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Turkish Journal of Public Health

VOLUME: 22 CONTENTS ISSUE: 3

Original Article

Review

Systematic Reviews and Meta Analysis

Letter to Editor

From the Editor

Dear readers and contributors,

As of 2024, the Turkish Journal of Public Health has continued to serve as a significant platform for the generation and dissemination of scientific knowledge in the field of public health. In this final issue of the year, we would like to share the annual statistics of our journal, reflecting on our past year and providing insights into the future. Throughout 2024, a total of 144 manuscript submissions were received. These manuscripts were predominantly research articles (83.3%), along with a smaller number of reviews and case reports. During the review process, 89 (61%) manuscripts were rejected for various reasons. The post-review rejection rate was relatively low (10.4%). The average decision time for manuscripts requiring peer review was 75 days. The average time from submission to acceptance was 120 days, aligning with international standards. However, for these processes to be more efficient and faster, greater involvement from public health experts in the peer review process is critical. Contributions to the peer review process not only enhance individual scientific expertise but also directly improve the quality of journal.

The year 2024 marked significant steps toward increasing the international visibility of TJPH. To expand its global reach and engage with a broader academic audience, the journal has completed applications to international indices, including PubMed, and the evaluation of the TJPH application is ongoing. These efforts will also increase the citation impact of the journal's publications. We kindly ask our readers and authors to support this initiative by actively citing published articles and promoting them to wider audiences. Citations are one of the most tangible indicators of the journal's scientific impact, playing a pivotal role in increasing its international recognition and reputation. We encourage our authors and readers to reference TJPH publications in their academic work and help disseminate these articles to broader networks. This year's statistics offer various insights into improving the journal's quality and optimizing processes including; Expediting the review process will enhance author satisfaction and facilitate more effective knowledge dissemination. Increasing the number of review articles and case reports will help the journal appeal to a broader scientific audience. Efforts to increase the visibility of articles through collaborations and promotional activities should be prioritized. Advancements in the PubMed and SCI application processes will be a milestone in the journal's journey toward international recognition.

These achievements have been made possible through the invaluable contributions of our authors, reviewers, and editorial team. As we move into 2025, we invite you to become part of the TJPH community to create greater scientific impact and promote public health. Your support in the peer review process and in citing published articles will be instrumental in advancing the journal's success. In this issue, we are pleased to present to our readers' appreciation six original research articles, one systematic review, one narrative review, and one letter to the editör. Enjoy reading the new issue, and wishing you a happy, healthy New Year!"

Yucel Demiral

Editor in Chief

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TURKISH JOURNAL OF PUBLIC HEALTH

ORIGINAL ARTICLE

Trends in research on the concept of active ageing: a bibliometric analysis

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Abstract

Objective: This study aims to provide insights into the scientific activity in the field by conducting a bibliometric analysis of studies examining the concept of active ageing in the Web of Science_ WoS database.

Methods: The research includes studies retrieved from the WoS database during a search conducted on September 2, 2023, containing keywords such as "active ageing," "active and healthy ageing," "healthy and active ageing," and "ageing well." The study examined various characteristics of these studies, including their type, publication frequency, relationship with sustainable development goals, country of origin, subject, journals, co-authors, author citations, and keywords. Bibliometric analyses were conducted using VOSviewer software.

Results: Out of the 1740 studies retrieved, materials such as editorials, book reviews, and conference abstracts (n=423) were excluded, leaving a total of 1317 studies for database inclusion, comprising 1203 articles and 114 reviews. Among the 1160 studies on Sustainable Development Goals, 15 out of 17 goals were covered. It was determined that 71% of the studies addressed the "Healthy and Quality Life" goal. Spain had the highest number of publications (n=201), while the United Kingdom received the most citations (n=3073). According to bibliographic matching analysis, the Gerontologist journal was identified as the most influential journal in the field.

Conclusion: The number and impact of research on active ageing have increased over time. The importance and impact of research in this field hold great potential to enhance the quality of life of the future elderly population and stimulate their societal contributions.

Keywords: Healthy Ageing, Elderly, Well Ageing

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INTRODUCTION

The ageing population is increasingly gaining importance as a phenomenon that reshapes the countries' demographic, social, and economic balance.[1] Globally, for the first time in history, the number of individuals aged 60 and over exceeded the number of children under 5 in 2020, and the rate of ageing in the population is steadily increasing.[2] In Türkiye, the rapidly increasing elderly population is attributed to the decline in fertility and mortality rates, as well as an increase in life expectancy at birth. According to population projections, it is estimated that the elderly population ratio will be 12.9% in 2030, 16.3% in 2040, and 22.6% in 2060.[3]

In order to convey a more inclusive message than healthy ageing, the term "active ageing" was adopted by the World Health Organization (WHO) in the late 1990s. This term is defined as the process of optimizing health, participation, and security opportunities to increase the quality of life as individuals age. This approach is based on the principles of the United Nations, including independence, participation, dignity, care, and self-realization, as well as the recognition of the human rights of older people.[4] The United Nations General Assembly declared the years 2021-2030 as the "Decade of Healthy Ageing" and requested guidance from the WHO to implement it.[2] Active ageing supports older individuals in maintaining their physical, social, and mental health to lead longer and healthier lives. It encourages the social participation of older individuals, promoting their involvement in the workforce, volunteer activities, and being a part of community life. Active ageing also advocates for continuous learning and awareness among older individuals, emphasizing that they can be a part of life independently of factors such as gender, ethnicity, disability, or other considerations. It encourages older individuals to use natural resources sustainably.[4] For all these reasons, active ageing aligns with the complementary goals of sustainable development, focusing on "healthy and successful ageing," "social participation and employment," "education and awareness," "social equality and inclusion," and "environmental sustainability of resources." A society where older individuals are healthy, productive, informed, and socially included can play a significant role in achieving sustainable development goals.[5,6]

On the other hand, age discrimination, particularly the explicit use of gender-biased stereotypes when describing older women and elderly characters outside the family,[7] situations such as informal employment, lack of supportive environments for meeting primary health and social needs,[8] and deficiencies in structures, personnel resources, and expertise for inter-sectoral collaboration are seen as barriers to active ageing.[9] The COVID-19 pandemic has further exacerbated inequalities, insecurity, and the exclusion of certain social groups by revealing the health, social, economic, and living conditions of the elderly.[1] The role of social and mental well-being as determinants of healthy ageing is increasingly acknowledged. This is also an indicator of active ageing.[10] The concept of active ageing is considered a key element in providing individuals with more opportunities throughout their lives and a better quality of life in old age, particularly in the context of social participation, integration, and adaptation.[1]

This study aims to conduct a bibliometric analysis of research on the concept of active ageing in the Web of Science (WoS) database. Considering the breadth of the existing literature on active ageing, it is evident that a significant portion of the studies in this field focus on the conceptual framework[11,12] and policy applications.[1,9,13] However, there is a lack of comprehensive review regarding the international trends in active ageing research, which countries and authors contribute the most to this field, and which topics receive greater attention. At this point, bibliometric analysis becomes critical to understanding the global trends in active ageing research. In particular, policies and social practices related to ageing, which have accelerated in the post-pandemic era, require a more systematic examination of studies in this field. Therefore, bibliometric analysis offers an innovative approach, providing a map of the dynamics of active ageing research, identifying gaps in this area, and offering essential insights into the current state of the scientific literature and future research domains.

In this context, bibliometric analysis not only illustrates how the concept of active ageing has evolved but also identifies which research areas have gained more interest, which topics still need to be explored, and which research subjects should be prioritized in the future. By doing so, it will provide concrete findings to address the gaps in the literature. Moreover, considering the impact of the pandemic and global demographic changes on active ageing, the study will offer critical guidance for policymakers and researchers in determining future roadmaps. In conclusion, this study aims to contribute to efforts that support the lives of elderly individuals by illuminating the evolution of the concept of active ageing in the scientific literature and visualizing significant trends and research gaps in the field.

Research Questions:

Q1. What are the publication and citation trends of studies on active ageing?

Q2. Who are the authors and countries that have contributed the most to the concept of active ageing?

Q3. Which articles and journals receive the most citations in research on the concept of active ageing?

Q4. What are the keywords commonly used in research on the concept of active ageing?

Q5. What are the topics associated with the concept of active ageing?

Q6. What opportunities and recommendations exist for future research on the concept of active ageing?

METHOD

Type and time of the research

The research was conducted as a bibliometric analysis study in the time interval between August and September 2023. *Bibliometric analysis* is a method used to analyze current trends in the literature of a specific field by examining various characteristics of scientific studies, such as their prevalence, impact, and interdisciplinary relationships, using bibliographic data.[14] In the writing of this study, the CARDA (Checklist for Assessment and Reporting of Document Analysis) guide was used to enhance the transparency and reproducibility of document analysis-based research. CARDA provides a checklist that ensures a systematic approach to data collection, analysis, and reporting in document analysis-based studies. This guide

structures the phases of document selection, data analysis, and interpretation of results to enhance the methodological reliability of the study and assists researchers throughout these processes.[15] In this study, CARDA was used to ensure the reliability and reproducibility of the methodology. For instance, during the data collection process, how the documents were selected and the criteria for their inclusion in the study were detailed. The CARDA checklist, in particular, ensured transparency in terms of the documents' nature, scope, and acquisition processes.

Data Collection Process

Research data was retrieved from the Web of Science (WoS), a comprehensive and prestigious database that includes scientific articles, conference papers, and other academic sources published in various disciplines. The research universe is formed by the existing literature in the WoS database. On September 2, 2023, the WoS database was searched using the keywords "active ageing," "active and healthy ageing," "healthy and active ageing," and "ageing well" without any restrictions on publication year, language, etc. Publications containing any of these keywords in their subject, title, or abstract were included in the sample. The search keywords were selected based on their established prominence in the literature related to ageing and their alignment with the World Health Organization's definitions and frameworks. These terms encapsulate the critical concepts of promoting health, participation, and quality of life in older adults.

Variables

The studies included in the scope of the research were examined based on the following variables: type, publication frequency, relationship with sustainable development goals, country, topic, top 10 journals with the highest number of publications (publication count, citation count, impact factor, and Q level), co-author relationships, author citation relationships, and the top 10 most frequently used keywords, considering bibliographic matches in the texts.

Statistical Analysis

Bibliometric analysis of the data obtained from the WoS database were presented using descriptive statistics and graphics. VOSviewer software (version 1.6.19) (https://www.vosviewer.com/) was utilized for data visualization. Through VOSviewer, analyses including co-author analysis, author citation analysis, source citation analysis, country citation analysis, institution citation analysis, keyword analysis, bibliographic coupling analysis of texts, and co-citation analysis of authors were conducted.

RESULTS

Through searches with keywords, 1740 studies were identified in the WoS database. A total of 423 studies in editorial material, book review, correction, meeting, meeting abstract, book chapter, conference paper, and letter formats were excluded from the research. The studies ranged from the oldest in 1991 (n=1) to the most recent in 2023 (n=95). Of the identified studies, 1203 were articles, and 114 were reviews, making a total of 1317 studies forming the database for this research. When the publication years of the studies were examined, it was observed that their distribution increased compared to the previous year. In the last five years before 2023, the frequency of publications for the studies,

moving backward in time, were 204, 164, 157, 113, and 90 publications, respectively.

Of the 1160 studies related to Sustainable Development Goals, it was observed that they covered 15 out of 17 goals, excluding the goals "16. Peace, Justice, and Strong Institutions" and "17. Partnerships for the Goals." It was determined that 71% of the studies covered Goal 3, "Good Health and Well-being."

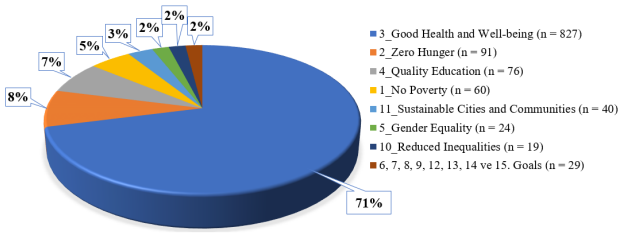

Figure 1. Distribution of studies according to sustainable development goals

While Spain was identified as the country with the most studies related to the concept of active ageing (n=201 publications), the country receiving the most citations for these publications was the United Kingdom (n=3073 citations). Figure 2 displays the publication and citation numbers of the top 10 countries where the studies are most frequently conducted. Data for Taiwan and Germany were also presented in the figure since both countries had an equal number of publications (n=63), placing them in the last position.

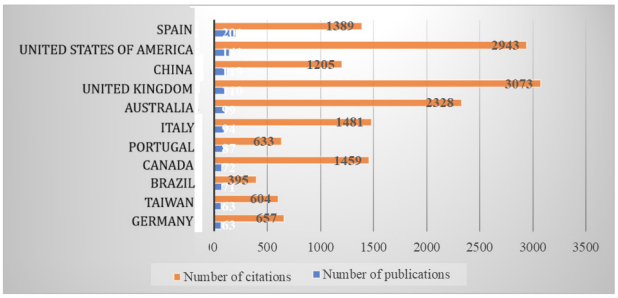

Figure 2. Publication and citation numbers of the top 10 countries with the most conducted studies

In the distribution of studies based on their topics, the top 10 topics were, in order: palliative care (n=225), nutrition and dietetics (n=185), social psychology (n=179), health policy (n=61), management (n=59), walking and posture (n=47), economics (n=45), political science (n=43), neurodegenerative diseases (n=32), and nursing (n=20).

The top 10 journals where studies on the concept of active ageing were most frequently published, along with the citation numbers, impact factors from the last five years obtained from the WoS, and the latest Q levels, were presented in Table 1.

Table 1. Top 10 journals with the most published studies and some characteristics

No	Journal name	Number of publications	Citation numbers	Impact factors	Q levels
1	International Journal of Environmental Research and Public Health	75	468	4.799	Q1 - Q2
2	Frontiers in Public Health	31	56	5.5	Q1
3	Journal of Aging and Physical Activity	25	233	2.2	Q4
4	Educational Gerontology	23	251	1.8	Q4
5	Gerontologist	19	1651	6.2	Q1
6	Ageing & Society	19	532	2.8	Q3
7	Journal of Aging Studies	16	288	2.8	Q3
8	Ageing International	15	155	1.6	Q4
9	Sensors	14	241	4.1	Q2
10	Sustainability	14	87	4	Q2 - Q3

Co-author Analysis

According to the co-author analysis conducted to examine the relationships and collaboration of authors who have collaborated in articles or research projects, 3744 authors had at least one publication and 1 citation related to the concept of active ageing. The top 3 authors conducting the most research on this topic were, in order, Taina Rantanen (n=16),

Erja Portegijs (n=13), and Milla Saajanaho (n=10). For the 235 authors with the highest collaboration and total link strength among the 3744 authors, a network and density map was presented in Figure 3.

Figure 3. Co-author analysis map

Author Citation Analysis

The top three authors who received the most citations for their research were Philip Atherton, Mike Larvin, and John Lund (each with 723 citations for their respective single studies). The top three authors with the highest link strength were, in order: Taina Rantanen (16 publications, 243 citations, 319 link strength), Erja Portegijs (13 publications, 202 citations, 289 link strength), and Milla Saajanaho (10 publications, 180 citations, 263 link strength). The author-citation analysis map for the shared citations of authors were presented in Figure 4.

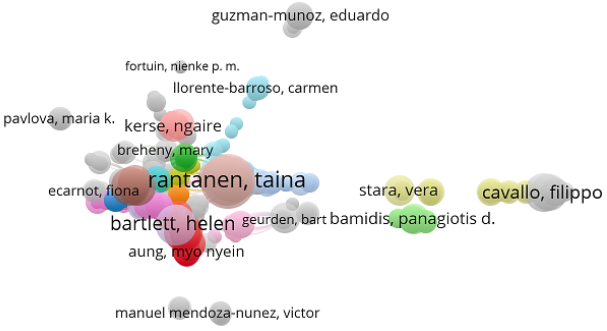

Figure 4. Author citation analysis

Keyword analysis

A total of 312 keywords were identified, each repeated in at least three studies. Based on the strength of connections established with other keywords for each of the 312 keywords, the keywords with the highest link strength were presented in Figure 2. The top 10 most used keywords, in order, were: active ageing (401 repetitions, 736 link strength), ageing (147 repetitions, 321 link strength), older adults (125 repetitions, 257 link strength), physical activity (69 repetitions, 189 link strength), quality of life (72 repetitions, 181 link strength), elderly (72 repetitions, 161 link strength), healthy ageing (55 repetitions, 121 link strength), ageing (63 repetitions, 119 link strength), older people (52 repetitions, 110 link strength), and health (44 repetitions, 99 link strength).

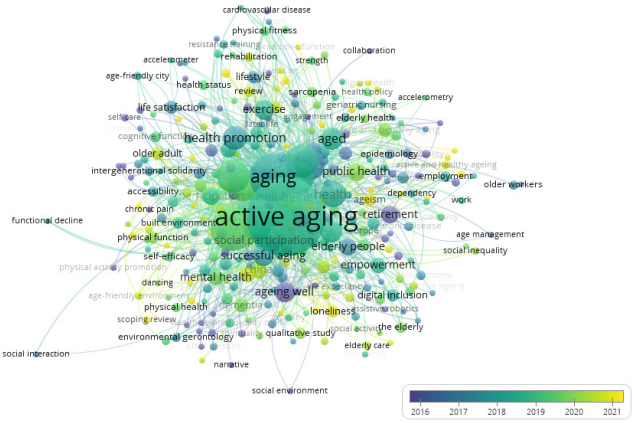

Figure 5. Keyword network analysis

Bibliographic match analysis of texts

A bibliographic match analysis was conducted through journals to determine the similarity and connections between articles that cite other articles, aiming to assess the impact capacity of the cited publications. According to the bibliographic match analysis results, the journal Gerontologist has been identified as the most influential journal in the field.

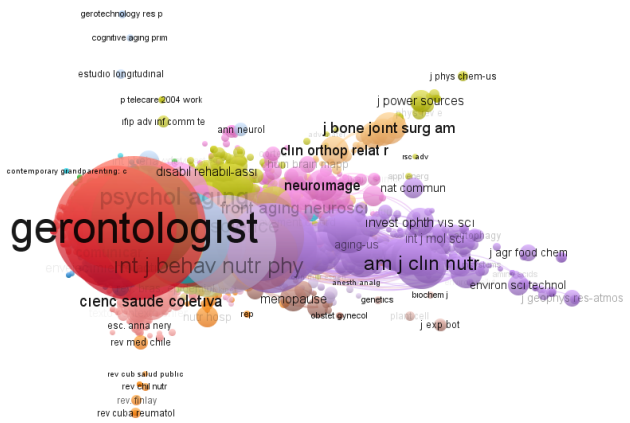

Figure 6. Journal-based bibliographic matching map

DISCUSSION

This study has presented a bibliometric analysis of research on the concept of active ageing and has revealed significant findings. The analysis results indicate an increasing trend in research on active ageing, particularly with a noticeable rise in the number of publications in recent years. The findings from this study contribute to a growing body of literature that frames ageing not only as a clinical or biological process but also as a social and participatory one.

However, it is essential to go beyond a descriptive account of these trends and consider how the current state of active ageing research can inform future research directions and policy changes. Active ageing research differs in scope and focus from more established fields, such as gerontology and geriatrics. While gerontology offers a comprehensive view of ageing, exploring the social, psychological, and biological changes associated with age, geriatrics is primarily concerned with the clinical care of elderly individuals.[16] On the other hand, active ageing emphasizes societal and policy interventions that promote autonomy, participation, and well-being in later life. This distinction suggests that the rise in active ageing studies may reflect a shift towards more holistic and preventive approaches to ageing, focusing on maintaining the quality of life rather than solely addressing the medical needs of older individuals.[17] This shift reflects a growing recognition of the need to focus on treating ageing-related diseases and creating environments that enable older individuals to thrive.

It is known that the effects of ageing vary across cultures and societies.[5] For instance, Barbabella et al. note that Italian policymakers prioritize interventions in labor market participation, lifelong learning, social and economic inequalities, health, and welfare in active ageing. They highlight, however, less attention to issues such as gender, equal opportunities, and sustainable cities.[1] Puspitasari et al., on the other hand, emphasize the need for creating a supportive environment focusing on addressing the informal employment of the elderly and meeting their primary health and social needs in Indonesia.[8] While the challenges affecting the elderly may vary from country to country, the Sustainable Development Goals are universal and can contribute to areas such as health, education, economic well-being, social participation, and the human rights of the elderly.[5,6] This analysis study also indicates the connection active ageing and sustainable development goals. Notably, studies focusing on health-related goals play a crucial role in promoting the healthy and quality living of elderly individuals.

Our study observed that the top five countries where studies on active ageing were conducted were Spain, the United States, China, the United Kingdom, and Australia, respectively. Mainly, the higher proportion of

the elderly population in Spain compared to other countries may had led to more extensive research on the concept of active ageing in this country. As of 2023, the percentage of individuals aged 80 and over is 6.2% in Spain, 5.3% in the United Kingdom, 4.4% in Australia, 4% in the United States, and 2.5% in China.[18] However, beyond demographic factors, Spain's proactive policy environment, mainly promoting healthy and active lifestyles for the elderly, has likely fostered a robust research output in this area. Spain has implemented several national strategies focused on elderly well-being, including the national strategy for active ageing, which aligns well with the growing academic interest in active ageing.[19,20] Within the Decade of Healthy Ageing 2020-2030 framework, Spain's ageing plans are aligned with the core principles set by the United Nations, such as active ageing, healthy ageing, social participation, independence, dignity, and care.[20] Moreover, Spain's solid public healthcare system and government investment in geriatric and public health research may have provided fertile ground for active ageing studies.[20,21]

In contrast, although the proportion of the elderly population is lower in the United Kingdom compared to Spain, the UK has a long history of gerontology and ageing research, supported by well-established institutions such as the Centre for Ageing Better and the UK's National Institute for Health Research (NIHR). The UK's research infrastructure is highly developed, with significant funding opportunities and a focus on interdisciplinary collaborations.[22,23] These factors may explain why the UK received more citations despite having fewer publications than Spain (n=3073). The UK's global research impact is enhanced by its involvement in international ageing studies and networks and its emphasis on translating research into policy recommendations that influence national and global discourses on active ageing. The UK's focus on high-impact publications in leading journals may also contribute to the higher citation count. Additionally, both countries' emphasis on preventive health measures, public health policy, and social inclusion for the elderly have likely fostered an environment conducive to active ageing research.

Although the proportion of the elderly population was lower in the United Kingdom and Australia, factors such as a large population (having a higher number of elderly individuals in absolute terms compared to other countries), research infrastructure, financial support, and effective collaboration between healthcare systems and research institutions may contribute to the leading position of the United States and China in scientific research on active ageing. In conclusion, these data suggest increased studies on active ageing in countries with a higher elderly population.

When examining the topic distributions of the concept of active ageing, it was observed that a broad spectrum of studies was conducted, including palliative care, nutrition and dietetics, social psychology, health policy, management, economics, and nursing. This situation allows us to understand the ageing process in a multifaceted way, indicating that the subject is not limited to health alone but also encompasses social, economic, and managerial dimensions. The investigation of the concept of active ageing in different fields signifies a multidimensional subject area, suggesting that it should be approached with an interdisciplinary perspective. Strong collaboration among geriatrics and

gerontology experts, palliative care specialists, nutrition and dietetics professionals, social psychologists, health policy experts, managers, economists, and nurses can contribute to finding comprehensive and effective solutions for ageing-related issues. By comparing the research outputs and citation impacts across these ageing-related fields, our study highlights that active ageing, while newer in scope, contributes to the broader discourse on ageing by emphasizing social determinants of health and promoting a multidisciplinary approach. It would be valuable for future research to integrate findings from gerontology and geriatrics further to contextualize active ageing within the broader ageing research landscape.

Although this study highlights significant research outputs in areas such as palliative care (n=225), nutrition and dietetics (n=185), and social psychology (n=179), several underrepresented areas within the active ageing research landscape remain. Notably, despite the increasing emphasis on physical and mental well-being, there is a lack of research on the role of digital technologies and intelligent environments in supporting active ageing. While topics such as health policy (n=61), management (n=59), and even walking and posture (n=47) have been explored, the growing trend of digital transformation in healthcare and social services has yet to be fully integrated into active ageing research. Future studies could focus on how technologies such as telemedicine, wearable health devices, and smart homes can facilitate active ageing by promoting independence, monitoring health, and improving the quality of life for elderly individuals. In addition to addressing existing research trends, future studies should focus on underexplored areas such as social participation, age-friendly environments, and policy interventions to promote active ageing in marginalized communities. The existing research tends to focus heavily on health and medical aspects, yet the social dimensions of active ageing should be more frequently studied. For example, while social psychology and social participation have been addressed to some extent, much remains to be explored regarding the role of social networks, community engagement, and lifelong learning in promoting active ageing. Future research could examine how social policies, such as age-friendly public spaces or intergenerational programs, contribute to the well-being of elderly individuals and how these initiatives can be scaled to different contexts.

When looking at the journals where studies on active ageing were most frequently published, the International Journal of Environmental Research and Public Health (75 publications) and Frontiers in Public Health (31 publications) stand out. The fact that both of these journals operate in the "Public Health" field indicates the importance of research on active ageing in this field. Additionally, bibliographic analyses conducted in the journals reveal that Gerontologist was the most influential source in the field. The Gerontologist journal received more citations than other journals in the field, making it a prominent source for studies on active ageing.

Limitations of the Study

The methodology used in this study followed standard bibliometric analysis practices, utilizing the WoS database. However, there are some limitations to conducting an analysis based solely on the WoS database. The exclusion of other major databases, such as

Scopus and PubMed, may result in overlooking significant contributions from specific regions or disciplines. Access to studies conducted in regions or disciplines where WoS is less prevalent may be limited. This could restrict the comprehensiveness of the research and introduce potential bias.

Nevertheless, WoS was chosen for this study due to its high reputation and broad coverage in academic literature. By combining different databases, future research could offer a broader and more interdisciplinary perspective. Such an approach could provide a more holistic view of active ageing research, reflecting regional and disciplinary diversity better. Despite this limitation, the study's findings offer valuable insights into understanding key trends and research gaps in active ageing.

Another limitation of this study was that the search was restricted to three specific keywords, which may limit the comprehensiveness of the analysis. Related terms, such as "productive ageing," could also be relevant and capture additional studies pertinent to active ageing. Future research could incorporate a broader range of keywords to ensure a more thorough exploration of the literature on ageing. Addressing this limitation in subsequent studies may provide further insights into active ageing and its various dimensions.

CONCLUSION

This bibliometric analysis sheds light on the overall development and trends in research on the concept of active ageing. The number and impact of studies on active ageing have increased, indicating a growing interest in the subject and its significant position in the scientific literature. Most studies focus on the sustainable development goals, particularly the goals of a healthy and quality life. This underscores the importance of active ageing as a crucial component of sustainable living. The leadership role of Spain in this field and the United Kingdom's status as the most cited country are noteworthy. The studies on the concept of active ageing cover various topics, including palliative care, nutrition and dietetics, and social psychology, indicating the multidimensional nature of the subject. A significant portion of the studies in this field were published in the Gerontologist journal, highlighting its contribution to the topic.

Based on the results of this study, the following recommendations can be made for future research on the topic of active ageing: To gain a more comprehensive and in-depth understanding, collaboration with colleagues from different disciplines and countries can be fostered, increasing the diversity of studies in this field. Active ageing research can be further associated with sustainable development goals, potentially encouraging a stronger focus on developing health policies and practices. The significance and impact of studies in this field have substantial potential to enhance the quality of life for the future elderly population and promote their societal contributions. Additionally, as the active ageing research continues to grow, there is an opportunity to influence global and national policies focusing on preventative health measures, public health policy, and social inclusion for the elderly. Aligning research with these policy priorities will help shape interventions that improve individual outcomes and reduce the societal burden associated with ageing populations.

