ISSN (Online) 3008-1467
ISSN (Print) 3008-1459

Libyan Journal of Public Health Practices

Volume 2. Number 1. (June) 2025

LJPHP

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Libyan Journal of Public Health Practices (LJPHP)

Journal homepage:https://journals.uob.edu.ly/LJPHP/index

ISSN (Online) 3008-1467

Research Article

Prevalence of Anxiety, Depression, and Stress Among Medical Students at the University of Benghazi

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ARTICLE INFO

Article history:
Received 30/9/2024
Revised 2/10/2024
Accepted 24/2/2025,
Available online June,2025

Keywords:
Anxiety
Depression
Stress
University Students
Medical Colleges

ABSTRACT

Anxiety, depression, and stress are significant indicators of student's mental health issues, and experiencing these symptoms can have a serious impact on individuals' well-being. This study aimed to assess the prevalence of anxiety, depression, and stress among medical students at the University of Benghazi in Libya. A cross-sectional study was conducted, using a web-based DASS-21 scale for data collection. The study included a sample of 741 medical college students, with 73.1% identifying as female and 26.9% as male. The findings revealed that 58.2% of females reported extremely severe anxiety, followed by 41.3% for stress and 40.5% for depression. Among males, 17.4% reported extremely severe anxiety, 14.0% reported depression, and 12.8% reported stress. In terms of age groups, the 19–21-year-old group had the highest rates of depression at 8.4%, followed by 13.5% and 8.9% for anxiety and stress, respectively. The 22–24 years old group had the highest rates of depression at 29.7%, anxiety at 38.9%, and stress at 28.6%. The study revealed that anxiety was more prevalent than both depression and stress among students aged 25 and older. Furthermore, the study investigated the factors contributing to these psychological issues and identified academic pressure, exhaustion, and poor time management as the primary causes of mental problems among students.

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1. Introduction

Almost everyone experiences stress, anxiety, and depression to some extent, and college students are certainly no exception as they make up a considerable portion of society [(1)]. The university years are a critical stage of development, during which most lifelong mental disorders tend to emerge. [2]. Numerous studies demonstrated that attending university is associated with a higher incidence of severe mental health issues and psychological disorders such as depression, anxiety, and stress, compared to the general population [3]. Thus, recognizing the signs of depression, anxiety, and stress is critical for maintaining good mental health, and failing to identify or promptly address these symptoms can have a detrimental impact on an individual [4]. Many college students report experiencing varying degrees of these challenges throughout their time in college for a variety of reasons. This is especially true for medical college students who face various of challenges and pressures during their academic journey. These pressures include a heavy academic workload, anxieties about exams, long work hours, a shortage of leisure time, intense competition, worries about meeting parental expectations, and financial strain [5,6]. Furthermore , depressive disorders and anxiety rank among the primary contributors to the global burden of disease and disability [7]. the existing body of literature on mental health issues indicates that students are under pressure to be ready for the challenges and increased responsibilities in the academic and social aspects of their lives. The prevalence and frequency of these issues vary across the globe due to various factors. Currently, mental health problems are considered a significant public health concern, contributing to one-third of disability worldwide [8]. The American Psychological Association notes that anxiety and depression are emotional responses that result in a similar range of symptoms. These symptoms include irritability, difficulty sleeping, muscle tension, and fatigue [6,7]. The Department of Health, Social Services and Public Safety highlighted that mental health refers to the psychological and spiritual resilience that enables individuals to manage everyday stress and enjoy life [9]. It is important to prioritize the mental health and positive social and emotional well-being of college students. These are not merely important in their own right, but also crucial to their physical health and academic success. “They play a crucial role in their overall well-being, academic performance, and competence throughout their lives” [10]. Mental health status is connected to behavioral patterns at all stages of life. Therefore, maintaining good mental health can help shield adolescents from engaging in risky behaviors such as substance abuse, crime, suicide, violence, and other behavioral problems [11]. Based on the above, this study aimed to estimate the prevalence of anxiety, depression, and stress among medical college students at the University of Benghazi, and identify the main underlying factors associated with these psychological issues. Therefore the research questions are:

1. What is the overall prevalence of depression, anxiety, and stress among students of medical colleges at the University of Benghazi?
2. What are the underlying factors causing anxiety, depression, and stress?

2. Methodology

2.1. Study design:

A descriptive cross-sectional web questionnaire-based study was conducted from February to May 2024. The study involved a voluntary sample of 741 students from the faculties of medicine, dentistry, pharmacy, public health, and biomedical sciences at the University of Benghazi, representing all academic years. Among the participants, 73.1% were female and 26.9% were male. Most students were between the ages of 22 and 24, and 34.0% were in their third year of study.

2.2. Data collection tool:

The study used Google Forms as an electronic tool to collect demographic data and other related information from the participants.. A pretested demographic questionnaire was used along with an Arabic

translation of the DASS-21, an instrument developed by researchers Lovibond and Lovibond. The Depression Anxiety Stress Scale (DASS-21) is a self-administered instrument that comprises 21 questions evenly divided into three self-report scales, each containing seven items. These items are designed to measure levels of depression, anxiety, and stress. The DASS-21 is a widely used self-report questionnaire that assesses the severity of symptoms related to depression, anxiety, and stress. This instrument is brief and easy to use, making it an effective screening tool for various emotional disorders. Therefore, it is a valuable resource in scientific research.

The DASS-21 questionnaire employs a four-point Likert scale, where participants... indicate how much each statement reflects their experiences over the past week. The scale ranges from 0, which signifies that the statement is completely inapplicable, to 3, indicating that the statement is highly applicable. The responses are then totaled using the Lovibond scoring system to generate a final score that represents the participant's mental health status.. This score can range from "normal" to "extremely severe"[12].
Table 1 displays the Lovibond scoring guide.

Table 1: The Lovibond scoring guide

Level	Depression	Anxiety	Stress
Normal	0-9	0-7	**0-14**
Mild	10-13	8-9	**15-18**
Moderate	14-20	10-14	**19-25**
Severe	21-27	15-19	**26-33**
Extremely severe	28+	20+	**34+**

2.3. Statistical Analysis:
The Statistical Package for the Social Sciences (SPSS), specifically version 22.0, was used to analyze the collected data. Descriptive statistical methods were used to outline the participants' socio-demographic characteristics and corresponding DASS-21 responses. This included calculating frequencies (n) and percentages (%). The final values for each DASS-21 subscale were obtained by summing the scores of the relevant items and then doubling them to align with the DASS-42 scale values.

2.4. Ethical considerations:
This study was approved by the Research Ethics Committee of the Faculty of Public Health at the University of Benghazi, and the participants implicitly participated in this research as the questionnaire was distributed electronically, and all data were anonymized to maintain confidentiality. Additionally, participants were all informed about the study's objectives and importance.

3. Results

3.1. Demographic characteristics
The table (2) below provides a comprehensive summary of the demographic composition of the study's participants. The sample includes 741 individuals, with 73.1% (n = 542) being females and 26.9% (n = 199) being males. This gender imbalance indicates that most study population students are female. Additionally, 52.8% (n = 391) of the sample falls within the 22-24 age range, and 34.0% (n = 253) are third-year students. Furthermore, 41.6% (n = 308) of the participants are from the faculty of medicine.

Table 2: The Distribution of Demographical Characteristics of Participants

Variable	Count	Percent
Age		
19-21	130	%17.50
22-24	391	%52.80
25 and older	220	%29.70
Gender		
Male	199	26.90%
Female	542	%73.10
College		
Biomedical sciences	91	12.30%
Dentistry	128	%17.30
Medicine	308	%41.60
Pharmacy	86	%11.60
Public health	128	%17.30
Academic year		
First	111	14.97%
Second	138	18.62%
Third	253	34.14%
Fourth	151	20.37%
Fifth	88	11.87%

3.2.Gender and age-based variability

The data in the Table 3 shows that females scored extremely severe rates of anxiety at 79.5% (n = 431), followed by stress at 56.5% (n = 306) and depression at 55.4% (n = 300). Meanwhile, males also scored extremely severe rates of anxiety at 65.2% (n = 129), followed by depression at 52.3% (n = 104) and stress at 47.7% (n = 95).

In examining age-based variability in the DASS (Depression, Anxiety, and Stress Scale), the results for different age groups (19–21, 22–24, and 25 years and older) highlighted significant differences in the levels of depression, anxiety, and stress. For the 19–21 age group, the findings revealed that 76.9% (n = 100) experienced extremely severe anxiety, 50.8% (n = 66) reported high levels of stress, and 48.5% (n = 63) experienced high levels of depression. In contrast, the percentages were significantly higher for the age group of 22–24. Specifically, 73.8% (n = 288) exhibited extremely severe anxiety, 56.3% (n = 220) reported extremely severe depression, and 54.2% (n = 212) experienced high levels of stress.

Anxiety was significantly more prevalent than depression and stress among students aged 25 and older. In this group, 78.2% (n = 172) reported high levels of anxiety, while 55.9% (n = 123) reported high levels of stress and 55.0% (n = 121) reported high levels of depression.

