Zhong, B. L., Luo, W., Li, H. M., Zhang, Q. Q., Liu, X. G., Li, W. T., & Li, Y. (2020). Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *International journal of biological sciences*, *16*(10), 1745–1752.

Zhang, M., Zhou, M., Tang, F., Wang, Y., Nie, H., Zhang, L., & You, G. (2020). Knowledge, attitude, and practice regarding COVID-19 among healthcare workers in Henan, China. The Journal of hospital infection, 105(2), 183–187. https://doi.org/10.1016/j.jhin.2020.04.012

Türk Fen ve Sağlık Dergisi

Turkish Journal of Science and Health

Recent Approaches to Antibacterial Textile Production Using Inorganic, Organic, and Sustainable Bioactive Substances: A Review

Gürsel Korkmaz* [iD]

Sivas Cumhuriyet University, Sivas Vocational School of Technical Sciences, 58140 Sivas, Türkiye

ABSTRACT:

Antibiotics have ushered in a new era in the treatment of bacterial infections. However, over time, microorganisms have developed resistance mechanisms that increasingly limit available treatment options. Consequently, identifying novel antibacterial bioactive substances and advancing research in this field have become urgent priorities. Beyond medical treatment, preventive approaches such as antibacterial textiles can contribute to the reduction of bacterial contamination.

Textile materials, due to their moisture content and nutrients, provide a suitable growing medium for bacteria. Bacteria that grow in contaminated textiles pose a threat to public health and reduce textile performance. Textile materials produced from various raw materials, such as cotton, polyester, and wool, can be gained antibacterial properties via appropriate bioactive substances and under appropriate conditions. Bioactive substances used in antibacterial textile applications are primarily divided into two categories: organic and inorganic. These substances can be produced synthetically or derived from natural sources, such as chitosan and casein, or from sustainable sources, such as coffee and tea waste.

This study analyzes antibacterial textile research published between 2015 and 2025, retrieved from the Web of Science and ScienceDirect databases. The studies were categorized as either organic or inorganic according to the type of bioactive substances used in antibacterial textile production, and these categories were further subdivided based on production methods. The article presents an overview of the production processes of these bioactive substances, their application methods on textile materials, and the outcomes of antibacterial performance evaluations.

Keywords: Antibacterial; antibacterial textile; bioactive compounds; functional textiles

*Corresponding author: Gürsel Korkmaz, email: gurselkorkmaz@cumhuriyet.edu.tr

INTRODUCTION

Antibacterial textiles can contribute prevent nosocomial infections and reduce the spread of antibacterial resistance. The World Health Organization (WHO) emphasized that more research should be conducted on antimicrobial textiles because textiles used in hospitals provide a suitable environment for the growth of hospital-acquired microorganisms (WHO, 2023). Antibacterial textiles can significantly benefit high-traffic areas such as hospitals, schools, public transportation, and gyms. In healthcare settings, antibacterial textiles can provide benefits in surgical gowns, bed linens, and curtains. Additionally, these materials can be an important strategy for reducing contamination and the spread of antibiotic-resistant microorganisms because they come into contact with people.

Following the COVID-19 pandemic, increased attention to hygiene and health in consumer habits has increased the demand for antibacterial textiles. People have begun to prioritize the health and safety features of the textile products they use in their daily lives, as well as their aesthetic and comfort features (Research and Markets, 2025). Grand View Research (2024) estimates that the antimicrobial textile market, which was USD 11.93 billion in 2023, will rise

to USD 19.04 billion in 2030. Additionally, products with antibacterial properties, such as bed sheets, pillowcases, and towels, have gained market share in the home textile sector.

Antibacterial textiles are created by integrating bioactive substances into different composition of textiles, such as cotton, polyester, and silk, in various forms, including fibers, yarns, and fabrics. The chemical structure of the bioactive agent and the textile material, as well as the functional groups present in the polymer chain, are crucial in these processes. Sometimes pretreating the textile material with plasma treatment, chemical modification, or mordanting creates active groups to which the bioactive agent can bind. Additionally, bioactive substances can be incorporated into the fiber structure during spinning processes, such as electrospinning or melt spinning, to create antibacterial fibers or surfaces. Washing resistance is another important consideration. Single-use products are not expected to be wash-resistant, but reusable products, such as sheets, pillowcases, and duvet covers, are. Washing resistance generally relates to the nature of the bioactive agent's binding to the textile material and the bond's resistance to washing conditions (Korkmaz, 2019).

Antibacterial textile materials are evaluated using various qualitative and quantitative standards. Qualitative methods typically examine the formation of inhibition zones on textiles placed on microorganism strains inoculated onto solid media. Quantitative methods focus on the percentage of bactericidal or bacteriostatic activity of a sample in contact with a bacterial solution over a specific period. These methods involve incubating the contaminated sample and the control under equal conditions for an equal period, inoculating the samples onto solid media, counting the resulting colonies, and comparing the percentage to that of the control. Standards such as the agar diffusion method and AATCC 147 stand out in qualitative methods. However, the literature shows that the AATCC 100, JIS 2801, JIS 1902, ASTM E2149, and ISO 20743 standards are frequently used in quantitative methods (Balakumaran et al., 2016; Guzińska et al., 2018; Maślana et al., 2022)

Bioactive substances used in the production of antibacterial textiles can be classified as organic or inorganic. Organic substances can be obtained from natural sources, such as neem oil, carotenoid and quinoa (Diksha et al., 2021; Suneeta et al., 2021; Taherirad et al., 2024) or synthetic substances such as quaternary ammonium salts (QAS), polypentamethylene guanidine sulfate (PPGS), and naphthalimide derivatives (Li et al., 2023; Staneva et al., 2019; L. Wang et al., 2024). The use of organic substances has been observed to impart antibacterial properties to various textile raw materials. Metals and metal oxides, particularly silver, zinc, and titanium, constitute another important class of bioactive substances in antibacterial textile applications. Inorganic bioactive substances predominantly contain metals and metal oxides and can be classified as substances obtained through biosynthesis with the help of a plant extract or microorganism (Rilda et al., 2023; Y. Zhou and Tang, 2018), or as commercially available substances (Dong et al., 2017). Bioactive substances from biowastes, such as coffee waste, olive tree leaves, and quince tree leaves, can also be evaluated for antibacterial textile production (Yılmaz and Bahtiyari, 2020; Zargarian et al., 2024). Antibacterial textiles can be produced through the extraction or direct application of these waste products, which currently have no commercial value but contain antibacterial properties.

This review focuses on the production of antibacterial bioactive substances and their application to textiles. Bioactive substances can be classified as organic, inorganic, or sustainable substances derived from waste. The study used Sciencedirect and Web of Science search engines to find recent studies on antibacterial textiles published between 2015 and 2025. The study aimed to inform future research by providing an overview of the production of antibacterial bioactive substances, their application to textile materials, binding mechanisms, and antibacterial activities.

Literature Summary on Antibacterial Textiles Obtained with Different Classes of Bioactive Substances

Antibacterial Textiles Prepared with Organic Bioactive Substances

Naturally Sourced Bioactive Substances and Textile Applications

Zhang et al. (2020) studied tannic acid (Figure 1) and the tannic acid-iron complex in order to impart antibacterial and flame-retardant properties to silk fabric. Their study revealed that untreated silk exhibited weak (22%) antibacterial activity against *Staphylococcus aureus* and *Escherichia coli,* whereas silk treated with ferrous sulfate exhibited moderate (50%) activity. Fabrics treated with tannic acid or the tannic acid-iron complex exhibited excellent activity (99.99% and 93%, respectively). Fabric treated with the complex maintained significantly higher activity even after 20 washing cycles (W. Zhang et al., 2020). Diksha et al. (2021) prepared an extract of *Glebionis coronaria (L.) Cass. ex Spach* and used spectroscopic methods to show the presence of carotenoid and flavonoid structures in the extract (Figure 2). Extraction was carried out in methanol and dichloromethane solutions. Cotton fabrics that were pretreated and premordanted with different mordants were immersed in prepared dye baths and impregnated for 10–15 minutes. Although antibacterial evaluation of the dyed fabrics was not conducted, the prepared extracts were examined at 10 mg/mL concentrations against *S. aureus* and *Aeromonas sp*. strains using the disk diffusion method. Both extracts exhibited activity against *S. aureus*, while the methanol extract was ineffective against *Aeromonas sp.* (Diksha et al., 2021).
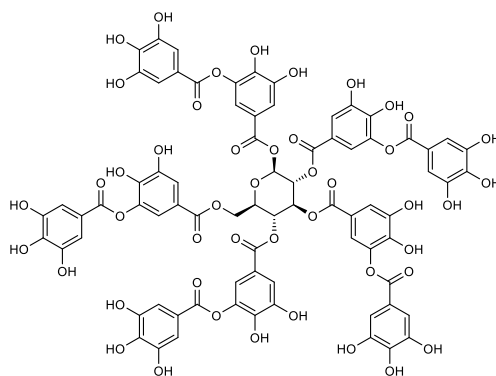
Figure 1. Chemical structure of tannic acid
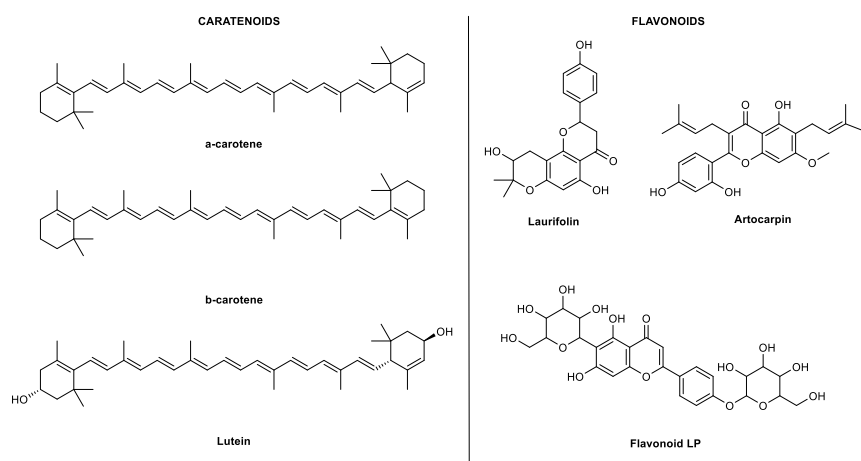
Figure 2. Chemical structures of some flavonoids and carotenoids (Diksha et al., 2021)

Taherirad et al. (2024) examined the performance of natural dyes obtained from the flowers, leaves, and stems of the quinoa plant, as well as the antibacterial properties of wool yarns dyed with these dyes. UV-VIS absorption analyses of the extracts revealed peaks associated with aromatic amino acids, carotenoids, chlorophyll, and betacyanins (Figure 3). Yarns dyed with leaf extracts after pre-mordanting with copper and iron exhibited antibacterial activity against the *S. aureus* bacterial strain. These yarns also exhibited excellent light and washing fastness, ranging from 3/4 to 4/5. However, no antibacterial activity was observed against *E. coli* in the samples (Taherirad et al., 2024).

Wu et al. (2025) oxidized a chitosan polymer obtained from natural sources. They then attempted to bond the resulting carboxyl groups to the hydroxyl groups of cellulose (Figure 4). First, the chitosan was oxidized in an HNO_3/H_3PO_4-$NaNO_2$ system. Then, it was treated with a 1:1:1 ratio of oxidized chitosan, cotton, and sodium phosphite at a 1:40 bath ratio at 80°C for one hour.

The fabrics were dried at 105 °C and fixed at 150 °C for five minutes. The antibacterial activities of the oxidized chitosan and the treated fabrics were investigated against *S. aureus* and *E. coli*. A quantitative evaluation of the fabrics, which formed an inhibition zone of 15-16.7 mm using the agar diffusion method, showed 99.99% activity against *S. aureus* and 98% activity against *E. coli*, even after 30 washes. The fabric also exhibited strong antiviral activity against bacteriophage MS2 (Y. Wu et al., 2025).

Ibrahim et al. (2016) produced antibacterial cotton fabrics by treating them with sericin (Figure 5), chitosan, and a mixture of the two. They performed the pad-dry-cure method in a padding machine using citric acid and NaH_2PO_2 as a catalyst at a 1/15 dye ratio for two hours. The dyed fabrics were dried at 80°C and fixed at 150°C for two minutes. In antibacterial analyses against *S. aureus*, the fabric treated with 10 mg/mL of chitosan exhibited 87% antibacterial activity. Meanwhile, the fabrics treated with sericin and sericin-chitosan exhibited 68% and 78% activity, respectively. After 10 washings, the activity levels were 63%, 42%, and 56%, respectively (Ibrahim et al., 2016).
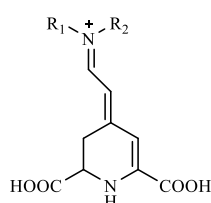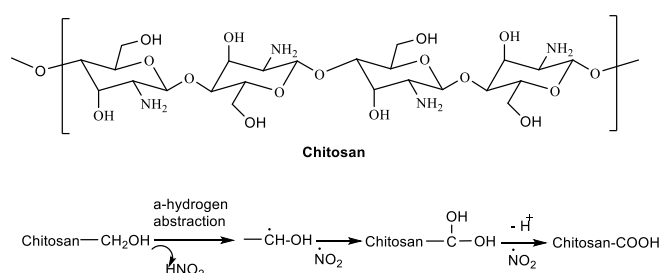

Figure 3. Chemical structure of betalain

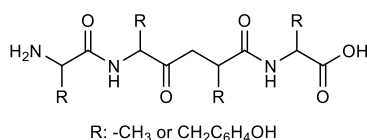**Figure 4.** Chemical structure of chitosan and chitosan oxidation

Figure 5. Chemical structure of the sericin (Aad et al., 2024)

Another study examined the interaction between chitosan and cotton. The study used commercially available chitosan, as well as chitosan synthesized by diacetylation of shrimp and crab waste. The cotton fabrics were modified with the chitosan derivative from shrimp shells, which exhibited the highest antibacterial activity. The chitosan-coated cotton samples were obtained by immersing the fabric in a solution of 2% acetic acid and chitosan for 24 hours. A 2.5% (v/v) triethyl orthoformate (TEOF) solution was also used as a crosslinker to bond the chitosan to the cellulose fibers (Figure 6). The results showed that the crosslinked fabrics produced 15 and 13 mm inhibition zones against the *S. aureus* and *E. coli* bacterial strains and exhibited stronger activity than the other sample, which produced 7 and 5 mm inhibition zones after 30 washes (Bukhari et al., 2023).

Moxibustion therapy is a traditional treatment method in Chinese medicine. Chen et al. (2024) investigated the antibacterial properties of moxa plant ashes and their extract by applying them to 100% cotton fabrics (Figure 7). They extracted the ashes in 50% ethanol at pH 4 with acetic acid at 80°C for 70 minutes. The fabrics were pre-mordanted with 3% soy protein and then dyed at 85°C for one and a half hours. In another application, moxa ash was placed on a grid and cotton fabric was placed under the grid. The ash was applied by pouring 80-90°C water onto the ashes several times. After both applications, the fabrics exhibited over 99% antibacterial activity against bacteria such as *S. aureus, Bacillus cereus,* and *E. coli* (J. Chen et al., 2024).

Another study examined the antibacterial properties of fabrics printed with Gardenia yellow dye (Figure 8). Fabrics pretreated with 10 g/L of tannic acid were colored with an inkjet printer using Gardenia yellow dye prepared at concentrations of 30–70 mmol/L. These fabrics exhibited over 95% antibacterial activity against *S. aureus* and *E. coli* bacterial strains. Tannic acid pretreatment was also found to increase washing, rubbing, and light fastness (M. Wang et al., 2023).
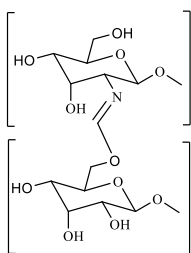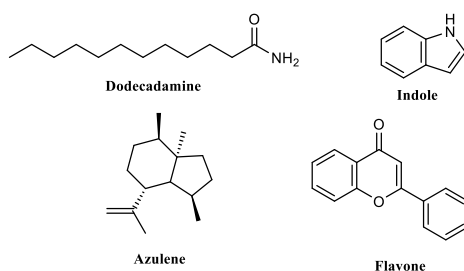

Figure 6. Chitosan bonded cellulose fiber

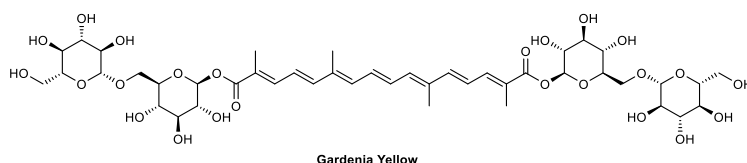**Figure 7.** Some components found in moxa ash

Figure 8. Chemical structure of Gardenia yellow dye

Zhang et al. (2023) prepared a coating material using lysozyme and tannic acid (Figure 9). Cotton, viscose, polyester, and wool fabrics were coated through two immersions in the coating bath, two spin cycles, and drying at 40°C. The cotton fabrics underwent an additional sol-gel process with 3-mercaptopropyltriethoxysilane (MPTES) and dimethyloctadecyl[3-(trimethoxysilyl)propyl]ammoniumchloride (DTSAC). Fabrics produced using this method exhibited over 99% antibacterial properties against S. *aureus* and *E. coli*. These fabrics were reported to withstand 50 washes and 10 rub cycles, and they also exhibited UV protection and antioxidant activity (N. Zhang, Wang, et al., 2023).

In another study of antibacterial textiles made from natural materials, researchers made zein and rosin baths using 70% ethanol (Figure 10). They added cotton fabrics to the baths and stirred them for two hours before rinsing them with distilled water. The antibacterial activity of the fabrics was observed to be 92.2% and 87.2% against *E. coli* and *S. aureus*, respectively (Z. Zhang et al., 2023).

Kumar et al. (2023) created microcapsules containing several active ingredients, including frankincense oil as the bioactive substance and chitosan as the shell (Figure 11). They applied the microcapsules to cotton fabrics using a padding mangle with the pad-dry method, incorporating 100 g/L of microcapsules and 30 g/L of binder. The fabrics were then dried at 80 °C for 5 minutes. The resulting fabrics exhibited 94.5% and 88.69% activity against *S. aureus* and *E. coli*, respectively. The fabrics also exhibited antioxidant, flame-retardant, mosquito-repellent, and fragrance-emitting properties (Kumar et al., 2023).

Attia et al. (2022) obtained multifunctional fabrics using the milk protein casein (Figure 12). After preparing the casein solution, they dispersed halloysite nanotubes into it using ultrasonication to form nanocomposite coating materials. The cotton fabrics were soaked in the coating solution for 10 minutes, squeezed in a two-roller padder, and dried and cured at 130°C. The fabrics formed a zone of 9 to 17.6 mm against *Bacillus sp.* and *E. coli.* The fabrics also exhibited flame-retardant properties and over 90% antiviral activity against adenovirus and herpesvirus (Attia et al., 2022).
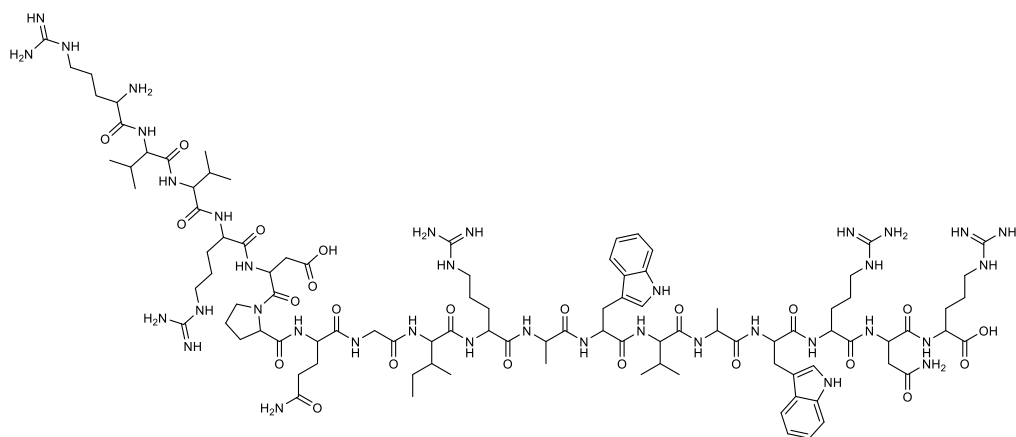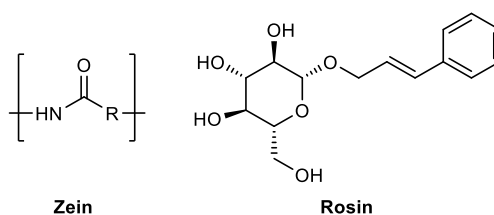

Figure 9. Chemical structure of lysozyme

Figure 10. Chemical structures of zein and rosin
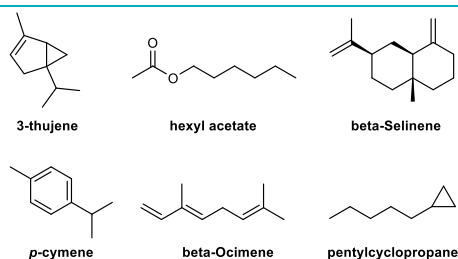
Figure 11. Some substances found in frankincense oil
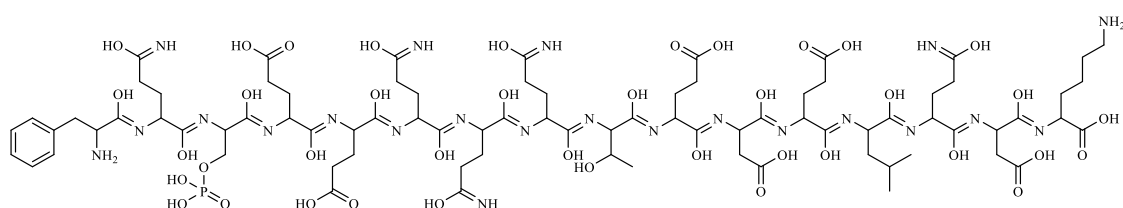

Figure 12. General structure of casein

Neem oil is effective for treating dermatological conditions such as psoriasis and eczema. Figure 13 shows some of the structures contained in neem oil. Suneeta et al. (2020) examined the process of treating cotton fabrics with neem oil extract using alum and copper sulfate as mordants. They investigated the antibacterial activity of the fabrics against *S. aureus* and *Salmonella typhi* bacteria using the AATCC 100 method. The fabrics exhibited similar levels of antibacterial activity against both bacterial species exceeding 99% with both mordants. However, it was observed that the antibacterial activity decreased to 55% and 38%, respectively, after 10 washes (Suneeta et al., 2021).

Synthetic Organic Bioactive Substances and Textile Applications

Zhou and Kan (2015) coated cotton fabrics using a combination of nitrogen plasma treatment and 5,5-dimethylhydantoin (DMH), applying the substances in different sequences. One sample was prepared without plasma treatment. Finally, they used chlorination with sodium hypochlorite to form N-halamine (Figure 14). The results showed that plasma treatment as a pretreatment resulted in better DMH binding to the fabric surface. These fabrics were reported to exhibit strong antibacterial activity against *S. aureus* and maintain this activity after rechlorination and washing (C. E. Zhou and Kan, 2015).
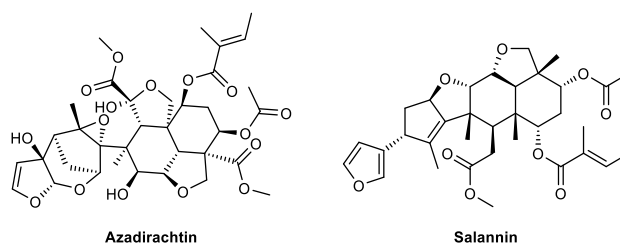

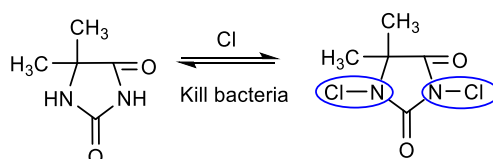**Figure 13.** Some components found in neem oil

Figure 14. Reversible redox reaction of DMH with halamine structures (N-halamine structures highlighted by blue cycles)

Wang et al. (2024) prepared biobased, antibacterial polyamide 6 (PA6) fibers using an ethylene-methyl acrylate-glycidyl methacrylate (EMA) terpolymer as a binder and polypropylene glycol succinate (PPGS) as an antibacterial agent (Figure 15). The fibers prepared with a 1% binder exhibited 99.99% antibacterial activity against the *S. aureus* and *E. coli* bacterial strains (L. Wang et al., 2024).