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Ethical Declaration: Since this bibliometric analysis was a literature review, ethical approval was not required to execution the study. However, the research was conducted with ethical principles, such as respecting copyright and using data with proper citation. Any research or data collection processes involving humans or animals were excluded from this study. The methodology and limitations of the study have been clearly stated, and the results of the study are presented in an unbiased manner.

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ORIGINAL ARTICLE

Malignancy risk in diabetes; a population study based on electronic health records

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Abstract

Objective: To document the risk of the most common types of malignancies in people with diabetes compared to the people without diabetes.

Methods: The data source of this study is the national electronic health records system of Türkiye (e-Nabız). We analysed only the data of people over 14 years old in 2019. All the people with ICD-O-3 codes recorded for the first time in 2019 were accepted as new tumour cases. Tumours with /3 behaviour codes were accepted as malignant.

Results: We detected 6,775,054 (10.6%) people with diabetes and 57,167,598 people without diabetes in our database. There were 63,696 new malignant cases in the group with diabetes and 123,662 new malignant cases in the group without diabetes. The total number of malignant tumours was 187,358. All types of major tumours seem to have increased risk. Pancreas cancer has the highest OR (odds ratio), 4.02 (3.71-4.36, 95% confidence interval), and larynx cancer has the lowest OR, 1.29 (1.19-1.41). OR for the presence of any malignancy in a person with diabetes is 1.87 (1.85-1.89).

Conclusion: All major types of malignant tumours have an increased incidence in people with diabetes. The results confirm the presence of a relationship between diabetes and malignancy.

Keywords: Neoplasms, Malignant, Diabetes Mellitus, Electronic Health Records

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INTRODUCTION

Diabetes mellitus is a systemic disease that has harmful effects on a series of physiologic processes in the human body. An increased risk of malignancy in diabetes was identified in the 1960s in population-based studies. There are some explanations for the mechanism of the development of malignancy in diabetes. Some researchers suspect shared risk factors in both diseases, such as age, sex, obesity, and dyslipidemia. There are several other suggested mechanisms for carcinogenesis in diabetes, including the direct effect of hyperglycemia, but their mechanisms are unclear yet[1]. Some studies have shown increased risks of some cancers after adjusting for other confounding factors, such as obesity and dyslipidemia. Possibly both types of factors are responsible together for carcinogenesis. Growth hormones, insulin resistance, inflammatory cytokines, adipokines, and hyperlipidemia are some of the variables that influence the development of obesity and diabetes. By controlling several signaling pathways, the metabolic anomalies linked to variations in these components' levels in obesity and diabetes may play a major role in the initiation and spread of cancer[2]. Insulin resistance linked to type 2 diabetes is known to adversely affect some important genetic and metabolic factors that may ultimately result in neoplastic transformation[3]. Additionally, some antidiabetics may increase the risk of cancer. There are also studies reporting a decreased risk of cancer by metformin[4].

Cancer risk is increased in both type 1 and type 2 diabetes mellitus. Studies suggest an association between type II diabetes and cancer in many organs, such as the endometrium, breast, stomach, colorectum, pancreas, liver, and blood[5]. Interestingly, prostate cancer is reported to have a lower incidence in people with diabetes[6]. Overall cancer incidence among people with diabetes is 10–20% higher than among those without diabetes[7]. Previous reports on the risk of major cancer types in diabetes are summarized in Table 1.

There may be also a sex difference on the effect of diabetes on cancer. According to a meta-analysis, the pooled adjusted RR for all-site cancer associated with diabetes was 1.27 (95% CI 1.21, 1.32) in women and 1.19 (1.13, 1.25) in men. Women with diabetes had 6% greater risk compared with men with diabetes (the pooled RRR was 1.06, 95% CI 1.03, 1.09)[24].

Türkiye has cancer registry centers, and the Ministry of Health publishes annual cancer statistics. The last cancer statistics book presented the data for 2018[25]. According to this report, cancer incidence is 283 for men and 232 for women per 100,000. The most common cancer types are lung, prostate, and colorectal in men and breast, thyroid, and colorectal in women.

The incidence of diabetes-related cancer has not been sufficiently studied in the Turkish population. There is only one study, a cohort study, conducted in the İzmir region[26]. In total, 1643 people with diabetes and 14,226 people without diabetes were followed up for diabetes-related cancer development in the following six years. According to the results of the study, diabetes-related cancer incidence was significantly higher in men with diabetes than without diabetes. No statistically significant increase in malignancy in women with diabetes compared to women without diabetes was observed.

This study aims to document the risk of the most common types of malignancies in people with diabetes compared to people without diabetes based on national electronic health records (EHR).

Table 1. Summary of some studies reporting the risk of malignancy in diabetes. OR: Odds ratio, RR: Relative risk, SIR: Adjusted standardized incidence ratio

Type of malignancy	Year	Type of diabetes	Study design	Risk (95% CI)
Oral	2021	Both	Meta-analysis	OR: 1.41 (1.10-1.81)[8]
Head and neck	2021	Type 2	Meta-analysis	RR: 1.04 (0.88-1.23)[9]
Pharynx	2021	Type 2	Meta-analysis	RR: 1.18 (0.94-1.49)[8]
Stomach	2022	Both	Meta-analysis	RR: 1.17 (1.02-1.34)[10]
Colon	2011	Both	Meta-analysis	RR: 1.27 (1.21-1.34)[11]
Liver	2012	Both	Meta-analysis	RR: 2.31 (1.87-2.84)[12]
Pancreas	2011	Both	Meta-analysis	RR: 1.94 (1.66-2.27)[13]
Larynx	2021	Type 2	Meta-analysis	RR: 1.03 (0.88-1.22)[9]
Lung	2020	Both	Meta-analysis	RR: 1.10 (0.99-1.23)[14]
Malignant melanoma	2014	Type 2	Meta-analysis	RR: 1.15 (1.00-1.32)[15]
Breast	2023	Type 2	Meta-analysis	RR: 1.20 (1.05-1.36)[16]
Uterus	2019	Both	Meta-analysis	RR: 1.72 (1.48-2.01)[17]
Ovary	2020	Both	Meta-analysis	RR: 1.20 (1.10-1.31)[18]
Prostate	2013	Type 2	Meta-analysis	RR: 0.86 (0.80-0.92)[6]
Kidney	2013	Both	Meta-analysis	RR: 1.40 (1.16-1.69)[19]
Bladder	2013	Both	Meta-analysis	RR: 1.35 (1.17-1.56)[20]
Thyroid	2017	Both	Meta-analysis	RR: 1.20 (1.09-1.33)[21]
Hodgkin disease	2012	Type 2	Meta-analysis	OR: 1.02 (0.86-1.19)[22]
Non-Hodgkin lymphoma	2020	Type 1	Meta-analysis	RR: 1.55 (1.15-2.08)[23]
Non-Hodgkin lymphoma	2020	Type 2	Meta-analysis	RR: 1.20 (1.12-1.30)[23]

METHOD

This study has been reported according to the RECORD Statement. The data source of this study is the national EHR system of Türkiye, e-Nabız (https://enabiz.gov.tr/). At the end of 2019, the system was storing the health data of 62,442,436 (97.7%) of 63,942,652 citizens over 14 years old.

We analysed only the data of people over 14 years old in 2019. First, we detected all the people who had diabetes. Our criteria for having diabetes mellitus were 1) having an HbA1c over 48 mmol/mol (6.5%) or 2) having a prescription with a diabetes mellitus diagnosis, with ICD-10 codes E10-E14. If only metformin is prescribed, the person is considered not to have diabetes because it is used in "prediabetes" and other indications[27], or 3) having at least two fasting blood sugar measurements over 126 mg/dl. The fasting blood sugars that were ordered from an emergency department or between 13.00 and 8:00 were excluded. The data was scanned from April 2015 to the end of 2019. e-Nabız system started in April 2015, and we do not have reliable data before this date. All the citizens without diabetes over 14 years old are in the comparison group. The pathology reports in the system were checked for the presence of any ICD-O-3 codes. If a patient had an ICD-O-3 code in 2019, their data were checked for the presence of the same code in previous years (2015-2018). All the people with ICD-O-3 codes recorded for the first time in 2019 were accepted as new tumour cases

for calculating 2019 incidences. Tumours with /3 behaviour codes were accepted as malignant.

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Clinical Research Ethics Committee of the Medical Faculty of Akdeniz University.

The data were analysed by Microsoft Excel 2016. Calculating the pooled (age and sex-adjusted) odds ratio and its confidence intervals were performed by the logit method Morris and Gardner described[28]. In the case of zero cases in any category, the number was entered as 0.001 in Excel to prevent division by zero errors. Odds ratios with their 95% confidence Intervals have been calculated.

RESULTS

We detected 6,775,054 (10.6%) people with diabetes and 57,167,598 people without diabetes in our database. There were 63,696 new malignant cases; 29,663 women and 34,033 men in the group with diabetes. There were 123,662 new malignant cases; 56,971 women and 66,691 men in the group without diabetes. The total number of malignant tumours was 187,358.

Age and sex-adjusted incidences of tumours in the population with diabetes and the population without diabetes are compared in Table II and Figure 1. All the tumours seem to have an increased risk. Pancreas cancer has the highest OR, 4.02 (3.71-4.36), and larynx cancer has the lowest OR, 1.29 (1.19-1.41). Men are more likely than women to develop certain cancers, such as colorectal, liver, pancreatic, thyroid, and other malignancies, as well as Hodgkin disease and non-Hodgkin lymphomas. Age and sex-specific incidences and ORs for each type of malignancy are presented in supplementary file.

Table 2. Age and sex-adjusted incidence (per 100,000) and pooled odds ratio of some malignant tumours in the populations with diabetes and without diabetes.

Type of tumour	Female			Male			Total		
	DM	Non-DM	OR (95% CI)	DM	Non-DM	OR (95% CI)	DM	Non-DM	OR (95% CI)
Oral and pharynx cancers (C00-C14)	9.8	4.7	1.70 (1.53-1.88)	19.8	7.4	1.86 (1.72-2.03)	14.8	6.1	**1.80 (**1.69-1.92**)**
Stomach cancer (C16)	21.2	10.0	1.73 (1.61-1.85)	36.0	18.0	1.72 (1.63-1.81)	28.5	14.0	**1.72** (1.65-1.79)
Colorectal cancer (C18-C20)	35.7	16.9	1.94 (1.84-2.03)	65.7	24.7	2.26 (2.17-2.35)	50.6	20.8	**2.12** (2.06-2.19)
Liver cancer (C22)	10.5	4.4	2.17 (1.97-2.39)	19.1	6.2	2.72 (2.51-2.94)	14.8	5.3	**2.48** (2.34-2.64)
Pancreas cancer (C25)	7.4	2.1	3.47 (3.06-3.93)	12.8	2.6	4.49 (4.03-5.00)	10.1	2.3	**4.02** (3.71-4.36)
Larynx cancer (C32)	0.9	0.6	1.42 (1.03-1.95)	9.8	7.2	1.29 (1.18-1.41)	5.3	3.9	**1.29** (1.19-1.41)
Lung cancer (C34)	22.1	11.8	1.67 (1.57-1.78)	91.5	52.1	1.55 (1.50-1.60)	56.7	31.9	**1.57** (1.53-1.62)
Malignant melanoma (C44)	1.4	0.9	1.48 (1.14-1.91)	2.5	1.1	1.95 (1.56-2.43)	1.9	1.0	**1.73** (1.46-2.05)
Breast cancer (C50)	108.7	58.2	1.70 (1.65-1.76)	1.9	0.8	1.82 (1.40-2.36)	55.5	29.6	**1.70** (1.65-1.76)
Uterus cancer (C54)	19.8	8.0	-	-	-	-	-	-	**2.38** (2.22-2.56)
Ovary cancer (C56)	9.4	3.4	-	-	-	-	-	-	**2.26** (2.00-2.54)

Table 2. (countinue) Age and sex-adjusted incidence (per 100,000) and pooled odds ratio of some malignant tumours in the populations with diabetes and without diabetes.

Prostate cancer (C61)	-	-	-	55.7	40.7	-	-	-	**1.35** (1.30-1.40)
Kidney cancer (C64)	8.0	3.4	1.96 (1.75-2.20)	19.0	7.1	2.17 (2.00-2.35)	13.5	5.3	**2.10** (1.96-2.24)
Bladder cancer (C67)	5.6	3.8	1.41 (1.26-1.58)	41.0	23.2	1.64 (1.57-1.62)	23.2	13.5	**1.61** (1.54-1.68)
Thyroid cancer (C73)	44.0	22.0	1.74 (1.64-1.84)	20.4	6.4	2.21 (2.01-2.44)	32.3	14.2	**1.84** (1.76-1.94)
Hodgkin disease (C81)	5.3	1.3	2.84 (2.26-2,58)	17.2	1.8	4.72 (3.97-5.62)	11.2	1.5	**3.93** (3.42-4.52)
Non Hodgkin lymphoma (C82–C86, C96)	9.7	4.0	1.92 (1.73-2.14)	23.8	5.3	2.61 (2.38-2.86)	16.7	4.6	**2.29** (2.14-2.46)
Other malignant tumours	180.2	74.0	1.96 (1.91-2.01)	282.2	67.0	2.24 (2.18-2.30)	231.1	70.5	**2.09** (2.05-2.13)
All malignant tumours (C00-C97)	499.6	229.6	1.87 (1.84-1.90)	718.2	271.5	1.88 (1.85-1.90)	608.5	250.5	**1.87** (1.85-1.89)

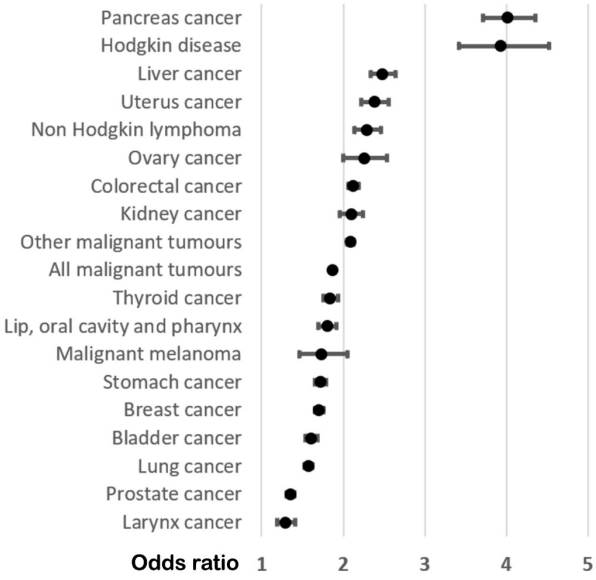

Figure 1: Age and sex-adjusted odds ratios of major malignancies in 6.8 million people with diabetes compared to 57.2 million people without diabetes. Lines representing confidence intervals are not visible for some tumours due to being too narrow.

DISCUSSION

The incidences of all the common malignancies were higher in people with diabetes compared to people without diabetes. Larynx cancer has the lowest OR, while pancreatic cancer has the highest. The odds ratio for the presence of any malignancy in a person with diabetes is 1.87 (1.85-1.89).

We preferred to use the odds ratio as the risk factor to apply the pooled odds ratio method in Morris and Gardner's study to adjust it for age and sex[28]. OR is very close to RR when incidence is low, so they can be accepted as the same in practice, to compare our results to the literature.

Liver, colon, pancreas, breast, endometrium, ovary, kidney, bladder, thyroid malignancies, and non-Hodgkin lymphoma were known to have a high risk in diabetes. A meta-analysis on pancreas cancer[13] reports 1.9 RR, which is quite lower than our results. However, another meta-analysis with only Chinese studies[29] reports a 3.7 RR, which is close to our result. This situation suggests the presence of genetic and/or environmental factors in the pathogenesis of pancreas cancer in diabetes. Our results are very close to the previous meta-analyses of liver[12], and bladder[20]. The risk of colorectal carcinoma (2.1 vs. 1.3)[11], breast cancer (1.7 vs. 1.2)[16], ovary cancer (2.3 vs. 1.2)[18], kidney cancer (2.1 vs. 1.4)[19], thyroid cancer (1.8 vs. 1.2)[21], and non-Hodgkin lymphoma (2.3 vs. 1.2)[23] are higher than the reported risks in the literature.

Some of the malignancies such as stomach (1.72 in our study vs. 1.10[10] in the literature), larynx (1.29 vs. 1.03[9]), lung (1.57 vs. 1.10[14]), malignant melanoma (1.73 vs. 1.15[15]), and Hodgkin's disease (3.93 vs. 1.02[22]), were reported as having no risk or a minimal increase in risk in diabetes. However, all these tumours have an increased risk in our data. Additionally, the total incidence of malignancy is increased by an OR of 1.87 (1.85-1.89), in contrast to the suggested 10-20% increase[7].

Prostate cancer was reported to have a lower risk in people with diabetes[6], but we have found an increased risk with an OR of 1.35 (1.30-1.40). This result is confusing, but it may be due to genetic or environmental factors. An increased risk of prostate cancer in Asian men (RR: 1.72) was reported in a meta-analysis[30].

We also analyzed if there is a sex difference in the effect of diabetes on cancer. According to a previous meta-analysis[24], women with diabetes had 6% greater risk compared with men with diabetes. We did not observe a general risk difference between men and women. In the meta-analysis, they observed a higher liver cancer risk in men. We observed the same pattern in our dataset. Additionally, we observed that men are more likely than women to develop colorectal, pancreatic, thyroid, and other malignancies, as well as Hodgkin disease and non-Hodgkin lymphomas. On the other hand, they observed an increased risk of oral, kidney, and stomach cancers in women, but our results have not confirmed this relation. The differences in these results may be due to genetic and environmental differences, sample size, and the absence of some confounding factors in our dataset.

This study examined the relationship between diabetes and cancer in Türkiye for the first time through national health records. Although the study has limitations, it provides us with valuable information due to the large volume of data. As the study was carried out on a large population, confidence intervals are very narrow. Some malignancies that revealed suspicious results in previous studies showed prominently increased risks. The increased risks in this study may be related to local and genetic factors for some of the malignancies and may not be generalizable to other countries. EHR systems are relatively new, and the quality of data in these systems is not excellent yet. Our system is also unsuitable for investigating causal relations because the data starts from 2015. In the future, with the accumulation of longitudinal data and better data quality in EHRs, we expect the scientific community to produce more information about diabetes and other diseases.

When we were extracting data for the study, the 2020 data was complete; however, we considered that the incidence of tumours must be lower than usual because of decreased patient admission during the COVID pandemic. Therefore, we preferred to work with 2019 data. Because this data is derived from the EHR, there may be questions about the reliability of the incidences in the present report. We compared our incidences to official 2018 statistics[25]. For example, in men, cancer incidence is 316 vs. 283 (per 100,000, our report vs. 2018 report), 58 vs. 60 for lung, 44 vs. 42 for prostate, and 31 vs. 28 for colorectal cancers. In women, cancer incidence is 270 vs. 232, 66 vs. 60 for breast, 21 vs. 20 for colorectal, and 24 vs. 27 for thyroid cancer. Our incidences are close to the official cancer registry data, although

there are differences of various magnitudes. The source of these differences may be the possibility of detecting old cases with new biopsies (the EHR system started in 2015, and its coverage was lower before 2019) or the possibility of some missed cases in the cancer registry. On the other hand, our method should have missed some cases because of the absence of a pathology report. According to official statistics, 91.3% of the cases have histopathological confirmation. However, these problems are valid for both people with and without diabetes. Our study is based on the data extracted from the national EHR, and this system is not specifically designed as a diabetes or cancer registry. We extracted the data from a daily operational database that may contain errors. Additionally, some data may be absent in the database, so it is possible that we could not include some diabetes or tumour cases. On the other hand, type 1 and type 2 diabetes may pose different risks to different tumours. However, we are not able to differentiate the type of diabetes in our dataset. So the results are a mixture of type 1 and predominantly type 2 diabetes. Another limitation is the absence of data related to possible confounding factors such as infections, alcohol, and smoking.

CONCLUSION

According to the results of the present study, all major types of malignant tumours have an increased incidence in people with diabetes. The population analysed in this study was larger than most previous studies, and ORs with quite narrow confidence intervals were obtained because the study is based on a national EHR system that contains 6,7 million people with diabetes and 57,2 million people without diabetes. The common risk factors for diabetes and malignancy, namely obesity and the absence of glycemic control, are serious public health problems to be fought. Health policymakers must also develop strategies for the early detection of malignancies in patients with diabetes.

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TURKISH JOURNAL OF PUBLIC HEALTH

ORIGINAL ARTICLE

Land use and trihalomethanes generation in water reservoir, a case study from Istanbul, Türkiye

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Abstract

Objective: The Büyükçekmece and Terkos drinking water reservoirs occur in the European part of Istanbul, have been created by isolation of two coastal lagoon lakes from the sea, which supply approximately 25% of water consumption of the Metropolitan city.

Methods: Treated waters of these two reservoirs have quite different trihalomethanes (THMs) concentrations although being adjacent basins that range between 10 - 30 (mean 20.8) ppb for the Terkos and 20 – 65 (mean 41) ppb for the Büyükçekmece reservoir. THMs concentration in treated water for both Büyükçekmece and the Terkos reservoirs increase in the summer and decrease in the spring. Furthermore, THMs of the treated water of Büyükçekmece reservoir are so higher than those of the other reservoir waters of İstanbul.

Results: The main reason of the higher value of THMs for the Büyükçekmece reservoir water could be related to ongoing agricultural activity in the vicinity of drainage basin. Another important indicator parameter for the THM formation mechanism is Specific UV absorbance (SUVA) value, that showed both of reservoir's organics in water mostly composed with hydrophilic properties.

Conclusion: Seasonal variations of low nitrate–high THMs in summer and high nitrate–low THMs in winter in treated lake waters can be explained by nitrogen run off from the land and consumption by photosynthesis when the water reach favourable temperature in summer. High nitrogen input into the Büyükçekmece reservoir could be associated with agricultural activity in the drainage basin which controls the high amount of organic carbon formation and high THMs generation during the treatment by chlorine.

Keywords: Büyükçekmece Lake, Terkos Lake, Trihalomethanes, Agriculture, Land Use

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INTRODUCTION

THMs are hazardous and carcinogenic matter which form as disinfection by-product during the water treatment by chlorine[1,2]. There are many research papers associated with public health effects of the THMs. The main concern dealing with the THMs are related to bladder cancer on male and fetal growth, stillbirth defects on female[3,4,5,6]. Many investigations have indicated a clear relation of bladder cancer and exposure to water disinfection by-products through ingestion, bathing, showering, and swimming in pools[7]. The allowable level of the THMs in drinking water changes from country to country or union states, for example the USA accepts 80 ppb as allowable limit, whereas EU 100 ppb. In last decades a big effort has been made by developed countries for reducing of the allowable THMs limit in drinking water[8]. However, owing to the high cost of the reducing of the THMs in drinking water, the allowable level has not been reduced to 40 ppb level.

THMs level of the drinking water of the Istanbul metropolitan is declared by its official web page of the Istanbul Water and Sewerage Administration Authority[9] for each treatment plant on average value basis. The THMs values of treated waters of İstanbul vary between 20–40 ppb, as a special case, treated water of the Büyükçekmece reservoir reveals the highest value of THMs as being between 20 – 65 ppb.

The first aim of this study is to understand why treated water from the Büyükçekmece reservoir includes the highest THMs value whereas the treated water of the nearby Terkos reservoir, reveals the lowest value. The second aim is to explain causes of the seasonal variations of THMs in treated water of the Büyükçekmece and Terkos reservoirs. For these purposes, variation in the nitrate content through the year of both treated waters have been comparatively investigated. During the study, land use map of the both drainage basins have been prepared for a comparative analysis of basin conditions. The ISKI water quality data[9], consisting of THMs, nitrate, chloride values of treated water of Büyükçekmece treatment plant and also the İkitelli treatment plant that purifiers the raw water of the Terkos reservoir have been used for both seasonality analyses. A land use map was prepared and calculated as percentage as settlement area, agricultural area, and forest- meadows area for both basins, using the Google earth 2023 data. Then a conceptual model explaining the variations and seasonality of THMs for two basin waters has been made on the basis of differences of land use characteristics and water chemistry.

Water supply in Istanbul

The city of İstanbul has not an important river for water supply and hence depends on collecting rain waters in seven small–sized drainage basins. Three of them occur in the Asian side and the four in the European side. Population of the İstanbul metropolitan city still increases and has reached from 3 to 18 million in the last 40 years. Today, managing of the mega city nearly equals to managing of the water resources. The city consumes 3.0 million cubic meter (Mm^3) water daily, which is roughly 1.1 billion m^3 water/year. However, the maximum water collection capacity of the seven water reservoirs of İstanbul is 847 million m^3. The Anatolian side water reservoirs collect 337 Mm^3 water (Elmalı 10 Mm^3, Ömerli 220 Mm^3 and Darlık 107 Mm^3),

whereas the European side reservoirs collect 410 Mm^3 water (Büyükçekmece 148 Mm3, Terkos 162 Mm^3, Sazlıdere 68 Mm^3 and the Alibey 34 Mm^3). Additionally, some water is taken from the Yeşilçay River to the Darlık reservoir (Figure 1).

During an extra dry season whole dam capacity of İstanbul drops to 500–600 Mm^3/year. For solving the water shortage of İstanbul two water carrying pipe lines have been constructed to transfer water from the neighbouring eastern (Melen River) and the western (Kazandere and Pabuçdere water dams) water basins (Figure 1).

The Melen basin water transfer project has been planned for a one billion cubic meter water transfer from the Melen basin to İstanbul along approximately 190 km length pipe line. After the first phase of the project roughly 400 Mm^3 water/year have been transferred to İstanbul by this pipe line during the driest year of 2014. When the Melen Project completed in a few years, 1 billion cubic metre w ater will be transferred to the İstanbul.

The western water transfer structures consist of two main dams as the Pabuçdere and the Kazandere which collects totally 160 Mm^3 water in forestry regions, far from the agricultural and other urban activity. This water transferred to the closest and the oldest water reservoir of İstanbul, the Terkos Dam via 60 km length pipe line (Figure 1).

Daily water treatment capacity of ISKI is 4,310,000 m^3 with six treatment plants in the Asian side (2,360,000 m^3) and six plants in the European side (1,950,000 m^3). Water sources of the İstanbul as both internal and external are nearly equal and disinfected using chlorine in the treatment plants (Table 1). Capacity of the all-water treatment plants, treatment methods have been summarised in Table 1. Water treatment process begin as either pre–ozonisation or pre–chlorination for reducing the organics and followed by aeration–coagulation–flocculation–filtration and chlorination. Owing to high water demand of the European side of Istanbul, the Melen water was treated in the Cumhuriyetköy treatment plant in Asian side and pumped to the European side, to the Kağıthane distribution centre by a tunnel that opened under the İstanbul Strait.

Today, ISKI makes big effort for supplying water for residents of İstanbul metropolitan city that created an interconnect water network for treated water. But there are no extra chlorination stations beyond the treatment plants, once a treated water given into the system no chlorine adding into the water anymore. Pre–ozonisation aims oxidation of the organics with two exceptions, the Büyükçekmece reservoir water and Melen water. Pre–ozonisation do not apply in to the raw waters of the Büyükçekmece because of its high bromine ions. High bromine in the Büyükçekmece lake water is possibly related to salty sea water intrusion from the Marmara Sea, which may have been infiltrated from the sand bar into the coastal dam by strong squeezing force of the sea waves. As it is known, bromide oxidise to the carcinogenic bromate forms during the ozonisation therefore, this process does not use for this lake water. The explanation of the without pre–ozonisation treatment for the Melen water in Cumhuriyetköy treatment plant is its low amount of organic matter content.