Table 3: Gender and age-based variability

Level	Gender		Age		
	Male	**Female**	**19-21**	**22-24**	**25+**
	Anxiety				
Normal	24 12.1 %	15 2.8%	10 7.7%	19 4.9%	**10 4.5%**
Mild	6 3.0%	13 2.4%	4 3.1%	9 2.3%	**6 2.7%**
Moderate	24 12.1 %	36 6.6%	10 7.7%	37 9.5%	**13 5.9%**
Severe	15 7.6%	27 8.7%	6 4.6%	37 9.5%	**19 8.6%**
Extremely severe	129 65.2 %	431 79.5%	100 76.9 %	288 73.8 %	**172 78.2 %**
Total	198 100%	542 100%	130 100%	390 100%	**220 100%**
Level	**Depression**				
Normal	5 2.5%	3 .6%	2 1.5%	5 1.3%	**1 .5%**
Mild	8 4.0%	17 3.1%	4 3.1%	13 3.3%	**8 3.6%**
Moderate	40 20.1 %	106 19.6	25 19.2 %	85 21.7 %	**36 16.4 %**
Severe	42 21.1 %	116 21.4%	36 27.7 %	68 17.4 %	**54 24.5 %**
Extremely severe	104 52.3 %	300 55.4%	63 48.5 %	220 56.3 %	**121 55.0 %**
Total	199 100%	542 100%	130 100%	391 100%	**220 100%**
Level	**Stress**				
Normal	18 9.0%	7 1.3%	6 4.6%	11 2.8%	**8 3.6%**
Mild	11 5.5%	20 3.7%	4 3.1%	20 5.1%	**7 3.2%**
Moderate	24 12.1 %	57 10.5%	16 12.3 %	43 11.0 %	**22 10.0 %**
Severe	51 25.6 %	152 28.0%	38 29.2 %	105 26.9 %	**60 27.3 %**
Extremely severe	95 47.7 %	306 56.5%	66 50.8 %	212 54.2 %	**123 55.9 %**
Total	199 100%	542 100%	130 100%	391 100%	**220 100%**

3.3. The prevalence across colleges.

The study comparing the mental health of students across medical colleges at the University of Benghazi reveals alarming levels of anxiety, depression, and stress. Notably, the faculty of medicine recorded the highest rates, with 32.7% for anxiety, 25.6% for depression, and 23.8% for stress. meanwhile, colleges such as dentistry, public health, biomedical sciences, and pharmacy reported that the prevalence of severe anxiety among their students was 12.4%, 11.6%,10.5%, and 8.4% of the total, respectively. Additionally, the prevalence of depression and stress among these colleges was approximately similar. These findings demonstrate the pressing need for proactive measures to address mental health issues among students. The data summarized in Table 4, which display severity stratified by colleges

3.4. The prevalence across academic years.

The data in Table 5 highlights the levels of depression, anxiety, and stress among students across various academic years. Researchers' analysis revealed that anxiety was the most common issue among students in all academic years, with the highest prevalence of 26.2% (n = 194) among third-year students. Additionally, stress levels were higher than depression among first- and third-year students, with 19.7% stress and 19.2% depression among third-year students, and 8.0% stress and 7.7% depression among first-year students.

3.5. Overall DASS prevalence

The study found that the overall rate of anxiety was 75.6% (n = 741), which was the highest among all respondents. The levels of stress and depression were quite similar, with stress at 54.1% and depression at 54.5%, both categorized as extremely severe. Table 6 and Figure 1 present statistical data on the overall prevalence of depression, anxiety, and stress.

Table 4: DASS severity stratified by colleges (n = 741)

Variable		Biomedical sciences	Dentistry	Medicine	Pharmacy	Public health
Depression						
	Normal	0 (0.0%)	1 (0.1%)	1 (0.1%)	2 (0.3%)	**4 (0.5%)**
	Mild	1(0.1%)	7 (0.9%)	6 (0.8%)	5 (0.7%)	**6 (0.8%)**
	Moderate	18 (2.4%)	23 (3.1%)	51 (6.9%)	23 (3.1%)	**31 (4.2%)**
	Severe	15 (2.0%)	32 (4.3%)	60 (8.1%)	19 (2.6%)	**32 (4.3%)**
	Extremely severe	57 (7.7%)	65 (8.8%)	190 (25.6%)	37 (5.0%)	**55 (7.4%)**
Anxiety						
	Normal	4 (0.5%)	6 (0.8%)	15 (2.0%)	5 (0.7%)	**9 (1.2%)**
	Mild	1 (0.1%)	5 (0.7%)	6 (0.8%)	4 (0.5%)	**3 (0.4%)**
	Moderate	3 (0.4%)	12 (1.6%)	23 (3.1%)	9 (1.2%)	**13 (1.8%)**
	Severe	5 (0.7%)	13 (1.8%)	22 (3.0%)	6 (0.8%)	**16 (2.2%)**
	Extremely severe	78 (10.5%)	92 (12.4%)	242 (32.7%)	62 (8.4%)	**86 (11.6%)**
Stress						
	Normal	2 (0.3%)	5 (0.7%)	9 (1.2%)	4 (0.5%)	**5 (0.7%)**
	Mild	3 (0.4%)	3 (0.4%)	14 (1.9%)	3 (0.4%)	**8 (1.1%)**
	Moderate	6 (0.8%)	15 (2.0%)	26 (3.5%)	8 (1.1%)	**26 (3.5%)**
	Severe	23 (3.1%)	40 (5.4%)	83 (11.2%)	26 (3.5%)	**31 (4.2%)**
	Extremely severe	57 (7.7%)	65 (8.8%)	176 (23.8%)	45 (6.1%)	**58 (7.8%)**

Table 5: DASS severity stratified by academic year (n 741)

Variable	First year	Second year	Third year	Fourth year	Fifth year
Depression					
Normal	1 (0.1%)	1 (0.1%)	3 (0.4%)	2 (0.3%)	**1 (0.1%)**
Mild	3 (0.4%)	12 (1.6%)	2 (0.3%)	5 (0.7%)	**4 (0.5%)**
Moderate	23 (3.1%)	30 (4.0%)	54 (7.3%)	26 (3.5%)	**13 (1.8%)**
Severe	26 (3.5%)	29 (3.9%)	51 (6.9%)	36 (4.9%)	**16 (2.2%)**
Extremely severe	57 (7.7%)	66 (8.9%)	142 (19.2%)	82 (11.1%)	**56 (7.6%)**
Anxiety					
Normal	6 (0.8%)	9 (1.2%)	12 (1.6%)	3 (0.4%)	**8 (1.1%)**
Mild	4 (0.5%)	2 (0.3%)	7 (0.9%)	4 (0.5%)	**2 (0.3%)**
Moderate	12 (1.6%)	13 (1.8%)	24 (3.2%)	8 (1.1%)	**3 (0.4%)**
Severe	7 (0.9%)	14 (1.9%)	14 (1.9%)	16 (2.2%)	**10 (1.4%)**
Extremely severe	81 (10.9%)	100 (13.5%)	194 (26.2%)	120 (16.2%)	**64 (8.6%)**
Stress					
Normal	4 (0.5%)	3 (0.4%)	11 (1.5%)	2 (0.3%)	**4 (0.5%)**
Mild	4 (0.5%)	9 (1.2%)	6 (0.8%)	7 (0.9%)	**5 (0.7%)**
Moderate	15(2.0%)	16 (2.2%)	28 (3.8%)	11 (1.5%)	**10 (1.4%)**
Severe	28 (3.8%)	43 (5.8%)	61 (8.2%)	50 (6.7%)	**21 (2.8%)**
Extremely severe	59 (8.0%)	67 (9.0%)	146 (19.7%)	81 (10.9%)	**47 (6.3%)**

Table 6: Overall DASS severity (n = 741)

Anxiety	%	Depression	%	Stress	%
Normal	1.1%	Normal	5.3%	Normal	3.4%
Mild	3.4%	Mild	2.6%	Mild	4.2%
Moderate	19.7 %	Moderate	8.1%	Moderate	10.9 %
Severe	21.3 %	Severe	8.5%	Severe	27.4 %
Extremely severe	75.6 %	Extremely severe	54.5 %	Extremely severe	54.1 %

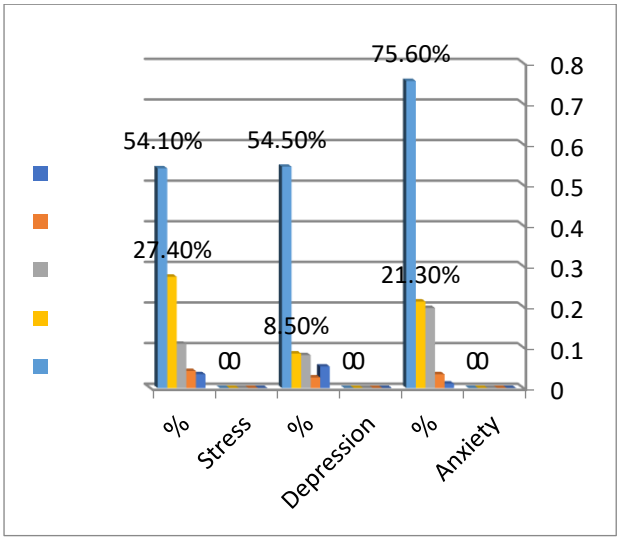

Figure 1. overall DASS severity

3.6. Possible causes of depression, anxiety, and stress:

The results from the students' responses, illustrated in Table 7, highlight potential reasons for depression, anxiety, and stress. The data shows that academic pressure was identified as the primary cause of their mental health issues, with 31.5% (n = 543) of respondents attributing it to this reason. Additionally, 21.1% (n = 364) and 14.3% (n = 247) of respondents reported exhaustion and poor time management as the most likely factors contributing to their mental health problems, respectively. However, only 1.2% (n = 20) of respondents cited personal reasons as the cause. The detailed reasons and their frequencies are provided in Table (7) and Figure (2).

Table 7: underlying reasons for depression, anxiety, and stress.

Causes of mental morbidities	Count	Percent
Poor time management	247	14.3%
High expectations from family	187	10.9%
Lack of sleep and rest	223	12.9%
Academic pressure	543	31.5%
Exhaustion	364	21.1%
Unknown causes	63	3.7%
Personal causes	20	1.2%

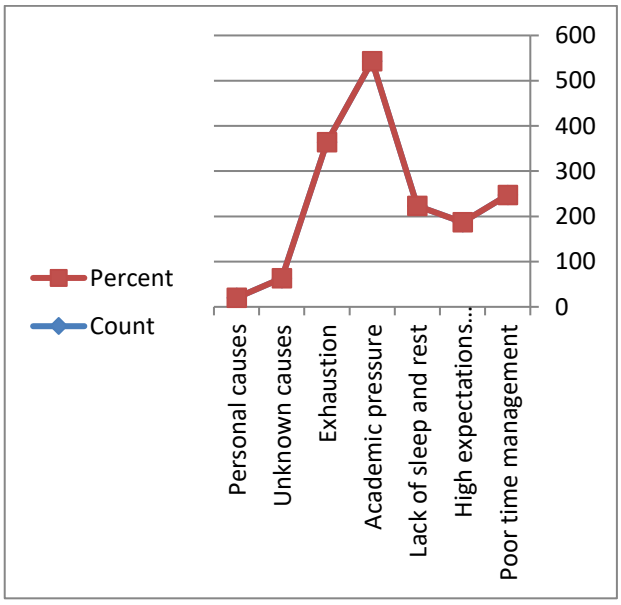

Figure 2. Possible causes of depression, anxiety, and stress

Discussion

The current study reveals that anxiety is the most prevalent mental health issue among medical college students, affecting 75.6% of them. This is followed by depression, which impacts 54.5%, and stress, affecting 54.1%. These findings align with studies conducted in Pakistan [13], Egypt [14], Jordan [15], Iraq [16], and

Saudi Arabia[17,18,19]. This suggests that the factors contributing to these psychological issues among students in these countries may be similar to those affecting medical students at the University of Benghazi. Additionally, the findings show that higher levels of anxiety, depression, and stress are more prevalent among females compared to males. However, the higher rates observed in females may be partly attributed to their greater representation in the sample. Moreover, this disparity might also stem from familial responsibilities, such as caring for children or elderly family members, which may burden them more. Furthermore, first- and third-year students are experiencing higher levels of depression, anxiety, and stress compared to their peers. This may be due to these students transitioning into more challenging stages of their education.