Akkaya and Özseker (2019) pretreat polyacrylonitrile (PAN) fabric with a nitrilase enzyme (Figure 16), followed by coating it with tetracycline. Characterization revealed the formation of -COOH groups in the polymer backbone due to the enzymatic treatment. Sample fabrics were analyzed against *S. aureus* bacterial strains using a similar agar diffusion technique. The results showed that although the fabric did not create an inhibition zone, no bacterial growth occurred in the area in contact with the fabric. The antibacterial activity of the fabric was maintained for eight weeks (Akkaya and Ozseker, 2019).

He et al. (2017) synthesized a zwitterionic sulfobetaine (CSPB) compound that contains a triazine group. They applied this compound to cotton fabrics (Figure 17). They applied a 30 x 40 cm² cotton fabric sample to a 20 g/L CSPB solution using a 10 g/L $NaCO_3$ padding method and cured it at 90 °C for three minutes. The authors reported that the betaine group in the compound's structure provided antibacterial activity and that the reactive triazine group provided binding. The resulting fabrics exhibited 95% and 98% activity against *S. aureus* and *E. coli* bacterial strains, respectively. The authors observed that the activity persisted for 30 washings (He et al., 2017).
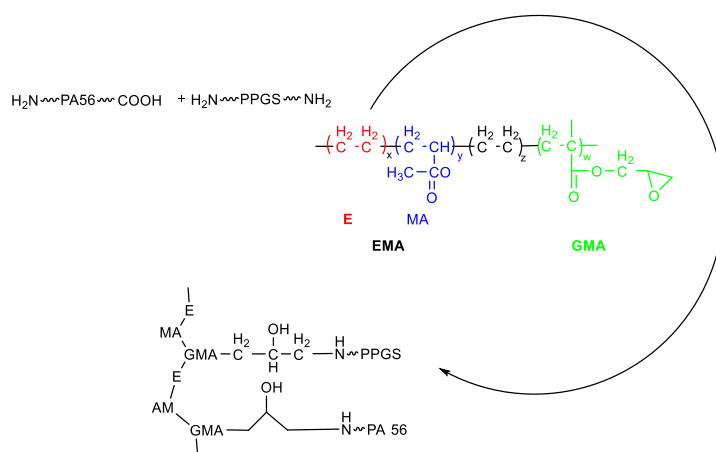

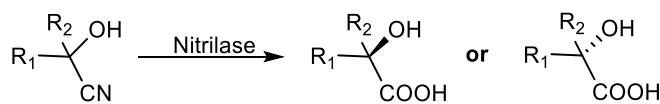**Figure 15.** Modification of PA56 fibers
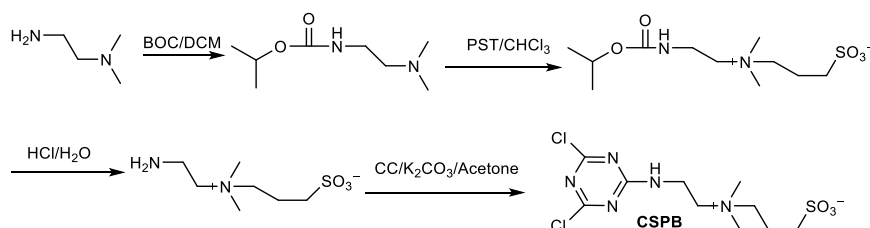

Figure 16. Nitrilation of PAN fibers

Figure 17. Syntehsizing of CSPB compound

Staneva et al. (2019) treated cotton fabric with chloracetyl chloride (CAC) in an *N,N-*dimethylformamide solution. After rinsing the fabrics with distilled water and drying them, they were dyed with a 1,8-naphthalimide derivative (NI). The researchers synthesized the NI according to a method found in the literature. The fabrics were dyed at a 1/40 bath ratio, at pH 8, and at 40 °C for 80 minutes (Figure 18). Finally, the fabrics were washed with ethanol and distilled water, followed by a nonionic detergent wash. The prepared samples exhibited 75%, 62%, and 47% antibacterial activity, respectively, against the bacterial strains *B. cereus, Acinetobacter johnsonii,* and *Pseudomanas aeruginosa* (Staneva et al., 2019).

Hongrattanavichit and Aht-Ong (2021) modified nanocellulose derived from sugarcane pulp using organosilane derivatives. The nanocellulose and organosilane derivatives were pre-hydrolyzed at a 1:3 ratio in an ethanol-water mixture at 60 °C. Then, the mixture was adjusted to pH 4 with acetic acid, and the solution was treated at 60 °C for two hours to prepare the silane-modified nanocellulose. The modified nanocelluloses were prepared at different concentrations, and cotton fabrics were immersed in these solutions for varying lengths of time. The fabrics were then fixed at 120 °C for two hours (Figure 19). Finally, unadhered components were removed by washing with acetone. All treated fabrics exhibited 99.99% activity against *S. aureus* and *E. coli bacterial* strains. Fabrics treated with APMS at a concentration of 0.50%-0.75% exhibited 99.99% activity against both bacterial species after ten washes (Hongrattanavichit and Aht-Ong, 2021).
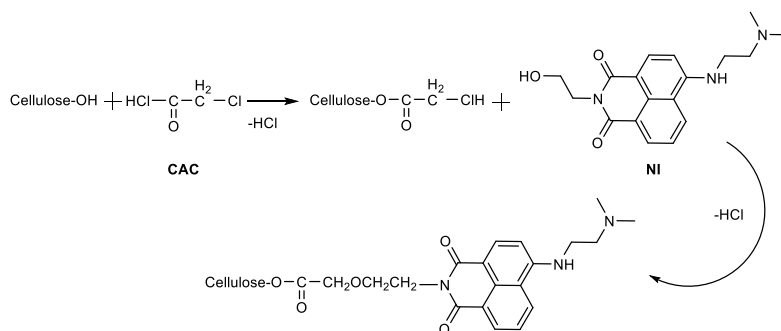

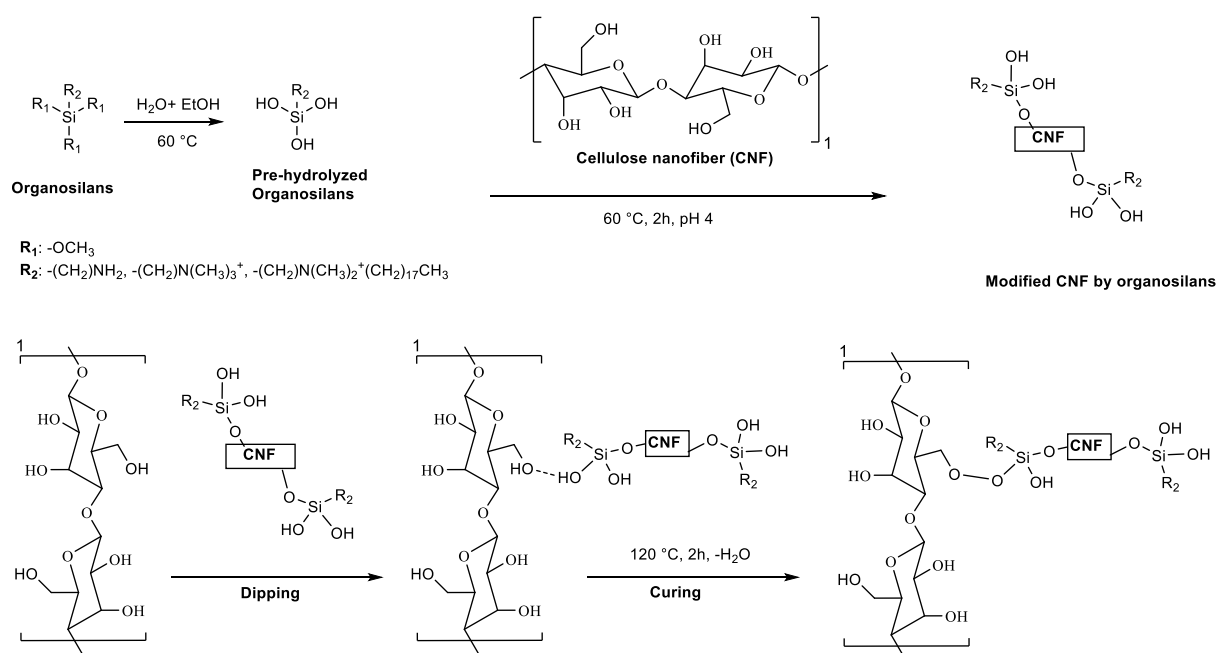**Figure 18.** Synthesis of a 1,8-naphthalimide derivative and modification of cellulose

Figure 19. Synthesizing of CNF-organosilan derivatives and treatment of cellulose by CNF-organosilanes

Zheng et al. (2022) grafted QAS onto cellulose nanocrystals (CNCs), as shown in Figure 20. They added these materials to a PAN solution to form the shell of the yarn, which was produced using the co-spinning method with a cotton core. However, only CNC-PAN and QAS-PAN shell yarns were produced. Fabrics obtained from yarns with CNC-PAN shells did not exhibit antibacterial activity. In contrast, yarns with QAS-PAN shells exhibited 93% and 99% activity against *S. aureus* and *E. coli*, respectively. Fabrics obtained from CNC-QAS-PAN shell yarns exhibited 99.99% bacteriostatic activity against both bacterial species within 120 minutes. The activity of fabrics stored in the dark for 60 days persisted, remaining above 99% after 10 washings (Zheng et al., 2022).

Deng et al. (2023) developed high-antibacterial-activity cellulose-based nonwoven fabrics by combining MXene quantum dots with antibacterial agents. In the study, Ti_3AlC_2 was treated with lithium fluoride and HCl at 35 °C for 24 hours. Then, the layers were separated using washing, centrifugation, and sonication in ethanol and dispersed in deionized water. These processes resulted in the formation of Ti_3AlC_2 (MXene) nanosheets. These nanosheets were then mixed with ethylenediamine and deionized water in an ultrasonic bath for 40 minutes. The mixture was then subjected to hydrothermal treatment at 180 °C. MXene quantum dots (MQDs) were prepared by filtration. On the other hand, the NCA compound was synthesized by neutralizing neomycin sulfate with $NaHCO_3$, reacting it with 3,4-dihydroxybenzaldehyde, and reducing it with $NaBH_4$ (Figure 21). To produce functional fabrics, cellulose nonwovens were sequentially immersed in an MQDs suspension, a Ni^+ solution, and finally an NCA solution in a nitrogen atmosphere. This last step was carried out with slow mixing for nine hours. The resulting fabrics exhibited 99.99% antibacterial activity against *S. aureus* and *E. coli*, as well as sensor properties, producing different fluorescent shades at different bacterial concentrations (Deng et al., 2023). Li et al. (2023) oxidized cotton fibers using the NaBr/TEMPO/NaClO system, forming carboxylate groups on the cellulose chains. Functional cotton fibers were obtained after treating the oxidized fibers with trimethylstearylammonium chloride (STAC) in distilled water at 60 °C for three hours. The fibers were then rinsed with deionized water and dried in a vacuum (Figure 22). Spunlace nonwoven fabrics were obtained by blending these fibers with 0–75% untreated cotton fibers at various ratios. Fabrics containing 10% functional fibers exhibited 90% activity against *S. aureus*, 99% activity against *E. coli*, and 85% activity against *Candida albicans*, respectively. They exhibited 99.99% activity against all microorganisms at a concentration of 50% (Li et al., 2023).
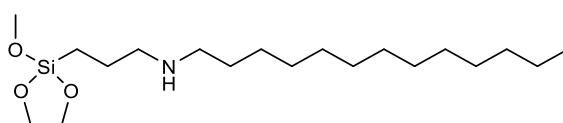

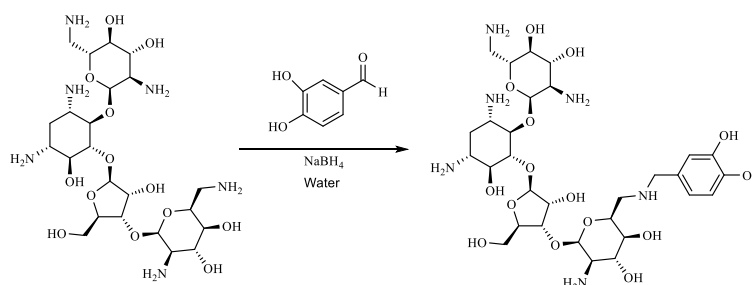**Figure 20.** Chemical structure of QAS

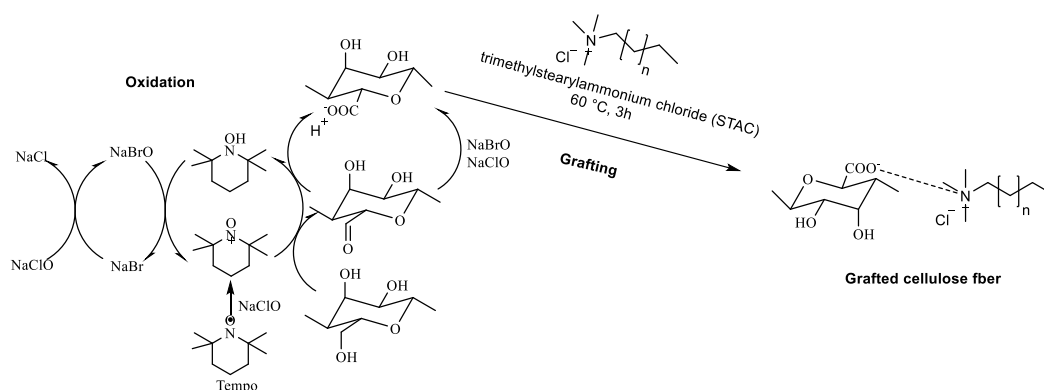**Figure 21.** Catechol-functionalized neomycin (NCA)

Figure 22. Oxidation of cellulose fiber and STAC-grafted cellulose fiber

In accordance with the literature, Demirdogen et al. (2020) synthesized 2-fluoropyridine derivatives and their Ni, Cu, and Co complexes (Figure 23). They prepared functional cellulose acetate gels by mixing the synthesized complexes with cellulose acetate at a 1:60 mass ratio in acetone for one hour at room temperature. Microfibrils were obtained by electrospinning. The obtained complex compounds exhibited the following activity against *S. aureus* and *E. coli*: 39 and 78 μg/mL for the Co complex, 78 and 150 μg/mL for the Ni complex, and 10 and 310 μg/mL for the Cu complex, respectively. Disk diffusion assays produced similar results against both bacterial strains, ranging from 14.8 to 19.3 mm. Textile fibers functionalized with the three complexes exhibited antibacterial activity ranging from 75 to 80% against both bacterial strains. The quantitative analysis results were similar for each complex (Demirdogen et al., 2020).

Xu et al. (2021) conducted a study on imparting antibacterial properties to PAN fibers. In this study, they formed hydroxyl groups on the PAN polymer chain by first treating it with COO-Na in a NaOH medium, and then with 0.1 M HCl (P-COOH). Then, chitosan was attached to the membrane in the presence of 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC) and N-hydroxysuccinimide (P-COOH-CS). Then, dyeing was carried out in a basic medium containing salt at 70 °C for six hours (P-COOH-CS-Dye). Finally, poly(hexamethylene biguanide) hydrochloride (PHMB) was immobilized on the dyed membranes for three hours (Figure 24). The antibacterial activities of the obtained membranes were investigated qualitatively and quantitatively. The authors reported that the P-COOH, P-COOH-CS, P-COOH-PHMB, and P-COOH-CS-PHMB membranes exhibited approximately 15%, 60%, 70%, and 90% activity, respectively, when compared with previous studies. Samples stained with Reactive Green 19 (RG19) and Reactive Red 141 (RR141) exhibited antibacterial activity against *E. coli* close to 100% and were wash-resistant (Xu et al., 2021).

Chen et al. (2023) formed dialdehyde groups on the cellulose polymer chain as a result of oxidation of cotton fabric with NaIO$_4$. Oxidized cotton fabrics were then added to Salmon protamine (PM) solutions prepared in deionized water and stirred at 25 °C for up to 3 hours to form a Schiff base, followed by ultrasonication with deionized water (Figure 25). The modified fabrics were found to exhibit 99% antibacterial activity against *S. aureus* and *E. coli*, withstanding 50 washing cycles and 500 mechanical treatments (M. Chen et al., 2023).
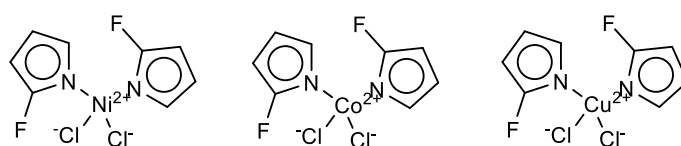

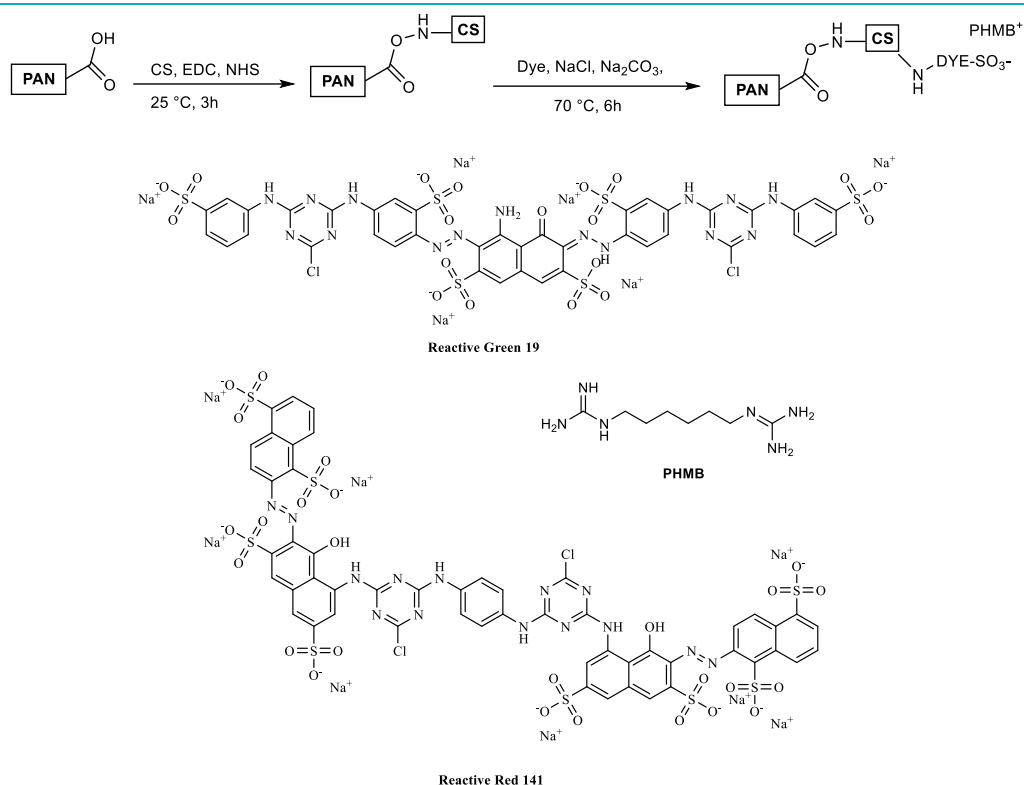**Figure 23.** 2-fluoropyridine metal complexes

Figure 24. Preparing of P-COOH-CS-Dye-PHMB, chemical structure of RG19, RR141 and PHMB
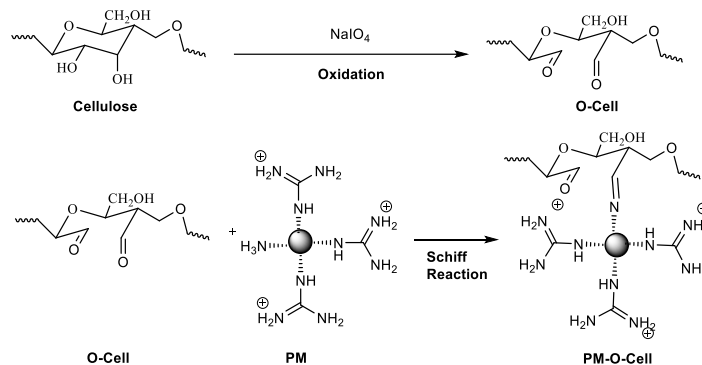
Figure 25. Cellulose oxidation and PM treatment on oxidized cellulose

Researchers investigated the antibacterial properties of fabrics made from polyester, poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), and polylactic acid (PLA) fibers, which were coated with polylactide oligomers (PLAO) (Figure 26). The study used fifty patient rooms from four different sections where the PLAO-coated textiles were placed. After seven days, six bacterial species (*S. aureus, Enterococcus faecalis, Haemophilus influenzae, E. coli,* and *P. aeruginosa*) were isolated and measured. As a result of the clinical study, 94% of the samples had fewer than 20 colony-forming units (CFU)/100 cm², and 50% had 0 CFU/100 cm², which meets

hygiene standards. In the in vitro study, uncoated fabrics exhibited 99.9% and 88% activity against *S. aureus* and *E. coli*, respectively. However, after five washes, activity decreased to 95% and 72%, respectively. Coated fabrics maintained 99.9% activity after five washes (Ma et al., 2024).