Two basin and two different waters

The Büyükçekmece and the Terkos drainage basin are two adjacent basins which are located in the western part of İstanbul city. Surface water of both basins were flowing into the shallow lagoon lakes, which were connected with the sea via narrow channels. Both shallow lagoon lakes were a few meters' depth isolated from the sea with earth fill–type dam structure and transformed to water reservoirs. Both reservoirs have a max depth of 7–8 m and collects 148 and 162 Mm^3/year water, respectively.

Raw water of the Büyükçekmece reservoir is treated at the lake shore, whereas the Terkos reservoir water is transferred to the Taşoluk, İkitelli and Alibey treatment plants. On the other hand, 160 million cubic meters' water/year of the Pabuçdere and the Kazandere dams located outside the city is diverted into the Terkos reservoir by pipeline. These two waters collecting dams have been constructed in the area covered by forest which provides environmentally suitable conditions for a reservoir far from any settlements, industry and the agricultural activities. Seawater intrusion are characterised by chloride ion increase in reservoir of Büyükçekmece and Terkos during the dry seasons of 2014. Agricultural activity and urbanization in the Büyükçekmece basin is higher than the Terkos basin. Contrary to the Büyükçekmece, the Terkos basin is surrounded by forest–meadows land (Figure 2).

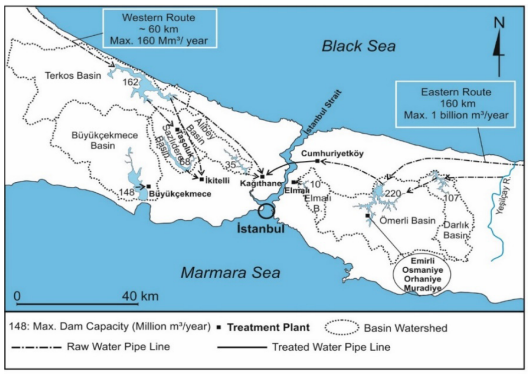

Figure 1 Main drainage basins, water reservoirs, water treatment plants and water transfer pipe lines of İstanbul.

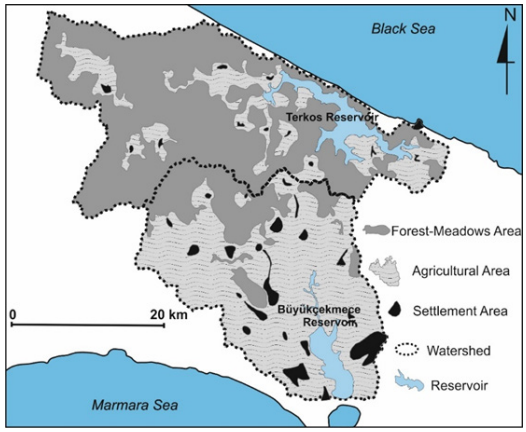

Figure 2. Land use map of the Büyükçekmece and Terkos drainage basins.

Table 1. Physical characteristics and treatment phases of the water treatment plants of İstanbul city

Treatment plant	Water source	Capacity (m^3/day)	Treatment method
Büyükçekmece	Büyükçekmece	400,000	Ch, A, C/F, F, Ch
Cumhuriyetköy	Melen	720,000	A, Ch, C/F, F, Ch
Ömerli	Ömerli + Melen	1100,000	A, P, C/F, F, Ch
Osmaniye		200,000	
Muradiye		300,000	
Orhaniye		550,000	
Kağıthane	Terkos + Melen +Alibey	700,000	A, P, C/F, F, Ch
Çelebi Mehmet Han			
Yıldırım Beyazıd Han			
Emirli	Yeşilçay + Darlık	500,000	A, C/F, F, Ch
İkitelli	Terkos + Istranca	800,000	A, P, C/F, F, Ch
Fatih Sultan Meh. Han		400,000	
II.Beyazıd Han		400,000	
Taşoluk	Terkos	50,000	A, P, C/F, F, Ch
Elmalı	Elmalı	40,000	A, P, C/F, F, Ch

A: Aeration P: Pre-ozonisation, C/F: Coagulation/Flocculation, F: Filtration Ch: Chlorination[9]

METHOD

Analytical Data

ISKI has analysed the raw and treated water as daily base and we used their last 5 years data. Organic carbon is defined by 5310SM, nitrates 4110SM, THMs 6232SM method[10]. Monthly mean values of the organic carbon, nitrates, THMs and chloride of the Büyükçekmece and Terkos water were calculated for five years period.

THMs, nitrates, organic carbon and salinity of two basin water

For a comparative analysis of the possible causes of seasonal variation in processed water of the two reservoirs a variation graph for THMs, nitrate, organic carbon and salinity has been prepared for a five-year period (Figure 3(a)–(b)).

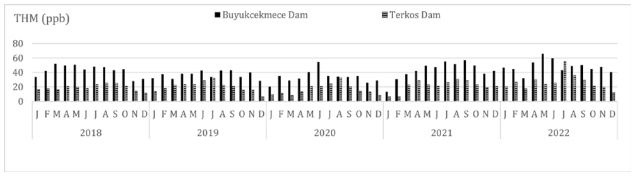

Figure 3(a). Seasonal variations of the THMs in treated waters of the Büyükçekmece and Terkos reservoirs[9].

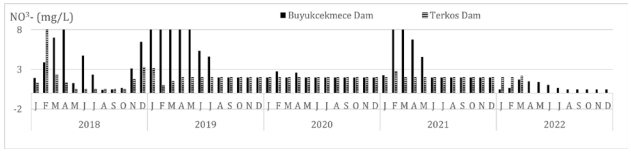

Figure 3(b). Nitrate variations in treated waters of the Büyükçekmece and Terkos reservoirs[9].

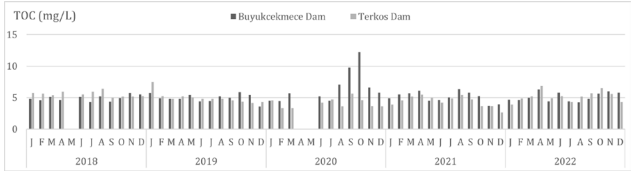

Figure 3(c). TOC variations in treated waters of the Büyükçekmece and Terkos reservoirs[9].

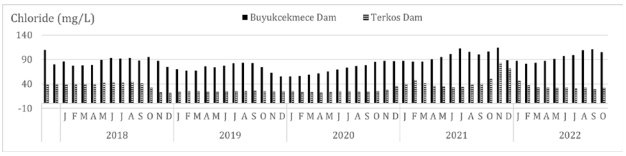

Figure 3(d). Seasonal change of chloride concentrations in treated water of the Büyükçekmece and Terkos water reservoirs[9].

RESULTS

THMs

THMs values for both reservoirs show very regular pattern as high in the summer and low in the spring season. THMs of the both reservoirs reveal a minimum value in 2018 considering the last 5 years. The lowest THMs values is in January and the highest are in June and July. This cyclic pattern should be related to the water temperature, which control the organic carbon synthesis in the lake water, that begins in April and reach the peak in August. Nitrate plays also a key role as another constituent that creates a biological–organic chain in the lake water in summer time (Figure 4).

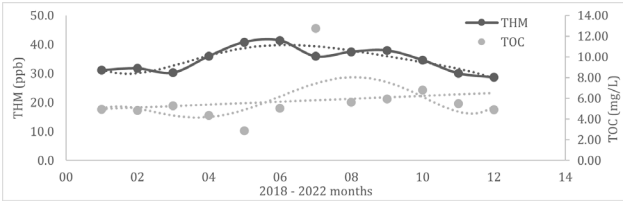

Figure 4. The figure shows the change in the mean of THM versus TOC in the waters of Büyükçekmece Lake for the last 5 years.

Figure clearly indicates a marked periodicity of THMs as peaks in June and July whereas the depletion in December and January.

Nitrates

Nitrate values of the lake water do not coincide with the THMs as shown in Figure 3(b). Nitrates of the Buyukçekmece and Terkos lake reveal a lowest value in 2020. In time period of 2018 to 2022, nitrate displays a marked cyclic change (the lowest is November and the

highest is April–May). A possible explanation of the lowest nitrate concentration in the treated water is completely consumption of nitrate during the creation of the organic matter in a whole suitable summer season. Another cause of nitrate depletion is limited rain and limited nitrate run off from the surrounding agricultural areas (Figure 5).

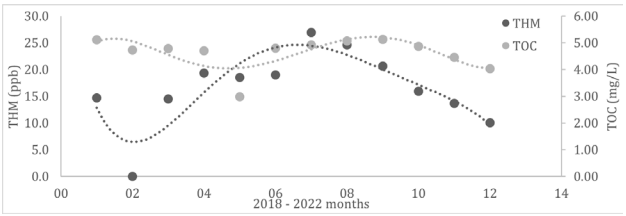

Figure 5. The figure shows the change in the mean of THM versus TOC in the waters of Terkos Lake for the last 5 years.

Organic carbon

Organic carbon content of the Terkos Basin water ranges between 3.66 and 5.85 mg/L whereas the Buyukçekmece lake ranges 4.29 to 12.21 mg/L (Figure 3c). Organic carbon values show a general enrichment at the summer season for the Terkos basin and reach top level at April and decrease to minimum point at January. On the other hand, organic carbon value of the Buyukçekmece lake reveals ondulatory pattern. The TOC values begin with 4.90 mg/L in January and drastically fall to 4.60 mg/L in April and again reach to 5.20 mg/L level int October and fall again to 4.75 mg/L level in December (Figure 6-7).

Salinity

Chloride values of the Buyukçekmece and Terkos lake water for 5 years period is shown in Figure 3(d)(Figure 3(d)). Chloride values of the Buyukçekmece Lake range between 60 to 120 mg/L which is higher than the Terkos lake (30- 80 mg/L) water because of the limited sea water dam water exchange in the Buyukçekmece Lake. Chloride values show a very well seasonality and a has a general increasing salinity trend. Salinity figure show a relative chloride peak in 2020 which is coincide with dry season for last 5 years.

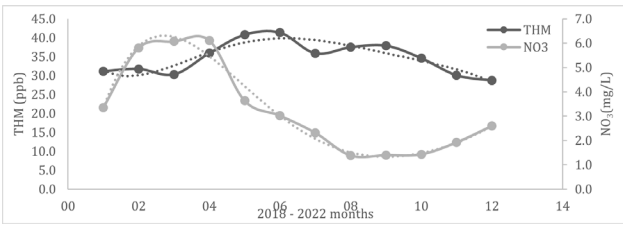

Figure 6. The figure shows the change in the mean of THM versus nitrate in the waters of Büyükçekmece Lake for the last 5 years.

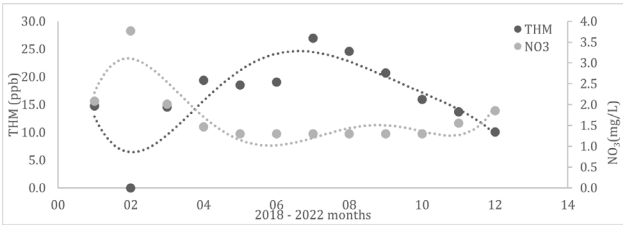

Figure 7. The figure shows the change in the mean of THM versus nitrate in the waters of Terkos Basin for the last 5 years.

Land Use

A zonal protection strategy for the drinking water basins has been declared by the Ministry of Water and Forestry in 2003 to be applicable to whole Turkey with minor additions by the municipalities[11]. According to the ministry regulation, from the lake shore towards 300 meters is defined as absolute protection zone, 300 meters to 1000 meters' proximate protection zone, 1000 meters to 2000 meters mediate protection zone, and 2000 meters to the basin as remote protection zone. Some limitations have been defined in that zones regarding settlement or agricultural manner[12,13]. For example, agricultural activity using fertilizer and organic chemicals is not allowed in these zones. However, fertilizers and pesticides more or less are widely used in all water basins and enhances if they close to market. It is also stated that nitrate inputs

associated with agricultural activity or natural ways into the Ömerli water reservoirs of İstanbul and its impacts on the environmental degradations[14].

ISKI also made some site planning approach for water catchment areas in 2003 where the first two zones have been banned to all constructions (0–1000 m), and third and fourth zones have been limited by 10 persons/hectare, and 20 persons/hectare, respectively. However, controlling of agriculture or other activities of people in the water basin is so difficult, especially for expanding cities and vote–based political circumstances. Today, the agricultural activities and the population are increasing and associated pollution and eutrophication is staying a growing environmental problem for the drinking water reservoirs.

Land use map of the Büyükçekmece and Terkos basins and surface area calculations has been made from the google earth data of October 2022. The land has been divided into three areas from the picture: as forest - meadows, agriculture and settlement. Calculations from the google earth indicated that settlement area covers 9%, forestry-meadows areas 19%, and agricultural area 72% for the Büyükçekmece basin whereas, 1% settlement, 17% agricultural and 82% forest area - meadows for the Terkos Basin. These proportional comparisons clearly indicate that agriculture-based environmental degradation is a major concern for the Büyükçekmece lake basin.

Figure shows the nitrate peaks in April and is low in October. A relative nitrate depletion of the two-basin water 2020 is seen so obvious. Please note that while THMs values is low (Figure 3a) nitrate is high or vice versa. This relationship clearly indicates that nitrogen originated from the land and stored in the reservoir water during the rainy and cool season then consumed by organic matter formation in summer time that causes THMs generation (Figure 8).

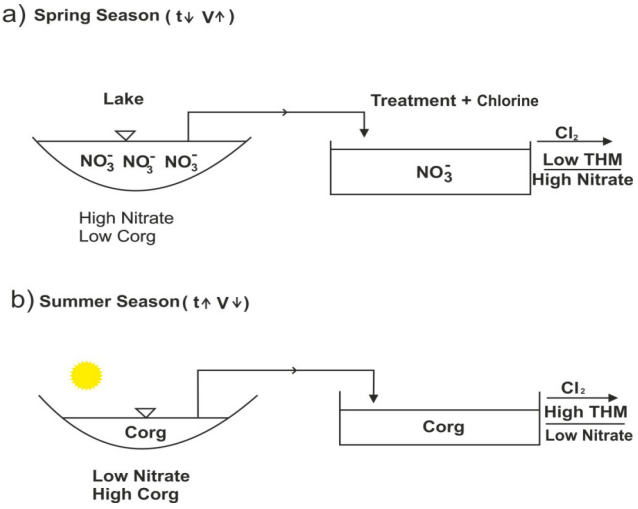

Figure 8. Conceptual model explaining causes of low THMs - high nitrate in summer and high nitrate-low THMs in spring season in treated waters of the Büyükçekmece and Terkos reservoirs. Corg: organic carbon, t: temperature, v: volume.

DISCUSSION

Water treatment plants of İstanbul produce up to 3.0 Mm^3 per day of drinking water. Although the treatment steps of these plants reveal some differences process is usually carried out in the following order: pre–chlorination, aeration, coagulation, flocculation, sedimentation, filtration and post chlorination. Pre–chlorination aims the reducing the organic matters and killing the microorganisms and pathogens that may cause the illness in humans. However, some THMs occurs during this pre–chlorination stage, then removed by following aeration processes. Removal of the whole organics in a limited time span is not possible; therefore, a final chlorination is needed to prevent re–growth of any kind of microorganism in the pipeline. For this purpose, legal limit of free chlorine at the end point of the distribution

network of Istanbul city is regularly controlled by ISKI.

In addition to TOC and NO_3^- parameters in the formation of THM in chlorinated water, an important indicator is also presenting analysis of UV absorbed (UV254) and specific UV absorbance (SUVA) parameters at 254 nm. SUVA parameter is the most important organic parameter used in estimating the structure of natural organic substances in surface waters and the formation of substances such as THM that occur during chlorination[15,16]. SUVA parameter > 3 L/mg.m indicates the presence of hydrophobic organic substances, while SUVA <3 L/mg.m indicates the presence of hydrophilic organic substances[17]. In the raw waters of Terkos Lake, which has the highest SUVA value, the organic compounds were found to be mostly composed of organics with hydrophilic properties.

Seasonal Variation Mechanisms

Beyond the seasonality of the THMs values, basin differences are also needed to explanation. Processed waters of the Büyükçekmece reservoir reveals the highest THMs values among the Istanbul reservoirs because of the dense agricultural activity and settlements in this drainage basin. Contrary to the Büyükçekmece, its adjacent Terkos reservoir water has the lowest THMs value because of the relatively forest- meadows nature of the drainage basin.

Land Use Impacts

The nitrate introduction via surface runoff from the agricultural–rural areas into the water reservoir possible enhance the formation of the organic matter. Beginning of the organic matter formation in the water nitrate simultaneously starts to decrease in summer. Particulate or dissolved organic carbon possibly reacts with chlorine during the water treatment processes and causes high TMHs–bearing water (Figure 8) in summer. In fact, during the low water level in summer time, large areas of the reservoirs are exposed where vegetation quickly develops. During the high-water level period in spring, this vegetation is flooded and begins to degradation and releases dissolved organic carbon in to the water. Instead of harvesting vegetation, dredging of organic matter - rich muds may be another THMs reducing processes during the low water period in summer. Today we have no data on the organic carbon content of the raw water of the Büyükçekmece and the Terkos water reservoirs.

Health Impact Discussion

The most recent studies on the epidemiological relationship between bladder cancer and THM levels were set out many researchers[18]. The study shows that daily THM dose in swimming pool increased it more than three times; 1,3 µg/day to 3,9 µg/day according to non swimmers[19]. Daily water use poses a danger, especially for water with high THM levels. Taking long showers, brushing teeth and washing hands significantly increase the daily THM dose we took.

Proposed Mitigation Strategies

In this context, reducing the THMs in water can be achieved by reducing organic carbon by three ways as stated[20], a: using membrane filter for trapping particulate organic carbon prior to chlorination, b: harvesting vegetation along the reservoir shore line and, c: Diverting the first 24 hours of water transfer. They argued that harvesting the vegetation and removing it from the reservoir margins prior to flooding could improve water quality by

reducing THM formation.

Policy and Regulation Challenges

In addition, there is no big effort for reducing the organic matter content of the water reservoirs. Farming areas or private settlement with in the absolute protection zone have not been completely expropriated by ISKI yet. Therefore, THMs values of the raw waters possibly will not decrease owing to on-going environmental detritions in the water basins in Istanbul in near future.

CONCLUSION

Despite the public health importance of THMs, there are limited publications related to THMs levels in the drinking water of Istanbul city both international journals and local meeting abstracts[21,22,23,24]. It is argued that THM enrichments on summer session in treated water of the Büyükçekmece reservoir is related to bromide increase in the lake water owing to evaporation[22]. On the other hand, increase in the THMs in treated waters of both coastal and inland reservoirs, in the summer, requires a valid explanation for the mechanism for high THMs generation.

In this context, the land use seems to main concern of the high THM generation. Pre–ozonation should be the first process for the Büyükçekmece reservoir water in order to decrease of the organic matter and/or THM values. For this purpose, sea water intrusion has to be control or stopped by making an impermeable barrier in coastal sandy material by concrete injection.

Indications of the high THMs concentrations in public water supplies to fatal growth, stillbirth and birth weight have been studied in different regions in the world for example in England and USA[3,25]. Similarly, health effects of THMs on residents of the western part of İstanbul should be comparatively study on the basis of bladder cancer case and other health problems.

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ORIGINAL ARTICLE

Occupational health and safety services during the pandemic from the perspective of occupational health and safety professionals working at site: A combination of questionnaire based and in-depth interview research from Türkiye

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Abstract

Objective: In this study, it was aimed to determine occupational health and safety practices in workplaces in COVID-19 pandemic and assess these practices from the perspective of occupational health and safety professionals.

Methods: In this study, questionnaire-based and in-depth interviews were used concomitantly. In the quantitative part, an electronic survey form was applied to 413 professionals. In the qualitative part, in-depth interviews were conducted with 24 professionals using a semi-structured interview form and the data were analyzed with MAXQDA.

Results: When the measures taken for mask use, social distancing and hygiene in workplaces during the pandemic were questioned, measures taken at the highest rate were related to mask use. In-depth interviews were grouped under three themes: difficulties, strengths and the effects of the pandemic. It was emphasized that difficulties were encountered in occupational health and safety implementation areas and the empowering role of professionals in the management of the process was emphasized. The disruption of routine OHS practices as a negative impact of the pandemic and the increase in OHS awareness as a positive impact were the most emphasized issues.

Conclusion: The highest precaution taken in workplaces was the use of masks. In in-depth interviews, almost all participants emphasized the difficulties encountered in occupational health and safety practices, the supportive role of professionals in the process, and the many positive and negative effects of the pandemic on practices.

Keywords: Pandemics, Occupational Health, Occupational Safety

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INTRODUCTION

The COVID-19 pandemic has affected all aspects of daily life. Workplaces have been influenced miscellaneously in terms of employers, employees, customers, and social repercussions during the COVID-19 pandemic.[1] Many workplaces and employers have faced difficulties due to the change in demand, supply chain, transportation and mobility and protective precautions oriented at employees.[2] All these difficulties have put forth once again the importance of occupational health and safety (OHS) practices in the management of the process.

During the COVID-19 pandemic, according to ILOSTAT data, the working population aged over 15 years worldwide made up 57.2% of the world population as of the year 2020.[3] Many people spend a major part of their days working and being in close contact with the public and other employees.[4] The most effective practices to protect employee health, and thus the health of the public are ensuring that the workplace is safe and healthy and taking the spread of the virus under control.[5,6] Moreover, workplaces are effective platforms where occupational health and safety (OHS) professionals can establish sensitivity towards OHS including the spread of information among employees and their families and prevention and protection precautions aimed at decreasing the spread of infectious diseases.[5] Apart from protecting employee health, OHS practices offered in workplaces are also important in terms of limiting the spread of the diseases in the public, preventing build-up in health services, supporting health services, and preventing workplace closures through early intervention.[7]

Due to these reasons, several national and international OHS organizations rapidly published guidelines related to infection control and protection measures at the workplace and gave suggestions during the COVID-19 pandemic.[8,9] OHS professionals, in response to these regulations, showed great effort and devotion in order to establish a safe and healthy working environment by making the workplaces take necessary precautions and regulate the workplaces accordingly.[10] Scientific researches on the subject that have been conducted based on the effect of infectious diseases in the last 20 years on OHS and public health are of vital importance in terms of offering points of intervention to OHS.

Evaluating the experiences and recommendations of OHS professionals who experienced the COVID-19 pandemic can provide important clues for future pandemics. In this research, it was aimed to determine OHS practices in workplaces in the early phase of the COVID-19 pandemic and assess these practices from the perspective of OHS professionals.

METHOD

Research Type

This is a descriptive research in which qualitative and quantitative data collection methods were used concomitantly.

Research Population and Sample

The population of the study consists of occupational health and safety (OHS) professionals working in Türkiye and actively providing services during the COVID-19 pandemic. No sampling was conducted in the quantitative part of the research. An online survey form was shared with OHS

professionals through social platforms, communication networks of the society and communicating with Joint Health and Safety Units (JHSU).[11] The data for the quantitative part of the study were collected between May 20 and June 30, 2020, after obtaining the Scientific Research Platform of the Ministry of Health, to evaluate the early period of the pandemic. During this period, a total of 440 OHS professionals participated in the quantitative part. Four hundred and thirteen surveys of good quality were included in the study. Of the participants, 277 (67.1%) were occupational safety specialists, 108 (26.2%) were occupational physicians, and 28 (6.8%) were other healthcare personnel.

Participants with whom qualitative research would be conducted were chosen from among the OHS professionals who were approved to participate in the qualitative research. Maximum variation sampling was used in selecting OHS professionals that would be included in the qualitative part of the research. The criteria that were grounded on in this sampling method were being an occupational physician/ occupational safety specialist, the form of delivery of service (within Joint Health and Safety Units or Occupational Health and Safety Units), and city where the service is provided. Participant inclusion continued until data saturation had been achieved and data started to repeat themselves. The data for the qualitative part of the study were collected between August-September 2020. Twenty-four OHS professionals were included in the qualitative part of the research. Of the participants, 13 were occupational safety specialists, 11 were occupational physicians.

Research Method

For the quantitative part of the research, a data collection form prepared by Google Forms and converted into an electronic survey form was used. Participant informed consent was obtained at the top of the electronic survey form following the explanation of research characteristics. Participants filling out the survey form were invited to the qualitative research at the end of the survey form. The questions regarding the measures taken by OHS professionals for COVID-19 in the workplace were prepared by considering the guidelines published by the Ministry of Family Labour and Social Services of the Republic of Türkiye and the recommendations for workplaces by international organizations.[12-16]

At the end of the first part of the study, the participants who declared that they agreed to take part in the qualitative research were called and the researcher informed the participant about the purpose, subject, general framework and interview method of the research. A written consent form was received by mail from the participants who agreed to participate in the study. The interviews were conducted by a researcher (corresponding author) with a doctoral degree in public health. A semi-structured interview form was used for in-depth interviews. The interview form had been reviewed and approved by an expert. The research was planned with a phenomenological design. The interviews were preferably conducted via video communication networks. At the beginning of the interviews, the aim of the research was explained, approval for audio recording was asked promising full confidentiality, and the interview was started after oral consent of the participant had been obtained. During the research, only audio recordings of the participants were taken. The researcher was not present at the field during the

qualitative research process but took notes of the environment and interview process. While presenting participant statements, the abbreviation "OP" stood for occupational physician, "OSS" abbreviation for occupational safety specialist, and participant number were used. Interviews with OP2 and OSS6 were cut several times. The remaining interviews were conducted in a quiet environment when the participant was alone and without any interruptions. These interviews lasted for an average of 40 minutes (min: 20 minutes- max: 92 minutes). The interviews and deciphering of the audio records were performed by the researcher only.

Data Analysis

Data obtained from quantitative research were analyzed using SPSS 23.0 (spss.ktu.edu.tr) statistical package. Descriptive statistics were given as number and percentage for categorical variables and mean, standard deviation or median and minimum, maximum for numeric data. Statistical alpha significance was accepted as $p<0.05$. OHS professionals may provide service in more than one workplace. Since infection spread risk is higher in crowded places, the answers on the survey were asked to be given considering the workplace with the highest number of employees.

Data collection and data analysis were performed synchronously during the qualitative research. Interviews with the participants were analyzed using MAXQDA 2020 (VERBI Software, 2019). During the coding phase of the qualitative data, a code list was formed considering the literature and participant responses. A thematic code list was formed determining the categories and themes that gathered the related codes considering the differences and similarities between the codes.

Research Approval

To conduct the research, application was made on May 14, 2020, to the Scientific Research Platform of of Health, and approval was received on May 19, 2020. Ethics Committee Approval was received University, Faculty of Medicine, Scientific Research Ethics Committee (Date: 13.07.2020, Number: 24237859-473). Informed consent was confirmed by the Ethics Committee.

RESULTS

Of the participants, 277 (67.1%) were occupational safety specialists, 108 (26.2%) were occupational physicians, and 28 (6.8%) were other healthcare personnel. The mean age of professionals was 39.9±9.8 years, 297 (71.9%) were male and 116 (28.1%) were female. Professional experience as an OHS professional was 6.0 (1-36) years. Of the participants, 291 (70.5%) worked full-time, 122 (29.5%) worked part-time. The number of employees at the workplace was 250 (3-10000).

The precautions reported to have been taken by OHS professionals during the COVID-19 pandemic in terms of masks, social distancing and general hygiene practices are presented in Table 1.