The authors suggested that the competitive environment and the tendency to compare oneself with peers could contribute to this issue. They also speculated that the fear of failure might lead to increased anxiety, as it was identified as the most significant concern among the ages of 22-24 group. The participants reported that academic pressure, exhaustion, and poor time management are the primary factors contributing to stress, anxiety, and depression. Furthermore, insufficient sleep and high family expectations also contributed to this issue. Moreover, a small percentage of participants thought that some of their symptoms were caused by unidentified factors, highlighting the lack of knowledge about mental health issues and their causes among college students in medical schools.

4. Conclusions

In summary, this study sheds light on the mental health challenges (stress, anxiety, and depression) experienced by medical college students at the University of Benghazi in Libya. It emphasizes the seriousness of these challenges based on variables such as gender, age, academic year, and college. The research revealed that anxiety is the most common issue among students, especially among female students, those in the faculty of medicine, third-year students, and students aged 22 to 24. Therefore, this research is valuable for developing health programs and offering resources and services through mental health support services and health educators. These initiatives can help create a positive learning environment, ultimately improving academic performance.

Recommendations

It is essential to recognize that significant measures need to be taken to enhance the mental well-being of university students as many students are unaware of mental health issues, their symptoms, and the contributing factors. Therefore, the authors suggest the following:

1. Increase awareness among students in medical colleges about mental health issues.
2. Provide workshops on time management and effective planning.
3. Focus on mental health to reduce stigma and improve overall mental well-being.
4. Conduct future studies similar to or complementary to the current study to highlight students' mental health issues.

Acknowledgements:

We extend our heartfelt gratitude to all volunteers who participated in this study.

Conflict of interest:

The researchers did not reveal any conflicts of interest.

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Libyan Journal of Public Health Practices (LJPHP)

Journal homepage:https://journals.uob.edu.ly/LJPHP/index
ISSN (Online) 3008-1467

Research Article

Food Insecurity and Hunger among Internally Displaced Families in Benghazi, Libya

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ARTICLE INFO

Article history:
Received xxxx
Revised xxxx,
Accepted xxxx,
Available online June 2025

keywords:
Food Security
Conflict
Internal Displacement
Benghazi, Libya
COVID-19.

ABSTRACT

Food security (FS) is a critical issue exacerbated by conflict and pandemics. This study investigated FS among internally displaced persons (IDPs) in Benghazi, Libya, during the COVID-19 pandemic. A cross-sectional survey was conducted with 120 IDP families residing in three camps in Benghazi, Libya. The Radimer/Cornell Hunger Scale was used to assess household FS. The findings revealed a high prevalence of food insecurity, with 91.7% of families experiencing some level of food insecurity. Factors such as parental education, paternal employment, and access to food storage and preparation equipment significantly influenced FS levels. The study highlighted disparities in FS between camps, with El-Helis camp showing higher levels of food insecurity. The complex interplay of conflict and pandemic-related disruptions to food systems, employment, and financial stability contributed to these challenges. This research emphasizes the urgent need for targeted interventions to address food insecurity among IDPs in conflict-affected regions. Such interventions should include immediate food assistance, improved distribution systems, and long-term strategies for building self-sufficiency and enhancing access to food resources.

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1. Introduction

Food security (FS) is defined as "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life [1]. There are four main dimensions of FS: (i) food availability, an indicator of food supply, agricultural production and trade; (ii) food accessibility, influenced by food prices and income; (iii) food utilization, determined by food diversity, preparation, safety, general hygiene and sanitation; and (iv) the stability of the previous three dimensions over time [2]. FS is demonstrably compromised in households residing in regions experiencing drought, floods [3, 4] and armed conflicts [5].

Since 2014, there has been a steady increase in overall food insecurity worldwide, and during 2019, it was estimated that more than one-quarter (25.9%) of the global population, that is 2 billion people, experienced food insecurity [6]. In 2020, COVID-19 restrictions disrupted food production and access in many countries, particularly low- and middle-income countries, worsening global hunger [7]. The State of Food Security and Nutrition in the World report indicates that global hunger worsened significantly in 2020, with the number of people categorized as food insecure increasing by more than the increase in the previous five years combined. This means that nearly one-third of the world's population (2.37 billion) lacked adequate food in 2020 [8].

According to the World Food Programme (WFP), the Arab world experienced a significant increase in food insecurity. In 2021, approximately 53.9 million individuals faced extreme food insecurity, representing a 55% increase compared to 2010. Furthermore, the number of people experiencing moderate to severe food insecurity was also on the rise, with projections indicating that 154.3 million individuals were affected in 2021 [9] A substantial body of research has investigated food insecurity within the Middle East and North Africa (MENA) region, encompassing countries such as Yemen [10], Palestine [11], Syria [12], and Lebanon [13]. These studies consistently demonstrate the widespread prevalence of food insecurity and hunger across the MENA region.

Violent conflicts exacerbate food insecurity through disruptions to food production, market functionality, and infrastructure [14]. According to the FSIN and Global Network Against Food Crises, 99.1 million people faced food insecurity due to violent conflict in 2020 in 23 countries [15]. The 2011 revolution in Libya resulted in a period of significant political and social instability. The country went through waves of armed conflicts that had a devastating effect on civilians in several ways, such as loss of life and injuries, disruption of basic services, limited access to healthcare, and psychological trauma [16]. A large number of people fled their homes due to violence or insecurity, and by 2020, there were still more than 392,000 internally displaced persons (IDPs) in Libya [17]. Fighting and instability have also disrupted food production, markets, and transportation, leading to food shortages and rising prices [18]. This worsened hunger and malnutrition, especially among vulnerable groups, such as IDPs, refugees, and migrants [17].

A survey was conducted in 2018 to compare the living conditions of IDP camps with those of the general population. The survey included 162 internally displaced families from around the Benghazi camps and revealed that people are living in poor conditions. They have lower education and healthcare rates, they live in cramped and unfinished buildings and tents, they have less nutritious food and they rely on negative coping mechanisms [19]. The typical jobs of the IDPs were in the informal sector, including daily labor in construction, agriculture, and services such as car washing or street vending. Hence, lockdowns and travel limitations caused by COVID-19 restrictions led to job losses and reduced income in people working in the private sector. With limited savings and social safety nets, IDPs are at

greater risk of the negative economic impacts of COVID 19 [20].

Prolonged political instability, outbreaks of violence and the risk of kidnapping among international workers have limited the ability of international organizations to work in Libya [17]. Moreover, COVID-19 restrictions imposed in 2020 constrained the methods of recruitment for proper data collection to assess the situation. Remote methods such as online surveys and phone interviews may have affected the precision of the data, and the recruited samples may not have been statistically representative [21].

Therefore, this study aimed to (i) assess the FS level in Libyan families that were displaced due to the conflict and settled in Benghazi city and (ii) explore whether there was a difference in FS levels between the camps during the pandemic period. This study's findings will contribute to a deeper understanding of the complex factors influencing FS among IDPs in conflict settings and pandemics, which can inform future research and interventions in similar contexts and could also contribute to the development of more effective policies and programs to address FS among IDPs in conflict-affected regions.

2. Methodology

This cross-sectional study was conducted in Benghazi city between February and March 2021. The IDPs in Benghazi are distributed over four camps around the city, known as El-Helis, Turkish Company, Bohdema and Garyounis. The management group of the Bohdema camp refused to cooperate with the researchers; therefore, the families were recruited from the following camps: El-Helis, Turkish Company and Garyounis. Face-to-face interviews were carried out with an adult representative for each household by the researchers (AA, AAA, ME).

A questionnaire was developed by the research team to achieve the aims of this study. It was divided into three sections as follows:
Sociodemographic section: Contains questions on the number of family members, number of children under 18 years of age, parents' education level, employment status, and total household income
Settlement date, number of years in the refugee center and external support received; questions about food storage and cooking facilities; and type and frequency of received aid.

Household FS: The validated Radimer/Cornell Hunger Scale was used to assess household FS [22]. The scale consists of 10 questions. Each question had three possible answers: “not true,” “sometimes true,” or “often true”, and participants were asked to answer according to the previous 12 months. According to the responses to the questions, the households were categorized into one of the following four categories: (i) food secure (negative response to all the questions), (ii) food insecure (at least one positive response to questions 1–4 but not 5–10), (iii) adult food insecure with hunger (a minimum of one positive response to questions 5–8) or (iv) food insecure with child hunger (a minimum of one positive response to questions 9 and 10). The questionnaire was previously translated into the Arabic language and used by a team of researchers at Oslo Metropolitan University, who kindly provided the translated version to be used in this study [23].

The University of Benghazi Review Board approved the study design, and a written consent form in the Arabic language was signed by a proxy adult from each household who agreed to participate in the study. The interviewers received training before commencing the data collection. Each family was informed that participation was voluntary and anonymous and that they had the right to withdraw from the study at any point without giving justification. Participants were given the opportunity to ask questions, and it was clarified for each family that this assessment was not directly related to receiving help from humanitarian organizations or access to government support.

The Statistical Package for the Social Sciences version 26.0 was used to store and analyze the data. For descriptive analysis, demographic and socioeconomic characteristics are presented as ranges or numbers and

percentages according to FS category. Pearson chi-square tests with 95% confidence intervals were used to assess the associations between demographic and socioeconomic characteristics and the level of FS. The Kruskal–Wallis H test was used to assess whether there was an association between living in one of the IDP camps and the answers provided to the questions. All p values <0.05 were considered to indicate statistical significance.

3. Results

One hundred and twenty Libyan families participated in this study, providing data from El-Helis, Turkish Company, and Garyounis camps. The majority of the interviews (82.5%) were conducted with senior males.