Naz et al. (2025) first subjected cotton fabric to a cationization treatment using 20 g/L mercaptopropyltris(methyloxy)silane at a 1:50 bath ratio, at 50 °C for 6 h. The fabrics were then cured at 100 °C for 1 min. The cationized cotton fabrics were subsequently coated with a 4% CQD solution (Figure 27). The CQD-coated fabrics exhibited over 88%

antibacterial activity against *S. aureus* (Naz et al., First, Wu et al. (2024) dissolved alphalipoic acid (ALA) in ethanol (EtOH) and prepared solutions of ALA, 1-(3-dimethylaminopropyl)-3-ethyl carbodiimide hydrochloride (EDC), and N-hydroxysuccinimide (NHS) in a 2:2:1 molar ratio, respectively. They added PEI to this solution and stirred it for 24 hours. Then, they removed the EtOH in an evaporator and dried it by freeze-drying to obtain ALA-grafted PEI (mPEI) (Figure 28). Then, mPEI was grafted onto vinylated

2025).

cotton fabric after 24 hours at 4 °C in a 50 g/L methacrylic anhydride solution via a thiol-ene click reaction. Finally, AgNPs were bonded to the cotton fabric via an in situ reaction with $AgNO_3$. The fabrics exhibited over 99% antibacterial activity against both *S. aureus* and *E. coli* after 30 minutes. This effect was observed to persist even after 20 washing cycles (L. Wu et al., 2024).
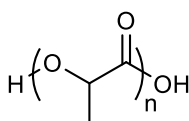
Figure 26. Chemical structure of PLAO
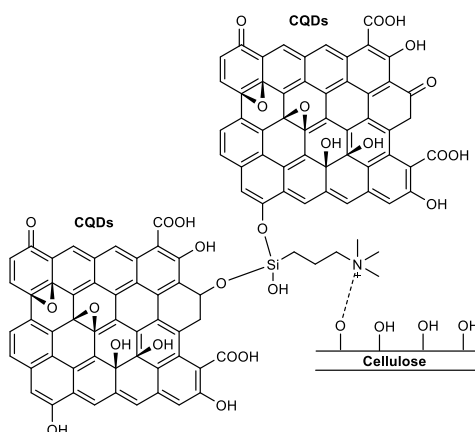
Figure 27. CQDs-treated cationized cellulose
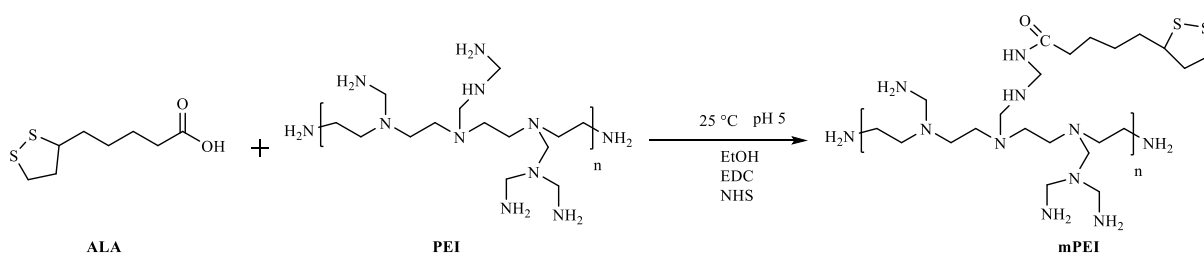
Figure 28. Synthesizing of mPEI

Antibacterial Textiles Prepared with Inorganic Bioactive Substances

Biosynthesized Inorganic Bioactive Substances and Textile Applications

The flowers of the Lonicera japonica Thunb. tree, commonly known as honeysuckle and found in East Asia, are rich in chlorogenic acid, which is known for its bioactive properties (Figure 29). Chlorogenic acid acts as a reducing agent in the biosynthesis of silver nanoparticles (AgNPs). Zhou and Tang (2018) used honeysuckle extraction to synthesize and stabilize AgNPs. The researchers prepared AgNPs by shaking

AgNO₃ in honeysuckle extract at pH 9, 50 °C, and for 60 minutes. The silk fabrics were then treated in an AgNP solution at pH 4, 80 °C for 1 hour. After treatment, the fabrics exhibited antibacterial activity against *S. aureus* and *E. coli*. They maintained over 70% activity against both bacteria even after 30 washings (Y. Zhou and Tang, 2018).

Rilda et al. (2023) synthesized zinc oxide nanorods (ZnO-NRs) from the mushroom *Agaricus bisporus* using the sol-gel hydrothermal method. First, ZnO seeds were mixed with zinc nitrate in a basic medium. Then, hexamethylenetetramine (HMT), polyethylene glycol (PEG) 6000, and mushroom powder were added and stirred for six hours. The gel was then autoclaved at 160 °C for 12 hours. The resulting gel was dried at 200 °C for four hours and then calcined at 700 °C for four hours to produce ZnO-NRs. Cotton fabrics were treated with 0.5 M adipic acid and 0.3 M NaH₂PO₂ as crosslinkers for 12 hours. The ZnO-NRs were transferred to the fabrics using the dip-spin coating method. To provide hydrophobicity, the fabric was treated with a 20% dodecyltriethoxysilane (DTES) solution (Figure 30) and then cured at 170 °C after rinsing. Finally, the fabrics were cured in an autoclave at 120 °C for three hours. The fabrics produced inhibition zones of 20 mm and 30 mm against the *S. aureus* and *P. aeruginosa* bacterial strains, respectively (Rilda et al., 2023).
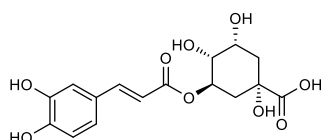
Figure 29. Chemical structure of chlorogenic acid
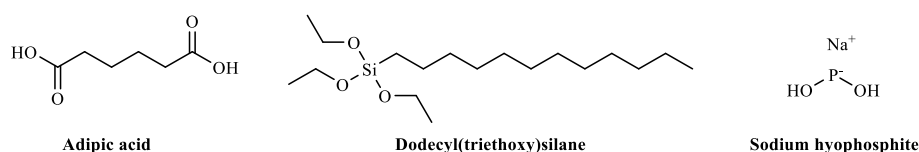
Figure 30. chemical structure of adipic acid, DTS, and sodium hypophosphite

In another study of ZnONPs, the fungus *Aspergillus terreus* was employed. The fungus was incubated in a Czapek Dox medium at a pH of 6.0, at a temperature of 28 °C, and at a speed of 150 rpm for three days. After incubation, the biomass was separated using Whatman paper. (Zn(CH₃CO₂)₂) was then added to the filtrate at various ratios, after which the mixture was incubated at 28 °C for 24 hours. The solid material formed during incubation was filtered and dried at 150 °C for 48 hours. Cotton fabrics measuring 30 cm² x 15 cm² were immersed in the prepared ZnONP solution for five minutes, wrung out, dried, and cured at 150 °C for two minutes. Microdilution results showed that the minimum inhibitory concentration (MIC) values against the Gram-positive bacteria *S. aureus* and *Bacillus subtilis* were 250 μg/mL, while the MIC value against the Gram-negative bacteria *E. coli* and *P.* aeruginosa was 500 μg/mL. Fabrics coated with a 20 ppm ZnONPs solution exhibited 82% and 75% antibacterial activity against Gram-positive (*S. aureus* and *B. subtilis*) and Gram-negative (*P. aeruginosa* and *E. coli*) bacterial strains, respectively. The fabrics also exhibited anti-UV properties (Fouda et al., 2018).

Ibrahim et al. (2016) isolated the bacterial strain *Streptomyces sp*. from marine sediment and used it to synthesize AuNPs. First, cotton and viscose fabrics were treated with O₂ plasma. Then, the fabrics were coated with AuNPs and a combination of these nanoparticles, ZnO and TiO₂, at a 1/15 bath ratio at pH 9 in an ultrasonic bath at 60 °C for 30 min. The fabrics were coated with 2% of the nanoparticles at a bath ratio of 1:15 at pH 9 in an ultrasonic bath at 60 °C for 30 minutes, after which they were rinsed

with distilled water. The fabrics exhibited significant antibacterial activity against *S. aureus* and *E. coli* strains, maintaining their activity even after 15 washings. Fabrics treated with AuNPs/ZnONPs, AuNPs/TiO2NPs, and AuNPs exhibited the strongest activity, respectively (Ibrahim et al., 2016).

Thanka Rajan et al. (2024) synthesized cerium dioxide (CeO_2) nanoparticles using a chemical precipitation method. Additionally, they synthesized nanocarbons using orange juice and ethanol and hybrid nanoparticles by ultrasonicating the mixture overnight. Fabrics were mixed in dispersions prepared from the resulting nanohybrid and other nanoparticles for two hours. Then, the fabrics were ultrasonicated in the same bath for 30 minutes at 60 °C. Experiments with *S. aureus* and *E. coli* bacterial strains revealed that fabrics treated only with nanocarbon did not create inhibition zones. In contrast, the nanohybrid-coated fabric formed zones of inhibition measuring 45 mm and 25.25 mm, respectively. Fabrics treated only with CeO_2 NPs formed zones of inhibition measuring 40 mm and 23 mm (Thanka Rajan et al., 2024).

Attia et al. (2023) synthesized CNCs from waste cotton clothing and phosphorylated them (F-CNCs). They coated viscose fabrics with F-CNCs, a graphene layer obtained by carbonizing tangerine peel, and polyaniline (Figure 31) and polypyrrole nanofibers. The treated viscose fabric produced 14.5 mm and 18.4 mm of inhibition against the *S. aureus* and *E. coli* bacterial strains, respectively. The fabric also exhibited flame-retardant, UV-resistant, and electrically conductive properties (Attia et al., 2023).
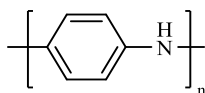
Figure 31. Chemical structure of polyaniline

Commercially Supplied Inorganic Bioactive Substances and Textile Applications

Spielman-Sun et al. (2018) examined the antibacterial properties of polyester fabrics treated with various forms of silver, as well as the release of silver after contact with artificial sweat and wastewater leachate. Specifically, they examined the antibacterial activity of fabrics treated with AgNp, AgCl, and AgO fibers following exposure to artificial sweat and wastewater leachate. Contact with solutions containing Cl ions (such as NaCl and artificial sweat) resulted in increased silver release compared to deionized water. However, sodium sulfide and acetic acid solutions reduced the release. Furthermore, AgCl-coated fabrics were found to be more chemically resistant than fabrics containing AgO. In summary, the authors reported that fabrics containing 10 µg of silver retained high antibacterial activity (Spielman-Sun et al., 2018).

Zhang et al. (2023) used lysozyme to stabilize molybdenum disulfide nanosheets during ultrasonic peeling. In a reducing environment, the lysozyme transformed into an amyloid-like phase, accumulated on the wool fabric, and then coated the AgNPs in situ. The resulting fabrics produced reactive oxygen species in the presence of light and exhibited antibacterial activity by releasing silver ions. The fabrics exhibited nearly 100% activity against *S. aureus* and *E. coli* and maintained over 99% of their activity after 50 washing cycles (N. Zhang, Shi, et al., 2023).

Dong et al. (2017) developed polyvinylidene fluoride (PVDF) nonwovens with one surface coated with PAN and the other surface coated with ZnO. First, PVDF was mixed in a dimethylformamide (DMF)/acetone mixture containing 1,3-diaminopropane (DAP), and then nanofiber layers were produced on aluminum foil by electrospinning. The layers were then coated with silane in an ethanol solution containing 10% (3-aminopropyl)trimethoxysilane (APTES) at 70 °C for ten hours. Then, ZnO cores were formed in an ethanol solution containing zinc acetate dihydrate and NaOH. The ZnO cores were then grown in solutions containing zinc nitrate hexahydrate and hexamethylenetetramine (HMTA) at 90 °C to obtain

ZnO-coated PVDF. Due to the use of aluminum foil, only one surface was coated with ZnO. Finally, a 7% PAN solution was applied to both the ZnO-coated and uncoated surfaces by electrospinning to prepare bifacially modified nanofiber sheets. Agar diffusion evaluation show that the ZnO-coated surfaces exhibited 8.8-13 mm inhibition zone against *E. coli* (Dong et al., 2017).

MXenes are two-dimensional, thin-layered materials composed of transition metal carbides, nitrides, or carbonitrides. They are used in sensors, water treatment, and textiles. These structures can adversely affect bacteria by generating reactive oxygen species when exposed to light. Yu et al. (2024) studied antibacterial cellulose nonwoven fabrics. In their study, the researchers bonded nanocellulose (CNs) to MXene and coated the outer layer with zeolitic imidazolate framework-8 (Figure 32). The MXene exhibited antibacterial activity by generating ROS under light and enhanced the binding of ZIF-8 on the outer layer. This smart material is photocatalytically triggered and was observed to rapidly destroy pathogenic bacteria (*S. aureus* and *E. coli*) within five minutes. The authors also found that Zn^{2+} ions released from the outer layer inhibited bacterial growth for two days (Yu et al., 2024).

The formation of ZnO nanoparticles was achieved through a systematic procedure involving the addition of 50 milliliters of a 1% hexamethyltriethylene tetramine (HMTETA) solution (see Figure 33) to 150 milliliters of zinc nitrate solutions, which had been prepared at concentrations ranging from 6.66 to 20 grams per liter. These solutions were then subjected to a stirring process for a duration of 30 minutes. Cotton fabrics were added into the resulting solution at a 1/50 bath ratio and agitated for a duration of 20 minutes. The fabrics were rinsed with distilled water, followed by drying and a cured at 140°C for three minutes. The coated fabrics demonstrated approximately 90% antibacterial activity against *S. aureus* and *E. coli* even after 20 wash cycles (Shaheen et al., 2016).

In a recent study, Jiang et al. (2025) fabricated PA6 fibers comprising Cu_2O-GO nanocomposites, which exhibited both immediate and sustained effects. The first step in the synthesis was to disperse graphene oxide (GO) in deionized water, followed by the addition of EDTA-2Na (Figure 34) and stirring for a period of three hours. Subsequently, $CuSO_4 \cdot 5H_2O$ was incorporated for a duration of one hour to facilitate the chelation process. Thereafter, NaOH and ascorbic acid were added and thoroughly mixed for an additional ten minutes. The synthesis of Cu_2O-GO nanocomposites was completed by subjecting the mixture to vacuum drying at a temperature of 60°C for a duration of 12 hours. The production of composite fibers entailed the incorporation of dispersions prepared from the nanocomposites into the caprolactane polymerization reactor at a 1/9 ratio. Subsequent polycondensation and purification of the resulting resins through melt spinning were then employed. Fibers containing 0.6% Cu_2O-GO demonstrated near-total activity against *B. subtilis* and *E. coli* within 10 minutes and retained 99.99% of their activity even after 50 washes (Jiang et al., 2025).
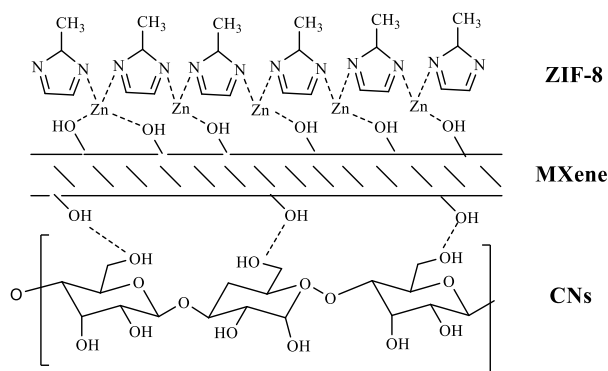

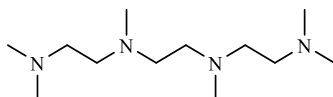**Figure 32.** ZIF-8-MXene modified CNs

Figure 33. Chemical structure of HMTETA

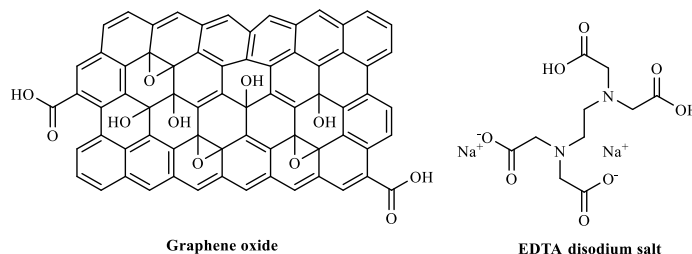Graphene oxide

EDTA disodium salt

Figure 34. Chemical structure of graphene oxide and EDTA disodium salt

In a related study, Najmi et al. (2023) reported that a $CuSO_4$ solution was stirred at 60 °C in the presence of NaOH in a basic medium until the color turned black. The resulting nanoparticles were separated by centrifugation. Then, they were washed and dried. The drying process was done at a temperature of 400°C for two hours to strengthen the crystal structure. The fabrics were cut into $2x2$ cm^2 pieces, and 100 μL of a nanoparticle solution with a concentration of 70 μg/mL was applied to fabrics made of different raw materials. Then, the fabrics were dried at 60°C for three hours. The coated fabrics showed 50% and 70% antibacterial activity against *Staphylococcus epidermidis* for nylon and neoprene, respectively (Najmi et al., 2024).

Fang et al. (2023) created a special coating for polyester fabrics using a spray method. They used a material called polyacrylate polymer and copper oxide spheres of different sizes. We made copper oxide nanospheres of different sizes by using different amounts of copper acetate and trisodium phosphate. Depending on their size, nanospheres in purple, blue-green, yellow, and orange colors were obtained. First, a 20% polyacrylate solution was sprayed onto polyester fabrics. Then, it was heated to 160°C for three minutes. Finally, 1% Cu_2O nanospheres were coated on the surface using the same method and cured under the same conditions. Fabrics coated with 202-nm green nanospheres showed almost 100% antibacterial activity against *S. aureus* and *E. coli* bacteria (Y. Fang et al., 2023).

In a later study, cotton fabrics measuring $5x10$ cm^2 were put into a liquid that had 1 milligram of ZnO particles and 2% OWF cellulase in it. After 30 minutes of treatment at 55°C, the samples were rinsed with distilled water and dried. The fabrics were 70% effective against *S. aureus* and 98% effective against *E. coli*. After just one wash cycle, the activity levels were recorded as 50% and 68%, respectively (Petkova et al., 2016).

Vieira et al. (2023) used gold-hydroxyapatite nanoparticles (AuNPs-HAp) to make cotton, polyester, and cotton/polyester fabrics more antibacterial. The fabrics were initially treated with bleach and a special plasma treatment. The bleaching process was done only on 100% cotton fabric, using a plasma treatment that used an atmospheric pressure DBD apparatus. The cotton/polyester and polyester fabrics were exposed to plasma treatment under the same conditions. Then, the fabrics were coated with a mixture of gold nanoparticles and a special liquid called Hap at a pH of 9. After that, the fabrics were then tested against *S. aureus, E. coli, P. aeruginosa,* and *S. epidermidis*. The findings showed that the 100% cotton fabric exhibited the highest antibacterial activity. The other two fabrics were less effective against *S. epidermidis* but demonstrated comparable performance to cotton in inhibiting the growth of *P. aeruginosa* (Vieira et al., 2023).

Sharifikolouei et al. (2021) coated the surface of a polybutylene terephthalate nonwoven fabric with Zr,

Cu, and Ag. The fabric was able to stop 95% of bacteria from forming biofilm on the fabric. Additionally, the ion release of the fabrics over a period of 24 to 120 hours was assessed through ICP-MS, and the authors concluded that the fabrics effectively conducted indirect assessments of cell compatibility (Sharifikolouei et al., 2021).

Sunthar et al. (2021) conducted a study on aluminum nitride-coated cellulose acetate composite materials. Initially, powdered cellulose acetate was dissolved in acetone, triacetin was incorporated as a plasticizer, and aluminum nitride (AIN) was added as an antibacterial agent. The mixture was thoroughly stirred until achieving homogeneity. The material was dried at 60°C overnight to completely remove the solvent, and the composites were ready for analysis. An AIN content that exceeds 10% has been demonstrated to result in a decrease in mechanical strength and an increase in thermal resistance. A specimen that had been treated with 20% AIN showed strong antibacterial effectiveness against *S. epidermidis* and *E. coli* bacterial strains. This led to a significant reduction in biofilm and bacterial counts after 24 hours (Sunthar et al., 2021).

In a separate study, aluminum oxide in the form of a dispersion was prepared in pure water by means of an ultrasonic bath. Modified glyoxylic resin was also incorporated into the bath, functioning as a catalyst and wrinkle-reducing agent. In the coating process, 100% linen fabrics were immersed in a prepared bath. The fabrics were first dried at room temperature, then at 110°C, and finally cured at 150°C for 2-3 minutes. Fabrics coated at a concentration of 5×10^4 ppm demonstrated over 99% antibacterial activity against *S. aureus* and *E. coli* bacterial strains. Subsequent to five wash cycles, the activity levels were found to be 99% and 93%, respectively (Yılmaz and Bahtiyari, 2021).

Bioactive Substances Derived from Biowaste and Sustainable Textile Applications

Resource depletion increases the importance of the terms reuse, recycling, and reduction (3R). The processing or recycling of waste materials aims to meet the need for raw materials and semi-finished products in many sectors, thereby reducing the environmental burden. This section summarizes antibacterial textile studies based on the processing or recycling of waste (X. Zhang et al., 2025).

Tea and coffee consumption are among the important biowastes, and these are being tested in biocomposite production, soil conditioning, and antibacterial applications (Murthy and Naidu, 2012; Yun et al., 2020; Cervera-Mata et al., 2019; Yılmaz and Bahtiyari, 2020). Figure 35 shows some substances in tea and coffee extracts. Xia et al. (2022) extracted coffee and black tea waste in a slightly alkaline medium with sodium bicarbonate in a 50% ethanol solution. This process produced dyes that they expected to have antibacterial properties. They dyed silk and wool fabrics with the resulting dyes at a pH of 4.8 and a temperature of 90°C for 90 minutes. Researchers reported that the resulting fabrics showed over 90% antibacterial activity against *E. coli, S. aureus,* and *C. albicans*, as well as antioxidant and ultraviolet protection (Xia et al., 2023).

Sülar et al. created textile surfaces with different layer counts and content ratios using waste tea and coffee pulp, polyethylene terephthalate fibers, waste cotton fibers, and a cotton woven fabric as a backing. The results did not indicate structures with strong antibacterial activity. Subjective evaluation of color changes after dripping milk on the surface followed by incubation indicated that the surface containing 1.5 g of waste tea—composed of a cotton/polyester bottom layer, a polyester/tea waste middle layer, and a polyester/cotton outer layer—exhibited antibacterial properties (Sülar et al., 2025).

Zargarian et al. (2024) obtained a coffee-integrated PAN nanosurface by electrospraying the suspension obtained from the coffee waste after washing, sieving, and grinding the used coffee grounds, and by simultaneously applying PAN electrospinning to the same collector. They then aimed to obtain antibacterial surfaces by conducting dopamine polymerization on the surface (Figure 36). Coffee biowaste contains structures such as lignin and melanoidins, which exhibit antibacterial properties. The authors observed that this nanomaterial exhibited strong bactericidal activity against the bacterial strain *S. aureus* under near-infrared light (Zargarian et al., 2024).

Coffe

Phenylindanes

Chlorogenic acid

5-caffeoylquinic acid

3-caffeoylquinic-1,5-lactone

Black tea

Katechine

Theaflavin
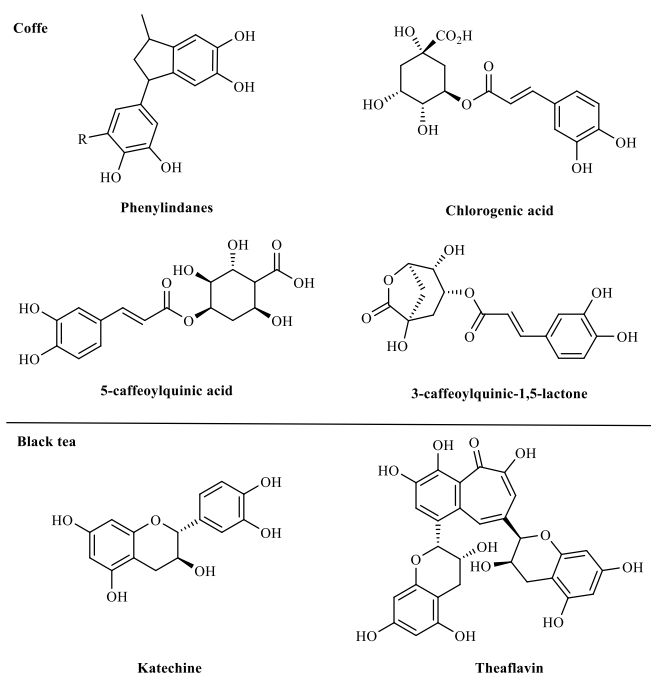
Figure 35. Some substances in tea and coffee extracts (Xia et al., 2023)
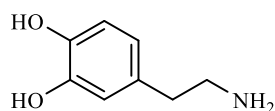
Figure 36. Chemical structure of Dopamine

Sludge generated during the treatment processes of textile factories poses an environmental burden due to its toxic components such as formaldehyde and lead. The biocidal properties of the oil obtained by pyrolysis of this structure are a significant research topic. Scheibe et al. (2022) pyrolyzed textile sludge at 500°C for 70 minutes and analyzed the elemental composition of the resulting byproducts using GC-MS. The researchers examined the antibacterial effects of pyrolysis oil on *E. coli, S. aureus, P. aeruginosa, and Klebsiella pneumoniae*. Structures such as pyridine, aniline, alcohols, aromatic hydrocarbons, ketones, and organosilicones were detected in the oil phase fraction, and this fraction exhibited antibacterial activity in the range of 9–17 mg/mL. The authors suggested that the oil phase fraction could be purified and transformed into a sustainable source of antibacterial agents, and that antibacterial textile research would be beneficial in this direction (Scheibe et al., 2022).