Table 1. The precautions taken by OHS professionals at the workplace

Mask use	**n**	**%**
To be worn when entering and exiting the building	399	96.6
Ensuring that employees constantly wear masks at the working environment	377	91.3
Distributing masks free of charge	372	90.1
Driver and all personnel wearing surgical masks during journeys inside the vehicle *	279	89.4
Ensuring that employees wear masks in rest areas †	314	76.8
Ensuring that people attending meetings in meeting halls wear masks	180	43.6
Social distance		
Re-arranging the carrying capacity of transportation vehicles consideringsocial distance *	269	86.2
Arranging the wait line at the cafeteria considering social distance ‡	291	85.1
Arranging tables in the cafeteria considering social distance ‡	286	83.6
Arranging the workspace considering social distance	334	80.9
Arranging the rest areas considering social distance †	312	76.3
Postponing face-to-face meetings and training until the pandemic has ended	298	72.2
Flexible shifts	243	58.8
Arranging teleconferences or remote trainings for meeting and trainings that cannot be postponed	222	53.8
Increasing the number of transportation vehicles *	166	53.2
Remote working	194	47.0
Hygiene		
Hand disinfectants at the entrances and exits of the workplace	366	88.6
Increasing the cleaning of toilets	353	85.5
Increasing the cleaning of the working environment	341	82.6
Measuring fever while entering and exiting the workplace	335	81.1
Regular disinfection of surfaces (working stations, counters, knobs, handles, devices shared, etc.)	329	79.7
Frequent cleaning of the transportation vehicles, especially the places that are touched the most*	243	77.9
Providing hand sanitizer in the cafeteria	259	75.7
Appropriate and sufficient ventilation of the environment	309	74.8
Regular disinfection of the cafeteria	253	74.0
Frequent disinfection of rest areas †	282	68.9
Providing handwashing units where appropriate	282	68.3
Disinfection of all equipment used by the employees (including instruments with screens)	281	68.0
Providing single-use seasonings, forks, knives, spoons, glasses, and toothpicks in the cafeteria ‡	232	67.8
Hand disinfectant in rest areas †	268	65.5
Distribution of foods and beverages as single-use food packets	209	61.1
Providing contact-free garbage bins	244	59.1
Providing disposable towels	238	57.6
Hand disinfectant in meeting halls	155	37.5

Data are presented as *n* (%) * Calculated for workplaces where transportation vehicles are used (N=312). † Calculated for workplaces with rest area (n=409) ‡ Calculated for workplaces with cafeteria (N=342)

Of the OHS professionals, 339 (82.1%) stated that there were employees with chronic diseases that would constitute a risk for COVID-19, and 174 (42.1%) emphasized that they had employees aged over 65 years. Figure 1 presents data on work arrangements OHS professionals made in the workplaces they offered their services for those with chronic diseases and over the age of 65 years.

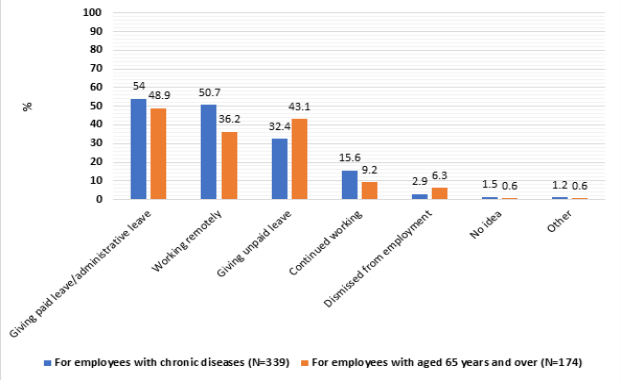

Figure 1. Working arrangements performed for employees over the age of 65 years and those with chronic diseases

Figure 2 summarizes data on the evaluation of employee adjustment to the precautions taken at the workplace by OHS professionals during the COVID-19 pandemic.

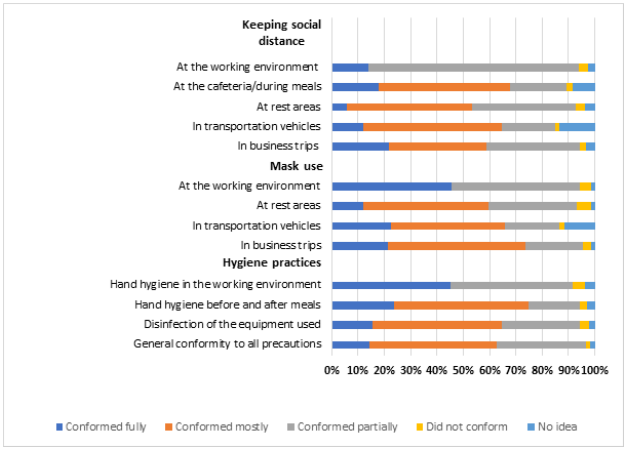

Figure 2. Evaluation of the conformity of the employees to the precautions during the COVID-19 pandemic

Following the revisions made during data analysis, 36 codes were formed by combining similar conditions and differences. These codes were divided into 9 categories and 3 themes (difficulties, strengths and effect) and are given in Figure 3.

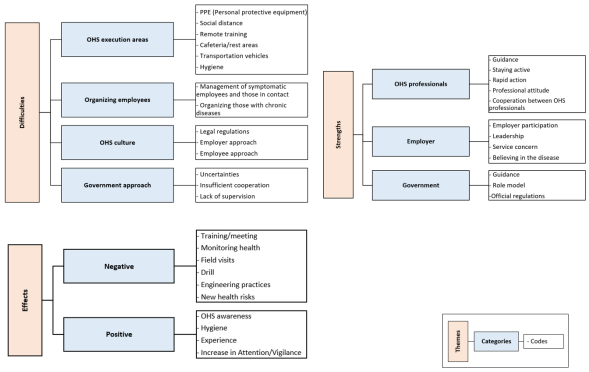

Figure 3. Themes, categories and codes formed in relation to the experiences of OHS professionals during the COVID-19 pandemic

Difficulties

The difficulties experienced by OHS professionals in managing the COVID-19 pandemic at the workplace were categorized as OHS execution areas, organizing employees, OHS culture, and government approach.

a.1. OHS execution areas

All the participants stated that they faced difficulties in relation to OHS execution areas. The use of personal protective equipment (PPE) and social distancing were the two most common difficulties in relation to OHS execution areas, which were followed by training, cafeteria/rest areas, transportation vehicles, and hygiene. Some of the statements of the participants related to the codes evaluated in the category of OHS application areas are as follows:

a.1.1. Personal protective equipment

"For instance, PPE is at the forefront for us, but since we made it mandatory to wear masks in this period, PPE use has become a problem. Safety goggles could not be worn due to misting. People who weld use welding masks and therefore did not want to wear pandemic masks, or they told me that since they wore

pandemic masks, they did not want to wear the welding masks (OP8)".

a.1.2. Social distance

"Since mines are underground, workers must work in very close contact. In short, we could not enforce social distancing on them (OSS11)."

a.1.3. Remote training

"We cannot plan online trainings on Meet to workers. Most of them do not have internet connection at home or use smart devices or connect with these devices (OP11)."

a.1.4. Cafeteria/ rest areas

"Of course, we made some things very difficult in the implementations; before, the chairs at the rest stops were designed for five or six people. We made them all for one person. But I guess due to the structure of the society, even though we made them for one person, we found the employees sitting two people in those single seats a lot (OP2)."

a.1.5. Transportation vehicles

"Regarding the transportation vehicles, for example, while only one transportation vehicle was used before, the load increased when 2 or 3 transportation vehicles were used due to the social distancing practice. We received complaints about this from time to time (IH5)."

a.1.6. Hygiene

"For example, we suggested a hand sanitizer with a pedal at the door entrance, and the administration said why did you suggest it, we don't accept it, it's an administrative decision (OSS12)."

"You say use disinfectant, use soap, soap your hands. How can I soap my hands, they tell me to take the product, how can I soap my hands every hour, every half hour (OSS13)."

a.2. Organizing employees

The majority of OHS professionals stated that they faced difficulties in managing symptomatic employees and those who were in contact with and organizing employees with chronic diseases. Some of the statements of the participants related to the codes evaluated in the category of organizing employees are as follows:

a.2.1. Management of symptomatic employees and those in contact

"We had to receive verbal information from the workers. Since we could not reach any official records, we could not obtain full information. We called the workers every day and found out who got into contact with them. The problem was that a COVID-positive patient was cast out by the others. This was just like what happens to an HIV-positive patient. In the end, due to such exclusion, we later learned that some workers were also positive. Therefore, contact tracing of that worker, separating and following them at home took very long. Hence, infectiousness increased (OP1)."

a.2.2. Organizing those with chronic diseases

Participants stated the fundamental reasons of the difficulties faced due to workers with chronic diseases as legal uncertainties related to private sector workers, financial worries of the employers and employees, and difficulty in reaching the medical records of the employees. The statements of an occupational physician regarding the difficulties experienced in organizing those with chronic diseases are as follows: "The biggest issue we have here is the

uncertainty in patients with chronic diseases. We really got exhausted. I am responsible for two factories divided by a wire fence. One of them did not victimize the workers with chronic diseases, and the workers I selected were sent home and received pay. In the other factory, these workers were sent home without pay (OP2)."

a.3. OHS culture

Another issue that OHS professionals emphasized was poor OHS culture. OHS professionals stated that the limited authority before employers due to legal regulations, which made it more difficult to manage the process. Some of the statements of the participants related to the codes evaluated in the category of OHS culture are as follows:

a.3.1. Legal regulations

"All of the methods that they determined were recommendations and were not mandatory for the employers. Therefore, we were very tired of trying to impose them on employers and trying to make them implement their practices according to these guidelines. Because we had no legal basis (OP8)."

a.3.2. Employer approach

"Social distancing rules, cafeterias, transportation services, locker rooms, etc., which were important for us during the pandemic, became a problem between us and the management. Because every work to be done on these issues was called extra cost, loss of time, loss of workers, loss of labor. For this reason, we had a lot of trouble with the employer (OP8)."

a.3.3. Employee approach

"You must use these masks during work. All employees use their masks during work, no problem. When they take a break, the masks come off. Why don't you wear the mask? They say they are on break. This is not a helmet so that you can take it off during the break, the time you should wear it is the break time. But we have seen that, unfortunately, our employees cannot even think about this (OSS9)."

a.4. Government approach

Another issue that OHS professionals stated about the difficulties they faced with the pandemic was the government's approach to workplaces in the process. There were uncertainties that arose from the fact that information on OHS practices specific to the sector could not be reached in the early period of the pandemic, there was lack of local and central cooperation with OHS professionals, OHS professionals did not get involved in the decisions-making process, and such weaknesses made it difficult for OHS professionals to manage the process. Some of the statements of the participants related to the codes evaluated in the category of Government approach are as follows:

a.4.1. Uncertainties

"The state published some circular notes and bylaws, but most of them were only on paper. The state did not have a clear plan on how to implement these. The pandemic was also new to them (OSS3)."

a.4.2. Insufficient cooperation

"OHS teams had to be supported by the Ministry of Health. They should have at least called or written and asked how we dealt with the process. We did not take part in any commission. The Ministry of Health

had to give us the authority with official correspondences so that we could manage the process effectively (OSS12)".

a.4.3. Lack of supervision

"Do you know that there is a control form sent by the governorate? Does the workplace comply with these rules, does it have an isolated room, does it apply the necessary social distancing rules? They came from public health centers. I found 10 deficiencies, they went before me and said thank you and left. Now, where they fill out the form and say thank you and leave, can I say you have deficiencies? So, the supervision mechanism is weak (OSS10)."

Strengths

This theme is based on the statements of OHS professionals regarding supportive factors that were effective in making OHS practices effective during the pandemic and regarding strengths in terms of OHS practices during the pandemic. The participants emphasized the supportive role of the OHS professionals, employers and government during this period.

b.1. OHS professionals

Nearly all of the participants underlined the role of OHS professionals in making OHS practices effective during this process. Among the statements of the participants, guidance, having been given an active role in the field, having taken rapid actions, professional attitude and cooperation between OHS professionals were at the forefront. Some of the statements of the participants related to the codes evaluated in the category of OHS professionals are as follows:

b.1.1 Guidance and rapid action

"OHS professionals approached the matter well. Healthcare workers, occupational physicians, and retired occupational physicians dominated the issue and shared very useful information. We were really prepared due to know-how and experience. Having experienced people on board, having implemented the practices that were applied abroad by immediately translating the articles into Turkish, and having physicians in the field of OHS and those that were specifically experienced on the subject paved our way (OSS13)."

b.1.2. Staying active

"The most important thing in this process is for OHS professionals to give on-the-job talks and to be in the field constantly. As occupational safety specialists, we said that we would get posters printed and hang these posters everywhere. We constantly sent e-mails to executives and were in the field constantly. We warned the employees whenever we realized a disobedience and avoided mistakes since awareness of the top management was also raised (OSS2)."

b.1.3. Professional attitude

"When something like this happens, we grasp the severity of the event differently than a normal citizen and prepare ourselves for it immediately (OSS10)."

b.1.4. Cooperation between OHS professionals

"Obviously, when I look at my own practices, there were big factories that I took as role models, there were the experiences of my friends, we passed the experiences with them. It is written in the guidebook, but we cannot do this, how did you complete this subject (OSS6)."

b.2. Employers

Some of the statements of the participants related to the codes evaluated in the category of employers are as follows:

b.2.1. Employer participation

"In this period, since we had an advisory role, it was the management that had full responsibility in implementing and supervising the practices that we recommended. In general, it looked like occupational health professionals that did the work, but decision-makers also had an active and efficient role in this period and faced many difficulties along the process (OP8)."

b.2.2. Leadership

"The management has a big role. If the management trusts occupational health and safety, OHS team, and implements the decisions properly, then the process goes smoothly (OSS7)."

b.2.3. Service concern

"During the pandemic, OHS professionals were very effective in the workplaces where they worked. Production did not stop. In a place where 300 people work, if 30 people test positive, that factory is closed for 15 days. We stayed there in 2-3 cases and prevented it from spreading.

b.2.4. Believing in the disease

"Although we provide training, as I said, we want them to take precautions against something they have not seen. After the cases happened, they became more aware (OSS7)."

b.3. Government

In terms of strengthening the process, the notification role of the government, official regulations and being a role model were emphasized. Some of the statements of the participants related to the codes evaluated in the category of government are as follows:

b.3.1. Guidance

"I think the Ministry of Health was the most active. The publications and booklets given by it. For example, I think there was a lot of dirty information on television (OSS4).

b.3.2. Role model

"The Minister of Health sat tall in the saddle, appeared on tv regularly and gave speeches related to the subject. I heard at the construction site that the workers were persuaded by the effort of the Minister of Health to at least wear the mask. His attitude really affected their attitude (OSS8).

b.3.3 Official regulation

"If it were not for the State's precautions, ours would be left hanging in the air. When the State adopted a decision, it was easier for us and more acceptable and convincing for the public to obey the regulations (OP2)."

Effects

OHS professionals also elaborated upon the negative and positive effects of the COVID-19 pandemic on OHS practices.

c.1. Negative

OHS professionals stated that, routine OHS practices such as training/meeting, monitoring health, field visits, drill, engineering practices were halted and additionally, new health risks emerged in this period:

c.1.1 Training/meeting

*"*We used to hold monthly meetings to prevent occupational accidents in the hospital. These

meetings were cancelled during the pandemic, and only meetings oriented at the pandemic were held (OSS12)."

c.1.2. Monitoring health

"It has many negative aspects. I cannot even get the tests that I need to write a medical report. For instance, we could not get respiratory function tests performed because everyone would blow into a device and might increase COVID-19 infection risk. However, if I do not know the person's respiratory function, I cannot decide if he/she is healthy (OSS9)."

c.1.3. Field visits

"We could not be in the field. The specialist or authorized person did not want to get into the field since we did not know who had it. The field was uncontrolled, and we could not take the necessary actions in the field (OSS7)."

c.1.4. Drill

"Earthquake drill, fire drill, their trainings, periodic examinations, normal occupational health and safety trainings were all interrupted. We were not able to perform our normal, regular responsibilities (OP11)."

c.1.5. Engineering practices

"All specialists had to focus on the health part of the job due to COVID-19. We are all skipping the technical part of our job. We focus more on social distance, contact, mask etc. There may be a problem with our electricity system, but we are all focused on coronavirus, which is a negative effect of the pandemic (OSS4)."

c.1.6. New health risk

"Allergies increased; eye dryness increased also. There are more cases of allergic dermatitis and eczematous reactions (OP1)."

c.2. Positive

The participants also emphasized some positive aspects of the COVID-19 pandemic on OHS. The participants focused on the fact that OHS awareness of the employees and employers increased, more importance was attached to hygiene, OHS professionals gained experience regarding management of infectious diseases, and vigilance of the employees in terms of risks and dangers increased:

c.2.1. OHS awareness

"Firms once again understood the importance of occupational health and safety and realized that it was teamwork. During the pandemic, the team that followed all protective precautions and the health of the workers comprised of 3 individuals: the occupational safety specialist, occupational physician, and the assistant healthcare worker. Therefore, they realized what this team meant in a factory. Now, they pay more attention to what we say (OP1)."

c.2.2. Hygiene

"People give more importance to hygiene now. This is an advantage for us to prevent the spread of COVID-19 and other infectious diseases (OSS3)."

c.2.3. Experience

"I realized that I was weak in matters on health. I had to improve myself. I am more informed now. Because I have researched, made risk analyses and emergency plans. These made me to become more aware of matters on health (OSS4)."

c.2.4. Increase in attention/ vigilance

"People are more attentive now. They also try not to go to hospital. They are more careful when they do their jobs. Occupational

accidents really decreased in this period. We did not dismiss any workers or reduced manufacturing capabilities. But we saw a decrease in occupational accidents. We are of the opinion that workers now do their jobs more carefully, of course we will be evaluating further in the future (OSS3)."

DISCUSSION

When the density of the working population and the crowdedness and mobility of the working environments are considered, workplaces become focal points in controlling such a pandemic. OHS professionals assumed a fundamental role in terms of implementing the precautions and transmitting information to employees and employers. Therefore, this research presents valuable information in connection to the practices and opinions of OHS professionals during the COVID-19 pandemic.

During the COVID-19 pandemic, national and international guides indicating the rules to be followed were published so that OHS professionals and employers could arrange the workplaces.[4,10,12] Within the scope of the research, the precautions taken by OHS professionals during the pandemic were questioned. This research showed that precautions that also appeared in the media including mask, distance and hygiene were more commonly implemented when compared to precautions that would require high cost or prevent the offering of services, like working with less personnel. In the study by Ishimaru et al. the most common workplace measure was to encourage the wearing of masks at work, followed by requesting employees not to go to work when ill and restricting work-related social gatherings and entertainment. In contrast, encouraging remote working was reported to be much less common.[17] In the study conducted by Asaoka et al. the most common precautions were hand washing, use of disinfectants, use of masks, and temperature measurement, while the least common precautions were shifting work, remote working, changing the working environment, and restrictions on cafeteria use.[18] In the study by Sasaki et al. hand washing, encouraging finger alcohol disinfection, and encouraging wearing masks were implemented over 80%, while shift work, encouraging remote work and working from home, changing the working environment (table layout, flow lines, etc.), restrictions on the use of cafeterias, and waiting at home for employees with a history of being abroad were reported to be implemented in less than 30% of the enterprises.[19] Like this study, it has been reported in the literature that mask, distance and hygiene measures are implemented at higher rates than measures such as shift work and organizing the work environment. The combined application of the recommended measures to stop the spread of COVID-19 infection in workplaces significantly reduces the risk of infection compared to their single use.[20,21] Therefore, as reported in the literature and in this study, it is thought that the implementation of some measures at workplaces at a much lower rate than others may be an obstacle in terms of preventing the spread of infection.

Apart from these precautions that involved workplace arrangements, it was decided with official regulations following the first case in our country that employees over the age of 60 years and with chronic diseases in state institutions would be on administrative leave.[22-24] However, a legal regulation was not made for those working in the private sector. It was detected in the research that the

manner of work for those over the age of 60 years and with chronic diseases varied from one workplace to another. These practices were in terms of paid leave, unpaid leave, and administrative leave. COVID-19 pandemic deepened the inequality between the sectors and institutions regarding employees' access to paid sick leave.[25,26] The findings of this research underline that employees with chronic diseases that constitute a risk for COVID-19 do not have equal conditions in protecting one's health and benefiting from financial rights and draw attention to another aspect of inequality in health.

In the second part of the research, experiences of OHS professionals regarding OHS practices during the COVID-19 pandemic were evaluated with semi-structured interviews. All the OHS professionals indicated that they faced difficulties in OHA practices during the COVID-19 pandemic. Difficulties with PPE and social distance were at the forefront. A factor that should be elaborated on is the compelling effect of other OHS practices related to the work itself on OHS practices related to the pandemic. This finding points to important intervention areas in terms of employee health and safety.

OHS professionals had a key role in being prepared against COVID-19 in the workplaces they offer their services and in intervening when there were possible/definite cases at the workplace.[27] To achieve this, OHS professionals needed to access credible information regarding the medical statuses of the employees. In this research, OHS professionals pointed out that they could not have access to official test results of those applying to hospital due to symptoms and could not isolate those who were symptomatic or had contact with a positive case until their status became clear. This situation points to organizational weakness in the management of workplaces during the pandemic.

The COVID-19 pandemic has shown that the best way to implement OHS precautions is effective cooperation between the employers, employees, and governments[28]. In this research, the participants indicated OHS professionals, employers and the state as the factors that contribute to OHS practices to come though during the COVID-19 pandemic. Nearly all of the participants in this research emphasized the role of OHS professionals in the efficiency of OHS practices during this process. There were statements expressing that rapid actions needed to be taken by OHS professionals at the workplace and be constantly active during the process.

In the research, many positive and negative effects of the COVID-19 pandemic on OHS were indicated by OHS professionals. When negative effects of the COVID-19 on OHS were evaluated, nearly all of the participants stated that routine OHS practices were badly influenced by the pandemic. During the COVID-19 pandemic, while risk factors against which measures should be taken at workplaces continued, OHS professionals, employers, and employees also faced the risks brought by COVID-19. This research found that most of the OHS professionals diverted their attention to precautions against the pandemic and trainings, employment examination, follow-up of employees with chronic diseases, examinations and tests including intermittent control examinations, field visits, meetings, drills, engineering practices were put on the backburner. Each OHS practice offered at the workplace is separately and interrelatedly important for employee health. A setback

in one of these precautions may generate a serious threat for the health and safety of the employee. Therefore, the current picture is worrisome in terms of possible negative effects of the setbacks on employee health. Even, some participants stated that new health problems emerged in employees and drew attention to the health effects of COVID-19 in the early period.

In the literature, one of the positive effects of the COVID-19 pandemic on OHS is that it increased the value of OHS.[29] In this research, participants stated that the pandemic made the employees, and the employers understand the value of OHS. Another positive effect is that conformity of rules at the workplace increased. Moreover, the participants also gained experience in managing infectious diseases at the workplace. In the 21st century when infectious diseases have become more spread and induced a public threat, it is significant for OHS professionals to obtain experience in how to deal with and manage an infectious disease and to become prepared for the upcoming process.

CONCLUSION

In this research, OHS practices and experiences of OHS professionals during the early period of the COVID-19 pandemic were evaluated using qualitative and quantitative methods together. When the measures taken regarding the use of masks, social distancing and hygiene practices in workplaces during the pandemic are evaluated, all three measures taken at the highest rate are related to the use of masks. In addition, it was found that the measures under the other two headings, such as flexible shifts, remote working, increasing the number of transportation vehicles and increasing hygiene equipment, which may disrupt service delivery or increase costs, were implemented at a lower rate. Professionals reported that staff compliance with measures was lower in rest areas. According to the results of the research, during the COVID-19 pandemic, there were deficiencies in both occupational health and safety practice areas and employee compliance. To overcome these deficiencies, it may be recommended to implement interventions and policies to strengthen the occupational health and safety culture for employers and employees. Again, an attention-grabbing finding was the uncertainty of the status of employees with chronic diseases and the health inequality that arose from it during the pandemic. Considering possible pandemics and other emergencies, the government should take measures to eliminate health inequalities among workers.

In-depth interviews were categorized under three themes: difficulties, strengths and the effects of the pandemic. All participants stated that difficulties were encountered in occupational health and safety implementation areas, and the empowering role of professionals in the management of the process was emphasized by almost all the participants. The difficulties and strengthening factors encountered in occupational health and safety practices during the pandemic should be carefully evaluated by occupational health and safety committees or employers and professionals in workplaces and risk plans should be made and prepared for another crisis. Professionals also drew attention to the many positive and negative effects of the pandemic on OHS practices. Nearly all OHS professionals stated that they experienced setbacks in routine OHS practices and the focus was solely on managing the pandemic. Furthermore, another effect of COVID-19 was that it led to new diseases to emerge in the employees, and

they should be recorded and followed-up in the long term. As emphasized by the participants, the positive effect of COVID-19 was that it raised OHS awareness in the employers and employees.

The COVID-19 pandemic brought about multifaceted experiences regarding OHS practice for the government, employees, and OHS professionals. In this respect, this and other scientific research should be carefully examined for OHS practices that could save lives in another possible crisis.

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ORIGINAL ARTICLE

Validation and reliability study of the Turkish version of the health services access scale

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Abstract

Objective: The aim of this study is to establish the Turkish validity and reliability of the Healthcare Access Scale and to determine whether perceptions of healthcare access vary according to demographic variables.

Methods: Data for the research were collected through surveys of 468 participants across Türkiye. Exploratory factor analysis and confirmatory factor analysis were conducted in the process of adapting the Healthcare Access Scale. In addition, t-tests and ANOVA tests were used to determine variations in access to healthcare according to demographic variables. The factors obtained from the exploratory factor analysis were confirmed by confirmatory factor analysis. The fit index values of the five-dimension health care access scale were found to be in the good fit range.

Results: As a result of the exploratory factor analysis, a five-dimensional structure was obtained, explaining 69.625% of the total variance. In the confirmatory factor analysis, the model's fit indices (CMIN/DF = 2.148, RMR = 0.049, GFI = 0.949, IFI = 0.969, TLI = 0.961, CFI = 0.969, NFI = 0.944, AGFI = 0.926, RMSEA = 0.050) were found to be satisfactory. Reliability analysis indicated a Cronbach's alpha coefficient of 0.919 for the entire scale, with coefficients for the subdimensions ranging from 0.740 to 0.874.

Conclusion: This study makes a significant contribution to the literature by testing the appropriateness, validity and reliability of the Healthcare Access Scale.

Keywords: Health Services, Health System, Validity and Reliability, Access to Health Services, Turkish Validity, Health

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INTRODUCTION

Health care is a vital determinant of overall well-being, encompassing not only physical health but also mental and social dimensions. The core objective of health services is to safeguard and improve public health, facilitate recovery, and support individuals and communities in leading healthier lives. This comprehensive focus highlights the importance of accessible, effective, and equitable health care services as fundamental to achieving positive health outcomes across diverse populations.[1-3] Closely linked to human health, health services are structured differently from other sectors. Although viewed through an economic lens, they are of strategic importance and require continuous improvement.[1] As a priority in national policies, health services are an integral part of social life, leading to significant progress in recent years.[3,4] Successful health systems require a patient-centred approach [5]. While access to health services is a fundamental right of every individual, there are challenges to accessing health care. In addition to excellent quality and quantity of health services, access is also crucial. This access should be equitable.[6] Therefore, many countries and organisations continuously evaluate their health systems in terms of effectiveness, equity, efficiency and quality.[7]

The provision of health care should be based on the medical needs of individuals rather than their income, race or place of residence. Policies, financing and delivery of health care are among the reasons for inequalities in access to health services.[8] Healthcare is becoming increasingly financially burdensome. Many people around the world are forced to spend money on health services, experiencing financial hardship and serious distress.[9] Families use their savings to pay for health care, borrow money, sell assets, cut back on food, cut back on education, and fall into poverty.[10] Therefore, health expenditure should be improved and subsidised through insurance programmes (in all forms, including national social security), health insurance schemes, mutual benefit societies and commercial private insurance.[11]

Countries have developed different health care systems with financial objectives such as keeping people healthy, providing patient care and controlling health care expenditure. The fundamental dynamics of these systems include the resources, management, organisation, delivery and financing of health services.[12] Healthcare is a constantly changing and evolving sector, essential for individuals and societies, and should be supported by new technologies and facilitated access.[13] The provision of quality health care requires health professionals to understand the needs of individuals and communities and to find the best solutions to those needs.[14] Individuals should know how to access health care, evaluate the quality of the services they receive, take responsibility for their health and protect their rights.[14] In addition, factors such as doctor-patient communication and the hospital environment should be assessed.[15]

Access to health care is linked to a number of factors that affect public health. Therefore, the reliability and validity of measures used in this area are crucial for policy making and health planning. Ensuring the validity and reliability of a Turkish health access scale is important for effective evaluation of health services in Türkiye. This study aims to contribute to the development of more effective and targeted

health policies by establishing a strong research infrastructure on access to health care.