3.1 Demographic characteristics of the included families: The number of family members ranged from 2 to 13 person. One hundred families (83%) had at least one child (< 18 years). Education level differed between parents, with more than 12% of the mothers and 6% of the fathers lacking formal education. However, fathers were more likely to be employed, with 87.5% reporting having a job compared to 20.8% of the mothers. In general, 82.5% of the families reported a total monthly income of less than 1000 Libyan Dinar (approximately $220).

More than 75% of the families reported living in camps since 2011, 20.8% did not provide arrival information, and the rest of the families arrived between 2012 and 2015. Sixty-five percent of the families experienced shortages in equipment such as refrigerators (17.5% lacking) and cookers (23.3% lacking) or inadequate cooking and storage equipment. Only 32 families (26.6%) reported receiving humanitarian food assistance from local charities and international organizations. They reported receiving fresh fruits and vegetables, canned food, dried wheat and legumes (Table 1).

3.2 Food security level and associations with other factors

The Radimer/Cornell hunger and food insecurity scale indicated that 91.7% of the families experienced a degree of food insecurity in the past 12 months, 20.8% of whom experienced food insecurity without hunger, 33.3% of whom experienced food insecurity with hunger and 37.5% of whom experienced food insecurity with child hunger (Figure 1).

The analysis revealed that FS was significantly associated with fathers' and mothers' education levels (p<.05), fathers' employment status (p=.001) and total family income (p=.03). A significant association was also detected between the FS level and the availability of food preparation and storage equipment (p<0.05). However, the analysis revealed no significant association between the FS level and the size of the family or mothers' employment status. The demographic characteristics of the families according to their FS level are presented in Table 1.

3.3 Food security status in each camp

The Radimer/Cornell hunger and food insecurity scale revealed differences in FS status among the camps. The figure shows that more food insecure families with hunger lived in El-Helis camp, followed by the Garyounis camp, and the Turkish company camp had the least hunger (Figure 2).

A comparison analysis of the answers to the questions of the Radimer/Cornell hunger and food insecurity scale indicated a significant difference between the camps in answering six of the ten questions, as shown in Table 2. For example, the percentage of participants who provided a positive response to the question "I ran out of the food that I needed to put together a meal and I did not have money to get more food" was 41.3% for families recruited from El-Helis camp, which is significantly greater than that for the Turkish company camp (32%) and the Garyounis camp (26.7%) (p=.03).

Table 1: Background characteristics at each food security level of the 120 internally displaced families recruited from three camps in Benghazi city and included in the analysis.

	Total	Food secure		Food insecure		*p*
			without hunger	with hunger	with child hunger	
No. (%) of families	120	10 (8.3)	25 (20.8)	40 (33.3)	45 (37.5)	
Refugee camp name						
Turkish Company	40	4 (10)	12 (30)	10 (25)	14 (35)	
Garyounis	40	4 (10)	9 (22.5)	16 (40)	11 (27.5)	
El-Helis	40	2 (5)	4 (10)	14 (35)	20 (50)	
Range of family members	2-13	2-9	2-12	3-12	2-13	.168
No.(%) of family with children (<18years)	100 (83.3)	8 (8)	22 (22)	33 (33)	37 (37)	
Education level of the mother						
None	15 (12.5)	2(13.3)	1(6.7)	6 (40)	6 (40)	.014
0-9 year	39 (32.5)	3 (7.7)	3 (7.7)	13 (33.3)	20 (51.3)	
>9 years	66 (55)	5 (7.6)	21(31.8)	21(31.8)	19 (28.8)	
Education level of the father*						
None	8 (6.7)	2 (25)	0	1(12.5)	5 (62.5)	.025
0-9 year	46 (38.3)	0	10 (21.7)	12 (26.1)	24 (52.2)	
>9 years	64 (53.3)	8 (12.5)	15 (23.4)	27 (42.2)	14 (21.9)	
No answer	2 (1.7)	0	0	0	2 (1.7)	
Employment status (Mother)						
Housewife	95 (79.2)	8 (8.4)	17 (17.9)	31(32.6)	39 (41.1)	.117
Employed	25 (20.8)	2 (8)	8 (32)	9 (36)	6 (24)	
Employment status (Father)						
Employed	78 (65)	8 (10.3)	22 (28.2)	26 (33.3)	22 (28.2)	.023
Freelance	27 (22.5)	0	2 (7.4)	7(25.9)	18 (66.7)	
Retired	15 (12.5)	2 (13.3)	1 (6.7)	7 (46.7)	5 (33.3)	
Monthly income **< 1000 LD	99 (82.5)	5 (5.1)	20 (20.2)	34 (34.3)	40 (40.4)	.005
Monthly income **> 1000 LD	21 (17.5)	5 (23.8)	5 (23.8)	6(28.6)	5 (23.8)	
Receiving humanitarian food assistance	32 (26.6)	2 (6.25)	10 (31.25)	9 (28.1)	11 (34.4)	.39
Food storage and preparation equipment not available						
Cooker	28 (23.3)	0	3 (10.7)	8 (28.6)	17 (60.7)	.017
Fridge	21 (17.5)	1 (4.8)	2 (9.5)	3 (14.3)	15 (71.4)	.006
Food preparation equipment	21 (17.5)	0	3 (14.3)	2 (9.5)	16 (76.2)	.001

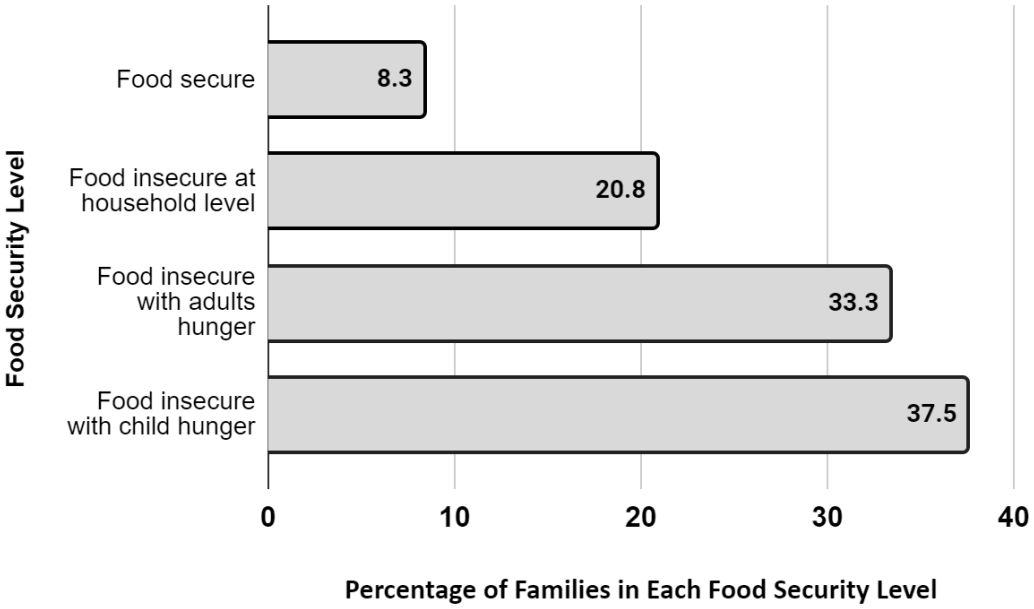

Figure 1: The percentage of families at each food security level (n=120 family).

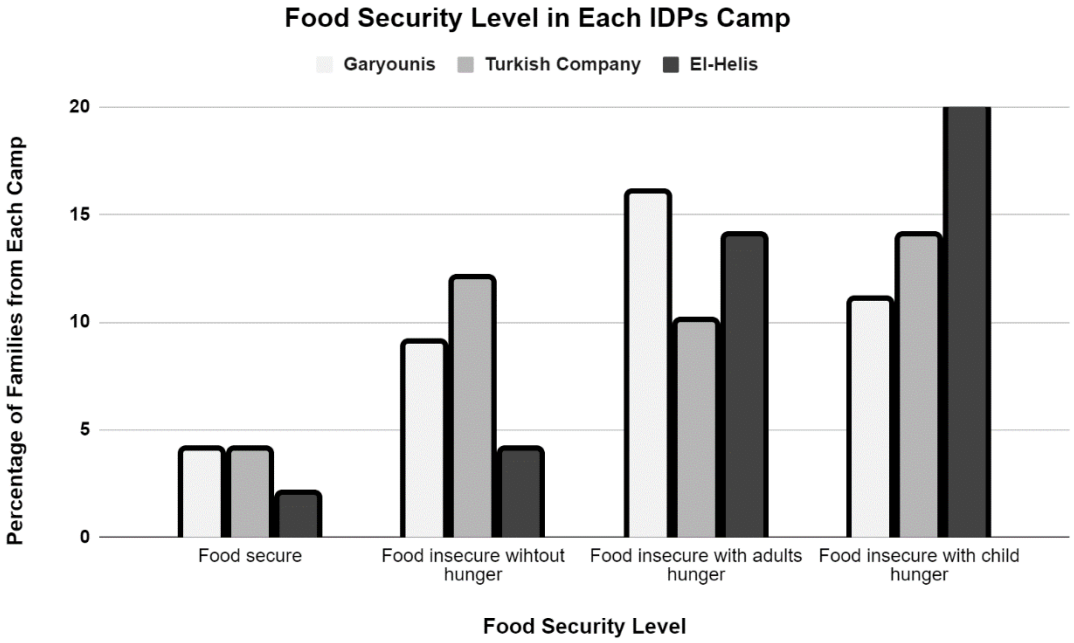

Figure 2: The percentage of families at each food security level at each IDP camp**.**

Table 2: Comparison of positive responses to the Radimer/Cornell Hunger Scale food security test for families recruited from each camp (n = 120)

	Number and percentage of positive response for all families and from families from each camp				
	All	Turkish Company	Garyounis	El-Helis	*p*
Food insecurity without hunger					
I worry whether my food will run out before I get money to buy more.	95 (79.2)	29(30.5)	30 (31.6)	36 (37.9)	0.114
We eat the same thing for several days in a row because we only have a few different kinds of food on hand and do not have money to buy more	98(81.7)	32 (32.7)	32 (32.7)	34 (34.7)	0.800
The food that I bought just did not last, and I did not have money to get more	85 (70.8)	28 (32.9)	26 (30.6)	31 (36.5)	0.468
I ran out of the food that I needed to put together a meal and I did not have money to get more food	75 (62.5)	24 (32)	20 (26.7)	31 (41.3)	0.037
Food insecurity with hunger					
I am often hungry, but do not eat because I cannot afford enough food	55 (45.8)	16 (29.1)	13 (23.6)	26 (47.3)	0.009
I eat less that I think I should because I do not have enough money for food	73 (60.8)	20 (27.4)	23 (31.5)	30 (41.1)	0.063
I cannot afford to eat properly	77 (64.2)	21 (27.3)	24 (31.2)	32 (41.6)	0.030
I cannot give my child (ren) a because I balanced meal, I cannot afford that	55 (45.8)	14 (25.5)	14 (25.5)	27 (49.1)	0.003
Food insecurity with child hunger					
My child (ren) is/are not eating enough because I just cannot afford enough food	43 (35.8)	13 (30.2)	10 (23.3)	20 (46.5)	0.057
I know my child (ren) is/are hungry sometimes, but I just cannot afford more food	41 (34.2)	14 (34.1)	9 (22)	18 (43.9)	0.104

4. Discussion

This study investigated FS during the COVID-19 pandemic among 120 Libyan families displaced from their original homeland and settled in Benghazi IDP camps. The analysis revealed high prevalence of food insecurity during 2020 among the explored camps. It also highlighted a disparity in FS levels between the explored camps. An association was found between FS and the educational levels of the parents, the employment status of the fathers and the availability of food storage and preparation equipment.