Plant based dyes are generally considered eco-friendly dyes due to their non-toxicity. These dyes may also contain bioactive compounds, such as phenolic compounds, which can impart antibacterial properties to fabrics. Zhang et al. (2021) published a study on the potential use of the seed coats of the *Eriobotrya japonica L. (loquat)* tree as antibacterial textile dyes. These substances are typically disposed of as waste. However, these fruits contain biologically active compounds, including flavonoids. This study examined the dyeing of wool fibers extracted from loquat seeds using traditional mordants and biomordants derived from Chinese Tallow, Folium Artemisiae Argyi, and Cinnamomum Camphora plants. The dyes were characterized by a variety of analytical methods, including UV–vis, FT-IR, SEM, TGA, EDS, and DSC analyses. Dyeings with biomordants exhibited higher color strength and stronger antioxidant, UV protection and antibacterial activity (against *S. aureus, E. coli)* than

dyeings with iron, aluminum and copper mordants (Figure 37) (Y. Zhang et al., 2021).

In another study on the extraction of dyes from plant waste, Hassan (2021) utilized dyes derived from feijoa fruit peel (B1) and mango pit (B2), in addition to commercial tannic acid (B3), to dye wool. Figure 38 shows some components of mango seed kernel and feijoa peel extracts. The results of the study indicate that B1 exhibited the optimal antistatic properties, B3 dyes demonstrated the strongest UV

protection and antioxidant activity, and wool fabrics dyed with mango pit dye displayed the most potent anti-insecticide and antibacterial properties. Antibacterial analysis, employing the AATCC 147 method, revealed that the fabrics did not form zones; however, B3 fabric exhibited no bacterial growth under the fabric (Against *S. aureus, P. aeruginosa, K. pneumoniae*). This outcome indicates that the fabrics demonstrate non-leaching antibacterial activity (Hassan, 2021).
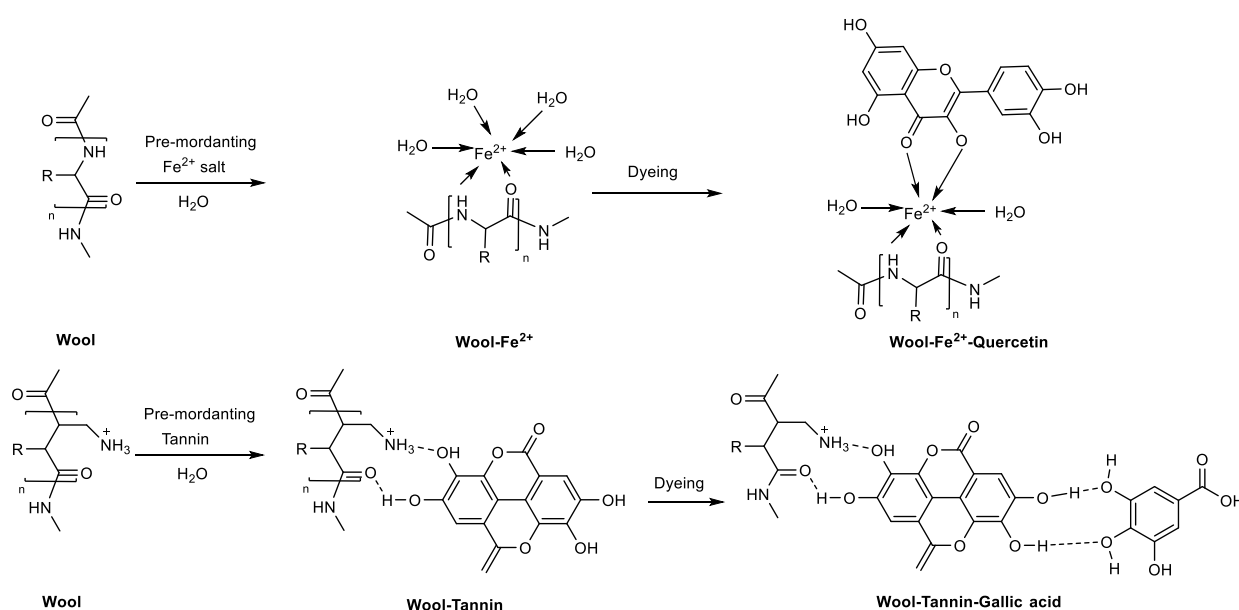

Figure 37. Binding of quercetin and gallic acid to wool pre-mordanted with metallic (Fe) and biomordant (tannic acid)
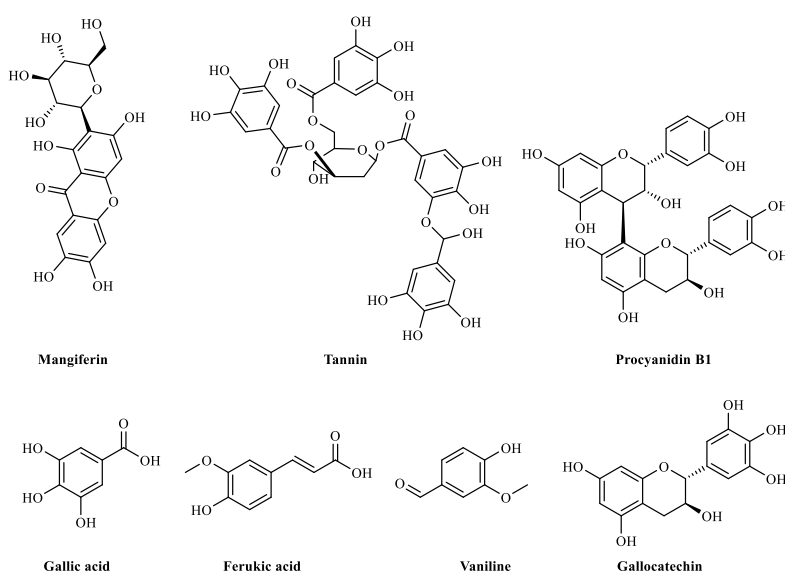

Figure 38. Some substances of of feijoa peel and mango seed

Olives are one of the most important agricultural products in Turkey and some other parts of the world. During the olive harvest, the leaves are separated and thrown away. Olive leaves contain active compounds such as phenolic compounds, p-coumaric acid, vanillin, luteolin, and vanillic acid. Yılmaz and Bahtiyari (2020) used the ground solid form of olive tree leaves and the dyes obtained by their extraction to dye cotton. The antibacterial activities of fabrics dyed with mordant-free extracts at 80°C and with ground leaves without extraction were determined to be 99.99% and 90%, respectively, against *S. aureus*. The same values were measured for *E. coli* at 95% and 70%, respectively. These fabrics were also found to have very good light and washing fastness values (4-5) (Yılmaz and Bahtiyari, 2020).

Another byproduct of silk production is sericin protein, which is separated during the process. Sericin, a protein found in silk, helps the silk cocoon stay intact. During the process of making silk fiber, this material is removed. Gökçe et al. (2020) soaped silk industry wastewater at a pH level of 9-10. Then, they removed the soap at a pH level of 3.5. Finally, they recycled sericin in powder form through filtration, precipitation, and lyophilization. Ag-Sericin nanocomposites (Ag-SNP) were made using a reductive system (NaOH/NaBH$_4$) with sericin from AgNO$_3$. Fabrics treated with 20 g/L of AG-SNP in a slightly acidic environment were observed to be 100% effective against *S. aureus* and *E. coli* bacterial strains, even after 20 washe cycles (Gokce et al., 2020).

Umesh et al. (2023) isolated pigments from the fungus *Talaromyces albobiverticillius* using liquid and solid commercial media and pineapple peel waste as media for use as textile dyes. The resulting dyes were applied to cotton fabrics with and without the mordants CuSO$_4$ and FeSO$_4$. Although the antibacterial activity of the fabrics was not investigated in this study, the antibacterial activity of the dye against *S. aureus, B. subtilis, P. aeruginosa,* and *E. coli* was investigated. The dye was inactive against *E. coli* at a concentration of 500 µg/mL, while it formed inhibitory zones of 1.3–1.9 cm in diameter against other bacterial strains. (Umesh et al., 2023). Cerempei et al. (2016) studied how to dye wool fibers with dyes made from the water extraction of waste quince leaves (*Cydonia oblonga*). The fabric was dyed at 100°C for two hours. Fabrics were treated with zinc chloride and silver nitrate in a separate bath after mordanting at 70°C, resulting in shades ranging from beige to reddish brown. They found that fabrics treated with silver nitrate were able to kill bacteria like *S. aureus, E. coli,* and *P. aeruginosa.* These fabrics also had very good color, washing, and rubbing fastness values (Cerempei et al., 2016).

Fang et al. (2022) used sweet potato leaves to dye silk, cotton, wool, and polyester fabrics. The authors tried to create a more affordable and environmentally friendly dyeing method by applying the dyes directly, without using mordants. All fabrics were dyed in 60% ethanol at a 1:10 bath ratio at 90°C and pH 7 for 90 minutes under the same conditions. The fabrics exhibited more than 98% antibacterial activity against *S. aureus* and *E. coli*. They maintained activity after 10 washing cycles, with 97% of their strength remaining, and 83% after 30 washing cycles. This study demonstrated that a single active ingredient can dye textile fibers with different functional groups without a mordant (J. Fang et al., 2022).

CONCLUSION

This review comprehensively examines antibacterial bioactive agents derived from organic, inorganic, and biological wastes and their textile applications. The reviewed studies focus on the preparation of bioactive agents, their application to textile materials, and the antibacterial activity of these materials. Furthermore, a schematic presentation of the bioactive agents, the auxiliary chemicals used, and the binding mechanisms to textile materials is provided.

Metal and metal oxide nanoparticles are attracting attention due to their easy binding properties to textile materials and their strong antibacterial effects. However, concerns exist regarding this class, such as potential toxic effects on human cells and potential environmental health hazards from wastewater. On the other hand, extracts isolated from plants offer an environmentally friendly and sustainable alternative for antibacterial textile

production thanks to their organic bioactive components. Antibacterial bioactive agents derived from environmental wastes and their textile applications also hold promise in terms of sustainability. However, limitations in this class relate to the regular supply of waste and the continuity of production. Antibacterial textiles can play a crucial role in reducing the spread of antibacterial resistance genes and the incidence of hospital-acquired infections, thereby contributing to the protection of public health. The literature summarized in this review is intended to guide future research in this field.

Conflict of Interest

The author declare no conflict of interest.

REFERENCES

Aad, R., Dragojlov, I., Vesentini, S. (2024). Sericin Protein: Structure, Properties, and Applications. Journal of Functional Biomaterials, Vol. 15. Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/jfb15110322

Akkaya, A., Ozseker, E. E. (2019). Modification of polyacrylonitrile fabric for antibacterial application by tetracycline immobilization. Polymer Testing, 78. https://doi.org/10.1016/j.polymertesting.2019.105959

Attia, N. F., Zakria, A. M., Nour, M. A. et al. (2023). Rational strategy for construction of multifunctional coatings for achieving high fire safety, antibacterial, UV protection and electrical conductivity functions of textile fabrics. Materials Today Sustainability, 23. https://doi.org/10.1016/j.mtsust.2023.100450

Attia, Nour F., Mohamed, A., Hussein, A. et al. (2022). Bio-inspired one-dimensional based textile fabric coating for integrating high flame retardancy, antibacterial, toxic gases suppression, antiviral and reinforcement properties. Polymer Degradation and Stability, 205. https://doi.org/10.1016/j.polymdegradstab.2022.110152

Balakumaran, M. D., Ramachandran, R., Jagadeeswari, S. et al. (2016). In vitro biological properties and characterization of nanosilver coated cotton fabrics - An application for antimicrobial textile finishing. International Biodeterioration and Biodegradation, 107, 48–55. https://doi.org/10.1016/j.ibiod.2015.11.011

Bukhari, A., Yar, M., Zahra, F., Nazir, A. et al. (2023). A novel formulation of triethyl orthoformate mediated durable, smart and antibacterial chitosan cross-linked cellulose fabrics. International Journal of Biological Macromolecules, 253. https://doi.org/10.1016/j.ijbiomac.2023.126813

Cerempei, A., Mureşan, E. I., Cimpoeşu, N. et al. (2016).

Dyeing and antibacterial properties of aqueous extracts from quince (Cydonia oblonga) leaves. Industrial Crops and Products, 94, 216–225. https://doi.org/10.1016/j.indcrop.2016.08.018

Chen, J., Zhou, Y., Yan, Z. et al. (2024). Moxa combustion waste and its bio activities on cotton -- a facile and green finishing process towards a sustainable and value adding application for medical textile. Journal of Cleaner Production, 483. https://doi.org/10.1016/j.jclepro.2024.144259

Chen, M., ShangGuan, J., Jiang, J. et al. (2023). Durably antibacterial cotton fabrics coated by protamine via Schiff base linkages. International Journal of Biological Macromolecules, 227, 1078–1088. https://doi.org/10.1016/j.ijbiomac.2022.11.287

Demirdogen, R. E., Kilic, D., Emen, F. M. et al. (2020). Novel antibacterial cellulose acetate fibers modified with 2-fluoropyridine complexes. Journal of Molecular Structure, 1204. https://doi.org/10.1016/j.molstruc.2019.127537

Deng, C., Yu, Z., Liang, F. et al. (2023). Surface nano-engineering of cellulosic textiles for superior biocidal performance and effective bacterial detection. Chemical Engineering Journal, 473. https://doi.org/10.1016/j.cej.2023.145492

Diksha, Singh, R., Khanna, L. (2021). Glebionis coronaria (L.) Cass. ex Spach (Asteraceae)- a new fabric dye with potential antibacterial properties. Journal of the Indian Chemical Society, 98(11). https://doi.org/10.1016/j.jics.2021.100193

Dong, Y., Thomas, N. L., Lu, X. (2017). Electrospun dual-layer mats with covalently bonded ZnO nanoparticles for moisture wicking and antibacterial textiles. Materials and Design, 134, 54–63. https://doi.org/10.1016/j.matdes.2017.08.033

Fang, J., Meng, C., Zhang, G. (2022). Agricultural waste of Ipomoea batatas leaves as a source of natural dye for green coloration and bio-functional finishing for textile fabrics. Industrial Crops and Products, 177. https://doi.org/10.1016/j.indcrop.2021.114440

Fang, Y., Chen, L., Zhang, Y. (2023). Construction of Cu2O single crystal nanospheres coating with brilliant structural color and excellent antibacterial properties. Optical Materials, 138. https://doi.org/10.1016/j.optmat.2023.113724

Fouda, A., EL-Din Hassan, S., Salem, S. S. (2018). In-Vitro cytotoxicity, antibacterial, and UV protection properties of the biosynthesized Zinc oxide nanoparticles for medical textile applications. Microbial Pathogenesis, 125, 252–261. https://doi.org/10.1016/j.micpath.2018.09.030

Gokce, Y., Aktas, Z., Capar, G. et al. (2020). Improved antibacterial property of cotton fabrics coated with waste sericin/silver nanocomposite. Materials Chemistry and Physics, 254. https://doi.org/10.1016/j.matchemphys.2020.123508

Grand View Research. (2024). Antimicrobial Textiles Market Size And Share Report, 2030. Retrieved September 24, 2025, from

https://www.grandviewresearch.com/industry-analysis/antimicrobial-textiles-market-report

Guzińska, K., Kaźmierczak, D., Dymel, M. et al. (2018). Anti-bacterial materials based on hyaluronic acid: Selection of research methodology and analysis of their anti-bacterial properties. Materials Science and Engineering C, 93, 800–808. https://doi.org/10.1016/j.msec.2018.08.043

Hassan, M. M. (2021). Enhanced insect-resistance, UV protection, and antibacterial and antistatic properties exhibited by wool fabric treated with polyphenols extracted from mango seed kernel and feijoa peel. RSC Advances, 11(3), 1482–1492. https://doi.org/10.1039/d0ra09699g

He, L., Gao, C., Li, S. et al. (2017). Non-leaching and durable antibacterial textiles finished with reactive zwitterionic sulfobetaine. Journal of Industrial and Engineering Chemistry, 46, 373–378. https://doi.org/10.1016/j.jiec.2016.11.006

Hongrattanavichit, I., Aht-Ong, D. (2021). Antibacterial and water-repellent cotton fabric coated with organosilane-modified cellulose nanofibers. Industrial Crops and Products, 171. https://doi.org/10.1016/j.indcrop.2021.113858

Ibrahim, N. A., Eid, B. M., Abdel-Aziz, M. S. (2016). Green synthesis of AuNPs for eco-friendly functionalization of cellulosic substrates. Applied Surface Science, 389, 118–125. https://doi.org/10.1016/j.apsusc.2016.07.077

Jiang, T., Zhou, J., Wang, R. (2025). Long-term and rapid antibacterial efficacy of Cu2O-GO nanocomposites for medical protective textiles. Composites Part A: Applied Science and Manufacturing, 190. https://doi.org/10.1016/j.compositesa.2024.108673

Korkmaz, G. (2019). Investigation of Antibacterial Activities of Chalcone Derivatives on Knitted Fabric Structures with Different Raw Materials. Institute of Science, Bursa.

Kumar, A., Singh, A., Sheikh, J. (2023). Boric acid crosslinked chitosan microcapsules loaded with frankincense oil for the development of mosquito-repellent, antibacterial, antioxidant, and flame-retardant cotton. International Journal of Biological Macromolecules, 248. https://doi.org/10.1016/j.ijbiomac.2023.125874

Li, Y., Zhao, H., Li, T. et al. (2023). Quaternary ammonium salts functionalized cotton fibers with highly effective and durable antibacterial performances for daily healthcare textile applications. Industrial Crops and Products, 202. https://doi.org/10.1016/j.indcrop.2023.117100

Ma, L. L., Wei, Y. Y., Li, J. et al. (2024). Clinical study of antibacterial medical textiles containing polyhydroxyalkanoate oligomers for reduction of hospital-acquired infections. Journal of Hospital Infection, 149, 144–154. https://doi.org/10.1016/j.jhin.2024.04.009

Maślana, K., Kędzierski, T., Żywicka, A. et al. (2022). Design of self-cleaning and self-disinfecting paper-shaped photocatalysts based on wood and eucalyptus derived cellulose fibers modified with gCN/Ag nanoparticles. Environmental Nanotechnology, Monitoring and Management, 17. https://doi.org/10.1016/j.enmm.2022.100656

Najmi, Z., Mlinarić, N. M., Scalia, A. C. et al. (2024). Antibacterial evaluation of different prosthetic liner textiles coated by CuO nanoparticles. Heliyon, 10(1). https://doi.org/10.1016/j.heliyon.2023.e23849

Naz, S., Ali, M., Ashraf, M. et al. (2025). Development of durable multifunctional textiles by application of carbon quantum dots synthesized from post-consumer cellulosic waste. Journal of Molecular Structure, 1335. https://doi.org/10.1016/j.molstruc.2025.141951

Petkova, P., Francesko, A., Perelshtein, I. et al. (2016). Simultaneous sonochemical-enzymatic coating of medical textiles with antibacterial ZnO nanoparticles. Ultrasonics Sonochemistry, 29, 244–250. https://doi.org/10.1016/j.ultsonch.2015.09.021

Research and Markets. (2025). Antimicrobial Textile Market Report 2025 - Research and Markets. Retrieved September 24, 2025, from https://www.researchandmarkets.com/reports/5751640/antimicrobial-textile-market-report?utm_source=GNEandutm_medium=PressReleaseandutm_code=bgsqwtandutm_campaign=2031108+-+Antimicrobial+Textile+Market+Report+2025%3a+Major+Trends+include+Sustainable+Antimicrobial+Textiles%2c+Smart+and+Wearable+Antimicrobial+Textiles%2c+Antiviral+Textiles+and+Odor+Control+Textilesandutm_exec=carimspi

Rilda, Y., Khairu Ummah, K., Septiani, U. et al. (2023). Biosynthesis of Zinc oxide nanorods using Agaricus bisporus and its antibacterial capability enhancement with dodeciltriethoxyl on cotton textiles. Materials Science and Engineering: B, 298. https://doi.org/10.1016/j.mseb.2023.116910

Scheibe, A. S., de Araujo, I. P., Janssen, L. et al. (2022). Products from pyrolysis textile sludge as a potential antibacterial and alternative source of fuel oil. Cleaner Engineering and Technology, 6. https://doi.org/10.1016/j.clet.2022.100408

Shaheen, T. I., El-Naggar, M. E., Abdelgawad, A. M. et al. (2016). Durable antibacterial and UV protections of in situ synthesized zinc oxide nanoparticles onto cotton fabrics. International Journal of Biological Macromolecules, 83, 426–432. https://doi.org/10.1016/j.ijbiomac.2015.11.003

Sharifikolouei, E., Najmi, Z., Cochis, A. et al. (2021). Generation of cytocompatible superhydrophobic Zr–Cu–Ag metallic glass coatings with antifouling properties for medical textiles. Materials Today Bio, 12. https://doi.org/10.1016/j.mtbio.2021.100148

Spielman-Sun, E., Zaikova, T., Dankovich, T. (2018). Effect of silver concentration and chemical transformations on release and antibacterial efficacy in silver-containing textiles. NanoImpact, 11, 51–57.

https://doi.org/10.1016/j.impact.2018.02.002

Staneva, D., Vasileva-Tonkova, E., Grabchev, I. (2019). Chemical modification of cotton fabric with 1,8-naphthalimide for use as heterogeneous sensor and antibacterial textile. Journal of Photochemistry and Photobiology A: Chemistry, 382. https://doi.org/10.1016/j.jphotochem.2019.111924

Sülar, V., Aksoy, S., İtani, B. et al. (2025). Production and performance of textile-based surfaces containing tea and coffee wastes. Journal of Cleaner Production, 506. https://doi.org/10.1016/j.jclepro.2025.145496

Suneeta, Harlapur, S., Harlapur, S. F. (2021). Enhancement of antibacterial properties of cotton fabric by using neem leaves extract as dye. Materials Today: Proceedings, 44, 523–526. Elsevier Ltd. https://doi.org/10.1016/j.matpr.2020.10.209

Sunthar, T. P. M., Boschetto, F., Doan, H. N. et al. (2021). Antibacterial property of cellulose acetate composite materials reinforced with aluminum nitride. Antibiotics, 10(11). https://doi.org/10.3390/antibiotics10111292

Taherirad, F., Maleki, H., Barani, H. et al. (2024). Optimizing dyeing parameters for sustainable wool dyeing using quinoa plant components with antibacterial properties. Cleaner Engineering and Technology, 21. https://doi.org/10.1016/j.clet.2024.100780

Thanka Rajan, S., Subramanian, B., Arockiarajan, A. (2024). Synergistic performance of biomedical textiles incorporated with cerium oxide carbon nanocomposites for the antibacterial and sunlight-driven photocatalytic activity of self-cleaning. Chemical Engineering Science, 298. https://doi.org/10.1016/j.ces.2024.120390

Umesh, M., Suresh, S., Santosh, A. S. et al. (2023). Valorization of pineapple peel waste for fungal pigment production using Talaromyces albobiverticillius: Insights into antibacterial, antioxidant and textile dyeing properties. Environmental Research, 229. https://doi.org/10.1016/j.envres.2023.115973

Vieira, B., Padrão, J., Alves, C. et al. (2023). Enhancing Functionalization of Health Care Textiles with Gold Nanoparticle-Loaded Hydroxyapatite Composites. Nanomaterials, 13(11). https://doi.org/10.3390/nano13111752

Wang, L., Zhou, B., Du, Y. et al. (2024). Guanidine Derivatives Leverage the Antibacterial Performance of Bio-Based Polyamide PA56 Fibres. Polymers, 16(19). https://doi.org/10.3390/polym16192707

Wang, M., Zheng, S., Fang, K. et al. (2023). Green fabrication of inkjet printed antibacterial wool fabric with natural gardenia yellow dye. Industrial Crops and Products, 206. https://doi.org/10.1016/j.indcrop.2023.117700

WHO. (2023). Guideline Infection prevention and control in the context of coronavirus disease (COVID-19): A guideline. Retrieved from http://apps.who.int/bookorders.