The main objective of this study is to assess the validity and reliability of the Turkish version of the Healthcare Access Scale developed by Penchansky and Thomas.[16] In addition, the performance of this scale according to demographic variables will be examined to understand differences that may occur in access to health care. This evaluation will play a crucial role in the planning of health policies and service.

Access to Healthcare

The Universal Declaration of Human Rights by the United Nations (UN) asserts that every individual is entitled to a standard of living adequate for health and well-being.[17] Articles 25.1 and 25.2 of the Universal Declaration of Human Rights stipulate the right of individuals and families to access health and well-being, alongside basic needs. Article 25.1 states, "Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control." Article 25.2 further emphasizes, "Motherhood and childhood are entitled to special care and assistance. All children, whether born in or out of wedlock, shall enjoy the same social protection".[18] In this context, it is emphasized that greater attention should be paid to women and children.

Access is generally recognized as a crucial factor in the matching between patients and health services The dimensions of this alignment identified by Penchansky and Thomas (1981) include availability, accessibility, appropriateness, acceptability and affordability. Ensuring these dimensions is essential for an effective health system.[16] Competence in the provision of health services is important, and existing resources must be used effectively.[19] In particular, the development of a knowledgeable and skilled health workforce should be supported.[20]

As stated by Sachs (2012), individuals worldwide have the right to accessible standards of health care, regardless of race, religion, political beliefs, economic or social status. Access to health should be based on the principle of equality for each individual.[21] Efforts should be made to minimise health inequalities in order to ensure fair and equitable access to health services.[22] At present, access and equity are among the key performance measures for health services.[23] Accessing healthcare can be hindered by various barriers. The demand for healthcare services in society is not always constant. Situations such as pandemics, epidemics, wars, natural disasters, and economic difficulties can affect access to healthcare.[24] Moreover, the distance to healthcare institutions is often perceived as a barrier to accessing healthcare.[19,25]Optimal healthcare delivery requires significant technology, is costly, and demands a qualified workforce. Geographic differences affect hospitalization durations among children, adults, and the elderly.[14] Current issues in healthcare payments are highlighted in various areas due to the gap between knowledge and application.[26] Access to healthcare services can be negatively affected by the complexity of payment reforms.[27]

In Türkiye, healthcare services include both public and private options. In Türkiye, access to healthcare services is provided through the General Health Insurance system. All citizens registered with the Social Security Institution can receive free medical treatment at contracted hospitals.[28] The Ministry of Health, Social Security, and universities play significant roles in the provision of healthcare services. According to reference [29] the Ministry of Health holds the primary responsibility despite the potential complexity arising from the involvement of multiple institutions.

In 2003, Türkiye implemented a healthcare reform called the 'Health Transformation'. The aim of this reform was to achieve structural transformations in healthcare policies, service delivery, financing models, personnel regulations, quality and quantity, public-private partnerships, and healthcare industries. The regulations focus on promoting collaboration between the public and private sectors, developing health tourism, and transforming healthcare industries.[30]

Countries aim to improve healthcare access by increasing financing sources. It is noted that healthcare expenditures are higher in developed countries due to a larger elderly population.[31] All countries, whether developed or developing, invest significantly in protecting and improving the health of their citizens. In Türkiye, healthcare expenditures totalled 4,985 million TL in 1999, increasing to 393,941 million TL in 2021 and projected to reach 606,835 million TL in 2022.[32]

METHOD

Population and Sample of the Study

The study population consists of individuals in Türkiye who currently use or have the potential to benefit from healthcare services. Based on data obtained from the address-based population registration system in 2022, Türkiye has a population of 85,279,553 people.[33] Therefore, for this study, the population will be determined using the convenience sampling method. The study's sample size was calculated using the $\boldsymbol{n}$=(p*q) formula, resulting in a determination that a sample size of 384 would be sufficient to reach the target.[34] In factor analysis, it is recommended to have 5 to 10 participants per item. For this 16-item scale, a sample size of 468 is adequate, meeting the recommended criteria. The final sample size of 468 confirms that the study has a sufficient number of participants. The convenience sampling method was chosen for its cost-effectiveness and speed compared to other sampling methods.

Data Collection Instruments and Adaptation Process

Approval was obtained for the translation of the Access to Health Services Scale developed by Penchansky and Thomas (1981) into Turkish via email.[16] Subsequently, the original scale was translated from English to Turkish, and expert opinions were sought to ensure linguistic and conceptual validity. The translation was sent to three language experts proficient in English. After making the translation compatible with the English original, adjustments and changes were made to ensure content validity based on the opinions of five experts, including four middle-level

and one senior-level hospital administrators experienced in hospital management. A pilot study was conducted with 19 and 24 hospital employees to obtain data on the test version of the research questions. Following the pilot study, the finalized research questions, along with questions prepared to obtain demographic information, received ethical approval. The research questions, approved by the ethics committee, were distributed to participants across Türkiye via an online survey.

Access to Health Services Scale:

The Access to Health Services Scale consists of 16 items and 5 dimensions. The dimensions are availability, convenience, affordability, accessibility, and acceptability.[16] Detailed information about the dimensions is provided below (Appendix-1).

Availability: The dimension of availability in the Access to Health Services Scale refers to the adequacy of available health services, including the type of health services and the availability of doctors, dentists, auxiliary health personnel, clinics, hospitals, and the ability to meet patient needs. It consists of 4 items in the original scale.

Accommodation: Accommodation is a dimension consisting of 4 items that measure the convenience provided in terms of waiting time for appointments, suitability of examination hours, time spent in the waiting room, and ease of communication with the physician.

Affordability: This dimension, consisting of 3 items, expresses the compatibility between the prices of the provided health services and the payment systems such as insurance that patients have. It can be considered an important dimension in terms of measuring the value perception formed in response to the total cost paid for the health service received by the patient.

Accessibility: Accessibility is one of the dimensions that assesses the convenience provided in terms of the time and distance it takes for patients requesting health services to reach the facility where the service will be provided. It is assessed with 2 items and is among the components affecting patient compliance in accessing health services.

Acceptability: Health service providers can provide services to patients selected based on certain characteristics. Therefore, this dimension, consisting of 3 items, addresses factors such as satisfaction derived from the location of the facility, the appearance of the facility, and seeing other patients receiving services from the facility, from the perspective of patients.

Demographic Information Form:

This form was created by researchers to determine the demographic characteristics of the participants. The form consists of 6 questions. Participants were asked about their age, gender, income level, education level, the type of hospital they generally receive services from, and the frequency of receiving healthcare services in the last 1 year.

Ethical Considerations and Data Collection

After determining the objectives and scope of the study, necessary documents were prepared to assess ethical suitability, and an application was made to the Artvin Çoruh University Scientific Research and Publication Ethics Committee. With the decision dated 05.02.2023 and numbered

E-18457941-050.99-80543, the ethics committee approved the study's ethical compliance. A brief paragraph explaining the purpose of the study was included at the beginning of the questionnaire, and informed consent was obtained from the participants. The survey covers individuals over the age of 18 throughout Türkiye. The data were collected using an online survey method, and the data collection process took place between 10.02.2023 and 10.01.2024, lasting approximately 11 months.

Data Analysis

The collected data were examined for missing data, and it was determined that there were no missing values. Before beginning the analysis of the data, a check for normal distribution was conducted to decide which method to use. In this context, it was evaluated whether the mean scores of the scale and its subscales exhibited a normal distribution. A decision was made taking into account the skewness and kurtosis coefficients as indicators of normality for the obtained data.[34]

To test the overall structure of the scale, exploratory factor analysis (EFA) was applied to the data collected from a total of 468 participants from different regions of Türkiye. Confirmatory factor analysis (CFA) was then conducted to confirm the fit of the emerged structure with the variables. Additionally, goodness-of-fit indices (CFI, TLI, RMSEA) were determined after conducting security analyses of the model defined by exploratory factor analysis and tested by confirmatory factor analysis. Accordingly, factor loading (CR) (>.70) and average variance extracted (AVE) (>.50) values were obtained to determine the fit of the variables in the constructed model. To determine whether there were differences in demographic characteristics and the frequency of receiving services from hospitals in terms of factors, t-tests and ANOVA were applied. The LSD (Least Significant Difference) test from the Post Hoc tests was employed to identify the source of differences among groups. SPSS 24 and Amos 23 packages were used to analyse the data.

RESULTS

The results of the conducted analyses have been elaborated in detail in this section to contribute to the research aim. The findings have been divided into four parts for evaluation: findings related to exploratory factor analysis, findings related to confirmatory factor analysis, basic analyses, and findings obtained from difference analyses.

Table 1 provides demographic data for participants from across Türkiye.

Table 1 shows that the majority of participants are female (68.8%) and most belong to the middle-income level (53.4%). The proportion of those receiving services from public hospitals (42.1%) is higher compared to other types of hospitals, with university graduates constituting the highest percentage (57.5%) in terms of education level. Furthermore, 55.8% of the participants are between the ages of 18-30. Moreover, the study revealed that 35.7% of the participants received hospital services seven or more times in the past year.

Table 1. Demographic Data

Variables		n	%	Variables		n	%
Type of Hospital Services Received	**Public Hospital**	197	42,1	**Gender**	Female	322	68,8
	Private Hospital	75	16,0		Male	146	31,2
	City Hospital	121	25,9	**Age**	18-30	261	55,8
	University Hospital	75	16,0		31-40	91	19,4
Income Level	**Low**	150	32,1		41-50	63	13,5
	Medium	250	53.4		51 and above	53	11.4
	High	68	14.5	**Frequency of Visiting Hospital (Within the last 1 year)**	0-1	38	8.1
Education	**Primary/Secondary School**	34	7.3		2-4	162	34.6
	High School	82	17.5		5-6	101	21.6
	University	269	57.5		7 and above	167	35.7
	Postgraduate	83	17.7				

Exploratory Factor Analysis

The results of the exploratory factor analysis of the Health Services Access Scale are presented in Table 2. The calculated Kaiser-Meyer-Olkin (KMO) value in Table 2 is 0.928, indicating an excellent result. In other words, the high KMO value suggests that the sample size used in the study meets the necessary conditions for conducting factor analysis. Additionally, since p(sig.)= p<0.001, the result of the Bartlett test is also found to be significant. These findings indicate that the data meet the necessary conditions for conducting factor analysis.

Table 2. Exploratory Factor Analysis Results

Factors	Item No	Factor Loadings	Eigenvalue	Explained Variance
Availability	Mv3	.729	7.263	%45.392
	Mv4	.713		
	Mv2	.692		
	Mv1	.691		
	Kly4	.518		
Accommodation	Kly1	.762	1.268	%7.925
	Kly2	.706		
	Kly3	.692		
Affordability	Odn1	.724	1.147	%6.546
	Odn2	.653		
	Odn3	.649		
Accessibility	Uls1	.869	1.086	%5.226
	Uls2	.829		
Acceptability	Kbl3	.743	1.009	%4.5[36]
	Kbl1	.658		
	Kbl2	.640		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax
Kaiser-Meyer-Olkin Measure of Sampling Adequacy(KMO): 0.928
Bartlett's Test of Sphericity: Approx. Chi-Square: 3570.698; df:120 sig:0.000
Explained Total Variance: %69,625

The explained total variance ratio in Table 2 is calculated as 69.625%. It is observed that the Availability factor explains 45.392% of the total variance, the Accommodation dimension explains 7.925%, the Affordability dimension explains 6.546%, the Accessibility dimension explains 5.226%, and the Acceptability dimension explains 4.536% of the total

variance.

Confirmatory Factor Analysis

The purpose of using both exploratory and confirmatory analysis in adaptation processes is that while exploratory factor analysis aims to generate theory, confirmatory factor analysis has a testing technique aimed at confirming the theory. In the use of confirmatory factor analysis for testing or scale development, structural equation modeling-based factor analysis and hypothesis testing are more acceptable because it is assumed that there may be correlations between the variables that make up the factors. Thus, it can be used to determine the level of fit of the model with the obtained variables.[35]

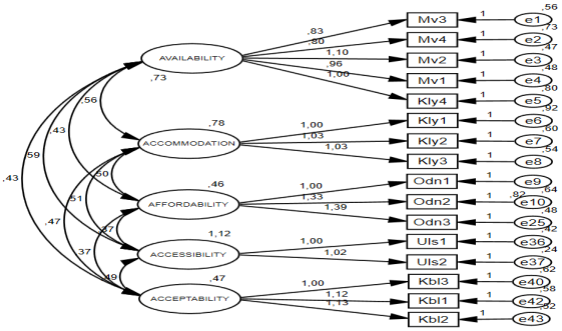

Figure 1. Confirmatory Factor analysis AMOS Output

Figure 1 shows the AMOS output for confirmatory factor analysis. Table 3 presents the calculated goodness-of-fit indices.

Table 3. Goodness-of-Fit Indices of The Health Services Access Scale

Indices	N	CMIN/DF	RMR	GFI	IFI	TLI	CFI	NFI	AGFI	RMSEA
Model	468	2.148	0.049	0.949	0.969	0.961	0.969	0.944	0.926	0.050

When examining the goodness-of-fit values of the health services access scale presented in Table 3, it can be observed that the CMIN, RMR, IFI, TLI, CFI, NFI, and RMSEA values are very good, while the GFI and AGFI values fall within the good fit range. This indicates a very good fit between the model and the dataset.[35]

Table 4. Interaction between factors and items

Factors	Item	Standardized Value	Estimate	Standard Error	T	P
Accommodation	Kly1	.677	1.000			
	Kly2	.761	1.031	.074	13.871	***
	Kly3	.780	1.035	.073	14.119	***
Affordability	Odn1	.601	1.000			
	Odn2	.749	1.329	.109	12.142	***
	Odn3	.805	1.386	.110	12.625	***
Availability	Mv4	.624	.800	.065	12.252	***
	Mv2	.808	1.097	.071	15.427	***
	Mv1	.762	.955	.065	14.679	***
	Mv3	.689	.833	.062	13.414	***
	Kly4	.691	1.000			
Accessibility	Uls1	.852	1.000			
	Uls2	.910	1.024	.054	18.917	***
Acceptability	Kbl3	.656	1.000			
	Kbl1	.709	1.123	.090	12.509	***
	Kbl2	.733	1.130	.088	12.806	***

Table 4 presents findings regarding the interaction between scale factors and scale items. Regression values indicate the predictive power of observed variables, i.e., factor loadings. Since all "p" values for the above model pairwise relationships are less than 0.001, the factor loadings are significant. The significant p-values indicate that the items are loaded onto the factors. Additionally, standardized regression coefficients greater than or equal to 0.624 indicate high factor loadings, i.e., the predictive power of latent variables for each item. Finally, the standard error ratios and t-values at the 99% confidence level (t>1.96) are at acceptable levels.

Primary Analyses

The calculated CR, AVE and Cronbach Alpha coefficients for the subscales of the Access to Healthcare Scale are presented in Table 5. As can be seen from Table 5, for the reliability analysis, an "item-total correlation-based item analysis" was performed on the data obtained from the target population, which yielded an overall reliability coefficient of Alpha=0.919 for the entire scale. Furthermore, the reliability coefficient for the availability dimension was alpha=0.838, for the accommodation dimension was alpha=0.783, for the affordability dimension was alpha=0.753, for the accessibility dimension was alpha=0.874 and for the acceptability dimension was alpha=0.740. These results indicate that the scale has a high reliability.

The calculated AVE values in Table 5 are greater than 0.519 and the CR values are greater than 0.715, confirming the construct validity of the scale. In addition, the skewness and kurtosis coefficients for the Access to Healthcare Scale range from 0.161 to 0.901, indicating that the scale data follow a normal distribution .[34]

Table 5. Cronbach's Alpha, CR, and AVE Values for Subscales of The Scale

Factors	Std. Error	Mean	Cronbach's α	AVE	CR	Skewness	Kurtosis
Availability	0.873	3.23	.838	.566	.803	-.187	-.408
Accommodation	1.024	2.69	.783	.519	.763	-.273	.702
Affordability	0.959	2.74	.753	.547	.715	.161	-.482
Accessibility	1.146	3.156	.874	.721	.837	-.396	-.901
Acceptability	0.861	3.189	.740	.564	.721	-.376	.095
Total Scale	.919						

Difference Analyses

Difference analyses based on demographic variables were conducted as part of the Turkish adaptation study of the Healthcare Access Scale. Given the coefficients of skewness and kurtosis, the data were assumed to follow a normal distribution. For the comparison of binary variables, t-tests were used, while for more than two variables, the LSD test was preferred to determine the source of group differences.[36] Table 6 shows the results of the differences in the dimensions of the Access to Healthcare Scale based on the gender and marital status of the participants.

Table 6. Comparison of Healthcare Access Dimensions and Gender and Marital Status

Factors	Variables	n	Mean	T	P
Availability	Female	146	3.2616	0.550	.617
	Male	322	3.2137		
Accommodation	Female	146	2.7192	0.361	.744
	Male	322	2.6822		
Affordability	Female	146	2.8607	1.804	.199
	Male	322	2.6884		
Accessibility	Female	146	3.1884	0.411	.569
	Male	322	3.1413		
Acceptability	Female	146	3.2763	1.469	.226
	Male	322	3.1501		

In Table 6, it is observed that the dimensions of the healthcare access scale did not vary based on participants' marital status and gender ($p>0.05$).

Table 7 presents the results of the ANOVA test conducted on the healthcare access scale

Table 7. Demographic Indicators Analysis in terms of Suitability, Accommodation, Affordability, Accessibility, Acceptability

Demographic Indicators	Variables	F	P	Source of Difference
Age	Availability	0.920	0.452	No Difference
	Accommodation	2.281	0.060	No Difference
	Affordability	2.231	0.065	No Difference
	Accessibility	0.489	0.744	No Difference
	Acceptability	0.513	0.727	No Difference
Type of Hospital Visited	Availability	1.458	0.214	No Difference
	Accommodation	3.232	0.012	University (2.76). Public (2.52). Private (2.85). City Hospital (2.85)
	Affordability	1.695	0.150	No Difference
	Accessibility	3.571	0.007	University (3.01). Public (2.97). Private (3.42). City Hospital (3.36)
	Acceptability	2.810	0.141	No Difference
Income Level	Availability	15.927	0.000	Low (2.92) Medium (3.32) High (3.55)
	Accommodation	13.994	0.000	Low (2.34) Medium (2.83) High (2.96)
	Affordability	29.757	0.000	Low (2.29) Medium (2.89) High (3.16)
	Accessibility	2.817	0.061	No Difference
	Acceptability	24.707	0.000	Low (2.80) Medium (3.34) High (3.47)
Education Level	Availability	1.507	0.199	No Difference
	Accommodation	1.328	0.258	No Difference
	Affordability	0.340	0.851	No Difference
	Accessibility	0.713	0.583	No Difference
	Acceptability	4.532	0.210	No Difference
Frequency of Hospital Visits (Last 1 Year)	Availability	2.093	0.029	0-1 (3.44).2- 4 (3.26). 5-6 (3.35). 7 and above (2.86)
	Accommodation	2.840	0.003	0-1 (2.93). 2- 4 (2.72). 5-6 (2.70). 7 and above (2.39).
	Affordability	2.722	0.004	0-1 (3.18). 2- 4 (2.83). 5-6 (2.85). 7 and above (2.45).
	Accessibility	1.131	0.339	No Difference
	Acceptability	1.287	0.241	No Difference

Table 7 summarizes the results of the ANOVA test. No significant differences were found in the sub-dimensions of healthcare services based on age and educational level ($p>0.05$). Regarding the type of hospital, no differences were observed in the Availability, Affordability, and Acceptability dimensions ($p>0.05$). However, public hospitals (2.52) had a significantly lower mean score for the Accommodation dimension compared to other hospital types ($p<0.05$). Additionally, individuals receiving services from university (3.01) and public hospitals (2.97) had lower perceptions of Accessibility than those using city (3.36) and private hospitals (3.42) ($p<0.05$).

No differences in the Accessibility dimension were found based on income level ($p>0.05$), but significant differences were observed in other dimensions ($p<0.05$). Low-income individuals reported lower perceptions of Availability, Accommodation, Affordability, and Acceptability, indicating greater challenges in accessing healthcare services.

Finally, regarding healthcare service utilization frequency, no differences were found in the Accessibility and Acceptability dimensions ($p>0.05$). However, individuals visiting 7 or more hospitals per year reported lower perceptions of Availability, Accommodation, and Affordability compared to others ($p<0.05$), highlighting greater difficulties in accessing healthcare services.

DISCUSSION

The results of this study confirm that the Health Services Access Scale is a reliable and valid instrument for measuring access to healthcare services in Türkiye. The EFA revealed that the scale includes five factors—Availability, Accommodation, Affordability, Accessibility, and Acceptability—explaining a total of 69.625% of the variance. The CFA demonstrated good model fit, with all fit indices indicating an excellent fit between the proposed model and the data. The reliability analysis yielded high Cronbach's Alpha values, confirming the internal consistency of the scale. The difference analyses indicated that demographic factors such as income level and type of hospital visited had significant effects on certain dimensions of healthcare access, while gender and marital status did not show significant differences. Compared to other studies in the literatüre; The Access of Older Adults to Outpatient Primary-Care Health Services Scale (AOAOPHSS) was evaluated for psychometric properties among Mexican older adults, resulting in a refined 21-item Accessibility Subscale with good internal consistency.[37] Another study introduced the Perceived Access to Health Services (PAHS) scale, demonstrating its relationship with perceived health vulnerability and overall health outcomes.[38] A Turkish study developed a scale to measure the impact of healthcare access on voter behavior, identifying three dimensions with acceptable reliability and validity.[39] Additionally, a 25-item Access to Health Care (AHC) instrument was developed and validated, encompassing six components: approachability, availability, accessibility, affordability, acceptability, and accommodation, showing strong construct validity and internal consistency.[40] These scales offer a valuable means of measuring and comparing the accessibility of healthcare services across diverse populations. In this context, the findings indicate that access to healthcare is a significant societal indicator, and that such scales can be employed for more comprehensive analyses of health policies and practices.

The study found that participants' perceptions of access to healthcare did not differ according to gender, age or level of education. However, those who received services from public and university hospitals, those with lower income levels and those who received 7 or more healthcare services per year were found to have relatively more difficulties in accessing healthcare services compared to their counterparts.

Repeating the study with a larger sample over different time periods across Türkiye could reflect trends in perceptions of access to healthcare and provide guidance for policy makers. In addition, factors such as the type of insurance, the presence of chronic diseases and the use of continuous medication are also likely to have an impact on perceptions of access to healthcare. Taking these factors into account in future studies is considered beneficial.

CONCLUSION

The results of this study are of particular significance for local policymakers, as they indicate potential avenues for enhancing or expanding healthcare services in order to guarantee equitable access for all citizens. A further study conducted across a range of regions in country over an extended period could reveal trends and shifts in perceptions of healthcare access, thus assisting in the formulation of policies. The incorporation of additional variables, such as insurance types, chronic diseases, and continuous medication usage, into future research will further enhance the scale's validity and comprehensiveness. This will guarantee that the scale remains a dynamic instrument, capable of supporting effective health policy decisions that align with the evolving structure of the national healthcare system.

Limitations

As with any study, this research has several limitations.

Sampling Method: The study employed a convenience sampling method, which limits the generalizability of the sample group. Alternative sampling methods could have provided a broader and more diverse group; however, this method was chosen for its cost-effectiveness and speed.

Regional Focus: Although the study includes 468 participants from various regions of Türkiye, the data is limited to specific regions. This may not fully capture the differences in access to healthcare services across various geographic areas.

Cross-Sectional Design: The study's cross-sectional design restricts the ability to examine causal relationships between factors affecting access to healthcare services. Longitudinal studies could provide more robust results.

Data Collection Period: The data collection period (from February 10, 2023, to January 10, 2024) lasted approximately 11 months. This duration may not sufficiently capture the evolving perceptions of access to healthcare services over time.

Demographic Limitations: The demographic information form used in the study examined basic characteristics such as age, gender, and income level. However, deeper socio-economic factors and health status variables were not considered.

In light of these limitations, it is expected that a more accurate evaluation of the research would be possible.

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Ethics Committee Approval

After determining the objectives and scope of the study, necessary documents were prepared to assess ethical suitability, and an application was made to the Artvin Çoruh University Scientific Research and Publication Ethics Committee. With the decision dated 05.02.2023 and numbered E-18457941-050.99-80543, the ethics committee approved the study's ethical compliance

Author Contrubition: Concept: NE, MF, OB; Design: NE; MF,OB Supervising: OB, MF, NE ; Data Collection and Processing: OB, MF,NE; Analysis and/or Interpretation: OB, MF;NE Critical Review: OB, MF,NE

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Appendix 1: Health Access Scale

Health Access Scale

Dimensions

Availability Dimension (Expressions ranging from 1 to 4)

Accommodation Dimension (Expressions ranging from 5 to 8)

Affordability Dimension (Expressions ranging from 9 to 11)

Accessibility Dimension (Expressions ranging from 12 to 13)

Acceptability Dimension (Expressions ranging from 14 to 16)

Note 1: There is no reverse-coded expression in the scale. A high score indicates easy access to health services and high satisfaction.

Note 2:The scale can be used with proper citation.

No	**Original Expression**	**Turkish Expression**	Extremely Dissatisfied	Dissatisfiedemnun	Neutral	Satisfied	Extremely Satisfied
1	*All things considered, how much confidence do you have in being able to get good medical care for you and your family when you need it?*	Her şeyi göz önünde bulundurduğunuzda, ihtiyacınız olduğunda kendiniz ve aileniz için iyi bir tıbbi bakım alabileceğinizden ne kadar memnunsunuz?					
2	*How satisfied are you with your ability to find one good doctor to treat the whole family?*	Tüm aileyi tedavi edecek iyi bir doktor bulabilmekten ne kadar memnunsunuz?					
3	*How satisfied are you with your knowledge of where to get health care?*	Nereden sağlık hizmeti alacağınız konusundaki bilginizden ne kadar memnunsunuz?					
4	*How satisfied are you with your ability to get medical care in an emergency?*	Acil bir durumda tıbbi yardım alabilme becerinizden ne kadar memnunsunuz?					
5	*How satisfied are you with how long you have to wait to get an appointment?*	Randevu almak için gereken bekleme süresinden ne kadar memnunsunuz?					