In this study, we observed a significant decline in the proportion of families categorized as food secure in 2018, the percentage decreased from 60% in 2018 [19], to less than 10% according to this study. This observation can be explained by two factors. The first is the complex impact of conflict and pandemics, both of which have exerted profound effects on (i) disruptions to food systems, supply chains, agricultural production, and distribution networks and (ii) employment and financial conditions: families within this vulnerable group have faced job losses, reduced income, and financial instability due to these dual crises [7],[14]. The second could be related to the use of different FS

assessment tools. Consequently, direct comparisons between the results cannot be straightforward. However, despite this methodological difference, our study highlights a critical concern: 37.5% of families experienced food insecurity with child hunger. Such severe conditions have far-reaching implications for children's development, health, and overall well-being [24]. Contrary to previous findings [25],[26], no significant association was detected between family size and FS level in our study. This divergence might be explained by the differing assessment contexts. While our data were collected during a period of instability, impacting access to food for families of all sizes and potentially masking the influence of family size on FS, the other two assessments by Curran's and Akbar likely took place under stable conditions.

Regarding the association between parental employment and FS, our findings partially align with those of Akbar [25]. The positive association observed with paternal employment is consistent with the traditional Libyan societal structure, where fathers are often the primary breadwinners. However, the lack of a significant association with maternal employment might be related to the complex relationship between mother employment and FS. While employed mothers may contribute to increased household income, balancing work and childcare responsibilities can limit the time available for food preparation, meal planning, and feeding children. Work-related stress can also negatively impact parenting practices and food choices [27].

In the Libyan context, the traditional gender roles, where fathers typically assume the primary breadwinner role, may further mitigate the direct impact of maternal employment on household FS. Future research could delve deeper into these nuances and explore the interplay of cultural factors, socioeconomic conditions, and maternal employment on food security outcomes.

Concerning the type of fathers' employment, our analysis revealed that 66% of families with self-employed fathers fell into the category of food insecurity with child hunger. Although we have no information about the status of these families before COVID-19, there is a high probability that COVID-19 worsened their situation. Previous research by Büyüksoy et al. revealed that food insecurity among self-employed households increased by 2.5-fold during the COVID-19 pandemic [28]. Families with self-employed fathers were likely more vulnerable to food insecurity due to the combined effects of reduced client demand and the inherent financial volatility of private businesses during the pandemic. Unlike salaried positions, private businesses often experience income fluctuations and lack steady income streams [29]. This financial insecurity directly translates to difficulties affording enough food for their families.

The limited access to food preparation and storage facilities corroborates the concerning situation of these families that was documented in the Multi-Sector Needs Assessment in Selected IDP in Benghazi, Libya in 2018 [19] and underscores the challenging living conditions faced by this vulnerable group. As highlighted by Oakley et al. in 2019 [30], a clear association exists between FS and the availability of food preparation and storage equipment. These tools are fundamental for ensuring food availability and usability. They prevent food waste and promote efficient food processing and preservation, ultimately contributing to a more secure and nutritious diet. The reasons behind the limited access to food aid for families in the IDP camps remain unclear. However, this might be a result of resource constraints faced by aid organizations or problems within the distribution system. The Conflict Sensitive Manual for Libya, published by The Peaceful Change initiative [31], highlights a significant challenge faced by these organizations in Libya. Armed groups or other actors steal aid supplies, including food, medicine, and shelter materials, from various locations for their use or resale on the black market. Disrupted transportation routes and security concerns for aid workers likely hinder effective distribution efforts.

The analysis also revealed disparities in FS between camps with the El-Helis camp (which

located on the outskirts of the city) facing more severe conditions. The Food and Agriculture Organization (FAO) of the United Nations has published a report in (2023) titled "Reducing inequalities for FS and nutrition" [32], it highlights the impact of place and space on FS inequalities. The report noted that remote people face structural inequalities that can lead to higher rates of food insecurity. Remote locations often face compounding challenges due to limited aid access, scarce markets, and limited opportunities for income generation for IDPs, all of which play a role in shaping FS.

This study offers unique insights into the FS challenges faced by IDPs in Benghazi, Libya, a population rarely examined in such detail. To ensure methodological rigor, the research employed a validated, culturally appropriate tool (the Radimer/Cornell Hunger Scale) and trained local researchers for data collection. Recruitment across three IDP camps enhances representativeness, while the study design goes beyond describing FS variations between camps and factors influencing food utilization within them, providing a nuanced understanding of IDPs' dietary challenges.

However, the generalizability of this study is limited by its methodological design. The cross-sectional approach hinders the establishment of cause-and-effect relationships. Using a longitudinal research design and employing a mixed methods approach may provide valuable insights for developing effective interventions. Nonprobability sampling methods may introduce selection bias, and relying on one respondent per household and not exploring coping mechanisms in detail are further limitations that call for future research with a more robust design to gain a deeper understanding of IDPs' experiences.

This study provides valuable insights for understanding and addressing food insecurity in other conflict-affected and crisis-prone regions. By understanding the specific challenges faced by these vulnerable populations, we can develop more effective interventions and programs to ensure their access to safe, nutritious food.

Implications for Policy and Practice

The findings of this study have significant implications for understanding and addressing food insecurity among displaced populations worldwide. A multi-sectoral approach is essential to tackle the complex challenges associated with food insecurity in conflict-affected and non-conflict settings.

Recommendations

- Education, Employment, and Financial Support: Invest in education and skills training programs to empower individuals and families. Implement effective social protection and financial assistance programs to reduce the impact of shocks.
- Infrastructure and Basic Services: Invest in infrastructure development and provide essential household items such as food storage and preparation facilities.
- Market Access and Supply Chains: Stabilize markets, improve transportation infrastructure, and promote local food production.
- Humanitarian Assistance: Prioritize food security as a central focus of humanitarian responses to vulnerable groups, including IDPs and refugees.
- Building Local Capacity: Empower communities to manage their own food systems by providing support to local farmers and promote sustainable agricultural practices.
- Collaboration and Data-Driven Decision-Making: Strengthen information systems to inform evidence-based policies and programs and regularly monitor and evaluate food security conditions among the vulnerable groups.
- Conflict Resolution and Peacebuilding: Address the root causes of conflict and promote dialogue to create a stable environment for food production and distribution.

By integrating these recommendations into their strategies, policymakers and humanitarian organizations can develop more effective approaches to address food insecurity and promote sustainable food systems in both conflict-affected and non-conflict settings.

5. Conclusions

In conclusion, this study revealed alarming food insecurity among IDPs in Benghazi, Libya, during the COVID-19 pandemic, with 37.5% of families experiencing child hunger. The combination of conflict and COVID-19 affected all aspects of FS: availability, accessibility, utilization, and stability. We recommend multiple approaches for solutions in similar situations. Immediate food assistance, improved distribution, storage/preparation facilities, and long-term income generation programs for this vulnerable group. Finally, we recommend further research to gain a deeper understanding of IDPs' experiences and coping mechanisms.

Acknowledgment
We would like to thank Professor Sigrun Henjum and her team at Oslo Metropolitan University for kindly providing the translated version of the Radimer/Cornell Hunger Scale. We also extend our thanks to all the families who participated in this study and the management teams of the camps for their cooperation and support in facilitating this research.

Conflict of interest
The authors reported no conflicts of interest.

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Libyan Journal of Public Health Practices (LJPHP)

Journal homepage: https://journals.uob.edu.ly/LJPHP
ISSN (Online) 3008-1467

Research article

A Comparative study for Diagnosis of initial caries using Laser Fluorescence Techniques, DIAGNOdent and Conventional Methods

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ARTICLE INFO

Article history:
Received 16/4/2025
Revised 1/5/2025
Accepted 15/5/2025
Available online June 2025

Keywords:
Early diagnosis
Occlusal caries
DIAGNOdent
Laser fluorescence
Conventional methods

ABSTRACT

Timely detection of dental caries, including early enamel lesions and advanced dentinal involvement, is essential for effective clinical management. This in vivo investigation assessed the diagnostic accuracy of conventional and fluorescence-based adjuncts across proximal, occlusal, and noncavitated facial smooth-surface lesions. A cohort of 195 patients (aged 8–40 years) underwent visual inspection, tactile probing, bitewing radiography, and evaluations using light-emitting diode (LED) fluorescence, laser-induced fluorescence, and the DIAGNOdent system. DIAGNOdent measurements were interpreted using both manufacturer-defined cutoffs and newly calibrated thresholds. Data were analyzed via receiver operating characteristic (ROC) curve analysis and chi-square tests, with significance at $p < 0.001$. ROC analysis yielded AUC values > 0.85 for fluorescence modalities, indicating robust discriminative performance.
Bitewing radiography demonstrated exceptional specificity—up to 99%—for identifying sound surfaces, corroborating findings in fluorescence studies of occlusal caries detection. DIAGNOdent showed superior sensitivity for enamel caries, with sensitivity approximating 85% using manufacturer cutoffs and 81% with revised thresholds, paralleling reported performance in vivo. Diagnostic accuracy for dentinal lesions was comparable between DIAGNOdent and traditional methods. Specifically, for noncavitated facial smooth-surface lesions, DIAGNOdent achieved over 84% overall accuracy, with sensitivity of 87.6% and specificity of 96.9%. Interobserver agreement across modalities was moderate to high ($\kappa = 0.33–0.75$), indicating reproducibility consistent with prior DIAGNOdent pen evaluations. Integration of visual inspection with fluorescence-based methods further enhanced diagnostic metrics, underscoring the value of adjunctive fluorescence devices. Overall, advanced fluorescence-based diagnostics—particularly DIAGNOdent—offer increased sensitivity and high specificity, supporting their clinical utility in early caries detection and timely intervention.