Wu, L., Fan, B., Yan, B. et al. (2024). Construction of durable antibacterial cellulose textiles through grafting dynamic disulfide-containing amino-compound and nanosilver deposition. International Journal of Biological Macromolecules, 259. https://doi.org/10.1016/j.ijbiomac.2023.129085

Wu, Y., Lan, J., Xu, L. et al. (2025). Degradation and selective-oxidization of chitosan realize preparation of cotton textiles with prominent antibacterial and antiviral activity via one-step esterification. Applied Surface Science, 695. https://doi.org/10.1016/j.apsusc.2025.162903

Xia, W., Li, Z., Tang, Y. et al. (2023). Sustainable recycling of café waste as natural bio resource and its value adding applications in green and effective dyeing/bio finishing of textile. Separation and Purification Technology, 309. https://doi.org/10.1016/j.seppur.2022.123091

Xu, F. X., Ooi, C. W., Liu, B. L. et al. (2021). Antibacterial efficacy of poly(hexamethylene biguanide) immobilized on chitosan/dye-modified nanofiber membranes. International Journal of Biological Macromolecules, 181, 508–520. https://doi.org/10.1016/j.ijbiomac.2021.03.151

Yılmaz, F., Bahtiyari, M. İ. (2020). Antibacterial finishing of cotton fabrics by dyeing with olive tree leaves fallen during olive harvesting. Journal of Cleaner Production, 270. https://doi.org/10.1016/j.jclepro.2020.122068

Yılmaz, F., Bahtiyari, M. İ. (2021). Antibacterial Finishing of Linen Fabrics by Combination with Nano-Aluminum Oxide and Crosslinking Agent. Fibers and Polymers, 22(7), 1830–1836. https://doi.org/10.1007/s12221-021-0865-5

Yu, Z., Deng, C., Ding, C. et al. (2024). Organic-inorganic hybrid ZIF-8/MXene/cellulose-based textiles with improved antibacterial and electromagnetic interference shielding performance. International Journal of Biological Macromolecules, 266. https://doi.org/10.1016/j.ijbiomac.2024.131080

Zargarian, S. S., Kupikowska-Stobba, B., Kosik-Kozioł, A. et al. (2024). Light-responsive biowaste-derived and bio-inspired textiles: Dancing between bio-friendliness and antibacterial functionality. Materials Today Chemistry, 41. https://doi.org/10.1016/j.mtchem.2024.102281

Zhang, N., Shi, R., Zhou, M. et al. (2023). Amyloid-like protein bridged nano-materials and fabrics for preparing rapid and long lasting antibacterial, UV-resistant and personal thermal management textiles. International Journal of Biological Macromolecules, 247. https://doi.org/10.1016/j.ijbiomac.2023.125699

Zhang, N., Wang, W., Zhou, M. et al. (2023). A controllable, universal, and natural supramolecular assembly coating strategy for multifunctionality textiles of antibacterial properties, UV resistance, antioxidant, and secondary reactivity. Industrial Crops and Products, 198. https://doi.org/10.1016/j.indcrop.2023.116637

Zhang, W., Yang, Z. Y., Tang, R. C. et al. (2020). Application

of tannic acid and ferrous ion complex as eco-friendly flame retardant and antibacterial agents for silk. Journal of Cleaner Production, 250. https://doi.org/10.1016/j.jclepro.2019.119545

Zhang, X., Zhu, Y., Li, M. et al. (2025). Sustainable preparation of multifunctional textile from oil-flax straw waste for thermal management, electromagnetic interference shielding, and antimicrobial. Surfaces and Interfaces, 61. https://doi.org/10.1016/j.surfin.2025.106069

Zhang, Y., Zhou, Q., Rather, L. J. et al. (2021). Agricultural waste of Eriobotrya japonica L. (Loquat) seeds and flora leaves as source of natural dye and bio-mordant for coloration and bio-functional finishing of wool textile. Industrial Crops and Products, 169. https://doi.org/10.1016/j.indcrop.2021.113633

Zhang, Z., Xie, Q., Chao, T. et al. (2023). Construction of rough surface based on zein and rosin to hydrophobically functionalize cotton fabric with antibacterial activity. Progress in Organic Coatings, 184. https://doi.org/10.1016/j.porgcoat.2023.107839

Zheng, H., Li, X., Liu, L. et al. (2022). Preparation of nanofiber core-spun yarn based on cellulose nanowhiskers/quaternary ammonium salts nanocomposites for efficient and durable antibacterial textiles. Composites Communications, 36. https://doi.org/10.1016/j.coco.2022.101388

Zhou, C. E., Kan, C. W. (2015). Plasma-enhanced regenerable 5,5-dimethylhydantoin (DMH) antibacterial finishing for cotton fabric. Applied Surface Science, 328, 410–417. https://doi.org/10.1016/j.apsusc.2014.12.052

Zhou, Y., Tang, R. C. (2018). Facile and eco-friendly fabrication of AgNPs coated silk for antibacterial and antioxidant textiles using honeysuckle extract. Journal of Photochemistry and Photobiology B: Biology, 178, 463–471. https://doi.org/10.1016/j.jphotobiol.2017.12.003

Cyberchondria in Care Personnel

Pelin Çelik [1]* , Fatma Hastaoglu [1]

[1]Sivas Cumhuriyet University, Vocational Health School Healh Programme, Elderly Care, Sivas, Türkiye

ABSTRACT:
Purpose: This descriptive study aimed to investigate the levels of cyberchondria among care personnel working in institutional settings.
Material and Methods: The study included 93 personnel from care centers in Sivas province, Turkiye. No sampling method was employed; all personnel meeting the inclusion criteria and willing to participate were included. Data were collected using the Cyberchondria Severity Scale–Short Form (CSS-12), along with a sociodemographic questionnaire covering variables such as age, gender, education level, smoking status, and previous training. All ethical and institutional permissions were obtained prior to data collection.
Results: Findings revealed that mild levels of cyberchondria were prevalent among participants. Significant associations were found between cyberchondria levels and sociodemographic variables including age, gender, education, and smoking. Specifically, lower education levels and smoking were linked to higher cyberchondria scores.
Conclusion: The results indicate the importance of implementing regular, targeted health and care trainings to reduce the risk of cyberchondria. Furthermore, ensuring access to credible health resources in institutional settings is essential for mitigating anxiety and preventing misinformation-related behaviors among care personnel.
Keywords: Cyberchondria; care personnel; health information

*Corresponding author: Pelin Çelik, email: pcelik@cumhuriyet.edu.tr

INTRODUCTION

Cyberchondria refers to the escalation of health-related anxiety due to excessive or repeated online medical searches (Starcevic & Berle, 2013). Rather than alleviating concerns, such searches often increase anxiety and uncertainty, especially when the information is inconsistent or alarmist (McElroy et al., 2019, Hashemi, 2020). In the era of digital health, cyberchondria has become a growing public health concern not only among patients but also among healthcare professionals, including care personnel (Ozer et al., 2023). Care workers in institutional settings frequently face emotionally demanding environments, exposure to illness, and palliative scenarios, which may trigger their own health-related fears (Lutwak 2017). Unlike trained clinicians, these personnel may lack formal education in interpreting medical data, making them more susceptible to misinterpreting online content (Maresca et al., 2022, Ozcinar & Gursoy, 2025). The expectation to provide real-time answers to patients and families further increases their reliance on internet sources during shifts (Starvaggi et al., 2024). While such behavior is well-intentioned, it can lead to heightened anxiety when the information is technical or misleading (Fluharty et al., 2016). Among healthcare staff, cyberchondria is fueled by the pressure to stay informed and competent under stress (Polit & Beck, 2017). Excessive online searching may result in overestimation of risks, self-diagnosis, and diminished trust in healthcare providers (Hashemi et al., 2020, Ozer et al., 2023).

These effects are particularly concerning in caregiving, where anxiety may impair empathy, concentration, and patient engagement. Chronic exposure to conflicting health information can also lead to cognitive overload, emotional fatigue, and burnout (Lutwak, 2017). Despite these risks, research on cyberchondria among care personnel remains limited. Most studies focus on students, the general population, or clinical staff such as physicians and nurses (Maresca et al., 2022, Ozcinar & Gursoy 2025, Starvaggi et al.,2024). Yet, institutional caregivers—especially those working in nursing homes and rehabilitation centers— represent a unique group often lacking formal training but immersed in health-related roles (Fluharty et al., 2016, Polit & Beck2017). Understanding cyberchondria within caregiving contexts is essential for safeguarding staff well-being and ensuring high-quality patient care. This research contributes to broader efforts to address occupational mental health challenges in an increasingly digitalized healthcare environment.

MATERIAL and METHODS
Purpose and Type of Study
The population of the descriptive study consists of all care personnel working in five different care centres operating in the province of Sivas. In the study, all personnel who worked between 01.12.2024 and 01.04.2025, who met the inclusion criteria and volunteered to participate in the study were included (n=93).

Sampling and Participant
Inclusion Criteria: All personnel who volunteered to participate in the study, who had no communication barriers, and who worked as care staff in the aforementioned care centers
Exclusion Criteria: All staff who do not meet the inclusion criteria or who wish to leave the study at any time

Data Collection Tools
Sociodemographic form consisting of 8 questions prepared in line with the literature was used (age, gender, education level, years of working in the institution, alcohol and smoking use, etc.).

Cyberchondria Severity Scale Short Form:
The Cyberchondria Severity Scale–Short Form (CSS-12), developed by McElroy et al. (2019), and validated for Turkish use by Terzi et al. (2024), includes 12 items without reverse scoring 2,19. Total scores range from 12 to 60, with a midpoint of 36. Severity levels are classified as follows: 12–24 (very low), 24–36 (low), 36–48 (moderate), and 48–60 (high). Higher scores indicate greater cyberchondria severity.

Statistical Analysis
The data were analyzed using SPSS version 22.0. Descriptive statistics (mean, standard deviation, frequency, and percentage) were used to summarize the participants' characteristics and cyberchondria levels. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test, and it was determined that the data followed a normal distribution ($p > 0.05$). To compare means between two groups, independent samples t-tests were employed, and for comparisons involving more than two groups, one-way analysis of variance (ANOVA) was conducted. In cases where ANOVA results were statistically significant, the Tukey HSD post hoc test was applied to identify which specific group differences accounted for the significance. A significance level of $p < 0.05$ was adopted for all statistical procedures.

Ethical Approval
Before starting the study, ethics committee permission was obtained with the decision of *… University Non-Interventional Ethics Committee dated 21.11.2024 and numbered 2024-11/09, and then data collection was started by obtaining official permission from the care centers. Staff were recruited voluntarily and the study was completed in accordance with human rights and the Declaration of Helsinki. All respondents participated in this study freely and signed an informed consent form.

RESULTS
In this study, the cyberchondria levels of care personnel were examined in detail based on sociodemographic variables. Three tables were prepared to present descriptive statistics,

comparative analyses, and frequency distributions related to cyberchondria severity and its subdimensions. These tables provide a comprehensive overview of how factors such as age, gender, education, smoking habits, and training status influence cyberchondria among institutional caregivers.

Table 1 shows the minimum, maximum and Mean ± SD values of the cyberchondria scale and its sub-dimensions, as well as the Cronbach alpha values of the scale. Accordingly, the total score obtained from the scale was determined as 26.74± 9.50, and according to the scale evaluation, a low level of cyberchondria can be mentioned.

Table 1. Cyberchondria Scale and sub-dimension scores and Cronbach's alpha values

Scale and Sub-Dimension	Cronbach's value	Min	Max	Mean ± SD
General Scale	0.862	13.00	50.00	26.74 ± 9.50
Extremism	0.830	3.00	15.00	8.36 ± 3.31
Anxiety	0.782	3.00	14.00	6.52 ± 3.25
Seeking assurance	0.650	3.00	15.00	6.92 ± 3.07
Strain	0.763	3.00	13.00	5.73 ± 2.28

Table 2. Percentage distribution of participants' sociodemographic characteristics

Sociodemographics		N	%
Age	18-25	36	38.7
	26-40	34	36.6
	41-55	20	21.5
	56 And Above	3	3.2
Gender	Female	57	61.3
	Male	36	38.7
Educational Status	Primary Education	15	16.01
	Secondary Education	38	40.9
	University	40	43.0
Marital Status	Married	50	53.8
	Single	43	46.2
Years Of Working in The Profession	Less Than 1 Year	39	41.9
	2-5 Years	25	26.9
	5-10 Years	11	11.8
	11-15 Years	12	12.9
	16 Years And Above	6	6.5
Years Of Working in The Institution	Less Than 1 Year	40	43.0
	2-5 Years	30	32.3
	5-10 Years	14	15.1
	11-15 Years	9	9.7
Have You Received Health Education?	Yes	78	83.9
	No	15	16.1
Have You Received Maintenance Training?	Yes	80	86.0
	No	13	14.0
Smoking	Yes	42	45.2
	No	51	54.8
Alcohol	Yes	3	3.2
	No	90	96.8
Do You Have a Relative Who Needs Care?	Yes	11	11.8
	No	82	88.2
Income Status	Bad	53	57.0
	Middle	32	34.4
	Good	8	8.6
Cyberchondria Level	Very Low Level	42	45.2
	Low Level	35	37.6
	Intermediate Level	15	16.1
	High Level	1	1.1

Table 2 outlines participants' sociodemographic characteristics. Most were female (61.3%), aged 18–25 (38.7%), and university graduates (43.0%). Over half were married (53.8%) and had received prior health training (83.9%). A large portion had less than one year of experience (41.9%), with 45.2% reporting smoking and only 3.2% reporting alcohol use. Notably, 88.2% had no one to care for, and 57.0% reported low income. When categorized by cyberchondria scores, 45.2% of participants exhibited a low level, indicating generally mild cyberchondria symptoms across the sample.

Table 3. Comparative analysis of participants' sociodemographic characteristics and scale and sub-dimension score averages

		Total Scale Score Mean Sd	Extremism	Anxiety	Seeking Assurance	Strain
Marital Status	Single	27.60± 9.43	8.92±3.33	6.60±3.05	6.94±3.03	5.86±2.18
	Married	25.74 ±9.59	7.72± 3.20	6.44±3.50	6.90±3.16	5.58±2.41
	p	0.35	0.48	0.23	**0.05***	0.16
Gender	Female	26.43± 8.91	8.17±2.98	6.57±3.27	6.85±2.83	5.52±2.14
	Male	27.22±10.47	8.66±3.80	6.44±3.25	7.02±3.46	6.05±2.48
	p	0.22	**0.03***	0.13	**0.05***	0.67
Have You Received Health Training?	Yes	27.01± 9.48	8.58±3.39	6.64±3.33	6.88±2.91	5.64±2.11
	No	25.33± 9.80	7.20±2.67	5.93±2.84	7.13±3.94	6.20±3.07
	p	**0.02***	0.06	0.19	**0.001***	**0.03***
Maintenance Training Did You Get it?	Yes	26.58± 8.85	8.33±3.34	6.53±3.15	6.83±2.89	5.72± 2.14
	No	27.69±13.21	8.53±3.23	6.46±3.95	7.46± 4.15	5.76±3.11
	p	**0.01***	0.09	0.10	**0.04***	0.15
Smoking	Yes	28.05± 9.37	8.16±3.50	5.71±2.93	6.54±3.12	5.66±2.54
	No	25.14± 9.52	8.52±3.17	7.19±3.37	7.23±3.03	5.78±2.07
	p	**0.01***	0.31	**0.02***	0.26	0.30
Alcohol	Yes	23.33± 8.50	8.66± 4.61	5.33±2.51	4.33±2.30	4.66±1.52
	No	26.85± 9.55	8.35±3.29	6.56±3.27	7.01±3.07	5.76±2.30
	p	0.42	0.45	0.23	0.13	0.24
Educational Status	Primary education	26.00±10.36	7.66±2.38	5.80±3.83	7.80±3.54	5.93±2.43
	Secondary Education	28.39±9.99	8.55±3.52	7.76±3.26	7.13±3.30	5.84±2.44
	University	25.45± 8.66	8.45±3.44	5.62±2.64	6.40±2.61	5.55±2.11
	F	**0.03***	0.44	**0.03***	0.13	**0.03***
Age Group	18-25	27.05± 9.87	8.55±3.41	6.77± 3.19	6.83±3.29	5.55±2.24
	26-40	25.52± 8.69	8.05±3.34	6.05±2.69	6.50±2.79	5.67±2.37
	41-55	28.40±10.37	8.60±3.34	7.10± 4.16	7.75±2.91	6.00±2.29
	56 and above	25.66±10.96	8.00±2.64	5.00±3.46	7.33± 5.13	6.66±2.51
	F	**0.005***	**0.03***	0.06	0.77	0.07
Years of Working in The Profession	Less than 1 year	27.38± 9.34	8.38±3.28	6.89±3.03	7.07±3.09	5.76±2.28
	2-5 years	25.52± 8.82	8.80±3.25	5.80±2.78	6.40±2.84	5.28±1.96
	5-10 years	28.63±11.99	8.36±3.10	7.09±4.22	7.81±3.57	6.36±2.80
	11-15 years	23.16±7.95	6.33±2.53	5.66±3.44	6.33±3.39	5.41±2.53
	16 and above	31.33±11.07	10.50± 4.46	7.83± 4.16	7.66±2.65	6.83±2.04
	F	**0.004***	0.06	0.42	0.70	0.29
Income Status	Bad	26.13± 9.61	8.07±3.42	6.41±3.02	6.77±3.28	5.54±2.23
	Middle	26.78± 8.66	8.56±3.26	6.50±3.25	6.71±2.58	5.84±2.38
	Good	30.62± 12.12	9.50±2.77	7.37± 4.80	8.75±3.28	6.50±2.32
	F	0.21	0.68	0.31	0.21	0.52

*p<0.05, significant

Table 3 presents the relationship between participants' sociodemographic characteristics and their cyberchondria levels. While marital status did not influence overall scores, single participants had significantly higher reassurance-seeking scores (p<0.05). Gender was not associated with total scores, but males scored significantly higher in reassurance-seeking and extremity subdimensions (p<0.05).

DISCUSSION

These findings are further supported by recent literature emphasizing the role of sociodemographic and psychological factors in the emergence of cyberchondria among healthcare personnel. For example, Jokic et al. (2023) found that individuals with higher levels of health-related anxiety were significantly more likely to engage in compulsive online symptom searches, especially those with lower e-health literacy. This aligns with our findings where caregivers with less caregiving-specific training scored higher on the CSS. Another study conducted among medical workers in Saudi Arabia revealed a correlation between cyberchondria and professional burnout, indicating that unregulated exposure to digital health content may elevate occupational stress (Aleyeidi et al., 2025). This is particularly relevant for care personnel, whose emotional labor often remains unrecognized in institutional frameworks. A recent systematic review by Duplaga & Grysztar (2021) also emphasized that males are more vulnerable to extreme forms of online health information-seeking due to perceived social barriers in expressing health anxiety. This may explain the elevated reassurance-seeking scores observed among male participants in our sample. Similarly, Sahan & Kacmaz (2024) highlighted that mid-career professionals, especially those with caregiving responsibilities, are more prone to digital health anxiety due to cumulative exposure to medical scenarios and a lack of formal coping mechanisms. Taken together, these results reinforce the urgency of integrating structured digital health literacy and emotional regulation programs within caregiving environments. Not only would this mitigate the risks associated with cyberchondria, but it could also improve the overall quality of

caregiving. As cyberchondria continues to gain recognition as an occupational mental health challenge (Sansakorn et al., 2024), our study contributes valuable regional data and underlines the importance of proactive institutional strategies. This study offers early empirical insights into cyberchondria among institutional care personnel, indicating generally low overall levels. There are studies in the literature with similar results (Garfin et al., 2020). However, significant differences were found across sociodemographic variables including gender, age, education, smoking behavior, and professional experience—suggesting that cyberchondria is shaped not only by individual anxiety but also by occupational exposure and digital behaviors. Notably, male caregivers demonstrated higher levels of cyberchondria, particularly in reassurance-seeking and extremism subdimensions, aligning with findings that men may engage in more compulsive online health searches, possibly due to lower health literacy or greater need for external validation (McMullan et al., 2019, Deniz & Koca, 2024). Education also emerged as a protective factor, as university-educated participants showed significantly lower scores, supporting the role of higher education in promoting critical engagement with online health information (Ozer et al., 2023, Ozcinar & Gursoy, 2025). Caregivers with general health training, but not caregiving-specific instruction, exhibited elevated cyberchondria, particularly in reassurance-seeking. This highlights the potential for generalized medical knowledge to increase anxiety when not coupled with contextual training and emotional regulation strategies (Fluharty et al., 2016). Smoking was associated with increased cyberchondria in the anxiety subdimension, supporting prior findings linking health anxiety and maladaptive behaviors such as frequent symptom-checking (Fluharty et al.,2016, Fang & Mushtaque, 2024). Higher scores among mid-life caregivers (41–55 years) and those with over 16 years of experience suggest cumulative occupational stress and perceived health vulnerability may elevate risk (Lutwak, 2017, Starvaggi et al., 2024). In this study, the 41–55 age group demonstrated higher levels of cyberchondria compared to other age groups. This may be attributed to increased online

health information seeking behavior, coupled with potentially limited digital health literacy. Furthermore, this age range represents a period where health-related anxieties may increase, making individuals more susceptible to cyberchondria when frequently consulting online sources. No associations were found with marital status or income, reinforcing evidence that psychological and occupational dynamics, rather than socioeconomic status, drive cyberchondria (Maresca et al., 2022, Jungman & Witthöft, 2020). Despite the overall low prevalence, subgroup vulnerabilities highlight a need for targeted interventions. Digital health literacy training, institutional access to verified medical databases, and psychological support services such as counseling and stress management are essential (Ozcinar & Gursoy, 2025; Newby & McElroy, 2020). For high-risk individuals, integrating smoking cessation and mindfulness-based approaches may reduce maladaptive behaviors.

CONCLUSION

This study offers an important contribution to the growing body of literature exploring cyberchondria within professional caregiving contexts. By focusing on care personnel working in institutional settings, the research sheds light on a population that has largely been overlooked in digital health anxiety research. The identification of sociodemographic and occupational predictors of cyberchondria—such as gender, education level, smoking behavior, and professional experience—underscores the multifaceted nature of this phenomenon and highlights the need for tailored preventive strategies. Understanding how these variables influence cyberchondria not only enhances the theoretical framework surrounding digital health behavior but also informs practical interventions aimed at improving the psychological well-being of care staff and ensuring safe, high-quality patient care. The study's findings also draw attention to the psychological burden faced by caregivers in an era marked by rapid digitalization and easy access to unverified medical information. By integrating quantitative data from a standardized measurement tool with detailed sociodemographic profiles, the research offers a comprehensive analysis of

cyberchondria's scope in care environments. However, several limitations should be acknowledged. The cross-sectional design of the study restricts causal inference, and the reliance on self-reported data may be influenced by social desirability bias. The sample was limited to one geographical region, which may affect the generalizability of the findings. Additionally, the study did not examine other psychological constructs such as general anxiety, burnout, or coping styles that may interact with cyberchondria levels. Despite these limitations, the study provides a valuable foundation for future research and institutional policy development. Longitudinal and qualitative studies are needed to explore causal mechanisms, while interventional approaches can assess the efficacy of targeted strategies in reducing cyberchondria among caregivers. Ultimately, addressing this emerging issue is essential for safeguarding both caregiver resilience and patient safety.

Conflict of Interest

No conflict of interest.

REFERENCES

Aleyeidi, N., Fayed, A., Alnowaiser, G., Aldubayyan, R., Alfahhad, L., Alhosaini, J., Ibrahim, S. F. (2025). Cyberchondria, somatic symptoms, and internet-based self-diagnosis behaviors among the Saudi population. Scientific Reports. https://doi.org/10.1038/s41598025026129

Deniz, S., & Koca, M. (2024). Cyberchondria in healthcare workers: An example from a training and research hospital. Journal of General Health Sciences, 6: (3), 504–513.