6	*How satisfied are you with how convenient physicians' office hours are?*	Doktorların muayene saatlerinin size uygunluğundan ne kadar memnunsunuz?					
7	*How satisfied are you with how long you have to wait in the waiting room?*	Bekleme odasında geçirmeniz gereken süreden ne kadar memnunsunuz?					
8	*How satisfied are you with how easy it is to get in touch with your physician(s)?*	Hekim(ler)inizle iletişim kurmanın kolay olmasından ne kadar memnunsunuz?					
9	*How satisfied are you with your health insurance?*	Sağlık sigortanızdan ne kadar memnunsunuz?					
10	*How satisfied are you with the doctors' prices?*	Doktor fiyatlarından ne kadar memnunsunuz?					
11	*How satisfied are you with how soon you need to pay the bill?*	Tedavi faturasını ödemeniz gereken süreden ne kadar memnunsunuz?					
12	*How satisfied are you with how convenient your physician's offices are to your home?*	Doktorunuzun ofisinin evinize yakınlığından ne kadar memnunsunuz?					
13	*How difficult is it for you to get to your physician's office?*	Doktorunuzun ofisine erişim kolaylığından ne kadar memnunsunuz?					
14	*How satisfied are you with the appearance of the doctor's offices?*	Muayenehanelerin görünümünden ne kadar memnunsunuz?					
15	*How satisfied are you with the neighborhoods their offices are in?*	Doktor ofislerinin bulunduğu mahallelerden ne kadar memnunsunuz?					
16	*How satisfied are you with the other patients you usually see at the doctors' offices?*	Muayenehanelerde genellikle gördüğünüz diğer hastalardan ne kadar memnunsunuz?					

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ORIGINAL ARTICLE

Assessing knowledge, attitudes, and practices of tobacco cultivators regarding their health hazards: a study on Kushtia district

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Abstract

Objective: Tobacco farming is common in Bangladesh, particularly in Kushtia district, but it's harmful to farmers' health. This study looks at what tobacco farmers know, think, and do about their health. The findings will help create targeted interventions to improve their well-being.

Methods: A survey was conducted among 300 tobacco farmers in Kushtia Sadar, Mirpur, and Daulatpur upazilas, including 214 males (71.3%) and 86 females (28.7%). Data were collected using a structured questionnaire covering demographics, knowledge, attitudes, and practices. Descriptive statistics and Pearson correlation analysis were performed using SPSS version 27 and Microsoft Excel version 19.

Results: The study found that 71.3% of tobacco farmers were men, and 38% had no formal education. Health problems were common, with 33% reporting allergies, 32% suffering from coughs and breathing issues, and 24% experiencing headaches. While 73.3% recognized the harmful effects of pesticides, only 59.3% were aware of the risks of handling tobacco leaves, and 40.7% acknowledged serious health risks from tobacco farming. Correlation analysis showed education level positively correlates with reporting physical health problems ($r = 0.181$, $p < 0.01$). Physical health problems positively correlated with acknowledging pesticide risks ($r = 0.230$, $p < 0.01$). However, a weak negative correlation ($r = -0.076$, $p < 0.01$) exists between physical health issues and concern about long-term effects.

Conclusion: In summary, this study highlights the need for targeted intervention to enhance knowledge and safer farming techniques, while also advocating for measures to protect farmers' health and promote sustainable practices in the tobacco sector.

Keywords: Knowledge, Tobacco Cultivators, Health Hazards

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INTRODUCTION

Tobacco, scientifically known as Nicotiana Tabacum, is a botanical species that is cultivated for its leaves, which undergo a drying process to be transformed into various tobacco products such as cigarettes, pipe tobacco, cigars, chewing tobacco, and snuff. The health risks associated with tobacco usage are widely recognized.[1] Tobacco production is rising globally, particularly in developing countries. Thus, the features of tobacco farm workers are changing and their job-related health risks are of great relevance to public health.[2] Bangladesh, one of the developing countries, consumes a significant portion of tobacco in the world. Tobacco in Bangladesh is being cultivated from the ancient time however nowadays commercial tobacco farming is under a debate.[3] Tobacco is considered to be a non-nutritive substance, and the utilization of tobacco as a raw material in any industry is deemed unsuitable for the health of humans.[4] Tobacco cultivation in Bangladesh accounts for less than 0.5% of agricultural employment, indicating that it is a labor-intensive crop.[5] Despite the fact that tobacco cultivation has adverse effects on health, the environment, and the economy, many producers will continue to cultivate tobacco across the globe.[6] Tobacco farmers constitute a specific demographic group characterized by their occupation, which renders them susceptible to occupational illnesses. Occupational diseases arise due to the interplay between workers acting as hosts and their work or the work environment. Long-term exposure to intricate and multifactorial dangers in the context of tobacco growing is likely to result in adverse health outcomes.[7] The presence of nicotine in tobacco cultivation poses a health risk, as it becomes water-soluble and dissipates in condensate water on tobacco leaves during early morning atmospheric moisture condensation.[8] The tobacco business says that growing tobacco can bring in money for the government and give farmers a good way to make a living. Truly, growing tobacco often causes issues with money, mistreatment of workers, damage to the environment, and health issues for farms.[9] Bangladesh occupies the 20th position among countries that produce tobacco. In recent years, there has been a notable 65% surge in tobacco cultivation relative to other cereal commodities.[10,11] According to the latest official agricultural statistics, it has been observed that out of the total of 64 districts, 29 districts exhibit varying degrees of tobacco cultivation, encompassing around 45,869 hectares of agricultural land.[12] Tobacco cultivation in Bangladesh is distributed over the country, with a notable concentration in the northern and southwestern regions, particularly in Rangpur and Kushtia. Additionally, the eastern mountainous region, such as the Chittagong Hill Tracts, also cultivates numerous tobacco kinds.[4] Farmers who work on tobacco farms or who process leaves are at risk for major health problems, including increased cancer risk from chemical exposure, respiratory disorders, and green tobacco sickness from coming into direct contact with tobacco leaves during cultivation and harvest.[13,14] Moreover, chemical poisoning affects farm workers and nearby residents of tobacco-growing fields due to pesticide application, which is frequently done by youngsters under the age of fifteen. [11,15] Tobacco is a significant global public health hazard, resulting in more than 8 million fatalities annually on a global scale. Approximately 1.3 million deaths

are the consequence of secondhand smoke exposure, while over 7 million deaths are directly attributable to smoking.[16] This study addresses the gap in understanding tobacco farmers' knowledge, attitudes, and practices regarding health risks in Kushtia, a key tobacco farming region. The research aims to develop targeted interventions to promote safer agricultural methods and improve farmers' health and well-being.

Literature review:

The World Health Organization estimates that, tobacco-related maladies claim the lives of 6 million individuals annually, which is more than the combined mortality from tuberculosis (TB), HIV/AIDS, and malaria.[17] A significant portion of tobacco workers, specifically 89.7%, expressed concerns regarding the potential health hazards associated with crop farming and processing employment.[18] Tobacco farming poses significant harm, not only due to its detrimental effects on workers, but also as a result of the utilisation of chemical fertilisers and pesticides.[18] Some tobacco growers are aware of the health risks that come with tobacco production, such as diseases linked to tobacco use and damage to the environment.[19] But people are worried that the government isn't doing enough to help and that switching to more sustainable options will be hard.[20] In addition, some people think that tobacco farmers get government money, which makes people feel mixed feelings about them.[21] Older age, lesser education, tobacco firm financial backing, ease of marketing tobacco products, access to financing, and the impression of larger profitability than other crops influence farmers' tobacco cultivation decisions.[22] A recent study by Rahman & Parvin, 2017, looked into the morals and economics of tobacco farming and found that farmers are unwilling to stop growing tobacco even though they say it is wrong.[23] A study found that the cultivation of tobacco in Bangladesh presents notable health risks for farmers.[18] Individuals engaged in tobacco farming encounter a range of health issues, including but not limited to signs such as nausea, vomiting, dizziness, headache, weakness, cough, difficulty breathing, and excessive salivation.[21] These health concerns impact not only the agricultural labor force but also the elderly, infants, and women residing in the farming communities. The absence of adequate safety protocols and persistent exposure to tobacco leaves heighten the likelihood of tobacco-related illnesses.[25] Farmers exhibit a notable deficiency in their knowledge and understanding regarding the potential health hazards linked to the cultivation of tobacco.[26]

METHOD

The current descriptive cross-sectional study was performed on 300 tobacco cultivators from three upazilas of Kushtia district using purposive sampling methods in 2024.

Sample Size

In this study, we selected 300 tobacco cultivators from the three upazilas of Kushtia District (Kushtia Sadar, Daulatpur, and Mirpur) using purposive sampling methods, ensuring balanced representation with 100 respondents from each upazila. Although Cochran's formula suggests a sample size of approximately 384 for a 95% confidence level and a 5% margin of error, our choice of 300 respondents was guided by practical considerations of field data collection and resource constraints. This sample size is sufficient to provide reliable and diverse

insights into the tobacco cultivation practices within the region.

Data Collection and Analysis:

Data were collected from tobacco cultivators in the three upazilas of Kushtia district using purposive sampling. A structured questionnaire, translated into Bangla to accommodate the predominantly illiterate population, gathered comprehensive data divided into four sections: demographic information, knowledge assessment, attitudes assessment, and practices assessment, based on the KAP (Knowledge, Attitudes, and Practices) model. Field data collectors assisted respondents in completing the questionnaires to ensure accuracy and completeness. The data were processed using SPSS version 27 and MS Excel version 2019, involving data entry, coding, and thorough cleaning. Normality tests indicated that the data followed a normal distribution. Descriptive statistics analyzed demographic characteristics and health risks, while Pearson correlation analysis examined relationships between various factors and awareness of tobacco hazards. This meticulous approach ensured robust and reliable data, providing valuable insights into the practices and health implications of tobacco cultivation in the Kushtia district.

RESULTS

In Table 1, participant demographic information is presented, providing insights into the characteristics of the sample population involved in the study. The study area comprised three distinct regions, with an equal distribution of participants across each area: Kushtia Sadar (33.3%), Mirpur (33.3%), and Daulatpur (33.3%). Gender distribution indicated a slight majority of male participants (71.3%) compared to female participants (28.7%). Age distribution revealed a diverse range of participants, with the majority falling between the ages of 31-45 (44.3%), followed by those aged 16-30 (34.0%), 46-60 (18.0%), and 61-67 (3.7%). Regarding education level, the majority of participants had no formal education (38.0%) or completed primary school (24.0%), while fewer had secondary school (25.0%), higher secondary (10.7%), or university education (2.3%). Designation varied among participants, with 60.3% identifying as owners and 39.7% as employees. A significant portion of participants (54.0%) reported growing tobacco on their land, with the majority cultivating 4-6 bighas of land (34.3%). Despite the labor-intensive nature of tobacco farming, the majority of participants (84.0%) perceived it as profitable based on time, labor, and cost considerations. Experience in tobacco cultivation varied, with the majority having 1-5 years of experience (56.3%), followed by 6-10 years (22.3%), 11-20 years (6.3%), 21-30 years (7.3%), and 31-45 years (5.7%). The comprehensive demographic information provided in Table 1 offers valuable insights into the characteristics of the study population, facilitating a deeper understanding of their perspectives and experiences related to tobacco farming.

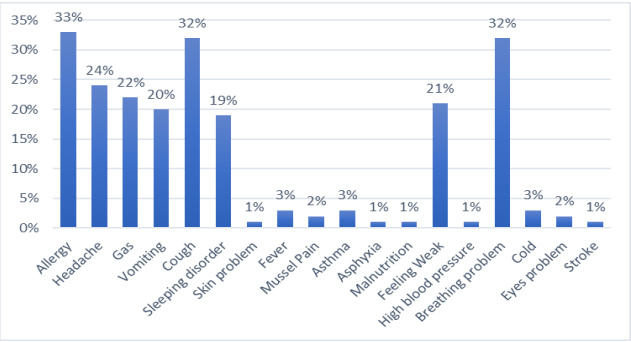

Figure 1. Different diseases of tobacco cultivators and their percentage

Table 1. Participants' demographic information

Variables	Responses	n	%
Study Area	Kushtia Sadar	100	33.3
	Mirpur	100	33.3
	Daulatpur	100	33.3
Gender	Male	214	71.3
	Female	86	28.7
Age	16-30	102	34.0
	31-45	133	44.3
	46-60	54	18.0
	61-67	11	3.7
Education level	No formal education	114	38.0
	Primary school	72	24.0
	Secondary school	75	25.0
	Higher secondary	32	10.7
	University	7	2.3
Designation	Owner	181	60.3
	Employee	119	39.7
Do you grow tobacco on your land?	Yes	162	54.0
	No	138	46.0
How many bighas of land do you cultivate tobacco?	Not answered	103	34.3
	1-3	44	14.7
	4-6	103	34.3
	7-9	35	11.7
	10-18	15	5.0
Based on time, labor, cost do you think tobacco farming is profitable?	Yes	252	84.0
	No	44	14.7
Experience in Tobacco Cultivation	Not answered	6	2.0
	1-5	169	56.3
	6-10	67	22.3
	11-20	19	6.3
	21-30	22	7.3
	31-45	17	5.7

Figure 1 presents the frequency and percentage distribution of various diseases prevalent among 300 tobacco cultivators in Kushtia district. Allergy ranks highest, affecting 33% of the total sample. Following closely are cough and breathing problems, each affecting 32%. Headaches are also common, with 24%, while gas-related issues affect 22%. Vomiting (20%) and sleeping disorders (19%) are also significant health concerns. Other ailments include muscle pain (2%), skin problems (1%), fever (3%), asthma (3%), asphyxia (1%), malnutrition (1%), feeling weak (21%), high blood pressure (1%), colds (3%), eye problems (2%), and strokes (1%). The rest of the respondents don't face any health issues. These statistics underscore the diverse health challenges faced by individuals involved in tobacco cultivation, highlighting the need for targeted interventions and healthcare support within this community.

Table 2. Participants' Knowledge Assessment

Variables	Responses	n	%
Do you think pesticides used in tobacco farming can make people sick?	Yes	220	73.3
	No	80	26.7
Do you know that moving tobacco leaves can be harmful to health?	Yes	178	59.3
	No	122	40.7
Do you think working long hours in tobacco farming can cause respiratory problems?	Yes	204	68.0
	No	96	32.0
Do you know the health risks of staying in the vicinity of nicotine in tobacco?	Yes	126	42.0
	No	174	58.0
Do you think it is important to use protective equipment while applying pesticides in tobacco cultivation?	Yes	253	84.3
	No	47	15.7

Table 2 presents an assessment of participant knowledge regarding various aspects of tobacco farming and associated health risks. The data highlights their perceptions and awareness levels of key factors in tobacco cultivation. A majority (73.3%) believe pesticides used in tobacco farming can make people sick, and 68.0% acknowledge potential respiratory problems from long hours of work in tobacco farming. Additionally, 84.3% recognize the importance of using protective equipment during pesticide application. However, only 59.3% are aware that handling tobacco leaves can be harmful, and just 42.0% understand the health risks of being near nicotine. These findings underscore varying

levels of awareness among participants about the health hazards of tobacco farming, indicating the need for educational interventions and awareness campaigns.

Table 3. Participants' Attitude Assessment

Variables	Responses	n	%
Do you believe that tobacco farming poses serious health risks to farmers?	Strongly disagree	8	2.7
	Disagree	39	13.0
	Neutral	80	26.7
	Agree	122	40.7
	Strongly agree	51	17.0
Are you concerned about the possible long-term health effects of tobacco farming?	Strongly disagree	4	1.3
	Disagree	78	26.0
	Neutral	95	31.7
	Agree	89	29.7
	Strongly agree	34	11.3
Do you think you may be at risk of getting sick from working with tobacco plants?	Strongly disagree	4	1.3
	Disagree	46	15.3
	Neutral	101	33.7
	Agree	118	39.3
	Strongly agree	31	10.3
Do you feel that the health risks of tobacco farming are serious?	Strongly disagree	2	0.7
	Disagree	46	15.3
	Neutral	108	36.0
	Agree	118	39.3
	Strongly agree	26	8.7
Are you open to adopt alternative farming practices that are less harmful to health?	Strongly disagree	4	1.3
	Disagree	42	14.0
	Neutral	124	41.3
	Agree	97	32.3
	Strongly agree	33	11.0

Table 3 examines participant attitudes and perceptions regarding health risks in tobacco farming and their openness to alternative practices. Results show that 40.7% agree and 17.0% strongly agree that tobacco farming poses serious health risks, whereas 2.7% strongly disagree and 13.0% disagree. Concerns about long-term health effects are evident, with 29.7% agreeing and 11.3% strongly agreeing, in contrast to 1.3% strongly disagreeing and 26.0% disagreeing. Regarding personal risk, 39.3% agree and 10.3% strongly agree that they may fall ill from working with tobacco, with 8.7% strongly agreeing on the seriousness of health risks, while 0.7% strongly disagree and 15.3% disagree. Attitudes towards adopting alternative farming practices show 32.3% agreeing and 11.0% strongly agreeing, though 41.3% remain neutral and 14.0% disagree. These findings highlight the nuanced perspectives of farmers, emphasizing the necessity for targeted educational interventions to promote safer agricultural practices in the tobacco industry.

Table 4. Participants' Practice Assessment

Variables	Responses	n	%
How often do you use protective equipment (eg, gloves, masks) when using pesticides in tobacco farming?	Always/ Often	72	24.0
	Sometimes	139	46.3
	Rarely/ Never	89	29.7
Do you regularly clean your hands and body after working with tobacco leaves or pesticides?	Always/ Often	217	72.3
	Sometimes	77	25.7
	Rarely/ Never	6	2.0
Have you ever sought training or information about safe tobacco growing practices?	Always/ Often	69	23.0
	Sometimes	131	43.7
	Rarely/ Never	100	33.3
How often do you open windows or wear safety equipment when storing pesticides?	Always/ Often	124	41.3
	Sometimes	126	42.0
	Rarely/ Never	50	16.7
Are you considering switching to alternative crops that pose less health risks in the future?	Always/ Often	112	37.3
	Sometimes	117	39.0
	Rarely/ Never	71	23.7

Table 4 provides insights into participants' behaviors and intentions regarding safety practices in tobacco farming, as well as their consideration of alternative crops with potentially lower health risks. Participants were asked to indicate the frequency of their use of protective equipment, cleanliness practices after working with tobacco leaves or pesticides, and seeking of training or information about safe tobacco growing practices. The data reveals varied levels of adherence to safety protocols among participants. A notable portion of participants (46.3%) reported using protective equipment sometimes, while 24.0% use it always or often, and 29.7% rarely or never use it. In terms of cleanliness practices, 72.3% of participants reported always or often cleaning their hands and body after working with tobacco, whereas 25.7% do so sometimes, and only 2.0% rarely or never clean. Additionally, 43.7% of participants sometimes seek training or information about safe tobacco growing practices, while 33.3% rarely or never do. When it comes to storing pesticides, 42.0% sometimes open windows or wear safety equipment, 41.3% always or often do so, and 16.7% rarely or never take these precautions. Lastly, regarding consideration of alternative crops, 39.0% of participants sometimes consider switching, 37.3% always or often consider it, and 23.7% rarely or never do. These findings underscore the importance of promoting consistent adherence to safety practices and exploring alternatives to mitigate health risks in tobacco farming.

The correlation figure 2 provides a detailed analysis of the relationships among gender, education level, physical health status, and various Knowledge, Attitude, and Practice (KAP) variables related to tobacco farming and health risks. Gender shows no significant correlation with education level or physical health problems, suggesting no observed association between gender and these variables in this dataset. However, education level positively correlates with reporting physical health problems ($r = 0.181$, $p < 0.01$), suggesting that individuals with higher education levels may be more aware of or inclined to report health issues, highlighting the role of education in health awareness. Physical health problems positively correlate with acknowledging the health risks of pesticides ($r = 0.230$, $p < 0.01$) indicating that those experiencing health issues may have heightened awareness level. Conversely, there is a statistically significant, but very weak negative correlation ($r = -0.076$, $p < 0.01$) between experiencing physical health problems and concern about long-term health effects, suggesting that individuals with physical health issues show slightly less concern about long-term risks. Additionally, education level negatively correlates with the use of protective equipment ($r = -0.383$, $p < 0.01$), suggesting that more educated individuals may be less likely to use protective measures when working with pesticides in tobacco farming. Additionally, physical health problems negatively correlate with the use of protective equipment ($r = -0.165$, $p < 0.01$), indicating that those experiencing health issues may avoid using protective gear, possibly due to discomfort or practical challenges. These findings illustrate the complex relationships between demographic factors, health status, and health-related attitudes and practices in tobacco farming, with statistically significant correlations (**) at the 0.01 level and (*) at the 0.05 level adding credence to the observed relationships.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Gender of the respondent	1																	
2. Education level	-0.001	1																
3. Do you suffer from any physical problems?	-0.064	.181**	1															
4. Do you think pesticides used in tobacco farming can make people sick?	-.132*	-.164**	.230**	1														
5. Do you know that moving tobacco leaves can be harmful to health?	-0.03	-.126*	.173**	.314**	1													
6. Do you think working long hours in tobacco farming can cause respiratory problems?	0.039	-0.043	.229**	.152**	.130*	1												
7. Do you know the health risks of staying in the vicinity of nicotine in tobacco?	0.017	-.210**	-0.073	0.086	.155**	0.005	1											
8. Do you think it is important to use protective equipment while applying pesticides in tobacco cultivation?	-0.05	-.265**	-0.06	.113*	0.017	-.138*	.125*	1										
9. Do you believe that tobacco farming poses serious health risks to farmers?	0.056	.230**	0.009	-.331**	-.350**	-.150**	-.175**	-.132*	1									
10. Are you concerned about the possible long-term health effects of tobacco farming?	0.049	.262**	-0.076	-.240**	-.330**	-.126*	-.143*	-.156**	.500**	1								
11. Do you think you may be at risk of getting sick from working with tobacco plants?	-0.009	.153**	-.176**	-.178**	-.321**	-0.073	-0.104	-.208**	.411**	.520**	1							
12. Do you feel that the health risks of tobacco farming are serious?	0.014	.180**	-0.054	-.216**	-.294**	-.151**	-0.105	-.156**	.493**	.471**	.458**	1						
13. Are you open to adopt alternative farming practices that are less harmful to health?	-0.044	.145*	0.017	-.135*	-.173**	-0.073	-.124*	-.129*	.355**	.277**	.208**	.389**	1					
14. How often do you use protective equipment (eg, gloves, masks) when using pesticides in tobacco farming?	-0.069	-.383**	-.165**	.191**	.187**	0.015	.223**	.306**	-.239**	-.314**	-.140*	-.146*	-.230**	1				
15. Do you regularly clean your hands and body after working with tobacco leaves or pesticides?	-0.022	-.220**	-0.114	.155**	0.038	0.05	-0.022	0.056	-0.094	-.174**	-0.076	-0.043	-0.071	.302**	1			
16. Have you ever sought training or information about safe tobacco growing practices?	0.051	-0.051	0.09	0.007	.150**	.116*	.118*	.150**	0.016	-0.033	-0.005	-0.048	-0.063	.223**	.115*	1		
17. How often do you open windows or wear safety equipment when storing pesticides?	-0.049	-0.04	0.024	-0.003	-0.084	0.027	-0.094	0.02	0.095	0.025	0.005	0.051	.158**	0.027	0.018	.116*	1	
18. Are you considering switching to alternative crops that pose less health risks in the future?	0.055	-0.092	0.066	0.078	.227**	.206**	-0.001	0.029	-.138*	-.196**	-.184**	-.187**	-.238**	.198**	0.08	.141*	.120*	1

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Figure 2. Pearson correlation among gender, education level, feeling physical problem with KAP variables

DISCUSSION

Using cross-sectional survey data, this study has ascertained the knowledge, attitude, and practices of tobacco cultivators' health hazards in three upazilas of Kushtia district. The majority of the respondents of the study were male (71.3%) while female was only (28.7%). Most of the respondents were illiterate (38%) while secondary school and university graduates are 25% and 2.3% respectively. We observed 84% of the study respondents think that based on time, labor, and cost tobacco cultivation is profitable. This belief motivates them to do more tobacco farming. Among the respondents, 56.3% reported having up to five years of tobacco farming experience, while the majority had no prior experience, making them more vulnerable to the risks due to their lack of protective knowledge. The study reveals a high prevalence of health problems among tobacco growers in the Kushtia district, with respiratory issues like allergies, cough, and breathing difficulties affecting 33%, 32%, and 32% of the sample population, respectively. There are some similar studies in literature which support the findings of this study. According to studies, tobacco producers have a higher chance of acquiring respiratory diseases.[15,28] Another study by Moyo et al., 2023 reported that, the incidence of breathing issues among tobacco farmers is large, with studies revealing a high occurrence of respiratory symptoms and airflow limitation caused by obstructive lung disease.[29] Furthermore, a significant proportion of tobacco farmers (24%) experience headaches, while 22% report gas-related concerns. The result of a study conducted in Brazil by Santos et al., 2017, reveals that the prevalence of headache among tobacco planters is found to be approximately 16.71% which is almost 7.30% lower than our study result.[30] Additionally, gas issues, such as stomach-ache, were discovered to impact around 8.30% of tobacco growers. These

findings indicate that tobacco cultivators in Kushtia experience headaches and gas issues more frequently than those in Brazil, underscoring the diverse health challenges that individuals engaged in tobacco cultivation are exposed to.

The study shows varying awareness levels about health dangers among tobacco farmers. Most participants recognize the risks of pesticides (73.3%) and the importance of protective equipment (84.3%), but fewer are aware of the risks of handling tobacco leaves (59.3%) and nicotine exposure (42.0%). These findings are more positive than Anbazhagan et al. (2022), which showed that frequent pesticide users lack awareness of their dangers and the need for protective gear, despite experiencing health issues.[31] According to studies, while some farmers wear protective equipment such as face masks and gloves, others may not use them efficiently.[32,33]

Participants' views on tobacco farming's health concerns vary in this study. Many (40.7%) agree that tobacco production provides major health dangers to farmers, with 17.0% strongly agreeing. However, 15.3% disagree. These indicate that tobacco farmers have different views on the health risks of their job. Tobacco farming is linked to several health issues for farmers, such as nausea, vomiting, vertigo, and respiratory ailments.[24] Concerns regarding the potential long-term health effects of tobacco cultivation were expressed by 29.7% of participants who agreed and 11.3% who strongly agreed, which is a noteworthy finding.[27] This finding indicates that a considerable percentage of respondents were cognizant of the possible health consequences associated with their profession, an essential factor in ensuring health and safety in the agricultural industry. Growers of tobacco in southern Brazil are conscious of the health risks associated with their occupation, which include musculoskeletal ailments, pesticide toxicity, and green tobacco illness.[27] The research shows mixed opinions on adopting less harmful farming methods: 32.3% agree, 11.0% strongly agree, 41.3% are neutral, and 14.0% disagree. This ambivalence could hinder efforts to promote eco-friendly and health-conscious practices in the tobacco sector.

The study reveals varied adherence to safety procedures among tobacco growers: 24.0% always or frequently wear protective gear with pesticides, 46.3% do so occasionally, but 72.3% consistently wash after handling pesticides or tobacco leaves, indicating generally high cleanliness levels. However, only 2.0% of tobacco farmers in Kushtia occasionally or never engage in safety practices, showing some gaps in knowledge and hygiene. The majority use safety measures, unlike in Indonesia, where only 34% of farmers practice safety.[35] Another interesting finding is that 37.3% of participants always or often consider switching to healthier crops, and 39.0% sometimes consider it. Studies in India show that farmers are willing to shift away from tobacco farming if certain criteria are met.[36] The United Nations Framework Convention on Tobacco Control emphasizes the need for regulatory land-use policies to promote varied farming techniques and alternative livelihoods, and highlights the global effort to facilitate transitions away from tobacco growing.[37] The study found that higher education levels are associated with increased reporting of physical health problems, suggesting greater awareness or

willingness to disclose issues. Gregorio et al. (2011) similarly found that tobacco knowledge is influenced by formal education levels.[38] This finding emphasises the potential significance of education in raising health awareness and encouraging people to recognise and report health issues, which is critical for successful health management and intervention.