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1. Introduction

Dental caries remains one of the most prevalent diseases on the global scale, posing considerable challenges with the detection and management of lesions on the approximal and occlusal surfaces of posterior teeth [1,2]. Their restricted accessibility due to close adjacent interproximal contacts, along with the complex surface topography in the fissured occlusal regions, generally makes visual as well as tactile inspection difficult, allowing the progression of early-stage lesions without detection [3],[4]. Despite numerous advances in diagnostic modalities, there is still no clear consensus on the optimal approach for early caries detection, particularly regarding threshold values and clinical applicability of adjunctive techniques. This lack of agreement underscores the need for comparative studies evaluating both novel and traditional methods under standardized conditions. Hence, improving detection methods showing high sensitivity, specificity, and reproducibility is increasingly important in modern dental practice.

Traditional methods, such as visual inspection and bitewing radiography, have classically been considered the "gold standards" for carious lesion detection [5]. While visual inspection is highly specific in nature, it is often low in sensitivity and operator dependent. On the other hand, bitewing radiography increases sensitivity in assessing approximal lesions but can underestimate the depth of the lesions and involves the use of ionizing radiation [6],[7]. These limitations have driven research towards the development of alternative detection methods based on the latest optical and laser technologies.

Current research interest has increasingly converged on fluorescence-based devices that have the potential to quantify the extent of demineralization in dental tissues [8],[9]. Most notable among these is the laser-induced fluorescence device DIAGNOdent, which emits a 655-nm wavelength beam, interacting with bacterial metabolites in carious lesions and producing an increased fluorescence signal proportional to the severity of the lesions [10]. Several studies have determined the high sensitivity of DIAGNOdent in detecting incipient and hidden caries, thus complementing or even surpassing conventional means under certain clinical conditions [11],[12]. Similarly, light-emitting diode (LED) technologies have shown promise by evaluating the differences in translucency between sound and demineralized enamel using computer-assisted algorithms, thereby expanding the range of noninvasive diagnostic methods [13].

From the clinic's point of view, prompt detection of medical conditions was linked with an emerging paradigm focusing on non-invasive methods in combination with preventive and conservative therapeutic methods [14],[15]. Interventional methods, such as remineralizing therapies and sealing procedures, relied on the accurate detection of initial-stage lesions in order to prevent or invert the progression of cariogenic disease while maintaining the structural health of the affected teeth [16]. Standardized visual systems for detection, such as the International Caries Detection and Assessment System (ICDAS), had promoted homogeneity of the criteria; yet, they were prone to interpretative errors and could be improved with higher objectivity owing to the use of fluorescence devices [17],[18].

Given the natural limitations of this study, the present research aims to assess the efficacy of DIAGNOdent and LED fluorescence methods in conjunction with conventional diagnostic methods like visual inspection and bitewing radiography in detecting varying degrees of incipient carious lesions. Analyzing the strengths and weaknesses of each method, this research hopes to reveal effective and practical means that support early detection, ensure minimal invasiveness, and eventually improve patient outcomes for primary and permanent dentition. Current research interest has increasingly converged on fluorescence-based methods by expanding the range of noninvasive diagnostic options. From the clinic’s point of view, prompt detection of medical and dental conditions improves patient outcomes for both primary and permanent dentition.

2. Methodology

2.1. Participant Selection

A group of 195 participants of both genders, between the ages of 8 and 40, were enlisted in dental clinics in Benghazi, Libya, during routine dental checks as part of normal community outreach activities. Inclusion criteria required the presence of initial fissure caries in permanent molars, as established through initial visual inspection. Subjects showing extensive cavitation's, severe hypomineralization of the enamel, previous restorative treatments, orthodontic appliances, or significant developmental defects were excluded from the study. Pre-entry explanations of the objectives, methodologies, safety procedures, as well as the possible benefits of the study, were made, after which written informed consent in conformity with ethics guidelines endorsed by the Benghazi University Ethics Committee (Approval Number: BU-2023-045) [19].

2.2.Clinical evaluations

All participants received thorough clinical examination within a dedicated dental operatory. Initial visual screening was carried out by two experienced examiners under optimal operatory illumination supplemented with a front-surface dental mirror for assistance, and with the addition of a sickle-shaped explorer as required. Tooth surfaces were dried using compressed air generated through a 3-in-1 syringe, and any surface plaque and debris were carefully removed with gauze, cotton pellets, and water as necessary. Occlusal surfaces of the first and second permanent molars were evaluated and graded based on the codes determined in Ekstrand's criteria for visual detection of caries [19]. For reasons of quality control, about 10% of the exams were replicated at random in order to measure inter-examiner reliability.

2.3. Radiographic Evaluation

Following the visual examination, standard bitewing radiographs were taken from both the left and right sides using Kodak Insight size 2 periapical film. The teeth were held in place in a holder (Kwik Bite holder GDS1360; Kerr Hawe, Bradford, UK), and the radiographic images were recorded using a Gendex Oralix unit set at 65 kV and 7.5 mA, with an exposure time of 0.22 seconds. After development, the radiographs were digitized using a high-resolution digital camera (EOS 350D; Canon, Tokyo, Japan) and stored in JPEG format on a computer. The radiographs were scored on a 19-inch liquid crystal display for the severity of occlusal caries by an examiner who was blind to the corresponding clinical outcomes, using modified radiographic criteria [20]. Intra-examiner consistency was ensured by re-examinations on at least one later day for 10% of the images as a measure of reliability.

2.4.Laser Fluorescence Assessment

For adjunctive diagnostic testing, the DIAGNOdent laser fluorescence unit (KaVo Dental, Biberach, Germany) was used. According to manufacturer's advice, the unit was recalibrated bi-daily on a ceramic standard. Each test sample tooth was cleansed with pumice in a rubber cup, then air-dried with compressed air to standardize the testing condition. The DIAGNOdent probe was placed at right angles to the occlusal surface and at an angle towards the occlusal fissure in order to read the maximum fluorescence measurement. For each tooth, three independent measurements were taken, with the maximum value being noted. A result of a value of 20 units or higher was considered as suggestive of dentin carious lesions [21]. About 10% of measurements were repeated on the same working day for validation of intra-examiner reliability.

2.5.Following Intervention

Patients diagnosed with initial-stage fissure caries—involving visual score V1, V3, or V4; radiographic score R1 or R2; or DIAGNOdent score of 20 or above—were scheduled for recall within two weeks. At the recall visit, an independent clinician carried out pit and fissure openings with the assistance of a fine carbide bur (Fissurotomy Micro NTF; SS White, Lakewood, NJ, USA). After the openings, the cavities were re-assessed with the use of a diagnostic coding system modified following

the study of Heinrich-Weltzien et al. [22]. According to the size of the lesion, as well as how deep it is, predictive intervention involved preventive sealant, resin restoration, or composite restoration as appropriate.

2.6. Examiner Calibration

Prior to study initiation, both visual and laser fluorescence examination methods were standardized through a calibration exercise using a pilot sample of 10 patients. Discrepancies in scoring were discussed in order to reach consensus; inter- and intra-examiner reliability were subsequently quantified via Cohen's kappa statistic [23]. This calibration ensured near-perfect agreement in the application of both the ICDAS-II visual scoring system and the DIAGNOdent readings.

2.7.Statistical Analysis

Results were reported as means with standard deviation for continuously measured variables, as well as frequencies with percentages in corresponding categorical variables. Evaluative effectiveness of the visual inspection and DIAGNOdent methods was determined in terms of sensitivity, specificity, overall accuracy, predictive values for being positive, as well as predictive values for being negative, together with the area under the ROC curve, respectively. Association between DIAGNOdent values and ICDAS-II scores were tested using Spearman's rank correlation coefficient, whereas the distribution of diagnostic scores were tested using the Chi-square test. Inter-examiner consistency was tested using Cohen's kappa statistics. The statistical analysis were conducted using MedCalc software (version 19; MedCalc Software Ltd., Ostend, Belgium), as well as using SPSS (version 11.5), with the significance level being at $P \leq 0.05$ [24].

3. Results and discussion

A group of 195 participants (about 60% females and 40% males) with a mean age of 24.3 ± 5.2 were sampled in the city of Benghazi. Cumulatively, 350 occlusal surfaces were examined using three different diagnostic methods: direct visual inspection based on ICDAS-II criteria, bitewing radiographic examination, and analysis with DIAGNOdent laser fluorescence technology.

3.1.Visual Evaluation (ICDAS

As per the ICDAS-II system, 157 occlusal surfaces representing 45% were classified as sound (ICDAS 0). 105 surfaces (30%) showed initial changes in enamel (ICDAS 1), while 88 surfaces (25%) were found with evident visual changes (ICDAS 2). Reliability between the examiners for visual evaluation proved excellent as reflected in the kappa value of 0.92 [25].

3.2.DIAGNOdent Assessment

Measurement averages for surfaces having enamel-limited lesions were determined as 26 ± 6 units. Surfaces with carious lesions penetrating into the dentin had significantly higher scores (mean 54 ± 20 units; $p = 0.003$). The ROC analysis found an optimal cut-off value for DIAGNOdent at 40, which gave a sensitivity of 70% and a specificity of 84% (AUC = 0.81) [26]. Reproducibility was high, with over 80% of repeated measures with DIAGNOdent showing differences of no more than 5 units (kappa = 0.85).

3.3.Bitewing Radiography

Radiographic assessment identified radiolucencies in 35 of 350 surfaces (10%). In spite of having high specificity of about 97%, the sensitivity fell short, especially for initial enamel lesions [27]. Examiner agreement on radiographic assessments was substantial, with a kappa of 0.75.