Duplaga, M., & Grysztar, M. (2021). The association between future anxiety, health literacy and the perception of the COVID-19 pandemic: A cross-sectional study. In Healthcare (Vol. 9, No. 1, p. 43). MDPI.

Fang, S., & Mushtaque, I. (2024). The moderating role of health literacy and health promoting behavior in the relationship among health anxiety, emotional regulation, and cyberchondria. Psychology Research and Behavior Management, 51–62.

Fergus, T. A., & Spada, M. M. (2017). Cyberchondria: Examining relations with problematic internet use and metacognitive beliefs. Clinical Psychology & Psychotherapy, 24: (6), 1322–1330. https://doi.org/10.1002/cpp.2102

Fluharty, M., Taylor, A. E., Grabski, M., & Munafò, M. R. (2016). The association of cigarette smoking with

depression and anxiety: A systematic review. Nicotine & Tobacco Research, 19(1), 3–13.

Garfin, D. R., Silver, R. C., & Holman, E. A. (2020). The novel coronavirus (COVID-2019) outbreak: Amplification of public health consequences by media exposure. Health psychology, 39(5), 355.

Hashemi, S. G. S., Hosseinnezhad, S., Dini, S., Griffiths, M. D., Lin, C. Y., & Pakpour, A. H. (2020). The mediating effect of the cyberchondria and anxiety sensitivity in the association between problematic internet use, metacognition beliefs, and fear of COVID-19 among Iranian online population. Heliyon, 6(10), e05064.

Jokic-Begic, N., Zajec, D., & Jokić-Begić, Ž. (2023). Predictors of cyberchondria during the COVID-19 pandemic. JMIR Formative Research, 7, e42206. https://doi.org/10.2196/42206

Jungmann, S. M., & Witthöft, M. (2020). Health anxiety, cyberchondria, and coping in the current COVID-19 pandemic: Which factors are related to coronavirus anxiety? Journal of Anxiety Disorders, 73, 102239.

Kurcer, M. A., Erdogan, Z., & Cakir Kardes, V. (2022). The effect of the COVID-19 pandemic on health anxiety and cyberchondria levels of university students. Perspectives in Psychiatric Care, 58: (1), 132–140.

Lutwak, N. (2017). Commentary: Thoughts on cyberchondria—a new challenge for healthcare providers. Internet Journal of Allied Health Sciences and Practice, 15(3), 1.

Maresca, G., Corallo, F., Catanese, G., Formica, C., & Lo Buono, V. (2022). Coping strategies of healthcare professionals with burnout syndrome: A systematic review. Medicina, 58(2), 327.

McElroy, E., Kearney, M., Touhey, J., Evans, J., Cooke, Y., & Shevlin, M. (2019). The CSS-12: Development and validation of a short-form version of the Cyberchondria Severity Scale. Cyberpsychology, Behavior, and Social Networking, 22(5), 330–335.

McMullan, R. D., Berle, D., Arnáez, S., & Starcevic, V. (2019). The relationships between health anxiety, online health information seeking, and cyberchondria: Systematic review and meta-analysis. Journal of Affective Disorders, 245, 270–278.

Newby, J. M., & McElroy, E. (2020). The impact of internet-delivered cognitive behavioural therapy for health anxiety on cyberchondria. Journal of Anxiety Disorders, 6, 102150.

Ozcinar, M., & Gursoy, E. (2025). Cyberchondria and health anxiety among caregivers of home healthcare patients in Eastern Türkiye: Cyberchondria and health anxiety. Essentials of Frontline Medicine Journal, 2(1), 7–13.

Ozer, O., Ozmen, S., & Ozkan, O. (2023). Investigation of the effect of cyberchondria behavior on e-health literacy in healthcare workers. Hospital Topics, 101(2), 94–102.

Polit, D. F., & Beck, C. T. (2017). Nursing research: Generating and assessing evidence for nursing practice (10th ed.). Wolters Kluwer.

Sahan, S., & Kacmaz, E. D. (2024). Searching for Health Information on the Internet; Determining the Relationship Between Nurses' Cyberchondria Levels, Health Anxiety, and Effective Factors. Mediterranean Nursing and Midwifery, 4(3), 159-165. https://doi.org/10.4274/MNM.2024.24209

Sansakorn, P., Mushtaque, I., Awais-E-Yazdan, M., & Dost, M. K. B. (2024). The relationship between cyberchondria and health anxiety and the moderating role of health literacy among the Pakistani public. International Journal of Environmental Research and Public Health, 21(9), 1168. https://doi.org/10.3390/ijerph21091168

Starcevic, V., & Berle, D. (2013). Cyberchondria: Towards a better understanding of excessive health-related Internet use. Expert Review of Neurotherapeutics, 13(2), 205–213. https://doi.org/10.1586/ern.12.162

Starvaggi, I., Dierckman, C., & Lorenzo-Luaces, L. (2024). Mental health misinformation on social media: Review and future directions. Current Opinion in Psychology, 56, 101738.

Terzi H, Akça A, Ayaz Alkaya S. Cyberchondria Severity Scale-Short Form: A Psychometric Study. General Medicine Journal. 2024;34(4):450-7.

Effects of Probiotics on Cholesterol Metabolism: Biochemical Mechanisms and Clinical Potential

Mehmet Çavdar [1]* [ID], Mahir Arslan [2] [ID], Meliha Çavdar [3] [ID]

[1]İnönü University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Malatya, Türkiye
[2]Sivas Cumhuriyet University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Sivas, Türkiye
[3]Erciyes University, Institute of Health Sciences, Department of Nutrition and Dietetics, Kayseri, Türkiye

ABSTRACT:

In recent years, the increasing prevalence of cardiovascular diseases has accelerated the search for natural and effective strategies to regulate cholesterol metabolism. In this context, the hypocholesterolemic potential of probiotic microorganisms has attracted growing scientific attention. Probiotics are live microorganisms that, when consumed in adequate amounts, provide health benefits to the host. They are primarily composed of species from the *Lactobacillus* and *Bifidobacterium* genera.

Numerous studies have demonstrated the ability of probiotic strains to affect cholesterol metabolism. They do so through a variety of underlying biochemical mechanisms. These include bile salt hydrolase activity for bile salt deconjugation, cholesterol assimilation and degradation, precipitation with secondary bile acids, binding to the microbial cell wall or membrane, and the effects of short-chain fatty acids produced during prebiotic fermentation. Several studies have reported that specific strains—particularly *Lacticaseibacillus casei*, *Lactobacillus acidophilus*, and *Lactiplantibacillus plantarum*—can effectively exert these effects. However, as most mechanisms have been investigated under in vitro conditions, their actual efficacy under physiological settings may be limited. Nonetheless, several human clinical trials have reported cholesterol-lowering effects of specific probiotic strains, although findings remain inconsistent and strain-dependent.

This review examines the impact of probiotics on cholesterol metabolism in detail and analyzes the relevant mechanisms based on findings in the literature. The current evidence suggests that probiotics can exert cholesterol-lowering effects in a strain-specific manner. These results suggest that probiotics hold potential as adjunct therapeutic agents for hypercholesterolemia, supporting their possible role in cardiovascular risk reduction. Nevertheless, further controlled and long-term clinical studies are needed to confirm these effects and support their potential role in therapeutic administrations.

Keywords: *Probiotics; cholesterol metabolism; hypercholesterolemia; hypocholesterolemia*

*Corresponding author: Mehmet Çavdar, email: mehmet.cavdar@inonu.edu.tr

INTRODUCTION

In the literature, numerous studies have examined the cholesterol-lowering capacity of probiotic bacteria (Al-Muzafar and Amin, 2017; Al-Sheraji et al., 2015; Keleszade et al., 2022; Li et al., 2022). However, the metabolic processes underlying this ability are mostly explained by in vitro studies. The most notable of these processes include bile salt hydrolase (BSH) activity, which enables the deconjugation of bile salts, the assimilation of cholesterol present in the media by probiotic bacteria, and the precipitation of cholesterol by secondary bile acids resulting from deconjugation. Additionally, cholesterol catabolism by enzymes present in some probiotics, the binding of cholesterol to the cell wall, and the incorporation of cholesterol into the bacterial cell membrane are recognized as important mechanisms. Short-chain fatty acids (SCFAs), produced during prebiotic fermentation, also play a significant role (Ooi and

Liong, 2010).

Wang et al. (2018) conducted a meta-analysis of randomized controlled trials to evaluate the effects of products containing either a specific probiotic strain or a mixture of strains on cholesterol parameters. They concluded that groups receiving probiotic supplementation showed a significant decrease in serum total cholesterol (TC) compared to controls, regardless of the probiotic form used. Subgroup analyses revealed that single strains such as Lactiplantibacillus plantarum, Bifidobacterium lactis, and Lactobacillus acidophilus were more effective than commercial mixtures such as VSL#3 (Wang et al., 2018). Another meta-analysis by Sharma et al. (2016) compared probiotic-treated groups with controls. This study indicated that serum TC and LDL cholesterol (LDL-C) levels decreased significantly by an average of 8.40 mg/dl and 6.63 mg/dl, respectively. However, no significant change was observed in HDL cholesterol (HDL-C) or triglyceride (TG) levels (Sharma et al., 2016).

Today, in addition to commercial probiotic mixtures, most probiotic strains isolated from foods or different parts of the human body belong to the Lactobacillus and Bifidobacterium genera. Among these isolates, species such as Lactobacillus johnsonii, Lactobacillus acidophilus, Lacticaseibacillus rhamnosus, Lactobacillus gasseri, Limosilactobacillus reuteri, and Lacticaseibacillus casei are frequently reported (Heller, 2001).

It has been observed that probiotic bacteria—whether applied alone or in mixtures—can produce hypocholesterolemic effects in both in vitro and in vivo environments (Anandharaj et al., 2020). However, despite these promising findings, outcomes across clinical trials remain variable. Such differences may be related to strain-specific effects, study heterogeneity, small sample sizes, or short intervention periods. These gaps underline the need for further well-designed, long-term studies to clarify the role of probiotics in cholesterol management. The aim of this review is to provide a comprehensive analysis of the mechanisms through which probiotic microorganisms exert cholesterol-lowering effects, while also evaluating their clinical potential as adjunct strategies for cholesterol management and cardiovascular risk reduction.

Mechanism of the Hypocholesterolemic Effects of Probiotics

Bile Salt Hydrolase Enzyme Activity

Bile plays a critical role in the digestion and absorption of fats in the small intestine due to its emulsifying properties. This water-soluble fluid is synthesized in the liver and then concentrated and stored in the gallbladder. During digestion, the gallbladder is stimulated by hormones, and bile is released into the small intestine via various metabolic pathways. Bile contains cholesterol, phospholipids, conjugated bile acids, bile pigments, and certain electrolytes (Begley et al., 2006).

Primary bile acids such as cholic acid and chenodeoxycholic acid have very low solubility in blood circulation. Therefore, their solubility must be increased so that these acids can accumulate in the gallbladder and then be transported to the intestines. To achieve this, primary bile acids are conjugated with glycine or taurine in the liver, converting them into bile salts with high water solubility. Under physiological conditions, bile salts constitute approximately 80% of the organic matter in bile fluid. As a result of enzymatic reactions, these bile salts undergo deconjugation and are converted into secondary bile acids such as glycocholic acid, taurocholic acid, and taurocholic acid (Önür and Beyler, 2001). Thanks to the BSH enzyme possessed by some probiotic microorganisms, bile salts undergo deconjugation, resulting in the formation of secondary bile acids. These secondary compounds have low solubility and their absorption by the small intestine is limited. As a result, most secondary bile acids are excreted from the body via feces. This reduction in bile salts stimulates the body to produce more bile. In this new synthesis process, the body uses its cholesterol reserves to produce the necessary bile salts. Consequently, probiotic strains that possess the BSH enzyme exert a cholesterol-lowering effect through this mechanism (Pereira and Gibson, 2002). Various studies in the literature indicate that one of the underlying mechanisms for the hypocholesterolemic effect of probiotics is the BSH enzyme activity found in certain probiotic strains (Ooi and Liong, 2010).

In an in vitro study conducted by Jones et al. (2004),

it was determined that the *Lactiplantibacillus plantarum 80* (pCBH1) strain, which possesses probiotic properties, has BSH activity. In addition, the researchers applied a microencapsulation method to increase the strain's resistance to environmental stress factors. As a result of this process, it was observed that the bacterium's capacity to deconjugate bile salts increased significantly compared to the live cell form, and consequently, the hypocholesterolemic effect also increased (Jones et al., 2004).

Similarly, Hernández-Gómez et al. (2021) evaluated the BSH enzyme activity of probiotic bacteria isolated from various local cheeses, dairy products, and commercial sources. Specifically, five different strains belonging to the genus *Lactobacillus* (*Lacticaseibacillus casei Shirota*, *Lactiplantibacillus plantarum 299v*, *Lacticaseibacillus rhamnosus ATCC 53103 (LGG)*, *Lactiplantibacillus plantarum DGIA1*, and *Limosilactobacillus fermentum K73*) BSH activity was found to be positive, and the extent to which these strains deconjugated bile salts *in vitro* was also measured. These analyses revealed that the *Lactiplantibacillus plantarum* DGIA1 strain deconjugated bile salts such as sodium glycocholic acid, sodium glycocholic acid, sodium taurocholate, and sodium taurodeoxycholate at rates of 69%, 100%, 81%, and 92%, respectively. These high deconjugating rates indicate that the strain has a hypocholesterolemic effect (Hernández-Gómez et al., 2021).

Tsai et al. (2014) examined approximately 800 different bacteria isolated from animals and plants for BSH activity under in vitro conditions. As a result of this screening, *Pediococcus acidilactici* NBHK002, *Bifidobacterium adolescentis* NBHK006, and *Lacticaseibacillus rhamnosus* NBHK007 were identified as the three probiotic strains with the highest BSH activity. They evaluated the cholesterol-lowering effects of the probiotic product named "PROBIO-S23," obtained from the combination of these three strains, in an in vivo model. The experimental animals were fed a high-fat, high-cholesterol (HFHC) diet for 6 weeks and administered low (78 mg/kg body weight (bw)/day), medium (390 mg/kg bw/day), and high doses (1950 mg/kg bw/day) of PROBIO-S23 product was administered daily via oral gavage for the same period. After six weeks of administration, significant decreases in serum TC, TG, and LDL-C levels were observed in all groups receiving the three different doses of probiotic mixture compared to the control group fed the HHF diet; however, no significant changes were detected in HDL-C levels (Tsai et al., 2014).

Most evidence suggests that BSH activity is one of the best-characterized mechanisms for the hypocholesterolemic effects of probiotics, though its impact remains strain-dependent. Various probiotic strains have demonstrated BSH activity and induced significant cholesterol-lowering effects, but the extent of this effect varies across different strains and environmental conditions. While the BSH mechanism has shown strong efficacy in vitro and in animal studies, its direct clinical relevance in humans remains uncertain. Further clinical trials are needed to determine how well this mechanism translates to human physiology, particularly in individuals with varying dietary patterns and health conditions.

Cholesterol Precipitation via Secondary Bile Acids

Probiotics can reduce cholesterol absorption through the precipitation of cholesterol by secondary bile acids, which are formed following the deconjugation of bile salts. Some probiotic strains, possessing bile salt hydrolase (BSH) activity, deconjugate primary bile acids, leading to the production of secondary bile acids. These secondary bile acids, having low solubility, are not readily absorbed in the small intestine, which promotes cholesterol excretion via feces. This process effectively reduces cholesterol levels (Begley et al., 2006; Klaver and Meer, 1993).

Shobrahani and Halami (2016) evaluated the cholesterol-lowering potential of three probiotic strains isolated from raw milk. Although these strains lacked BSH activity, the researchers tested their effects in acidic environments (pH 5.0). When bile fluid was added, cholesterol levels decreased by 18-20%. When conjugated bile acids were included, secondary bile acids formed, and cholesterol levels decreased by 28-31%. This showed that secondary bile acids precipitate cholesterol more effectively in acidic environments (Shobrahani and Halami, 2016).

In another in vitro study, *Lacticaseibacillus paracasei* M3, *Lacticaseibacillus casei* M5, and *Lacticaseibacillus paracasei* M7 were analyzed. *L. casei* M5 had the highest cholesterol precipitation capacity (50.16 μg/mL). This strain also showed the highest BSH activity, supporting the link between BSH activity, secondary bile acid production, and cholesterol precipitation (Bhat and Bajaj, 2020).

Despite these findings, the physiological relevance of this mechanism is debated. Cholesterol precipitation occurs optimally at acidic pH (5.0-6.0), yet the human intestinal lumen is neutral to slightly alkaline (pH ~7.0). Since cholesterol solubility increases at near-neutral pH, precipitation with secondary bile acids may be limited in vivo (Reis et al., 2017).

The ability of secondary bile acids to precipitate cholesterol has been well-documented, particularly in acidic environments. However, the relevance of this mechanism in the human intestine, which operates at a neutral pH, remains unclear. Despite this, studies suggest that probiotics can still contribute to cholesterol reduction through secondary bile acid production and precipitation, particularly in controlled, low pH conditions. Although secondary bile acid-induced cholesterol precipitation has been observed in vitro, its clinical relevance in humans is less certain due to the neutral pH of the human intestine. Further clinical investigation is required to assess whether this mechanism can be effectively leveraged in humans and under what conditions (e.g., dietary factors or gut microbiome composition) this effect might be enhanced.

Binding of Cholesterol to the Cell Membrane

One of the mechanisms involved in the cholesterol-lowering effect of probiotic strains is the binding of cholesterol to the probiotic cell wall. Kimoto et al. (2002) tested seven *Lactococcus* strains under different conditions: live and growing cells, live cells with metabolic activity stopped, and heat-killed cells. The highest cholesterol removal occurred with live and actively multiplying strains. Remarkably, some heat-inactivated strains also retained the ability to bind cholesterol to their cell walls, maintaining part of their cholesterol-lowering effect (Kimoto et al., 2002).

Incorporation of Cholesterol into the Structure of the Cell Membrane

Another mechanism considered to be one of the cholesterol-lowering effects of probiotic bacteria is the uptake of cholesterol present in the media into the cell and its integration into the cell membrane structure (Ooi and Liong, 2010).

Lye et al. (2010a) investigated 15 probiotic strains and found that those with the highest hydrophobicity (*L. acidophilus* ATCC 314, *L. acidophilus* FTCC 0291, *L. delbrueckii* subsp. *bulgaricus* FTCC 0411 and FTDC 1311, and *Lacticaseibacillus casei* ATCC 393) had greater ability to incorporate cholesterol. Cells grown in cholesterol-supplemented media showed significant changes in fatty acid profiles compared to cholesterol-free conditions. Fluorescence anisotropy analyses revealed that cholesterol molecules were incorporated into the phospholipid tails, membrane surfaces, and bilayer structures of probiotic membranes. This integration, although strain-dependent, contributes to cholesterol reduction (Lye et al., 2010a).

Cholesterol Assimilation

Another mechanism contributing to the cholesterol-lowering effects of probiotic bacteria is defined as cholesterol assimilation. This property may vary depending on the strain, and the presence of bile salts is required for the assimilation process to occur (Tomaro-Duchesneau et al., 2014). Some probiotic bacteria can assimilate cholesterol through their cell walls, which have a peptidoglycan structure. Furthermore, the literature reports a positive correlation between the amount of exopolysaccharide produced by these bacteria and their cholesterol assimilation capacity. These strains use bile salts while assimilating cholesterol; in the resynthesis of bile salts, they consume cholesterol from the body's cholesterol pool. This process ultimately results in a hypocholesterolemic effect (Reis et al., 2017).

In an *in vitro* study conducted with different probiotic strains belonging to the *Lactobacillus acidophilus* genus, it was determined that cholesterol assimilation rates varied between 11% and 71% depending on the strain in the presence of

various bile salts. The highest cholesterol assimilation ability was found in the *Lactobacillus acidophilus* ATCC 4356 strain (Lin and Chen, 2000).

Cholesterol Catabolism

Another mechanism found in some probiotic strains that contributes to lowering cholesterol levels in the media is cholesterol catabolism. As a result of this process, a large portion of cholesterol is converted into coprostanol, while a smaller portion is converted into coprostanol (Juste and Gérard, 2021). In addition to cholesterol ingested with food and reaching the small intestine, cholesterol synthesized endogenously and transported via transintestinal cholesterol efflux (i.e., the direct passage of circulating cholesterol into the intestinal lumen) can also be catabolized by certain probiotic strains present in the intestine. The enzyme responsible for this conversion is the cholesterol reductase enzyme found in the structure of these probiotics (Reis et al., 2017).

In an in vitro study using lactic acid bacteria, the cholesterol-lowering effects of five different probiotic strains with the highest level of hydrophobicity were investigated. Intracellular and extracellular cholesterol reductase enzyme activity was detected in all these strains. It was stated that these strains create a hypocholesterolemic effect by converting cholesterol present in the media into coprostanol (Lye et al., 2010b).

Short-Chain Fatty Acids Produced by the Fermentation of Prebiotics

One of the reasons behind the cholesterol-lowering effect of some probiotic strains is the SCFAs produced when probiotic bacteria in the gut microbiome ferment prebiotics as a substrate. Among these acids, propionate is particularly noteworthy for its inhibitory effect on cholesterol synthesis in the liver and is known to contribute to the balancing of serum cholesterol parameters (Markowiak-Kopeć and Śliżewska, 2020).

In an in vivo study conducted by Hara et al. (1999), rats used as experimental animals were divided into three different groups. The first group was fed a diet without pulp, the second group was fed a diet enriched with pulp obtained from sugar cane, and the third group was fed a diet prepared with a SCFA mixture and bile salt supplement. At the end of the experiment, tissue samples obtained from the livers and small intestines of the rats were examined; it was determined that the lowest cholesterol synthesis rate was observed in the group consuming the SCFAs mixture ($p<0.05$) (Hara et al., 1999).

CONCLUSIONS AND RECOMMENDATIONS

This review summarizes the current evidence on the impact of probiotic bacteria on cholesterol metabolism. Various probiotic strains have shown significant cholesterol-lowering potential through multiple mechanisms. One key mechanism is bile salt hydrolase (BSH) activity, which promotes the deconjugation of bile salts, leading to the production of secondary bile acids that reduce cholesterol absorption. Additionally, probiotics contribute to cholesterol assimilation and membrane incorporation, wherein they assimilate cholesterol through their cell walls or incorporate it into their membrane structures, thereby reducing the available cholesterol. Bile acid precipitation is another mechanism in which secondary bile acids formed from probiotics precipitate cholesterol, reducing its absorption in the small intestine. Furthermore, the production of short-chain fatty acids, particularly propionate, inhibits cholesterol synthesis in the liver and helps balance serum cholesterol levels.

Meta-analyses indicate that probiotic strains such as Lactobacillus acidophilus, Lacticaseibacillus casei, and Lactiplantibacillus plantarum can significantly reduce serum cholesterol levels. However, the effects of these strains remain strain-specific and are influenced by various factors, including dosage, duration, host physiology, and environmental conditions. Although in vitro studies provide valuable mechanistic insights, their translation to in vivo conditions is still limited. Therefore, there is a critical need for long-term, controlled clinical trials to fully understand the efficacy of probiotics in human populations.

In terms of future research, strain characterization is essential. Detailed analysis of probiotic strains will help identify those with the most potent cholesterol-lowering effects, allowing for the development of

more targeted and effective interventions. Moreover, multi-strain versus single-strain comparisons should be explored to determine which approach offers the greatest benefits for cholesterol reduction. Clinical trials are also necessary to assess the impact of probiotics on cholesterol metabolism in humans, establishing appropriate dosage and duration guidelines for their effective use. Another significant recommendation is the development of functional foods and supplements. The creation of synbiotics—combinations of probiotics and prebiotics—could enhance the efficacy of probiotics in cholesterol management. Additionally, exploring technologies such as microencapsulation will improve the stability and viability of probiotics during gastrointestinal transit.