Although the sample size of this study was smaller than the initially calculated target, the findings remained consistent across key demographics, showing clear and repeated patterns in the knowledge, attitudes, and practices (KAP) variables among tobacco farmers. This consistency suggests that the sample, though reduced, was sufficiently representative to provide meaningful insights into the broader population in the region. The balanced representation across the three main upazilas also added robustness to the data, reinforcing that the core findings reflect broader trends within the Kushtia district.

CONCLUSION

This study provides a comprehensive assessment of the knowledge, attitudes, and practices (KAP) of tobacco cultivators in Kushtia district, highlighting demographic characteristics, prevalent health issues, and participants' awareness and safety measures. It underscores the significant health risks faced by tobacco growers, including respiratory diseases, migraines, and gastrointestinal problems. Despite varying demographics, many participants perceive tobacco farming as financially rewarding, indicating a need for interventions that balance economic benefits with health concerns. While awareness of pesticide-related risks is evident, gaps remain regarding other hazards like direct tobacco leaf contact and nicotine exposure, emphasizing the importance of educational initiatives. The study also reveals diverse perspectives on health risks and receptiveness to alternative farming approaches, underscoring the necessity for tailored interventions that accommodate differing viewpoints. Ensuring consistent adherence to safety protocols through regulatory enforcement and comprehensive training is crucial. Actionable recommendations include targeted educational campaigns, advocacy for precautionary measures, and support for alternative livelihoods to promote health and sustainability in the tobacco sector.

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Ethical Declaration : While the research team was unable to obtain formal ethical clearance due to the absence of an established committee at the Islamic University, rest assured that the researchers adhered to the ethical criteria mentioned in the Helsinki Declaration throughout the study. The researchers gave individuals a concise informed consent form and clearly discussed all ethical aspects. The confidentiality was preserved, and no personal information (such as names, addresses, or contact information) was obtained. Participants received no

monetary compensation and were able to decline any enquiries. In addition, reputable scholars assessed the study questionnaire to ensure that it met ethical norms and scholarly principles.

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REVIEW

Risk compensation (Peltzman's effect) during the COVID-19 pandemic: a narrative review

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Abstract

Objective: The implementation of a safety measure can have counterproductive effects on other protective measures and people engage in risk compensatory behavior (fewer safety behaviors). It is essential to summarize different researches to better understand the dynamics of risk compensation during COVID-19 pandemic in order to develop evidence-based interventions. Mass vaccination and public use of facemasks, among others, had been widely adopted to halt COVID-19 pandemic. Given marked variability in vaccines effectiveness and the lack of evidence of facemask efficiency in preventing spread of infection, all preventive measures should be used as a single package. People might feel false sense of safety when engaging in any of these COVID-prevention behaviors, as predicted by risk compensation theory. this review aims to address the ongoing debate about risk compensation during COVID-19 pandemic; to summarize the findings of previous studies about it; and to provide new evidence base of the effects of a specific preventive measure on the other measures.

Methods: A structured search on PubMed and Google Scholar on January 8, 2024 for ever published articles in English using keywords in different combinations ("Peltzman effect" OR 'risk compensation' OR 'risk homeostasis') AND ('COVID19' OR 'COVID-19' OR 'covid19' OR 'covid-19' OR 'SARS CoV2' OR 'SARSCoV-2' OR'SARS-CoV-2' OR 'SARS-COV2') AND ('face mask' OR 'face cover') AND ("distancing" OR social distancing") AND ("Vaccines' OR "Vaccination") AND ('hand hygiene') AND ('Sanitizers'). The search included various study designs including both observational and experimental studies.

Results: Studies showed conflicting results and no definite conclusion can be drawn about the risk compensation during COVID-19 pandemic.

Conclusion: Current literature failed to provide a solid evidence of risk compensation during the current pandemic. More community-based intervention studies are needed to provide solid bases for future pandemics.

Keywords: Peltzman Effect, Risk Compensation, Risk Homeostasis, COVID-19

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INTRODUCTION

World Health Organization (WHO) acknowledged the COVID-19 pandemic on 11 March 2020.[1] People who perceived the COVID-19 virus as threatening are more likely to adopt the recommended preventive measures, especially up-taking the vaccines.

Vaccination has played a key role in reducing the health burden of COVID-19, however, concern has been raised worldwide that risk compensation, a process whereby feelings of security arising from being vaccinated may lead people to reduce their engagement in other protective behaviours[2], could detract from the overall health benefit of the COVID-19 vaccination campaign.[1]

Throughout the pandemic, the world has become familiar with the concept of risk compensation. In circumstances that are perceived as unsafe, people naturally modify their behavior, compensating to minimize that risk. The effects of risk compensation tend to fade over time as the personal threat decreases.[2] This is known as pandemic fatigue that is decreasing adherence to risk reduction strategies complicating public health efforts. Availability of vaccines further weaken adherence to other safety measures.[2] This phenomenon, in which individuals respond to safety measures with a compensatory increase in risky behavior, is named the "Peltzman Effect" first described it in 1975.[2,3] The Peltzman's phenomenon has been varying, identified in specific safety interventions but not others.[2] The famous example the use of pre-exposure prophylaxis to lower the risk of HIV transmission has been linked with diminished intention to wear condoms, greater numbers of sexual partners, and increased occurrence of sexually transmitted infections in some studies.[4,5]

Rationale

Although theoretically plausible, empirical evidence on risk compensation is mixed. There are many studies in different countries and dates with conflicting results about presence of risk compensation and its effects during COVID-19 pandemic.[8] Risk compensation in response to government actions became a public issue. There is a need for further research to better know the dynamics of risk compensation during pandemics in order to develop evidence-based interventions to mitigate the potential negative consequences of Peltzman's effect and to examine the presence of a risk compensation effect of one preventive measure on other measures.

Aim

To provide a short review on risk compensation and related terms and to summarize the findings of previous studies about risk compensation during COVID-19 pandemic.

METHOD

This study is a narrative review that summarizes results of previous publications regarding the theory of risk compensation and its presence during COVID-19 pandemic. A structured search on PubMed and Google Scholar on January 8, 2024 using the following search terms in different combinations ("Peltzman effect" OR 'risk compensation' OR 'risk homeostasis') AND ('COVID19' OR 'COVID-19' OR 'covid19' OR 'covid-19' OR 'SARS CoV2' OR 'SARSCoV-2' OR'SARS-CoV-2' OR 'SARS-COV2') AND ('face mask' OR 'face cover') AND ("distancing"

OR social distancing") AND ("Vaccines' OR "Vaccination") AND ('hand hygiene') AND ('Sanitizers'). All previous English publications were included. We excluded case reports, case series, duplication, editorial and non-formal/ personal notes. All other study designs were included if they consider the effect of one or more preventive measures on the other measures, whatever the target group. A total of 117 articles were downloaded, 60 of them were included in the review and 20 of them were found to have findings about risk compensation during COVID-19 pandemic.

RESULTS AND DISCUSSION

Peltzman effect

In 1975, Samuel Peltzman first described the phenomenon of compensating behavior (Peltzman effect, aka: risk compensation or risk homeostasis in epidemiology). This phenomenon has been used to explain the unintended consequences of a number of health care interventions [3].

In his paper "The Effects of Automobile Safety Regulation," Peltzman[3] concluded that safety regulations like seatbelt laws did not affect highway death rates. Instead, the implementation of safety regulations led to riskier behavior from drivers. As a result, while driver death rates decreased, pedestrian death rates and property damage accidents increased.[3] The basic premise of the theory is that people hold a specific target risk level or risk preference that they attempt to maintain. If a situation exceeds this target risk level, people engage in actions to lower the perceived risk. People likewise engage in risk-taking behaviors when the perceived risk is lower than their risk preference.[2] The external implementation of safety devices or regulations can lead to a risk reduction (e.g., a seat belt protects the driver from serious accidents) [3], causing people to feel safer, which then results in more risk-taking behavior [2].

There are confusion and debate among different specialties about the three terms Peltzman effect, risk compensation and risk homeostasis. Some scholars consider these terms to be synonymous while others consider they represent different ideas [6].

The risk compensation theory (RCT) is a behavioral model of human attitudes towards risk which suggests that people might adjust their behavior in response to the perceived level of risk. The decrease in perceived risk through access to preventive measures may lead to increasing frequency of risky behaviors especially in the domain of health-related behaviors. The COVID-19 pandemic has exposed people to the sense of risk compensation and behavior change in response to the perceived risk. This results in false sense of safety and un-intended consequences. This phenomenon has been reported especially after mass vaccination with possible negative effects and effectiveness of vaccination programs.[7,8]

Risk compensation has been investigated even before COVID-19 pandemic using different methods e.g., observational studies or natural experiments[9], lab experiments[10], self-report questionnaires [11], and population-level statistics.[12] These studies reported the presence of risk compensation and showed that it may not be universal and depend on the type of the behaviors and the intervention.

Risk homeostasis is a controversial hypothesis suggesting that people undertaking protective interventions are likely to exhibit increased

harmful behaviors and be exposed to higher risk. They compare the expected benefits and costs of safe behavior versus the expected benefits and cost of the risk behavior.[6]

Mechanism of risk compensation

There was an interaction between the multiple preventive measures that lead to risk compensation during COVID-19 pandemic. The mechanism of risk compensation includes both economic and psychological aspects. Economically safety can be perceived as a good, and thus traded for other more desirable goods.[2,13]

Risk homeostasis theory explains the psychological aspect that is people reached desired level of risk, if this level is reduced by an intervention people will uptake other risks until they return to this tolerated risk level.[13]

Hedlund [2] has identified four mental preconditions that play a role in risk compensation behavior: 1) the intervention must be visible; 2) there is a perception of protection, 3) motivation to increase risk-taking, and 4) control and opportunity to adjust behavior. A contributing factor is the effectiveness of the intervention on mutant strains. However, most of vaccines are protective against new mutants.[14] All these criteria were meeting in the COVID-19 pandemic.[15] The COVID-19 preventive measures are visible (e.g. vaccine uptake, wearing facemask, ..etc) and many people preceive these measures as protective so people adopt them. Pharmaceutical companies claimed the high effectiveness of different vaccines that encourage vaccinated persons to take the risk of neglecting other protective measures. Most of these measures are under perosnal control and are available for all people.

Risk compensation and various preventive measures of COVID-19

Currently the COVID-19 preventive measures include mass vaccination as a specific measure and non-specific measures that pertinent to all respiratory infections e.g., facemask wearing, social distancing, lockdown, personal hygiene and use of sanitizers. All these strategies have focused on breaking the chain of virus transmission. All preventive measures should be taken as a single package for effective control of COVID-19 at community level. It is not clear whether the simultaneous adoption of all preventive measures is additive or multiplicative in effects. To the best authors' knowledge there is no literature to support the effects of simultaneous or combined use of different preventive measures.

(1)COVID-19 vaccines

Efficacy of COVID-19 vaccines varies and all vaccines give neither immediate nor full protection. However, over-confidence in vaccines gives a sense of personal safety and is associated with increasing in risky behavior by neglecting other non-specific preventive measures including facemask use, distancing and hand hygiene. The vaccinated individuals could still become infected and transmit the virus and its variants.[16] An epidemiological study showed that the probability of COVID-19 positivity increased after the first dose of the vaccine,[17] Ioannidis,[18] in his mathematical model concluded that risk compensation may eliminate the benefits of COVID-19 vaccines, especially with low vaccine effectiveness and/or low probability of infection in population.

(2)Facemask wearing

Wearing facemask correctly in closed spaces was recommended to decrease transmission of COVID-19 viruses. There is uncertainty about the size of effects of face coverings in the package of measures for reducing transmission. Evidence from laboratory and community experiments as well as observational studies justifies the use of facemas.[19,20,21] Mask wearing may encourage people to neglect other preventive measures and increases the risks for transmission and reduces its benefits.[22] It is recommended to wear facemasks with other preventive measures because their minimal risks and substantial effects.[23]

(3)Social distancing and avoiding physical contact

Social or physical distancing from others cut the chain of transmission of infectious diseases including COVD-19.[24] The distance specified to be six feet (about two meters) at least.[25] Physical distancing includes shielding and avoiding gatherings and crowd, shaking hands, hugging and kissing.[26] Early social distancing has substantial impact on the number of infected individuals and deaths by COVID-19 and is dependent upon demographic, environmental, behavioral and economic dimensions.[27]

(4)Lockdown (mobility limitation)/ quarantine

The lockdown, quarantine and mobility restrictions are special types of social distancing enforced by governments to halt the COVID-19 pandemic. These include closure of non-vital services and retail shops as well as precautionary measures at work and in educational settings.[28]

Many studies concluded that the pandemic can be curbed by lockdown in different countries.[29,30,31] Furthermore, some scholars postulated that lockdown affects the environment, people's psychology, and economy.[29] Some studies reported no effect of lockdown on morbidity and mortality of COVID-19 and recommended the economy-friendly relaxed control measures to prevent the adverse effect on mental health and quality of life associated with lockdown fatigue and increased mortality from other causes e.g., myocardial infarction, suicide, and stroke.[32,33]

For lockdown to be effective it should be applied in a large scale and very early in the pandemic associated with other control measures after assurance of people's solidarity as well as adherence to the necessary changes through information, education and communication (IEC).[32,34] Cost-benefit analysis should be considered before enforcing lockdown for future pandemic.[35]

(5)Personal hygiene and use of sanitizers

During the COVID-19 pandemic, personal hygiene and sanitizers use were advocated and promoted to prevent the spread of infection together with other measures.[36] These included thorough cleaning of hands either with 60% alcohol-based rub or soap and water, cover mouth and nose by a tissue when coughing or sneezing, dispose tissue into closed pin, and disinfect regularly touched surfaces e.g., door handles, phone screens and faucets.[37,38,39] The challenges of these measures in developing countries are high population density, low hand washing facilities, air pollution, lack of access to clean water as well as limited personal protective equipment. The correct and sound use of disinfectants and sanitizers is important to avoid their adverse effects on the humans, animals, and environment.[40,41]

Table 1. Summary of risk compensation in different COVID-19 preventive measures.

Author & Year	Study design	Country/ setting	Population	Protective measure	Effect on other measures	Risk compensation
Chen et al. [42]	Cross-section	China, hospital	544 COVID-19 inpatients grade III	Vaccination	More hand-washing & mask wearing after vaccination than prior to it. -Significant lower % of wearing masks and hand washing in non-vaccinated group	No
Hall et al. [8]	Cross-section	Canada	1958 general population		Vaccinated are more likely to perform distancing, mask wearing and hand hygiene than unvaccinated.	No
Yang et al. [43]	Online survey	China	602 travellers		No significant differences in hand washing and mask wearing among travellers. These measures partly improved among vaccinated.	No
Hale et al. [44]	Cross-section	12 European countries	754 (2 periods) Oxford COVID-19 Government Response Tracker		No reduction in distancing or mask use	No
Wambua et al. [45]	Cross-section	16 European countries	29292 general population		More social contacts	Yes
Desrichard et al. [16]	Longitudinal study	UK	765 general population		14 precautionary measures	No
Wright et al. [46]	Longitudinal study	UK	70,000 adults		General precautionary measures & social distancing	No
Hwang et al. [47]	Panel data + cross-section	South Korea	Daily vaccines, credit cards, airline companies, survey (4980 subjects)		Shopping, travel & socialization	No
Agrawal et al. [48]	National panel data	USA	122,405 observations		Mask, hand washing, avoiding crowds and restaurants	No
Oliver et al. [49]	Observational cross-section	USA	2,068 general population	Facemask	Social distancing	No
Seres et al. [50]	Randomized field experiment	Germany	Joining lines in front of stores		Social distancing	No
Aranguren et al. [51]	Field experiment	France	>4500 real-life interaction		Distancing	Yes
Kovacs et al. [52]	Ecologic study	Germany	geo-located smartphone data.		Social mobility	Yes
Luckman et al. [7]	Two online scenarios	UK	401 & 400 general population		Participants would stand, sit, or walk closer to the stranger if either of them was wearing a mask.	Yes
Wadud et al. [53]	Record-based	Bangladesh.	Daily mobility & COVID-19 cases records		Significant increases in community mobility and decreases in stay at home associated with increases in new COVID-19 cases.	Yes
Jorgensen et al. [54]	Quasi-experimental	Denmark	106,880 General population		Decrease in close contact. No effect on hygiene	Yes (close contact) No (hygiene)
Yan et al. [55]	Quasi-experimental	USA	Daily SafeGraph smart device location data and variation in the date of face mask mandates		Less time at homes and more visits to high-risk location	Yes
Aranguren [56]	Cross-section observational	France (Paris)	1396 & 1326 pediasterns (2 waves)		Men: less distancing Women: distancing in one wave	Yes (men) No (women)
Guenther et al. [57]	Cross-section	UK	1254 general population	Lockdown	Increase mask use & distancing	No
Henk et al. [58]	Longitudinal	Germany	989 general population	Quarantine & face masks	Less distancing	Yes

Table 1 summarizes the risk compensation of each preventive measure on the other measures in different studies. Twinety studies explored risk compensation. It is clear that the majority of studies are cross-sectional in design (50%; 10 out of 20) done in general population of Europe, USA and Canada (80%; 16 out of 20); three are longitudinal, two quasi-experimental and only one field trial. Risk compensation was studied mostly for vaccination (50%; 10 out of 20) and facemask (50%; 10 out of 20) as these are the most commonly adopted measures. Risk compensation behavior was reported in 40% (8 out of 20) of studies retrieved. Few studies were done in developing countries (25%, 5 out of 20) where the situation may be worse than developed countries.[42,43,47,53]

Effects of risk compensation

Risk compensation phenomenon reverses the benefits of different COVID-19 preventive measures, especially if each intervention is not sufficiently effective when used alone in real life or among high-risk groups. Witnessing someone else taking a precaution could potentially increases one's possibility of taking a risk e.g., who have not received a COVID-19 vaccine may, consciously or subconsciously, neglect facemasks and distancing as long as others received the vaccine. This could be potentially disastrous resulting in a higher disease burden.[59]

How to overcome risk compensation?

For counteracting and neutralizing the false believe leading to risk compensation it is important to recognize and be aware of its existence in the community. Public campaign of IEC (information, education and communication) should be carried out by the mass media, government and medical personnel to reinforce all preventive measures to be tackled as a single package.[60] The public health messages should be clear, reliable, straightforward, and feasible.

Risk compensation in COVID-19 varies from population to another and within different strata of the same population depending on risk perception and level of adherence with public health measures.[15] Counteracting the widespread misinformation (infodemic) should be a component of COVID-19 control program.

Limitations and biases

A limitation of this narrative review is the contradictory findings regarding risk compensation during the COVID-19 pandemic in the included studies. There is no standardization of research designs, most of them are descriptive in nature with self-reported answers that introduce recall bias and/or social desirability impage. Also studies were done on different populations and different dates.

CONCLUSION

This brief narrative review revealed that several amounts and types of risk compensation have occurred in response to some preventive measures but not in reaction to others. Studies showed conflicting results and no definite conclusion can be drawn.

Alertness of risk compensation counteracts the false believes and practices. It is important to implement all preventive measures as a single package to augment each other including vaccination, facemask wearing, physical and social distancing and sanitizers use.

Risk compensation is more likely to be reported in observational rather than experimental studies with conflicting results and higher risk of bias. There is a need for social and behavioral longitudinal research, especially in developing countries, to map risk compensation types and at high-risk groups to tackle this phenomenon as COVID-19 is still existing.

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SYSTEMATIC REVIEWS AND META ANALYSIS

Effect of mediterranean diet on breast cancer: meta-analysis

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Abstract

Objective: In this meta-analysis, we have assessed the effects of Mediterranean Diet on breast cancer.

Methods: Case-control and cross-sectional studies were searched using PubMED, SpringerLink, and Taylor & Francis databases for inclusion in the meta-analysis. We confined our search to the studies conducted and published after year 2000. From all the included studies, geography, sample size, study design, study evaluation method, outcome, risk factors (lowest and highest limit and OR values), and 95% confidence interval data were extracted. Eleven studies with 26361 participants were included of which 10 were case-control studies and 1 was cross-sectional study.

Results: Following the analysis according to the random effects model, it was observed that compliance with the Mediterranean Diet or the high consumption amount of olive oil, seafood, whole grains, vegetables, and fruits in the Mediterranean Diet has a positive effect on breast cancer. The effect size was found to be OR 0.77 (0.68-0.88).

Conclusion: This meta-analysis, including the studies evaluating the effect of Mediterranean diet on breast cancer, concluded that the Mediterranean Diet has positive effects on breast cancer. The risk of breast cancer was found to be decreased with the increased compliance of the Mediterranean Diet.

Keywords: Breast Cancer, Cross-Sectional Study, Mediterranean Diet

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INTRODUCTION

Breast cancer is the second leading cause of death worldwide and is the most common cancer among women[1]. It accounts for over 2 million cases each year[2]. Breast cancer has multifactorial etiology which includes several factors such as age, genetic factors, hormonal factors, family history, use of alcohol, use of tobacco, obesity and physical inactivity[3,4]. Breast cancer cases are less observed in women of younger age and more in women of older age. Incidences of breast cancer have been found to sharply increase within the age group of 45 to 50[4].

Studies have shown that highest rate of breast cancer were observed in USA, and Northern Europe and lowest in Asia. Racial and ethnic differences also have an impact on the breast cancer incidences[5]. High incidences of breast cancer were observed in Caucasians than African Americans in women above the age of 50 years[6]. Family history has also been considered as an important risk factor for breast cancer but overall, less than 10% of all breast cancers have been found to be associated with inherited genetic mutations[7]. Hormonal factors such as increased level of estrogen hormone, post-menopausal hormonal therapy, birth control pills, fertility medications and increased levels of testosterone hormone in women have been strongly associated with risk of breast cancer[8].

Association of diet with breast cancer has been studied widely keeping in consideration food groups, single food and nutrients along with their effect on the survival of the patients[9]. The studies which have focused on the effect of individual foods and nutrients on the survival in cancer patients were able to provide restricted information on the effect of diet as they did not study interaction between the particular nutrient and other constituents of the diet. Therefore, regardless of many studies, the findings related to single nutrient or individual food have not given complete information on role of dietary pattern in the etiology of breast cancer. While it has been directly related to alcohol use[10,11], the evidence determined about some specific food and food groups is still controversial[12,13].

To overcome, the above said issues, it has been suggested to evaluate the effect of complete dietary patterns which are a combination of specific nutritional indicators on breast cancer. It would be helpful to therefore understand which dietary style in total could have a better effect on breast cancer survival. One such dietary pattern is Mediterranean diet which is considered to be a healthy dietary pattern. Mediterranean diet, which means “diaita” in Greek, meaning “lifestyle” includes high consumption of olive oil, olives, whole grains, vegetables and fruits, oil seeds, legumes and fish; with medium eggs, poultry and dairy products. It is a diet characterized by low levels of red meat and meat products. The Mediterranean diet, introduced by Ancel Keys in the 1960s, is one of the most widely researched and well-known dietary patterns worldwide. The traditional Mediterranean diet has its origins in the civilisations surrounding the Mediterranean Sea. This dietary pattern is therefore closely associated with the social behaviour and lifestyles of the Mediterranean region. The Mediterranean diet has been recognised as an ‘intangible cultural heritage of humanity’ by the United Nations Educational, Scientific and Cultural Organisation because it is deeply rooted in its geographical origins, has positive effects on health and has protective effects on the environment. Since the 1960s, increasing evidence has demonstrated the potential

positive effects of the Mediterranean diet on health[14].

The Mediterranean diet has been found to have a protective effect on breast cancer because of the nature of its constituents. It is rich in antioxidants, carotenoids, vitamins, flavonoids, squalene found in extra virgin olive oil and dietary fiber. This diet model prevents DNA damage by decreasing endogenous estrogen level[15], increasing sex hormone binding globulin levels[16], and showing a positive response to the harmful effects of free radicals[17,18]. Various studies have shown that this dietary pattern can reduce the risk of breast cancer by reducing the oxidative risk[19,20].

Worldwide, breast cancer incidences differ drastically from each other[21]. Due to lack of evidence-based studies, the association between the Mediterranean diet and breast cancer is still under debate. According to the EPIC (European Prospective Investigation into Cancer) study, when the effects of the Mediterranean diet was examined on all types of cancer, it showed protective effect against various types of cancer, especially breast cancer[22].

Another important study, PREDIMED randomized study, showed that the Mediterranean diet had a preventive effect against breast cancer especially on post-menopausal breast cancer. This study concluded that extra virgin olive oil, which is included in the Mediterranean diet, has a very potential effect in primary prevention of breast cancer. Long-term and comprehensive studies are needed to further ascertain the positive effects of the Mediterranean diet on breast cancer[23].

Herein, we conducted a meta-analysis of available cross sectional and case control studies which have assessed the association between the adherence to a Mediterranean diet and breast cancer, in order to establish the effect of adherence to a Mediterranean diet on breast cancer.

METHOD

Literature Search Study

An electronic literature search was conducted to identify relevant studies published in English between 2000-2020 from PubMed, SpringerLink, and Taylor & Francis databases with the following keywords. "Mediterranean Diet" OR "olive oil" OR "whole grain" OR "seafood" OR "vegetable and fruit" AND "breast cancer". We did not keep the restriction of age of the participants for selecting studies for this meta-analysis. In addition, references cited in the original studies were manually searched.

Inclusion Criteria

Titles and abstracts of the publications on the relationship between the Mediterranean Diet and breast cancer incidences were reviewed. The full texts of the articles whose abstracts were found appropriate were downloaded and deemed eligible for this meta-analysis if they fulfilled the following inclusion criteria: 1-) case-control and cross-sectional studies; 2-) studies that yield results on breast cancer; 3-) Studies including Odd Ratio (OR), 95% confidence interval (CL) data; 4-) Studies after 2000.

Exclusion Criteria

Comments, reviews, cohort studies, and unpublished studies were excluded from the analysis. A total of 940 articles were found in the first search. Thirty potentially relevant articles were dropped after duplication analysis, summary and title screening, removal

of studies prior to 2000, and exclusion of non-breast cancer studies and studies with breast cancer recurrence. Nineteen of these articles were not included in the study due to the lack of appropriate statistical data. After all these exclusion criteria, a total of 11 studies were left for the meta-analysis. The articles reviewed were tagged as "Mediterranean Diet[21-24]," "olive oil[22,25]," "healthy[26,27]," "dietary pattern[28]," "whole grain[29]," "fatty fish[30]," "Western diet[31]." Healthy diet is characterized by the consumption of vegetables and fruits, seafood, poultry. The Western diet is a diet characterized by refined grains, red meat, processed meat, high-fat foods and sweets. The flow diagram of the steps of the article selection process for meta-analysis is given in Figure 1.

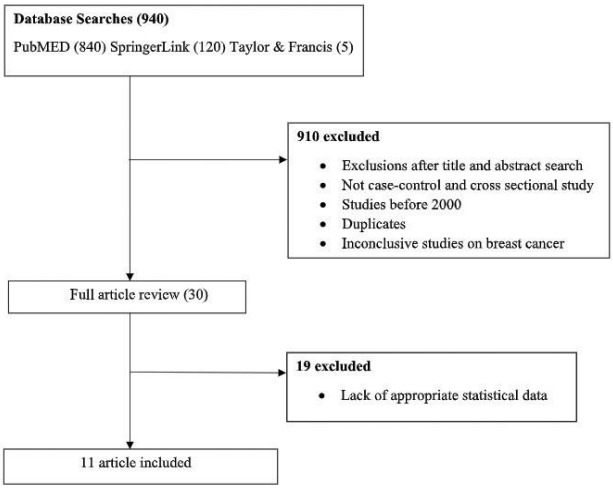

Figure 1. Flow diagram showing the steps of the article selection process for meta-analysis

Data Extraction

We extracted the following data from all the included studies; authors, year of publication, geography of the study, sample size, study design, age range of the participants, study evaluation method, outcome, risk factors (lowest and highest limit and OR values) and 95% confidence interval.