3.4.Holistic Diagnostic Approach

Integration of visual inspection using the ICDAS V1 threshold in combination with measurements via DIAGNOdent at a cut-off score of 40 had improved sensitivity and specificity at values of 67% and 94%, respectively. Youden index of the combined approach, measured at 0.61, outperformed the indices for each discrete method, thus signaling significantly improved diagnostic performance.

The chi-square test results showed that the differences in detection between the methods were statistically significant (χ^2, $p < 0.001$).

Table 1. Distribution of Caries Status by Diagnostic Method (n = 350 Occlusal Surfaces)

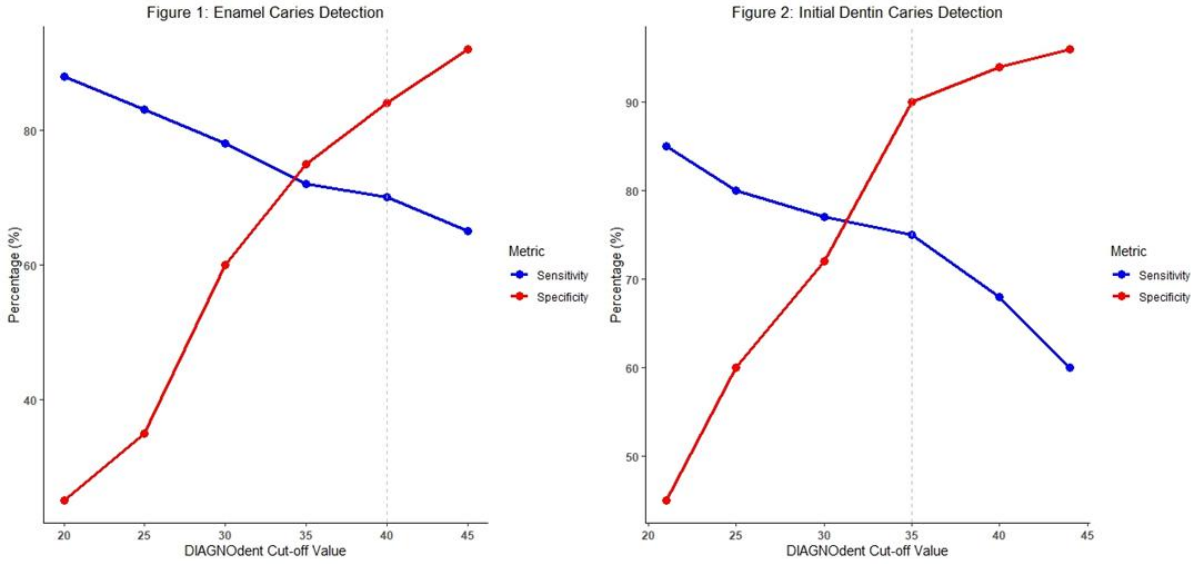
Diagnostic Method	Category	Number of Surfaces	Percentage (%)
Visual Examination (ICDAS-II)	Sound (ICDAS 0)	157	45.0
	Early Enamel Change (ICDAS 1)	105	30.0
	Distinct Enamel Change (ICDAS 2)	88	25.0
DIAGNOdent	Enamel Lesion (Score < 40)	215	61.4
	Dentinal Lesion (Score ≥ 40)	135	38.6
Bitewing Radiography	Negative (No Radiolucency)	315	90.0
	Positive (Radiolucency Observed)	35	10.0

Note*:* The DIAGNOdent categories were defined according to our ROC-derived optimal cut-off (score = 40).

Table 2. Diagnostic Accuracy Parameters for Caries Detection Methods

Diagnostic Method	Sensitivity (%)	Specificity (%)	Accuracy (%)	Youden Index
Visual Examination (ICDAS-II)	65	90	78	0.55
DIAGNOdent (cut-off = 40)	70	84	77	0.54
Bitewing Radiography	35	97	65	0.32
Combined (Visual + DIAGNOdent)	67	94	80	0.61

Note: The integrative diagnostic approach, utilizing visual examination according to the ICDAS V1 criteria and DIAGNOdent at a chosen cut-off value of 40, was yielding the maximum Youden index, reflecting the greatest overall accuracy. Statistically significant differences were noted for all methods used (χ^2, $p < 0.001$).



Figures 1 and 2 indicated that sensitivity (blue) was optimal at lower cut-off values for DIAGNOdent and declined as the cut-off increases. Specificity (red), on the other hand, increased as the cut-off increases.

Figure 1 (cavities in the enamel) had optimal balance at a cut-off value of approximately 40, with approximately 70% sensitivity and approximately 84% specificity. **Figure 2** (early dentin cavities) had approximately 35 as the optimal cut-off for approximately 75% sensitivity and approximately 90% specificity. These graphs illustrated the trade-off between identifying more true cases (high sensitivity) vs. decreasing false positives (high specificity). The present research revealed that with different methods, it was possible to identify signs of decay in the population in Benghazi city earlier. In this research, our findings indicated the following important points:

3.5.How Effectively Visual Inspections Function

ICDAS-II examination was simple and inexpensive for detection of problems in the teeth. Examiners tended to agree on their findings (kappa = 0.92), but visual examination could overlooked fine details in the enamel, and thus initial cavities might be missed [25],[28]. For patients who were new, this was significant because prevention would prevent cavities from beginning.

3.6.How DIAGNOdent operates

DIAGNOdent quantified the light emitted by porphyrins (waste products of bacteria) in decaying tissue. It distinguished very accurately between healthy enamel and those regions in which decay had reached the dentin. For the new cut-off of our ROC analysis of 40 units, the optimal balance between sensitivity (70%) and specificity (84%) was achieved. These findings were consistent with other studies that reported comparable optimal levels for detection of cavities [26,29]. The reproducible findings of DIAGNOdent also indicate that it was valuable as an additional diagnostic tool, in particular for inspecting early decay in regions where visual cues might be difficult to observe [30].

3.7.X-ray Limits

Bitewing radiography, despite its high specificity (≈97%), lacked sensitivity in the detection of early enamel caries. This outcome was not unexpected since radiographs typically required a significant degree of mineral loss (approximately 40%) before radiolucencies become detectable [27],[31]. Thus, when used as an isolated method, radiography might not capture the full spectrum of early carious changes. Furthermore, variations in image contrast and interpretation—compounded by the limited two-dimensional representation of three-dimensional structures—further diminish its sensitivity [32].

3.8.Working Together for Better Outcomes

Our data revealed that combining visual inspection with DIAGNOdent measurements markedly improved overall diagnostic performance. The enhanced Youden index (0.61) reflected a favorable trade-off between reducing false positives and negatives. This integrated approach leveraged the qualitative assessment of enamel appearance (from visual inspection) and the quantitative measurement of bacterial by-products (from DIAGNOdent), thereby offering a more reliable clinical decision-making framework [33,34]. The combined method might thus be particularly valuable in a population where early diagnosis is imperative to prevent lesion progression.

3.9.Impact on Health and Future Plans

Combining these diagnostic devices makes it possible to create a more personalized and less invasive treatment regimen. Each tool is less accurate on its own, and together they can be used to take preventive measures in their initial stages, thereby decreasing the demand for invasive procedures later in the future. Standardization of recordings made with DIAGNOdent is necessary with proper cleaning of the teeth, controlling moisture, and maintaining consistent light exposures for achieving accurate outcomes [30],[35]. There is a need for additional long-term studies for determining how accurately these diagnostic standards can forecast changes in the progression of the lesions over time and how varying groups and circumstances can have variable threshold values [36].

3.10.Study Limitations

Our study provided definite evidence that the combined diagnostic approach was beneficial. Nevertheless, several issues, such as its single study design and potential variations in oral factors (such as saliva and stains) that could influence DIAGNOdent readings, exist. Future

investigations utilizing digital X-rays and more sophisticated calibration procedures could enhance the precision of cavity detection [37].

4. Conclusions

Our findings indicated that different detection methods assisted in identifying early tooth decay in 195 patients in the age range of 8 to 40 years in Benghazi city. Visual examination according to ICDAS-II criteria functioned well in various observers but frequently neglected minute problems in the enamel structure. Laser light utilizing DIAGNOdent was optimal in detecting problems within the enamel at level 40 (around 70% sensitivity, 84% specificity), as well as in detecting initial decay in the dentin at level 35 (around 75% sensitivity, 90% specificity). While bitewing radiographs were highly specific, they were insensitive and could not detect earlier non-cavitated lesions. Notably, visual examination in combination with DIAGNOdent decreased false negatives as well as false positives, resulting in improved diagnostic outcomes (Youden index, 0.61). These findings indicated that this combined method was an excellent, reproducible, and non-surgical means for detecting tooth decay at an initial stage, enabling swift prevention as well as enhanced outcomes for patients in contemporary dental practice.

Acknowledgment

The authors would like to thank all students who participated in the research.

Conflict of Interest

No conflict of interest was declared by the authors.

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Libyan Journal of Public Health Practices (LJPHP)

Journal homepage: https://journals.uob.edu.ly/LJPHP
ISSN (Online) 3008-1467I

Research Article

Impact of Smoking on Periodontal Health: A Comparative Study Between Libyan & Egyptian adult population

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ARTICLE INFO

Article history:
Received 18/4/2025
Revised 1/5/2025
Accepted 14/5/2025
Available online June 2025

Keywords:
Smoking
Cigarette
Periodontal disease
Attachment loss
Community Periodontal Index

ABSTRACT

Periodontal disease remains a major public health concern worldwide, with tobacco use identified as one of the most significant modifiable risk factors. This study aims to assess and compare the periodontal health status and the impact of smoking among the adult populations in Alexandria (Egypt) and Benghazi (Libya). A cross-sectional study involving 2,920 adult participants in both cities. Periodontal status was assessed using the Community Periodontal Index (CPI) and Loss of Attachment (LOA) scores. Participants were categorized based on smoking status, smoking type, and duration of smoking. Statistical analyses were conducted using Chi-square tests with significance set at $P < 0.05$. Heavy smokers demonstrated a significantly higher prevalence of deep periodontal pockets compared to non-smokers in Alexandria and Benghazi, 69.4% and 56.5%, respectively ($P < 0.0001$). Cigarette smoking was associated with more severe periodontal conditions than shisha smoking, particularly in Benghazi ($P= 0.007$). Duration of smoking was strongly associated with periodontal deterioration, with deep pockets present in 87.1% of long-term smokers in Alexandria and 73.7% in Benghazi ($P < 0.0001$). Smoking, particularly cigarette use and prolonged exposure, was significantly associated with worsening periodontal health. These findings underscore the importance of incorporating smoking cessation efforts into dental care and public health strategies to mitigate periodontal disease progression.