Lastly, it is crucial to focus on environmental and host factors. Future studies should examine how factors such as diet, pH, microbiome composition, and metabolic conditions influence the effectiveness of probiotics. This will be key to optimizing their clinical use. In conclusion, probiotics hold significant potential as functional agents for cardiovascular protection. However, further research is necessary to clarify the strain-dependent efficacy of probiotics and to refine their use in clinical settings.

Conflict of Interest

The authors declared that there is no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval: Not subject to ethical approval in terms of research quality.

REFERENCES

Al-Muzafar, HM., and Amin, KA. (2017). Probiotic mixture improves fatty liver disease by virtue of its action on lipid profiles, leptin, and inflammatory biomarkers. BMC Complement Altern Med, 17, 43-49. https://doi.org/10.1186/s12906-016-1540-z

Al-Sheraji, SH., Amin, I., Azlan, A., Manap, MY., and Hassan, FA. (2015). Effects of Bifidobacterium longum BB536 on lipid profile and histopathological changes in hypercholesterolaemic rats. Benef Microbes, 6(5), 661-668. https://doi.org/10.3920/BM2014.0032

Anandharaj, M., Sivasankari, B., and Rani, RP. (2020). Corrigendum to "effects of probiotics, prebiotics, and synbiotics on hypercholesterolemia: a review". Chi J Biol, 2020, 8236703.

https://doi.org/10.1155/2020/8236703

Begley, M., Hill, C., and Gahan, CGM. (2006). Bile Salt Hydrolase Activity in Probiotics. Appl Environ Microbiol, 72, 1729-1738. https://doi.org/10.1128/AEM.72.3.1729-1738.2006

Bhat, B., and Bajaj, BK. (2020). Multifarious cholesterol lowering potential of lactic acid bacteria equipped with desired probiotic functional attributes. 3 Biotech, 10(5), 1-16. https://doi.org/10.1007/s13205-020-02183-8

Hara, H., Haga, S., Aoyama, Y., and Kiriyama, S. (1999). Short-chain fatty acids suppress cholesterol synthesis in rat liver and intestine. J Nutr, 129(5), 942-948. https://doi.org/10.1093/jn/129.5.942

Heller, KJ. (2001). Probiotic bacteria in fermented foods: product characteristics and starter organisms. Am J Clin Nutr, 73, 374-379. https://doi.org/10.1093/ajcn/73.2.374s

Hernández-Gómez, JG., López-Bonilla, A., Trejo-Tapia, G., Ávila-Reyes, SV., Jiménez-Aparicio, AR., and Hernández-Sánchez, H. (2018). In Vitro Bile Salt Hydrolase (BSH) Activity Screening of Different Probiotic Microorganisms. Foods, 10(3), 674-682. https://doi.org/10.3390/foods10030674

Jones, ML., Chen, H., Ouyang, W., Metz, T., and Prakash, S. (2004). Microencapsulated genetically engineered Lactiplantibacillus plantarum 80 (pCBH1) for bile acid deconjugation and its implication in lowering cholesterol. J Biomed Biotechnol, 2004(1), 61-69. https://doi.org/10.1155/S1110724304307011

Juste, C., and Gérard, P. (2021). Cholesterol-to-Coprostanol Conversion by the Gut Microbiota: What We Know, Suspect, and Ignore. Microorganisms, 9(9), 1881. https://doi.org/10.3390/microorganisms9091881

Keleszade, E., Kolida, S., and Costabile, A. (2022). The cholesterol lowering efficacy of Lactiplantibacillus plantarum ECGC 13110402 in hypercholesterolemic adults: a double-blind, randomized, placebo controlled, pilot human intervention study. J Funct Foods, 89: 104939. https://doi.org/10.1016/j.jff.2022.104939

Kimoto, H., Ohmomo, S., and Okamoto, T. (2002). Cholesterol removal from media by lactococci. J Dairy Sci, 85(12), 3182-3188. https://doi.org/10.3168/jds.S0022-0302(02)74406-8

Klaver, FAM., and Meer, RVD. (1993). The assumed assimilation of cholesterol by lactobacilli and Bifidobacterium bifidum is due to their bile salt-deconjugating activity. Appl Environ Microbiol, 59(4), 1120-1124. https://doi.org/10.1128/aem.59.4.1120-1124.1993

Li, Y., Chen, M., Ma, Y., Yang, Y., Cheng, Y., Ma, H., Ren, D., and Chen, P. (2022). Regulation of viable/inactivated/lysed probiotic Lactiplantibacillus plantarum H6 on intestinal microbiota and metabolites in hypercholesterolemic mice. NPJ Sci Food, 6(1), 50-59. https://doi.org/10.1038/s41538-022-00167-x

Lin, MY., and Chen, TW. (2000). Reduction of cholesterol by Lactobacillus acidophilus in culture broth. J Food Drug Anal, 8(2), 97-102. https://doi.org/10.38212/2224-6614.2840

Lye, HS., Rahmat-Ali, GR., and Liong, MT. (2010a). Mechanisms of cholesterol removal by lactobacilli under conditions that mimic the human gastrointestinal tract. Int Dairy J, 20(3), 169-175. https://doi.org/10.1016/j.idairyj.2009.10.003

Lye, HS., Rusul, G., and Liong, MT. (2010b). Removal of cholesterol by lactobacilli via incorporation and conversion to coprostanol. J Dairy Sci, 93, 1383-1392. https://doi.org/10.3168/jds.2009-2574

Markowiak-Kopeć, P., and Śliżewska, K. (2020). The Effect of Probiotics on the Production of Short-Chain Fatty Acids by Human Intestinal Microbiome. Nutrients, 12(4), 1107-1111. https://doi.org/10.3390/nu12041107

Ooi, LG., and Liong, MT. (2010). Cholesterol-Lowering Effects of Probiotics and Prebiotics: A Review of in Vivo and in Vitro Findings. Int J Mol Sci, 11(6), 2499-2522. https://doi.org/10.3390/ijms11062499

Önür, ND., and Beyler, AR. (2001). Safra asitleri metabolizması. J Ankara Univ Fac Med, 54(1), 65-76. https://doi.org/10.1501/Tipfak_0000000295

Pereira, DIA., and Gibson, GR. (2002). Cholesterol Assimilation by Lactic Acid Bacteria and Bifidobacteria Isolated from the Human Gut. Appl Environ Microbiol, 68, 4689-4693. https://doi.org/10.1128/AEM.68.9.4689-4693.2002

Reis, SA., Conceição, LL., Rosa, DD., Siqueira, NP., and Peluzio, MCG. (2017). Mechanisms responsible for the hypocholesterolaemic effect of regular consumption of probiotics. Nutr Res Rev, 30(1), 36-49. https://doi.org/10.1017/S0954422416000226

Sharma, S., Kurpad, AV., and Puri, S. (2016). Potential of probiotics in hypercholesterolemia: A meta-analysis. Indian J Public Health, 60(4), 280-286. https://doi.org/10.4103/0019-557X.195859

Shobharani, P., and Halami, PM. (2016). In vitro evaluation of the cholesterol-reducing ability of a potential probiotic Bacillus spp. Ann Microbiol, 66, 643-651. https://doi.org/10.1007/s13213-015-1146-6

Tomaro-Duchesneau, C., Jones, M. L., Shah, D., Jain, P., Saha, S., and Prakash, S. (2014). Cholesterol assimilation by Lactobacillus probiotic bacteria: an in vitro investigation. BioMed Research International, 2014, 380316. https://doi.org/10.1155/2014/380316

Tsai, CC., Lin, PP., Hsieh, YM., Zhang, ZY., Wu, HC., and Huang, CC. (2014). Cholesterol-lowering potentials of lactic acid bacteria based on bile-salt hydrolase activity and effect of potent strains on cholesterol metabolism in vitro and in vivo. Sci World J, 2014, 690752. https://doi.org/10.1155/2014/690752

Wang, CS., Li, WB., Wang, HY., Ma, YM., Zhao, XH., Yang, H., Qian, JM., and Li, JN. (2018). VSL#3 can prevent ulcerative colitis-associated carcinogenesis in mice. Worl J Gastroenterol, 24(37), 4254-4262. https://doi.org/10.3748/wjg.v24.i37.4254

Türk Fen ve Sağlık Dergisi

Turkish Journal of Science and Health

The Relationship Between Prenatal Attachment And Spiritual Well-Being in High-Risk Pregnant Women in Turkey: A Cross-Sectional Study

Gizem Çıtak [1]* (ID)**, Zeynep Polat** [1] (ID)

[1] Tokat Gaziosmanpaşa University, Faculty of Health Sciences, Department of Midwifery, Tokat, Türkiye

ABSTRACT:

Purpose: This cross-sectional study aimed to examine the relationship between prenatal attachment and spiritual well-being in high-risk pregnant women in Turkey.

Material and Methods: Data were collected between May 1 and June 1, 2025 from 123 participants at the obstetrics outpatient clinic and wards of a training and research hospital. Participants completed a Personal Information Form, the Prenatal Attachment Inventory (PAI), and the Three-Factor Spiritual Well-Being Scale (3F-SWB).

Results: High levels of prenatal attachment and spiritual well-being were observed among participants. Prenatal attachment was significantly associated with age, planned pregnancy, and psychological status, while spiritual well-being was significantly related to family structure and psychological status. Moreover, a moderate, positive, and statistically significant correlation was found between prenatal attachment and spiritual well-being.

Conclusion: These findings highlight the importance of integrating spiritual and emotional support services into midwifery care for high-risk pregnancies.

Keywords: Midwifery; spiritual well-being; prenatal attachment; high-risk pregnancy

Corresponding author: Gizem Çıtak, email: gizem.citak@gop.edu.tr

INTRODUCTION

Pregnancy represents a unique and transformative phase in a woman's life. In addition to physiological and psychological changes, pregnancy brings biochemical and anatomical transformations. Beyond being a physical experience, pregnancy is also a profound spiritual journey. This period offers expectant mothers the opportunity to witness and engage with the miracle of life. Fostering spiritual well-being during pregnancy can help women experience this phase more peacefully and meaningfully, thereby strengthening maternal identity and laying the foundation for a secure parent-child bond (Okanlı et al., 2003).

Maternal mental health during pregnancy significantly influences both pregnancy outcomes and the quality of the bond between the mother and fetus. It is widely accepted that prenatal attachment defined by Muller (1993) as the emotional connection an expectant mother develops with her unborn child emerges during the prenatal period and is shaped by various psychological and physical factors (Muller and Ferketich, 1993; Ben Taleb et al., 2015; Elkin, 2015).

In some cases, the natural course of pregnancy may be disrupted by complications. A high-risk pregnancy refers to any condition involving physiological or psychosocial risks that may threaten the life and

health of the mother, fetus, or newborn. Although the incidence of high-risk pregnancies in Turkey has declined, nearly one in three pregnancies is still considered high-risk. Women in this category often face heightened emotional, physical, and social stressors, which may negatively affect prenatal attachment. Studies have reported that mothers with high-risk pregnancies tend to have lower levels of prenatal attachment compared to those with low-risk pregnancies (Atasever and Çelik, 2018).

The term *spirituality* originates from the Latin word *spiritus*, meaning "to breathe" and "to be alive." Broadly, spirituality refers to the process of making sense of life and finding meaning (Surbone and Baider, 2010). It is a multidimensional concept that offers individuals a sense of purpose, trust, and guidance, especially during difficult and sensitive periods. Spirituality is recognized as a critical factor in maintaining overall health and coping with life-threatening situations (Davison and Jhangri, 2013). Research indicates that individuals with high levels of spirituality tend to demonstrate greater emotional stability, awareness, and adaptability when faced with life challenges (Abdollahpour and Khosravi, 2018; Emmons, 2000). Moreover, spiritual well-being has been associated with happiness, life satisfaction, mental health, and psychological resilience (George, 2006; Göcen, 2013). According to Smith et al. (2013), spiritual well-being enhances healthy behaviors, positive emotions, family connections, and social support, all of which contribute to improved psychological resilience (Smith et al., 2013).

Given this context, the current study aims to examine the relationship between spiritual well-being and prenatal attachment in women with high-risk pregnancies. To the best of our knowledge, this is one of the first studies in Turkey to investigate the intersection of spirituality and maternal-fetal attachment in this population.

MATERIAL and METHODS
Purpose and Type of the Study

This study employed a descriptive, cross-sectional design to examine the relationship between spiritual well-being and prenatal attachment in women with high-risk pregnancies.

Sampling and participant

The research was conducted between May 1 and June 1, 2025 in the obstetrics outpatient clinic and inpatient wards of a training and research hospital in Turkey. A non-probability sampling method was preferred because the exact number of women with high-risk pregnancies presenting to the clinic during the study period could not be predicted in advance. The sample size was calculated using G*Power 3.1.9.7 software (Faul et al., 2007). Based on Cohen's (1988) recommendation for a medium effect size (r = 0.3) and informed by data from Dağlar et al. (2022), a sample size of 112 was determined to achieve a statistical power of 0.90 with a 5% margin of error (Cohen, 1988; Kurnaz and Türkmen Çevik, 2019). Considering a possible 10% data loss, the final sample consisted of 123 women diagnosed with high-risk pregnancy.

In this study, high-risk pregnancy was defined as the presence of maternal or fetal conditions that may endanger the health or life of the mother, fetus, or newborn. This included women diagnosed by an obstetrician with conditions such as gestational diabetes, preeclampsia, multiple pregnancy, placenta previa, preterm labor risk, or other complications documented in the medical records.
Inclusion criteria were: being diagnosed with high-risk pregnancy by a physician, being ≥18 years old, being able to speak and understand Turkish, and volunteering to participate. *Exclusion criteria* were: having a pre-existing psychiatric disorder, being unable to communicate effectively due to cognitive or language barriers, and declining to participate in the study.

Data Collection Tools

Personal Information Form: Developed by the researchers based on the existing literatüre (Gözen, 2013; Atasever and Çelik, 2018), this form contains 32 questions regarding the participants' sociodemographic and obstetric characteristics.

Prenatal Attachment Inventory (PAI): The Turkish version of the PAI was developed by Türkmen Çevik and Kurnaz (2019) to measure prenatal attachment levels (Ekşi and Kaardaş, 2017). The inventory includes 33 items rated on a 3-point Likert scale: (1 = strongly disagree, 2 = partially agree, 3 = strongly

agree). The scale includes three sub-dimensions: *Curiosity and Excitement* (Items 1–13), *Acceptance and Enthusiasm* (Items 14–22), and *Hope* (Items 23–33). (see Appendix A). Total scores range from 33 to 99, with higher scores indicating stronger prenatal attachment. The original internal consistency of the PAI was reported as α = .94. In the current study, Cronbach's alpha was .80 for the total scale and ranged from .80 to .82 for the subscales, indicating good reliability (see Table 1).

Three-Factor Spiritual Well-Being Scale (3F-SWB): Originally developed by Ekşi and Kardaş (2017), and

renamed in 2019, this 29-item scale assesses spiritual well-being across three dimensions: *Transcendence*, *Harmony with Nature*, and *Anomie (Baş Durdu, 2025)*. Items are rated on a 5-point Likert scale, with higher scores indicating greater spiritual well-bein. (see Appendix B). Total scores range from 29 to 145. In the original study, the scale's internal consistency was α = .88. In the current sample, the Cronbach's alpha value for the total scale was .80. Subscale alphas were as follows: Transcendence = .77, Harmony with Nature = .80, and Anomie = .80. (see Table 1).

Table 1. Mean Scores and Cronbach's Alpha Reliability Coefficients for the PAI and the 3F-SWB Subscales and Total Scores among Pregnant Women

Scales	X̄±SD (min-max)	Cronbach's Alpha
Total PAI	**93.53±7.16**	**0.80**
Curiosity and Excitement	36.22±3.36	0.81
Acceptance and Enthusiasm	25.93±1.88	0.82
Hope	31.37±2.73	0.80
Total 3F-SWB	**122.33±13.18**	**0.80**
Transcendence	66.07±7.61	0.77
Harmony with Nature	31.18±3.49	0.80
Anomie	25.08±5.41	0.80

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 24.0. Descriptive statistics, including means, standard deviations, minimum and maximum values, and percentages, were used to summarize the data. For group comparisons, the Kruskal–Wallis and Mann–Whitney U tests were applied to non-normally distributed data, whereas independent samples t-tests and one-way ANOVA were used for normally distributed variables. The relationship between prenatal attachment and spiritual well-being scores was analyzed using Spearman's rank-order correlation coefficient. A p-value less than .05 was considered statistically significant.

Ethical Approval

Ethical approval for the study was obtained from the Social and Human Sciences Ethics Committee of a university hospital (Approval Date: March 5, 2025; Decision No: 01-72). Additionally, institutional

permission was granted by a training and research hospital in the Black Sea Region (Approval Date: April 24, 2025; Decision No: 563600). Participants were informed about the purpose of the study, assured of confidentiality, and informed that data would be used solely for scientific purposes. Written informed consent was obtained from all participants. All procedures were conducted in accordance with the ethical principles of the Declaration of Helsinki, and particular care was taken to uphold the principle of individual autonomy.

RESULTS

In the comparison of total PAI scores with the sociodemographic and obstetric characteristics of the pregnant women, significant differences were identified in terms of age, pregnancy planning status, and psychological condition (p < 0.05). Regarding the "Curiosity and Excitement" subscale of the PAI, significant differences were observed for age, pregnancy planning status, psychological condition,

and pregnancy risk status (p < 0.05). Significant differences in the "Acceptance and Enthusiasm" subscale scores were found in relation to age, smoking during pregnancy, pregnancy planning status, and psychological condition (p < 0.05).

Lastly, the "Hope" subscale scores showed significant differences based on age, pregnancy planning status, and psychological condition (p < 0.05) (see Table 2).

In the comparison of the total scores of the 3F-SWB with the sociodemographic and obstetric characteristics of the pregnant women, significant differences were found in terms of family structure and psychological condition (p < 0.05). Additionally, a significant difference was observed between the

"Harmony with Nature" subscale and family structure (p < 0.05). Furthermore, the "Anomie" subscale showed significant differences related to both family structure and psychological condition (p < 0.05) (see Table 3).

A positive, statistically significant, and moderate correlation was found between the total scores of the PAI and the 3F-SWB among the pregnant women (r = 0.329, p < 0.001). Additionally, positive and statistically significant correlations were observed between the total scores of the 3F-SWB and the PAI subscales: "Hope" (r = 0.230, p < 0.001), "Acceptance and Enthusiasm" (r = 0.314, p < 0.001), and "Curiosity and Excitement" (r = 0.330, p < 0.001) (see Table 4).

Table 2. Comparison of Pregnant Women's Sociodemographic and Obstetric Characteristics with Total and Subscale Scores of the PAI

Pregnant Women's Characteristics	Mean Total Scores of PAI X̄±SD	Mean Curiosity/Excitement X̄±SD	Mean Acceptance/Joy X̄±SD	Mean Hope X̄±SD
Age				
18-22	95.85±2.44	36.92±1.97	26.62±0.50	32.31±0.94
23-27	95.56±4.63	37.17±2.24	26.32±1.19	32.07±2.18
28-35	93.56±7.53	36.31±3.47	25.87±2.09	31.37±2.65
36 +	85.87±9.28	32.67±4.30	24.53±2.69	28.67±3.73
p	*14.564/0.002** *	*8.065/0<001*** *	*7.801/0.049** *	*15.132/0.002** *
Education Level				
Literate	93.14±7.10	36.29±3.03	26.57±0.78	30.29±3.77
Primary Education	92.57±8.30	35.69±4.04	25.74±1.94	31.14±3.20
High School	93.98±6.68	36.44±0.07	25.96±1.93	31.57±2.41
p	-0.715/0.474*	0.619/0.540***	1.686/0.430**	2.747/0.253*
Working Status				
Yes	94.08±6.82	36.31±3.46	26.15±1.69	31.62±2.45
No	93.13±7.43	36.15±3.31	25.77±2.01	31.20±2.93
p	-1.017/0.309*	0.813/0.805***	-1.123/0.261*	-0.813/0.416*
Perception of Ekonomic Status				
Income is less than expenses	92.79±5.98	36.00±2.93	25.79±1.36	31.00±3.03
Income equals expenses	94.16±6.13	36.28±3.05	26.14±1.73	31.73±2.16
Income is more than expenses	92.87±8.76	36.20±3.93	25.69±2.21	30.98±3.29
p	2.264/0.322**	0.041/0.960***	3.340/0.188**	0.963/0.618**
Place of Recidence				
Village	95.33±2.69	36.22±1.92	26.67±0.70	32.44±1.13
District	95.09±6.24	36.97±2.90	26.38±1.43	31.74±2.59
City	92.66±7.75	35.90±3.63	25.66±2.09	31.10±2.88
p	2.256/0.324**	1.212/0.301***	5.666/0.059**	2.877/0.237**
Family Structure				
Nuclear Family	93.60±7.12	36.22±3.34	25.96±1.86	31.41±2.73
Extended Family	92.82±7.93	36.18±3.71	25.64±2.15	31.00±2.89
p	-0.492/0.623*	-0.244/0.807*	-0.309/0.757*	-0.818/0.413*
Smoking During Pregnancy				
Yes	93.83±5.42	36.35±2.60	25.78±1.41	31.70±2.67
No	93.46±7.53	36.19±3.52	25.97±1.98	31.30±2.75
p	-0.899/0.368*	1.586/0.840****	*-2.285/0.022* *	-1.166/0.244*

*Man Whitney U test, ** Kruskall Wallis Test, ***One Way ANOVA, ****Independent T Test

Table 2. (Continued) Comparison of Pregnant Women's Sociodemographic and Obstetric Characteristics with Total and Subscale Scores of the PAI

Pregnant Women's Characteristics	Mean Total Scores of PAI X̄±SD	Mean Curiosity/Excitement X̄±SD	Mean Acceptance/Joy X̄±SD	Mean Hope X̄±SD
Pregnancy Planning Status				
Planned	95.06±5.09	36.80±2.70	26.28±1.38	31.98±1.72
Unplanned	87.81±10.39	34.04±4.56	24.65±2.81	29.12±4.29
p	*-2.980/0.003**	*17.520/0<001*****	*-2.958/0.003**	*-2.796/0.005**
Psychological Status				
Good	95.53±4.53	36.85±2.77	26.53±0.95	32.15±1.38
Moderate	91.53±8.40	35.73±3.53	25.29±2.34	30.51±3.51
Bad	87.17±12.60	33.00±5.76	24.50±3.27	29.57±4.36
p	*10.996/0.004***	*4.734/0.011****	*17.775/0<001***	*7.730/0.020***
Risk Status of the Pregnancy				
Risk of Preterm Labor	93.60±6.03	36.40±2.55	25.80±2.17	31.40±1.92
Risk of Miscarriage	95.65±5.14	37.52±2.04	26.22±1.44	31.91±2.53
Risk of Fetal Anomaly	93.25±6.73	35.38±3.99	26.13±1.35	31.75±1.58
Gestational Diabetes	94.55±5.37	36.45±2.76	26.50±0.60	31.60±2.58
Preeclampsia	92.92±0.38	35.15±4.18	26.31±0.85	31.46±3.09
Advanced Maternal Age	85.13±11.55	32.50±5.60	24.13±3.22	28.50±3.85
Other (Postterm Pregnancy, Adolescent Pregnancy, etc.)	93.72±7.60	36.58±3.09	25.72±2.28	31.42±2.83
p	7.495/0.278**	*2.832/0.013****	3.879/0.693**	11.757/0.068**
Current Trimester				
First Trimester	92.91±7.13	36.03±3.50	25.91±1.57	30.97±3.13
Second Trimester	94.50±7.08	36.59±3.19	26.16±1.96	31.75±2.59
Third Trimester	93.34±7.29	36.12±3.41	25.83±2.01	31.39±2.59
p	2.258/0.323**	0.271/0.763***	4.003/0.135**	2.640/0.267**
Desire for Baby's Gender				
Yes	93.86±7.15	36.31±3.29	26.00±1.95	31.55±2.61
No	93.33±7.36	36.25±3.98	25.75±1.91	31.33±1.96
Unknown	92.48±7.31	35.88±3.40	25.80±1.68	30.80±3.41
p	-0.044/0.965**	0.159/0.853***	2.022/0.364**	1.056/0.590**
Consanguinity with Spouse				
Yes	93.13±6.64	35.75±3.19	26.38±1.06	31.00±3.29
No	93.56±7.23	36.25±3.38	25.90±1.93	31.40±2.70
p	-0.315/0.752*	-0.611/0.541*	-0.523/0.601*	-0.100/0.921*
Childbirth Education Status				
Yes	93.40±7.45	36.31±3.68	25.80±1.80	31.29±2.73
No	93.60±7.04	36.17±3.18	26.01±1.94	31.42±2.75
p	-0.262/0.793*	0.906/0.820****	-1.582/0.114*	-0.709/0.479*
Planned Mode of Delivery				
Vaginal Delivery	94.25±5.92	36.56±2.63	26.06±1.80	31.63±2.48
Cesarean Delivery	92.75±8.29	35.85±4.00	25.80±1.98	31.10±2.98
p	-0.174/0.862*	8.029/0.241****	-0.984/0.325*	-0.421/0.674*