The quality of the studies included in the meta-analysis was evaluated with the Newcastle-Ottawa Scale.

Statistical Analysis

Comprehensive Meta Analysis (CMA) license software was used for the data analysis. The data of all articles meeting the inclusion criteria and decided to be included in the study was entered into the CMA program. CMA program was used to obtain the general effect sizes, forest plot, funnel plot graphics.

The heterogeneity of the articles was evaluated. Q statistics is used to calculate the effect size in meta-analysis studies, to decide on the fixed and random effect model and to measure the heterogeneity between the studies. In the analysis of the Q statistics, it is tested whether all the studies show the overall effect. As a result of the analysis, if the significance value (p) is below the critical value, it could be interpreted as not all the studies show the same effect. In this case, it can be said that there is heterogeneity between the studies[24,25]. The I^2 statistics provides information about the ratio of this heterogeneity. If the individual study results included in the meta-analysis are homogeneous, the fixed effect model is used, and in the case of heterogeneous, the random effects model is used[32].

Publication bias in the studies was examined with a funnel plot. There should be symmetry in the funnel plot, when there is no spring bias. If there is a bias in the publications included in the study, this situation causes an asymmetrical appearance in the graphic and one corner of the graphic is emptier than the other corner[26].

RESULTS

Total 940 articles were obtained from the literature search; of which, 11 articles, including a total of 26,361 participants, which evaluated the relationship between the Mediterranean Diet and breast cancer were included in the study. 10 of these articles were case-control studies and 1 article was across-sectional study. The main characteristics of these studies (type of study, participant age range, sample size, country of study, evaluation criteria and other features) have been shown in Table 1.

Table 1. General characteristics of the studies included in the meta-analysis

Author/ Year	Place	Ages of Participants	Study Type	Number of Participants	Diet Assessment Method	Assessment	Adjustment
Turati et al. 2008	Italy Switzerland	23-78	Case-Control	3034 cases 3392 controls	78-item FFQ (Food Frequency Questions)	Med Diet Score	Anthropometric measurements, smoking and alcohol consumption, family history, hormone replacement therapy (HRT) use, personal medical history, menopausal status, education, BMI, oral contraceptive use
Garcia-Arenzana et al. 2013	Spain	45-69	Cross-Sectional	3548 post and perimenopausal	117-item FFQ	Mammography	BMI, menopausal status, educational status, socioeconomic status, hormone replacement therapy, physical activity, smoking habit, alcohol consumption, mammographic density
Demetriou et al. 2012	Cyprus	40-70	Case-Control	935 cases 817 controls	32-item FFQ	MedDiet Score by Panagiotakos MedDiet Score by Martinez-Gonzalez	Level of education, marital status, BMI, physical activity status, smoking habits, alcohol consumption, family history of breast and ovarian cancer, hormone replacement therapy, age at pregnancy and menarche, gestation period, parity, breastfeeding, age at first and last pregnancy
Garcia-Segovia et al. 2006	Canary Islands	25-85	Case-Control	291 cases 464 controls	88-item FFQ		Chronic diseases, sociodemographic variables, smoking habits (age at onset, age at quitting, smoked per day, type of tobacco), alcohol consumption (amount of alcohol consumed per day, drinking patterns), physical activity, menstrual and reproductive events and nutritional beliefs, opinions and attitudes, family history of diseases,
Mourouti et al. 2014	Greece	44-68	Case-Control	250 cases 250 controls	86-item FFQ	Med Diet Score And IPAQ (International Physical Activity Questionnaire)	Educational level, financial status, BMI, physical activity, smoking habits, family history of breast and ovarian cancer, gynecological medical history (age of menopause, age of menarche, and use of hormone replacement therapy)

Table 1.(countinue) General characteristics of the studies included in the meta-analysis

Bessaoud et al. 2008	France	25-85	Case-Control	437 cases 922 controls	59-item FFQ	Healthy and Unhealthy diet model	Reproductive and menstrual factors, demographic characteristics, oral contraception, family history of cancer, hormone replacement therapy anthropometric factors, physical activities, and smoking habits.
Buck et al. 2011	Germany	50-74	Case-Control	2884 cases 5509 controls	176-item FFQ	Healthy and Unhealthy diet model	Menstrual status, demographic characteristics, hormone replacement therapy, family history of breast cancer, breastfeeding, smoking, and alcohol consumption, BMI
Kim et al. 2009	South Korea	25-77	Case-Control	358 cases 360 controls	103-item FFQ	IPAQ MET (metabolic equivalent of task)	Demographics and lifestyle factors (alcohol consumption, smoking habits, and physical activity), age at menarche, age at menopause, menopause status, menopausal status, postmenopausal hormone use
Zhang et al. 2010	China	25-70	Case-Control	438 cases 438 controls	81-item FFQ	Healthy and Unhealthy diet model	Sociodemographic characteristics, weight, height, BMI, menstrual and reproductive history, menopausal status, use of contraceptive drugs, use of exogenous hormones, history of benign breast disease, family history of breast cancer, physical activity, smoking habits, alcohol consumption, and prior disease history.
Mourouti et al. 2015	Greece	44-68	Case-Control	250 cases 250 controls	86-item FFQ	Med Diet Score IPAQ	Educational level, BMI, smoking habits, physical activity, alcohol consumption, family history of breast cancer, gynecological medical history, hormone replacement therapy
Castelló et al. 2014	Spain	Women of similar age (± 5)	Case-Control	1017 cases 1017 controls	117-item FFQ	aMED (alternate Mediterranean Diet) AHEI (Alternative Healthy Index)	Demographic characteristics and anthropometric characteristics, personal and family history of breast cancer, physical activity and diet, smoking habits, alcohol consumption

The age range of the study participants varied between 23 and 85 years. Four of the studies were conducted among post- and perimenopausal women. Studies had been conducted in Italy, Spain, Cyprus, Greece, Canary Islands, France, Germany, South Korea and China.

MedDiet Score was used in 5 of the studies and adherence to the Mediterranean Diet was evaluated. Alternative assessment methods were used in other studies. Food frequency questionnaires were used to evaluate the dietary patterns of the participants. The International Physical Activity Questionnaire (IPAQ) was used to evaluate their physical activity.

When the heterogeneity test results were examined, it was observed that the effect sizes of the studies included in the meta-analysis were heterogeneously distributed and the heterogeneity was high (Q: 56 I^2: 82).

While the part indicated in the form of black squares next to each study in the forest chart

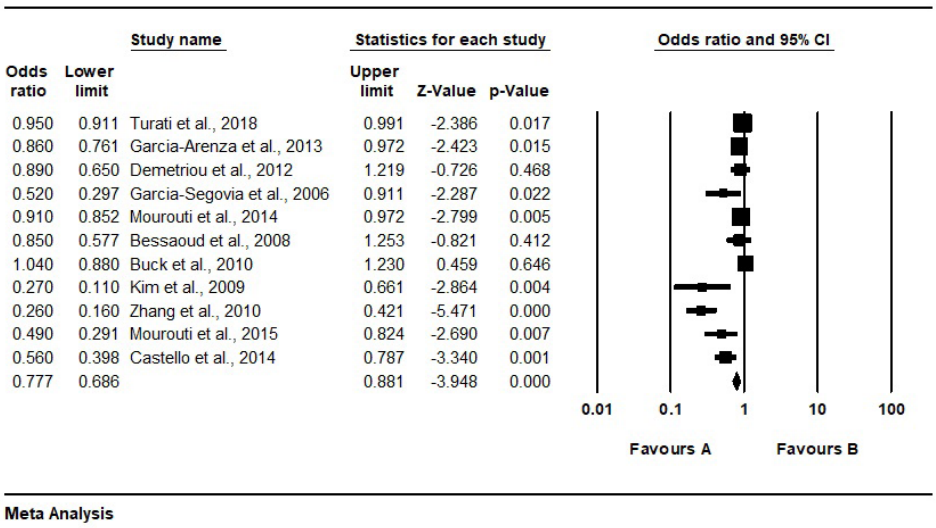

Figure 2. Forest chart showing the effect sizes of the studies

used in meta-analysis indicated the effect size of that study in the present meta-analysis, the lines on both sides of the black square indicated that the effect size of that study was in the 95% confidence interval. The rhombus at the bottom of all the squares showed the overall effect size of all the studies. In meta-analysis studies, a general conclusion is reached based on the effect size of each study. Eleven studies conducted to examine the effect of the Mediterranean Diet on breast cancer were included in the meta-analysis and the effect sizes for all the included studies were calculated and the overall effect size was reached.

As seen in Figure 2, as a result of the analysis made according to the random effects model, it was observed that compliance with the Mediterranean Diet or the high consumption amount of olive oil, seafood, whole grains, vegetables and fruits in the Mediterranean Diet had a positive effect on breast cancer. Moreover, it could be stated that the incidences of breast cancer were lower in women who were on this diet. The effect size of the Mediterranean Diet on breast cancer was found to be OR 0.77 (0.68-0.88).

The funnel plot that gives information about whether there is publication bias in the studies included in the meta-analysis has been shown in Figure 3. As evident from the funnel plot in the figure, 6 of the studies included in meta-analysis were between the axis and 4 were outside the axis. Accordingly, it was determined that 4 studies did not have an effect size, yet a significant number of other studies were at a level to contribute to the effect size. When the funnel plot was examined, it was seen that the effect sizes of the studies included in the meta-analysis had been distributed close to symmetry. Therefore, it could be inferred that there was no publication bias in the study.

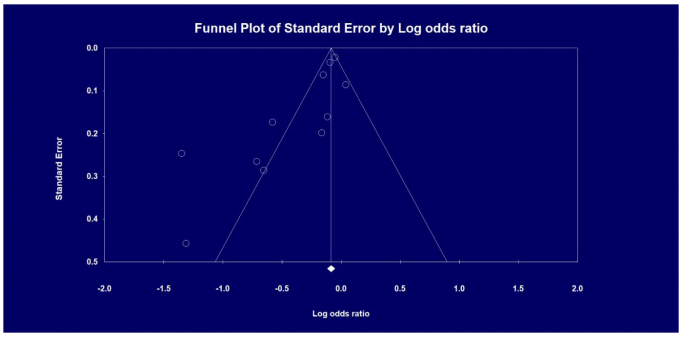

Figure 3. Funnel plot showing publications bias in CMA program

DISCUSSION

Various studies have been conducted to investigate the association between Mediterranean diet and breast cancer in last decade[16,23,27,29] which included retrospective case-control studies, prospective cohort studies as well as cross-sectional studies. However, till date, there is no precise conclusion regarding the association of Mediterranean diet in reducing the risk of breast cancer. Our present meta-analysis included 11 studies based on inclusion and exclusion criteria, which were focused on the association of Mediterranean diet and breast cancer published since year, 2000. We had found strong evidence for high heterogeneity among the studies used for this meta-analysis, therefore we used random-effects model in this study to calculate RR and maintaining the stability of the results.

In this meta-analysis study, 11 effect sizes belonging to 11 studies were calculated. While a statistically significant difference was found in 10 studies, no significant difference was found in 1 study. This study aimed to examine the effect of the Mediterranean Diet and the consumption of olive oil, fish, whole grains, vegetables and fruits, which are the basic foods of the Mediterranean Diet, on breast cancer and breast density with meta-analysis method

As per the analysis conducted in this data based on available literature, it was concluded that the Mediterranean Diet reduced the risk of breast cancer, and the incidence of breast cancer in women decreased with the increase in compliance with the Mediterranean Diet [OR 0.77 (0.68-0.88)]. In line to our findings, a case-control study conducted in Italy and Switzerland, which evaluated the effect of Mediterranean diet on breast cancer using MedDiet Score, it was found that the highest adherence score to the Mediterranean Diet was associated with lower breast cancer[31]. These results were also consistent with a previously conducted meta-analysis wherein it was shown that adhering to Mediterranean diet reduced the risk, incidences and mortality related to many types of cancer, including breast cancer[33]. A stratification analysis conducted by menopausal age showed that a significant inverse association between the risk of breast cancer and Mediterranean Diet[22].

The consumption of olive oil, which protects against many diseases, especially cardiovascular diseases with its monounsaturated fatty acids, is quite high in the Mediterranean Diet and is basically the main source of fat. It contains abundance of Oleic acid. Oleic acid is known to suppress the overexpression of oncogene HER2 and thereby promote the apoptotic death in

tumor cells[34]. This suggests that olive oil used in Mediterranean diet could have a positive impact on breast cancer suppression. In a study on olive oil, the relationship between olive oil consumption and mammographic breast density was investigated, and it was reported that the prevalence of breast density decreased with high olive oil consumption [OR 0.86 (0.76-0.96)][35]. Since high mammographic breast density is one of the major risk factors associated with breast cancer, reduced breast density after olive oil consumption indicates that it could modulate mammographic breast density which is an important risk bio-marker for breast cancer. Few other studies also supported that olive oil has a protective role on breast cancer [OR 0.52 (0.30-0.92)][36]. In a meta-analysis study, wherein relationship between olive oil intake and breast cancer was evaluated, it was found that there might be an inverse relationship between olive oil intake and breast cancer[37]. However, more extensive studies with long-term follow up are needed to ascertain these findings.

Fish, an example of good quality protein, is one of the frequently consumed foods in the Mediterranean Diet. Some epidemiological studies and meta-analyses have indicated that ω-3 fatty acid supplementation has positive effects on various cancers[38,39]. In a study investigating the risk of breast cancer with fish consumption, it was shown that w-3 fatty acids were inversely related to postmenopausal breast cancer [OR 0.27 (0.11-0.66)][40]. The anti-carcinogenic potential of fish and other seafoods is mainly due to the presence of n-3 polyunsaturated fatty acid which acts by inhibiting the transformation of arachidonic acid into eicosanoids, thereby regulating signaling for cell growth[38]. This further proves the importance of another component of Mediterranean diet in reducing the risk of breast cancer.

Whole grains included as the basic foods of the Mediterranean Diet have low glycemic index, increased satiety, rich fiber content, and contain phytochemicals and are found to be protective against cardiovascular diseases. In a study investigating the relationship of whole grain consumption with breast cancer risk, whole grain consumption was found to be associated with lower breast cancer risk [OR 0.49 (0.29-0.82)][41].

The Western Diet is characterized by the consumption of high calorie, high protein and high fat foods. It is very low in fiber and usually contains fried foods. A study compared the western diet style with the Mediterranean Diet, and it was observed that the compliance with the Western Diet was associated with a high risk of breast cancer [OR 1.46 (1.06-2.01)], and compliance with the Mediterranean Diet was associated with a lower risk of breast cancer [OR 0.56 (0.40-0.79)][42]. Likewise, in another study investigating the effect of the Mediterranean and Western Diet on breast density, women who were highly dependent on Western diet had higher breast density than those with low breast density [OR 1.25 (1.03-1.52)], but this study did not find any significant association between the Mediterranean Diet and breast cancer risk [OR 0.99 (0.81-1.21)][43].

Although many studies found a relationship between the Mediterranean diet and low breast cancer risk, and Western diet and high breast cancer risk, there are some studies which did not show this effect. In a study, it was reported that both the Healthy diet [OR 1.04 (0.88-1.23)] including the Mediterranean Diet components and the Unhealthy diet [0.96

(0.81-1.13)] models containing the Western Diet components had no relationship with the breast cancer[44]. Similar result was obtained in a meta-analysis with cohort studies. In this study, it was stated that there was no relationship between the adherence to the Mediterranean Diet and the incidence of breast cancer [RR 1.01 (95% CI, 0.88-1.16)][45].

It has been observed in a study that the risk of breast cancer increases by 56% for each additional 100g / day red meat consumption[45]. Reduced consumption of red meat in Mediterranean diet could also be one of the contributory factors for the anti-carcinogenic effect of this diet. Red meat serves as a source of few known mutagenic compounds like heterocyclic amines which have a relationship with the etiology of breast cancer[11,46].

Various other studies supported the finding of our study. In a study examining the relationship between nutrition and breast cancer among Korean women, it was reported that high intake of vegetables and seafood had an inverse relationship with breast cancer [OR 0.14 (0.08-0.25)][47], which are the main constituents of Mediterranean diet.

A cohort study and meta-analysis was conducted which investigated the relationship between compliance with the Mediterranean Diet and the risk of breast cancer (and estrogen / progesterone receptor subtypes, ER / PR). This Dutch Cohort study conducted research on the diet and lifestyle changes of 62,573 women for 20.3 years. It was observed in this study that there was an inverse relationship between compliance with the Mediterranean Diet and the risk of receptor-negative breast cancer[48].

In a cross-sectional study in which alcohol consumption and adherence to the Mediterranean Diet were measured and their relationship with breast density was investigated, adherence to the Mediterranean Diet and the use of multivitamin-multiminerals were inversely related to breast density and could have a protective effect against breast cancer (OR 0.53; 95% CI 0.34-0.83), whereas high alcohol consumption was reported to cause an increase in breast density (OR 1.47; 95% CI 0.82-2.63)[49].

Study Strengths and Weaknesses: One of the main strengths of this meta-analysis is that it is a systematic review of the possible effects of the Mediterranean diet on breast cancer from a large pool of studies. An important advantage, especially in terms of understanding the relationship between diet and cancer, is that it brings together different studies and provides more robust and generalisable results. However, one of its weaknesses is the heterogeneity that was observed between the studies. Each of the studies analysed may have used different methods. For example, the definition of diet, the characteristics of the participants or the follow-up periods may have been different. One of the weaknesses is these methodological differences.

Study Limitations: Case-control and cross-sectional studies were screened for inclusion in the meta-analysis. PubMED, SpringerLink and Taylor & Francis databases were used. Our search was limited to studies whose publication date was after the year 2000.

CONCLUSION

Many studies have shown that olive oil, fish, whole grains, vegetables and fruits, which are the components of the Mediterranean Diet, are effective in reducing breast cancer. Thanks to these foods, fiber, antioxidants, flavonoids, vitamins, and carotenoids taken regularly in

the Mediterranean diet which can reduce excess estrogens in a natural way and neutralize free radicals. In this way, the Mediterranean diet serves as a protective factor against the risk of breast cancer. At the same time, reduced consumption of red meat and refined foods in this dietary pattern that increase the risk of breast cancer are also supporting this effect. According to the results we obtained from the meta-analysis of the studies conducted with the Mediterranean Diet and its components, it has been observed that the Mediterranean Diet has positive effects on breast cancer, and the risk of breast cancer decreases with the increase of compliance with the Mediterranean Diet.

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Ethical Declaration: This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Hurrem Sultan Hospital, Ethics Committee No: November 13, 2020-40.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Con-ceptualization, ÜD and AK; methodology, ÜD and RMK; software, RMK and ÇPF; vali-dation, RMK., ÇPF and AK; formal analysis, ÜD; investigation, AK resources, RMK and ÇPF; data curation, ÜD; writing—original draft preparation, ÜD and AK; writing—review and editing, RMK and ÇPF; visualization, ÜD; supervision, ÜD; project administration, ÜD and AK; funding acquisition, ÜD. All authors have read and agreed to the published version of the manuscript.

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LETTER TO EDITOR

Commentary: Expanding the horizons of RE-AIM framework in public health research

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Abstract

Objective: This commentary critically examines Yuliawati *et al.*'s 2024 review, "Analysis of research public health trends with the RE-AIM model and VOSviewer: A literature review," which investigates the application of the "Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM)" framework in public health research. The review highlights trends in 279 studies conducted between 2017 and 2022 and draws attention to the insufficient focus on environmental health and sanitation interventions within the RE-AIM framework. The objective is to address these gaps and propose future directions for broadening the framework's application.

Methods: The commentary evaluates the methodology used by Yuliawati *et al.*, with particular attention to their utilization of the VOSviewer tool to map trends in RE-AIM-based research. It also explores the identified research gaps and incorporates insights from existing literature to examine the barriers that limit RE-AIM's application in environmental health and sanitation.

Results: Yuliawati *et al.*'s review demonstrates growing interest in the RE-AIM framework, but points out a notable deficiency in its application to environmental health and sanitation interventions. This commentary identifies potential reasons for this gap, such as limited interdisciplinary collaboration and resource constraints, and suggests that addressing these challenges could improve RE-AIM's effectiveness in these fields.

Conclusion: This commentary advocates for future research to overcome the barriers to RE-AIM's application in environmental health and sanitation. It emphasizes the importance of interdisciplinary approaches and the need for a more adaptable framework to evaluate complex, multi-faceted public health challenges.

Keywords: Public Health Research, Implementation Science, Longitudinal Data, Environmental Health

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ANALYSIS OF RESEARCH PUBLIC HEALTH TRENDS WITH THE RE-AIM MODEL AND VOSVIEWER: A LITERATURE REVIEW

Yuliawati *et al*. 's 2024 review article, "Analysis research public health trends with the RE-AIM model and VOSviewer: A literature review," offers a comprehensive examination of the application of the RE-AIM framework in public health research.[1] "Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM)" is a framework used to evaluate health interventions based on five key dimensions. It aims to assess their impact on health outcomes while also considering scalability, sustainability, and real-world applicability to determine the broader effectiveness and potential of health programs in diverse settings.[2,3] VOSviewer https://www.vosviewer. com/ is a free computer program designed for constructing and visualizing bibliometric maps, with a focus on the graphical representation and easy interpretation of large maps.[4] Through the application of the VOSviewer tool for bibliometric analysis, the authors have identified trends across 279 RE-AIM-based studies published between 2017 and 2022. The review focuses particularly on the lack of research at the intersection of environmental health, sanitation, and the RE-AIM framework, highlighting gaps that open avenues for future exploration. Although their findings are insightful, there are several opportunities to expand on the challenges and potential solutions to integrating RE-AIM into underrepresented areas like environmental health.

The core strength of Yuliawati *et al*. 's review article lies in the application of the VOSviewer tool to visualize public health research trends using RE-AIM. This tool has allowed the authors to categorize and map research articles, offering a clear representation of active research areas and under-explored topics, particularly those related to environmental health and sanitation. The review effectively identifies a clear gap in the application of RE-AIM in sanitation and environmental health interventions, a topic that has not seen much scholarly attention in recent years.[1] As emphasized in a 2019 publication, understanding the reach and sustainability of interventions within these domains requires careful consideration of factors such as community engagement and resource limitations, which are often overlooked by conventional research methodologies.[5] The authors' analysis additionally confirms the growing interest in RE-AIM across public health research. This finding resonates with the increasing emphasis on evaluating not only the efficacy of public health interventions but also their real-world applicability and sustainability across diverse settings.[6] The utility of the framework in assessing the broad and long-term impact of public health interventions is emphasized, especially in terms of scalability and adaptability to different populations.

The limitations and areas for further exploration identified in the current article include the insufficient research on environmental health and sanitation using the RE-AIM framework. This commentary posits that the review would be enhanced by a more comprehensive analysis of the barriers contributing to the existing gap. The authors acknowledge the scarcity of studies in these areas, though further exploration of the underlying reasons for this underrepresentation would provide valuable insight. Factors such

as interdisciplinary collaboration or the lack thereof may contribute to the limited application of RE-AIM in environmental health. As noted in the context of the use of the RE-AIM framework to guide iterative adaptations, addressing complex health challenges requires not only a framework for planning and evaluation but also close collaboration with key implementation partners, including health care providers, local stakeholders, and community representatives, to inform data-driven decisions and ensure successful adaptations throughout program implementation.[2] The absence of such collaborations might explain why interventions in sanitation and environmental health are often complex, multifaceted, and harder to evaluate using traditional public health frameworks. While Yuliawati *et al*.'s review suggests that sanitation and environmental health are underresearched in relation to RE-AIM[1], it would be beneficial to explore the structural challenges that may hinder their effective evaluation. Data availability, for example, may pose a significant barrier, as collecting comprehensive, longitudinal data on the effectiveness of sanitation interventions in diverse contexts can be both costly and time-consuming. The difficulty in measuring long-term impacts, such as improvements in community health over several years, poses an additional challenge to studies using RE-AIM's "Maintenance" dimension. A 2021 publication addressed 13 specific areas where misconceptions have arisen regarding the use of RE-AIM and provided a summary of current guidance on these issues. As emphasized in the evolution of the RE-AIM framework, many implementation science models and frameworks, including RE-AIM, have advanced, been misunderstood, and at times, been misapplied. While some degree of this is inevitable, concrete actions were suggested that reviewers, framework developers, and those selecting or applying frameworks can take to prevent or mitigate these challenges, fostering more accurate and effective use in the future.[3] In light of these ongoing challenges and the need for continued refinement, the 2024 review could also explore ways in which RE-AIM can be adapted to address the unique characteristics of environmental health interventions. Unlike clinical or behavior-based public health interventions, environmental health initiatives often involve multilevel impacts that span across communities, institutions, and ecosystems. As highlighted in 2019, there persists a critical need to adapt the RE-AIM framework to better account for these extensive and interconnected influences.[5] This could involve a more thorough application of the framework, focusing on how environmental health interventions engage various stakeholders, including local governments, health care providers, and community-based organizations.

A call for future research emphasizes the need to prioritize the integration of the RE-AIM framework into environmental health and sanitation studies, as suggested by Yuliawati *et al*..[1] Given the growing significance of these areas, particularly in the context of global health challenges such as water sanitation and climate change, more targeted research is essential to understand how RE-AIM can be effectively applied in low-resource settings. Investigating the "Reach" and "Effectiveness" dimensions of sanitation interventions could yield valuable insights into the factors influencing their adoption and success in

resource-poor communities. Understanding how local populations perceive and engage with these interventions could also help tailor them to meet specific community needs, thereby enhancing their long-term sustainability. An additional critical aspect is the exploration of the role of the RE-AIM framework in evaluating the long-term "Maintenance" of environmental health interventions. As noted in 2022, Iterative RE-AIM has proven feasible in diverse projects, but key questions remain about its strengths, limitations, and effectiveness. To address these, future research should focus on optimizing its frequency, improving data for adaptation decisions, enhancing health equity, and determining the most cost-effective facilitation approach.[2] Research could additionally explore how RE-AIM can be adapted to capture complex, long-term processes, and assess the ongoing effectiveness and feasibility of interventions in various contexts. A particularly exciting avenue for future research involves the potential for interdisciplinary approaches that integrate environmental health, social sciences, and public health. Such collaboration could provide a more holistic framework for evaluating sanitation interventions and understanding how factors like cultural norms, social capital, and local governance structures impact their effectiveness. This approach would align well with the goals of RE-AIM, as it would allow for a more complete assessment of how interventions operate across multiple levels and stakeholders.

This commentary article, in conclusion, remarks that Yuliawati *et al*. 's review article is a timely contribution to the literature on the RE-AIM framework and its application in public health research. Their findings call attention to the growing interest in RE-AIM and its importance in evaluating public health interventions, particularly with regard to ensuring their sustainability and impact over time 1. The review would be further enhanced by exploring the barriers to the application of the RE-AIM framework in underexplored areas, such as environmental health and sanitation, and by providing practical recommendations to overcome these challenges. This would add considerable value to the literature and offer actionable insights for advancing the framework's utility in these critical domains. The authors of the review article could significantly advance future research and enhance the applicability of the RE-AIM framework to complex, multi-level public health challenges by addressing the areas outlined in the present commentary. As the global community faces increasing challenges in sanitation and environmental health, expanding the use of RE-AIM to assess these interventions will be critical for developing effective, scalable, and sustainable solutions. Future research in this area will build on the foundation laid by Yuliawati *et al*., providing valuable insights into how RE-AIM can be tailored to better assess and improve interventions in sanitation and environmental health.

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such as paragraphing, formatting, section partitioning, standardizing the reference list, finding synonyms no more than ten words, and correcting inadvertent typographical errors.

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