*Man Whitney U test, ** Kruskall Wallis Test, ***One Way ANOVA, ****Independent T Test

Table 3. Comparison of Pregnant Women's Sociodemographic and Obstetric Characteristics with the Total and Subscale Scores of the 3F-SWB

Pregnant Women's Characteristics	Mean Total Scores of the 3F-SWB X̄±SD	Mean Score of the Transcendence X̄±SD	Mean Score of the Harmony with Nature X̄±SD	Mean Score of the Anomie X̄±SD
Age				
18-22	120.31±8.69	68.31±5.10	28.92±3.79	23.08±5.45
23-27	124.37±11.32	66.78±6.71	31.46±3.21	26.12±5.03
28-35	122.15±13.38	65.87±7.58	31.43±3.34	24.85±5.29
36 +	119.13±19.45	62.87±10.91	31.47±4.12	24.80±6.67
p	0.720/0.542***	1.403/0.245***	2.073/0.107***	1.147/0.333***

*Man Whitney U test, ** Kruskall Wallis Test, ***One Way ANOVA, ****Independent T Test

Table 3. (Continued) Comparison of Pregnant Women's Sociodemographic and Obstetric Characteristics with the Total and Subscale Scores of the 3F-SWB

Pregnant Women's Characteristics	Mean Total Scores of the 3F-SWB X̄±SD	Mean Score of the Transcendence X̄±SD	Mean Score of the Harmony with Nature X̄±SD	Mean Score of the Anomie X̄±SD
Education Level				
Literate	125.57±9.96	69.86±5.30	31.86±2.96	23.86±7.10
Primary Education	122.40±12.68	66.86±6.85	30.77±4.18	24.77±5.85
High School	122.01±13.71	65.40±8.02	31.30±3.22	25.32±5.11
p	0.233/0.793***	1.379/0.256***	0.411/0.664***	0.312/0.733***
Working Status				
Yes	121.56±14.40	65.29±8.42	31.27±3.31	25.00±5.46
N	122.89±12.29	66.63±6.97	31.11±3.64	25.14±5.42
p	1.276/0.583****	2.402/0.335****	0.255/0.807****	0.078/0.887****
Perception of Economic Status				
Income is less than expenses	120.14±12.82	65.57±8.08	31.21±4.19	23.36±4.98
Income equals expenses	123.47±11.18	66.64±6.46	31.22±3.21	25.61±5.12
Income is more than expenses	121.38±15.81	65.40±8.97	31.11±3.72	24.87±5.91
p	0.545/0.581***	0.380/0.685***	0.013/0.987***	1.049/0.353***
Place of Recidence				
Village	126.00±12.57	67.00±5.61	31.11±4.10	27.89±5.68
District	123.65±13.86	67.65±7.76	31.38±3.86	24.62±5.78
City	121.35±12.99	65.29±7.71	31.10±3.30	24.96±5.20
p	0.736/0.481***	1.223/0.298***	0.078/0.925***	1.360/0.261***
Family Structure				
Nuclear Family	123.16±13.04	66.24±7.38	31.39±3.36	25.53±5.32
Extended Family	113.82±12.03	64.27±9.89	29.00±4.21	20.55±4.25
p	*-2.337/0.019**	-0.546/0.585*	*-2.017/0.044**	*-2.922/0.003**
Smoking During Pregnancy				
Yes	119.22±13.63	65.22±8.91	30.87±3.13	23.13±4.78
No	123.04±13.04	66.26±7.32	31.25±3.58	25.53±5.47
p	0.004/0.211****	1.285/0.556****	1.078/0.640****	0.381/0.055****
Pregnancy Planning Status				
Planned	122.47±12.76	66.03±7.44	31.08±3.32	25.36±5.32
Unplanned	121.77±14.91	66.19±8.38	31.54±4.13	24.04±5.73
p	1.283/0.810****	0.877/0.924***	1.623/0.557****	0.903/0.271****
Psychological Status				
Good	125.13±11.18	66.82±6.58	31.37±3.41	26.94±4.51
Moderate	120.20±13.60	65.88±8.02	31.02±3.66	23.31±5.20
Bad	107.83±19.63	59.00±12.18	30.33±3.38	18.50±7.28
p	*6.304/0.002***	3.031/0.052***	0.322/0.726***	*13.293/0<001***
Risk Status of the Pregnancy				
Risk of Preterm Labor	118.80±12.01	65.60±7.70	30.47±4.32	22.73±5.39
Risk of Miscarriage	123.22±11.89	66.74±6.26	30.78±3.87	25.70±6.47
Risk of Fetal Anomaly	124.38±9.94	66.13±6.60	32.13±2.69	26.13±4.19
Gestational Diabetes	117.20±13.14	62.75±8.71	30.30±3.21	24.15±4.98
Preeclampsia	123.38±10.00	66.85±5.65	31.31±2.42	25.23±4.00
Advanced Maternal Age	127.25±19.99	67.75±9.27	32.50±4.72	27.00±7.80
Other (Postterm Pregnancy, Adolescent Pregnancy, etc.)	124.14±14.14	67.00±8.19	31.67±3.24	25.47±5.02
p	8.183/0.225**	5.675/0.461**	6.638/0.356**	5.005/0.543**
Current Trimester				
First	118.75±13.66	64.19±8.23	30.28±3.34	24.28±5.64
Second	125.34±12.70	67.66±7.44	32.13±3.83	25.56±5.53
Third	122.63±12.93	66.22±7.26	31.15±3.30	25.25±5.27
p	2.066/0.131***	1.702/0.187***	2.277/0.107***	0.501/0.607***
Desire for Baby's Gender				
Yes	123.58±13.09	66.65±7.11	31.23±3.61	25.70±5.41
No	122.08±13.51	66.33±9.41	32.17±3.18	23.58±4.98
Unknown	118.12±12.97	63.92±8.30	30.52±3.19	23.68±5.42
p	1.683/0.190***	1.259/0.288***	0.933/0.396***	1.878/0.190***

Table 3. (Continued) Comparison of Pregnant Women's Sociodemographic and Obstetric Characteristics with the Total and Subscale Scores of the 3F-SWB

Pregnant Women's Characteristics	Mean Total Scores of the 3F-SWB X̄±SD	Mean Score of the Transcendence X̄±SD	Mean Score of the Harmony with Nature X̄±SD	Mean Score of the Anomie X̄±SD
Consanguinity with Spouse				
Yes	115.63±19.35	61.88±11.26	29.88±4.22	23.88±7.47
No	122.79±12.63	66.36±7.27	31.27±3.44	25.17±5.28
p	-1.190/0.234*	-0.992/0.321*	-1.020/0.308*	-0.396/0.692*
Childbirth Education Status				
Yes	124.71±12.78	66.98±6.79	31.73±3.61	26.00±5.19
No	120.95±13.29	65.54±8.04	30.86±3.40	24.55±5.50
p	0.001/0.128****	0.886/0.315****	0.649/0.182****	0.478/0.154****
Planned Mode of Delivery				
Vaginal Delivery	121.97±11.86	65.67±7.12	31.11±3.45	25.19±5.04
Cesarean Delivery	122.71±14.57	66.49±8.15	31.25±3.56	24.97±5.83
p	2.252/0.756****	0.747/0.553****	0.460/0.819****	1.893/0.822****

*Man Whitney U test, ** Kruskall Wallis Test, ***One Way ANOVA, ****Independent T Test

Table 4. Relationship Between the Total and Subscale Scores of the PAI and the Total and Subscale Scores of the 3F-SWB

		Total Score of the 3F-SWB	Anomie Subscale of the 3F-SWB	Harmony with Nature Subscale of the 3F-SWB	Transcendence Subscale of the 3F-SWB	Total Score of PAI	Hope Subscale of the PAI	Acceptance and Enthusiasm Subscale of the PAI	Curiosity and Excitement Subscale of the PAI
Total Score of the 3F-SWB	r p	1	0.657** 0.000	0.803** 0.000	0.848** 0.000	0.329** 0.000	0.230** 0.000	0.314** 0.000	0.330** 0.000
Anomie Subscale of the 3F-SWB	r p		1	0.348** 0.000	0.268** 0.003	0.221* 0.014	0.184* 0.042	0.233** 0.010	0.192* 0.034
Harmony with Nature Subscale of the 3F-SWB	r p			1	0.659** 0.000	0.255** 0.004	0.137 0.130	0.215* 0.017	0.297** 0.001
Transcendence Subscale of the 3F-SWB	r p				1	0.298** 0.001	0.219* 0.015	0.281** 0.002	0.320** 0.000
Total Score of PAI	r p					1	0.756** 0.000	0.749** 0.000	0.897** 0.000
Hope Subscale of the PAI	r p						1	0.610** 0.000	0.520** 0.000
Acceptance and Enthusiasm Subscale of the PAI	r p							1	0.536** 0.000
Curiosity and Excitement Subscale of the PAI	r p								1

DISCUSSION

In our study, the mean total score of the PAI among pregnant women was found to be 93.53 ± 7.16, indicating a high level of attachment. Similar studies in the literature also report high prenatal attachment levels among pregnant women. For example, Baş Durdu (2025) reported a total PAI score of 94.53 ± 8.43 in her study (Alkaş and Varşoğlu, 2023). Likewise, Alkaş and Varşoğlu (2023), in their research examining the relationship between anxiety and

prenatal attachment, found a PAI score of 91.51 ± 11.32. However, some studies have reported lower mean PAI scores. Kartal and Karaman (2018), following participation in prenatal education programs, found a score of 71.88 ± 8.25 (Kartal and Karaman, 2018; Küçükkaya et al., 2018). In the study by Küçükkaya et al. (2018), the PAI score was reported as 64.89 ± 21.15. Additionally, Potur et al. (2020) conducted a study in Istanbul and found the mean PAI score among pregnant women to be 62.21 ± 10.66; they also reported that primiparous women had statistically significantly higher attachment scores compared to multiparous women (Yılmaz and Beji, 2010). These differences can be explained by factors such as sample characteristics, gestational weeks, risk status, education level, and psychological condition in the respective studies. Overall, however, the findings of our study align with the literature indicating a high level of prenatal attachment among pregnant women.

In our study, when comparing the total PAI scores of pregnant women with their sociodemographic and obstetric characteristics, statistically significant differences were found between prenatal attachment levels and factors such as age, planned pregnancy, and psychological status (p<0.05). The literature indicates that education and socioeconomic status are among the important factors affecting prenatal attachment (Trombetta-Lima et al., 2021; Ataman et al., 2022). Similarly, Ataman et al. (2022) reported that planned pregnancy status, pregnancy intention, economic condition, and family structure influence prenatal attachment (Aykaç, 2021). However, another study conducted by Aykaç (2021) found no significant effect of age, education level, employment status, and income level on prenatal attachment (Bilgiç, 2019). This suggests that prenatal attachment may be influenced differently by individual, cultural, and environmental factors.

In our study, the mean total score on the 3F-SWB among pregnant women was found to be 122.33 ± 13.18, indicating a high level of spiritual well-being. Similarly, Bilgiç (2019) reported a mean spiritual well-being score of 125.59 ± 12.97 in a study conducted with pregnant women (Dunn et al., 2007). Other studies in the literature also highlight generally high levels of spiritual well-being among pregnant women. For instance, Abdollahpour and Khosravi (2018) found a spirituality score mean of 64.43 ± 16.51 among pregnant participants (Abdollahpour and Khosravi, 2018). Dunn et al. (2007), in their study examining the relationship between anxiety, depression, and spiritual well-being in pregnant women, reported an average spiritual well-being score of 110.0 (Edis and Bal, 2024). Variations in mean scores across different studies largely arise from structural differences in the measurement instruments used and the diversity of cutoff points applied. However, overall, the finding of high spiritual well-being among pregnant women is consistent with existing literature. This suggests that pregnancy may represent a period of heightened spiritual awareness for women and that spiritual resources could play a significant role in supporting psychological resilience during this process.

In our study, a comparison of the total scores on the 3F-SWB with the sociodemographic and obstetric characteristics of pregnant women revealed significant differences in family structure and psychological status (p < 0.05). Additionally, significant relationships were found between the "Harmony with Nature" subscale and family structure, as well as between the "Anomie" subscale and both family structure and psychological status (p < 0.05) (Table 2). These results indicate that family support and parental mental health have a significant impact on the spiritual well-being levels of pregnant women. Similarly, the literature reports that factors such as income status and planned pregnancy influence spiritual well-being among pregnant women (Buldur and Göcen, 2021). Moreover, unplanned pregnancies have been reported to have negative effects on spiritual well-being (Izadi et al., 2020). These findings underscore the critical role of family support and psychological well-being in enhancing spiritual well-being during the pregnancy process.

In our study, a positive, statistically significant, and moderate correlation was found between the total scores of the PAI and the 3F-SWB (p < 0.05). This finding indicates that higher levels of spiritual well-being strengthen prenatal attachment behaviors.

Similarly, a cross-sectional study conducted by Izadi et al. (2020) with 200 pregnant women in Qazvin, Iran, reported a positive and significant relationship between spiritual health and prenatal attachment scores (r = 0.40, p < 0.001) (Sidhu and Dhamania, 2025). This study demonstrated the supportive role of spiritual well-being in fostering emotional attachment during the preparation for motherhood. Likewise, Sidhu and Dhamania (2025) in their research in Jaipur identified a strong positive correlation between maternal-fetal attachment and spiritual health (r = 0.65, p < 0.05), emphasizing that spiritual orientation enhances the bonding process during pregnancy (Baltacı and Vatansever, 2022). In Turkey, Baltacı and Vatansever (2022) compared women with spontaneous pregnancies and those who conceived through assisted reproductive technologies, finding that women with higher spiritual well-being also had significantly stronger prenatal attachment. These findings align with our study results, supporting the notion that spiritual well-being positively influences the mother–infant bond by enhancing psychological resilience during pregnancy.

Limitations

This study has some limitations that should be acknowledged. Firstly, the use of a non-probability sampling technique may limit the representativeness of the sample, which affects the generalizability of the findings to all high-risk pregnant women. Secondly, the cross-sectional design restricts the ability to infer causal relationships between spiritual well-being and prenatal attachment. Thirdly, data were collected using self-report questionnaires, which may be subject to social desirability and recall biases. Additionally, the study was conducted in a single hospital setting, which might not reflect experiences in other regions or healthcare environments. Future research with larger, more diverse populations and longitudinal designs is recommended to further explore and confirm these relationships.

CONCLUSION

This study highlights the importance of spirituality as a supportive factor in the maternal–fetal relationship during pregnancy. The findings suggest that fostering spiritual well-being may strengthen the emotional bond between mother and baby, contributing to a healthier pregnancy experience. Interventions that encourage spiritual well-being—such as counseling, supportive care, or holistic health practices—may help expectant mothers cope more effectively with the challenges of pregnancy and enhance maternal identity. Future studies could focus on developing and testing structured programs that integrate spirituality into prenatal care and exploring how such approaches affect long-term maternal and child outcomes. In practice, strengthening psychological well-being during pregnancy may support and enhance mother–baby bonding.

Conflict of Interest

The authors declare that there is no conflict of interest.

REFERENCES

Abdollahpour, S., Khosravi, A. (2018). Relationship between spiritual intelligence with happiness and fear of childbirth in Iranian pregnant women. *Iranian Journal of Nursing and Midwifery Research, 23*(1), 45–50. https://doi.org/10.4103/ijnmr.IJNMR_39_16

Alkaş, Ü., Varşoğlu, Y. (2023). Anxiety and prenatal attachment in primiparous pregnant women: Effects of the pandemic period. *Journal of Women's Health Nursing, 9*(1), 1–11. https://dergipark.org.tr/tr/download/article-file/2767516

Ataman, H., Akarsu, Ö., Budak, M. İ. (2022). Determining the relationship between marital adjustment and prenatal attachment in high-risk third-trimester pregnant women. *Turkish Journal of Family Medicine and Primary Care, 16*(4), 670–680. https://doi.org/10.21763/tjfmpc.1097177

Atasever, İ., Çelik, A. S. (2018). The effect of prenatal stress on maternal and child health. *Anatolian Journal of Nursing and Health Sciences, 21*(1), 60–68. https://dergipark.org.tr/tr/download/article-file/464386

Aykaç, E. G. (2021). Relationship between temperament traits and prenatal attachment characteristics, depression, and anxiety levels in pregnant women [Master's thesis]. Istanbul Gelisim University. https://acikerisim.gelisim.edu.tr/items/07fab53f-

435f-4e24-a1ea-9ed5ac9d2e36

Baltacı, D., Vatansever, Z. (2022). Evaluation of anxiety, stress and spiritual well-being in pregnant women with spontaneous and assisted reproduction pregnancies. Turkish Journal of Obstetrics and Gynecology, *19*(3), 190–196.
https://doi.org/10.4274/tjod.galenos.2022.22062

Baş Durdu, C. (2025). The relationship between personality traits, social media use, and prenatal attachment in pregnant women [Master's thesis]. Sakarya University, Institute of Health Sciences.

Ben Taleb, Z., Bahelah, R., Fouad, F. M., Coutts, A., Wilcox, M., & Maziak, W. (2015). Syria: Health in a country undergoing tragic transition. International Journal of Public Health, *60*(Suppl 1), S63–S72.
https://doi.org/10.1007/s00038-014-0586-2

Bilgiç, G. (2019). Relationship between fear of childbirth and psychological and spiritual well-being in pregnant women [Master's thesis]. Bolu Abant İzzet Baysal University.
https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=ND0CS-FCwOxywlNYoY8lFg&no=aHIX55VDi0YAhbVbzV6ggg

Buldur, A. H., & Göcen, G. (2021). Examination of the religious, spiritual, and psychological conditions of women during the process of unplanned pregnancy. Journal of Values Education, *19*(42), 337–374.
https://doi.org/10.34234/ded.1009333

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Davison, S. N., & Jhangri, G. S. (2013). The relationship between spirituality, psychosocial adjustment to illness, and health-related quality of life in patients with advanced chronic kidney disease. Journal of Pain and Symptom Management, *45*(2), 170–178.
https://doi.org/10.1016/j.jpainsymman.2012.02.019

Dunn, L. L., Handley, M. C., & Shelton, M. M. (2007). Spiritual well-being, anxiety, and depression in antepartal women on bedrest. Issues in Mental Health Nursing, *28*(11), 1235–1246.
https://doi.org/10.1080/01612840701526104

Edis, E. K., & Bal, S. (2024). Life satisfaction, psychological resilience, and spiritual well-being levels of pregnant women. Spiritual Psychology and Counseling, *9*(3), 241–257.
https://doi.org/10.37898/spiritualpc.1449307

Ekşi, H., & Kardaş, S. (2017). Spiritual well-being: Scale development and validation. Spiritual Psychology and Counseling, *2*, 73–88.
https://doi.org/10.12738/spc.2017.1.0022

Elkin, N. (2015). Prenatal attachment levels of pregnant women and factors affecting them. STED, *24*(4), 230–236. https://dergipark.org.tr/tr/download/article-file/1906958

Emmons, R. A. (2000). Is spirituality an intelligence? Motivation, cognition, and the psychology of ultimate concern. International Journal for the Psychology of Religion, *10*(1), 3–26.
https://doi.org/10.1207/S15327582IJPR1001_2

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, *39*(2), 175–191.

George, M. (2006). Practical application of spiritual intelligence in the workplace. Human Resource Management International Digest, *14*(5), 3–5.
https://doi.org/10.1108/09670730610678181

Göcen, G. (2013). The relationship between psychological well-being and religious orientation within the framework of positive psychology: A study on adults. Social Sciences, *7*(13), 97–130.
https://isamveri.org/pdfdrg/D03402/2013_7_13/2013_7_13_GOCENG.pdf

Izadi, F., Golmakani, N., Hashemian, M., & Modares Gharavi, M. (2020). The relationship between spiritual health and maternal-fetal attachment in pregnant women. Iranian Journal of Nursing and Midwifery Research, *25*(6), 501–505.
https://doi.org/10.4103/ijnmr.IJNMR_212_19

Kartal, Y., & Karaman, T. (2018). The effect of childbirth preparation education on prenatal attachment and depression risk in pregnant women. Zeynep Kamil Medical Bulletin, *49*(1), 85–91.
https://doi.org/10.16948/zktipb.321210

Kurnaz, F., & Türkmen Çevik, F. (2019). Prenatal attachment scale: Reliability and validity study. Hacettepe University Faculty of Health Sciences Journal, *6*(2), 112–138.
https://doi.org/10.21020/husbfd.453796

Küçükkaya, B., Dindar, İ., Erçel, Ö., & Yılmaz, E. (2018). Pregnant women's concerns about birth and postpartum periods according to pregnancy trimesters. Journal of Academic Research in Nursing (JAREN), *4*(1), 28–36.
https://doi.org/10.5222/jaren.2018.028

Muller, M. E., & Ferketich, S. (1993). Factor analysis of the Maternal Fetal Attachment Scale. Nursing Research, *42*(3), 144–147.
https://pubmed.ncbi.nlm.nih.gov/8506162/

Okanlı, A., Tortumluoğlu, G., & Kırpınar, İ. (2003). The relationship between perceived social support from family and problem-solving skills in pregnant women. Anadolu Psikiyatri Dergisi, *4*, 98–105.
https://search.trdizin.gov.tr/en/yayin/detay/20203

Potur, D., Doğan Merih, Y., & Demirci, N. (2020). Evaluation of factors affecting prenatal attachment in primiparous and multiparous pregnant women. Journal of Academic Research in Nursing, *6*(1).
https://doi.org/10.5222/jaren.2020.65265

Sidhu, A., & Dhamania, M. (2025). Spiritual health and maternal fetal attachment among pregnant women. Global Journal for Research Analysis, *12*(1), 40–42.
https://www.worldwidejournals.com/global-journal-for-research-analysis-GJRA/fileview/spiritual-health-and-maternal-fetal-attachment-among-pregnant-women_January_2023_6008705982_1508691.pdf

Smith, L., Webber, R., & Defrain, J. (2013). Spiritual well-being and its relationship to resilience in young

people: A mixed methods case study. SAGE Open, *3*(1), 1–16. https://doi.org/10.1177/2158244013492951

Surbone, A., & Baider, L. (2010). The spiritual dimension of cancer care. Critical Reviews in Oncology/Hematology, *73*(3), 228–235. https://doi.org/10.1016/j.critrevonc.2009.09.006

Trombetta-Lima, M., Munhoz, T. N., Figueiredo, B., et al. (2021). Pre-natal attachment and parent-to-infant attachment: A systematic review. Frontiers in Psychology, *12*, 620942. https://doi.org/10.3389/fpsyg.2021.620942

Yılmaz, S. D., & Beji, N. K. (2010). Pregnant women's levels of coping with stress, depression, and prenatal attachment, and the factors affecting these. Journal of General Medicine, *20*(3). https://search.trdizin.gov.tr/tr/yayin/detay/132172