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1. Introduction

Periodontal disease, encompassing gingivitis and periodontitis, is a prevalent chronic inflammatory condition affecting the supporting structures of the teeth [1]. It is a leading cause of tooth loss among adults globally. The etiology of periodontal disease is multifactorial, with microbial plaque being the primary initiator, and various risk factors influencing its progression and severity [2].

Among the modifiable risk factors, smoking has been extensively studied and identified as a significant contributor to periodontal disease.it increases the incidence of periodontitis by 85% [1]. A direct correlation exists between smoking and increased tooth loss. Additionally, smoking is associated with a higher incidence of recurrent and refractory periodontal disease [2],[3]. The severity of periodontal disease has been linked to both the type and intensity of smoking habits, with studies showing that smokers exhibit deeper periodontal probing depths, greater clinical attachment loss, and more pronounced alveolar bone loss compared to non-smokers [2-4].

Numerous epidemiological studies, both cross-sectional and longitudinal studies, have consistently demonstrated an increased prevalence and severity of periodontal disease outcomes in smokers. For instance, smokers are reported to have a 2- to 8-fold higher risk of developing periodontitis and experiencing periodontal tissue loss compared to non-smokers. Furthermore, smoking has been associated with greater increases in probing depth and attachment loss [5-6].

Beyond cigarette smoking, other forms of tobacco use, such as cigars and pipes, have been found to exert similar detrimental effects on periodontal health, contributing to increased tooth loss and periodontal disease [7],[8]. While smokeless tobacco products tend to cause more localized effects, they are nonetheless associated with gingival recession and the development of white mucosal lesions [9]. While the association between smoking and periodontal deterioration is well established, the extent of its impact may vary across different populations due to variations in genetics, socio-cultural norms, oral hygiene practices, healthcare accessibility, and tobacco consumption behaviours [10],[11].

Egypt and Libya, two neighbouring North African countries, share several cultural and environmental similarities but differ in healthcare infrastructure, public health initiatives, and smoking prevalence. Egypt has a more developed dental healthcare system, including a wider network of public dental clinics, dental schools, and preventive programs integrated within its national health services. In contrast, Libya's oral healthcare system has been significantly affected by years of political instability and underfunding, leading to limited access to dental care. These differences present a valuable opportunity to investigate how smoking contributes to periodontal disease outcomes in two distinct, yet geographically and culturally connected populations. Conducting a comparative analysis of adult populations in Alexandria (Egypt) and Benghazi (Libya) allows for a better understanding of region-specific disease patterns and contributes to identifying high-risk groups and tailoring public health interventions accordingly. Therefore, this study aims to assess and compare the periodontal health status and the impact of smoking among the adult populations of Alexandria Governorate in Egypt and Benghazi City in Libya. The findings are expected to contribute to the development of tailored preventive and therapeutic strategies to improve periodontal health outcomes in these regions.

2. Methodology

2.1. Study Design and Population

This cross-sectional study was conducted to assess the prevalence and severity of periodontal disease among adult populations in Alexandria, Egypt, and Benghazi, Libya. The ethical clearance was obtained from the Faculty of Dentistry, Alexandria University, Egypt in addition to Faculty of Dentistry, University of Benghazi, Libya. The informed consent was obtained from all participants along with the completed self-administered questionnaire.

A stratified random sampling approach was used to ensure representation across key demographic groups. The patients were selected from outpatient dental clinics affiliated with the Ministry of Health in both cities. The inclusion criteria were: individuals aged 30-60, residing in either Egypt or Libya, and willing to provide informed consent. Exclusion criteria included individuals with incomplete questionnaires and those with cognitive impairments that could affect the accuracy of responses. Data collection extended over a period of six months

A total of 2,920 participants were recruited, comprising 2,500 subjects from Alexandria (1,051 males and 1,449 females) and 420 subjects from Benghazi (148 males and 272 females). Participants were categorized based on smoking status (non-smoker, light smoker, heavy smoker), smoking type (cigarette. Shisha, both), and duration of smoking.

2.2. Periodontal Examination

Periodontal health status was assessed using the Community Periodontal Index (CPI), a standardized tool recommended by the World Health Organization (WHO) for evaluating periodontal conditions. The CPI measures probing depth and clinical attachment loss to determine the prevalence and severity of periodontal disease. Clinical examinations were performed using a WHO-calibrated periodontal probe [12] and a mouth mirror. To ensure consistency and minimize examiner bias, all clinical assessments were conducted by a single trained examiner.

2.3. Data Collection

In addition to the clinical examination, a structured questionnaire was designed to collect data on potential risk indicators for periodontal disease. The questionnaire gathered information on socioeconomic factors, smoking status, frequency, type and duration of smoking.

2.4. Statistical Analysis:

Descriptive statistics were presented through means, frequencies (n) and percentages (%). The chi-square test was used to compare distributions between the groups. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 24.0.

3. Results

The current study showed that an increased percentage of subjects with healthy sextants (score 0) was detected among non-smokers in both Alexandria and Benghazi at 1.4%, and 0.3%, respectively, compared to both heavy and light smokers. Furthermore, heavy smokers also showed an increased prevalence of deep periodontal pockets compared to non-smokers. These results are statistically significant ($p < 0.0001$) in both cities, suggesting a strong association between smoking and worsening periodontal status (Table 1).

The results also showed that non-smokers showed the highest percentages in relation to levels of attachment loss (score 0) compared to heavy and light smokers (Table 2).

Cigarette smoking was associated with more severe periodontal conditions (especially deep pockets) in Alexandria (68.4%) ,and Benghazi (47.2%). In Benghazi, the type of smoking significantly affects periodontal health, with cigarette smokers showing more severe disease than shisha smokers, (χ^2) = 14.02, P = 0.007 (Table 3).

Cigarette smokers showed greater variation in LOA levels, including more moderate to severe cases. However, no statistically significant associations were found between the type of smoking and LOA in either city, $P > 0.05$ (Table 4).

In both Alexandria and Benghazi, as the duration of smoking increases, the percentage of individuals with deep periodontal pockets (score 4) increases sharply to 87.1%, and 73.7%, respectively. The relationship between the duration of smoking and periodontal deterioration was statistically highly significant ($P < 0.0001$) in both cities.

4. Discussion

The present study demonstrates a clear association between smoking and periodontal deterioration, with non-smokers in both Alexandria and Benghazi exhibiting higher

percentages of healthy sextants (score 0) compared to both light and heavy smokers. Specifically, 1.4% and 0.3% of non-smokers in Alexandria and Benghazi, respectively, had healthy periodontal status, whereas heavy smokers exhibited a substantially higher prevalence of deep periodontal pockets, a finding that was statistically significant ($p < 0.0001$). These findings are consistent with numerous previous studies that have reported poorer periodontal health among smokers compared to non-smokers.

It was found that smokers are four times more likely to have periodontitis than non-smokers emphasizing the strong dose response relationship between tobacco use and periodontal disease severity [13]. In other studies, smokers were found to have a two to six times increased risk of developing periodontal disease compared to non-smokers, suggesting that smoking impairs the host immune response and reduces the healing capacity of periodontal tissues, thereby contributing to deeper periodontal pockets and greater attachment loss [4,14].

Table 1: Relation between Periodontal Status as assessed by CPI Index and Smoking levels

City	Smoking levels	Healthy (score 0)	Bleeding (score 1)	Calculus (score 2)	Shallow pockets (score 3)	Deep pockets (score 4)	X^2/ P value
Alexandria	**Light smoker**	N/A	N/A	18.6%	19.2%	62.2%	117.85
	Heavy smoker	0.7%	N/A	11.8%	18.1%	69.4%	< 0.0001*
	Non-smoker	1.4%	0.7%	22.4%	30.4 %	45.1%	
Benghazi	**Light smoker**	N/A	N/A	36.4%	39.4%	24.2%	25.81
	Heavy smoker	N/A	N/A	4.8%	38.7%	56.5%	< 0.0001*
	Non-smoker	0.3%	N/A	27.3 %	43.3%	29.1 %	

Table 2: Relation between periodontal status as assessed by LOA and smoking levels

City	Smoking levels	0-3 mm (score 0)	4-5 mm (score 1)	6-8 mm (score 2)	9-11 mm (score 3)	12 mm or more (score 4)	X^2/ P value
Alexandria	**Non-smoker**	56.5%	24.3%	12.2%	4.5%	2.5%	121.33
	Heavy smoker	32.1%	32.7%	21.7%	8.7%	4.8%	< 0.0001
	Light smoker	40.9%	28.1%	18.1%	9.4%	3.5%	
Benghazi	**Non-smoker**	77.7%	11.6%	4.7%	2.8%	3.1%	32.83
	Heavy smoker	46%	17.5%	17.5%	9.5%	9.5%	< 0.0001*
	Light smoker	78.8%	9.1%	9.1%	3%	N/A	

Table 3: Relation between Periodontal Status as assessed by CPI Index and Type of smoking

City	Type of smoking	Healthy (score 0)	Bleeding (score 1)	Calculus (score 2)	Shallow pockets (score 3)	Deep pockets (score 4)	X^2/ P value
Alexandria	**Cigarette**	0.6%	N/A	%12.3	18.7%	68.4%	7.07
	Shisha	N/A	N/A	20%	17.3%	%62.7	0.32 NS
Benghazi	**Cigarette**	N/A	N/A	14.3%	%38.5	47.2%	14.02
	Shisha	N/A	N/A	**100%**	N/A	N/A	0.007*

* P value is statistically significant at the 5% level (P < 0.05) NS: Not statistically significant

Table 4: Relation between periodontal status as assessed by LOA and types of smoking

City	Type of Smoking	0-3 mm (score 0)	4-5 mm (score 1)	6-8 mm (score 2)	9-11 mm (score 3)	12 mm or more (score 4)	X^2/ P value
Alexandria	**Cigarette**	33.3%	32.1%	21.5%	8.9%	4.2%	5.35
	Shisha	40%	30.7%	13.3%	9.3%	6.7%	0.72 NS
	Both	40%	20%	26.7%	6.7%	6.7%	
Benghazi	**Cigarette**	56%	15.4%	15.4%	7.7%	5.5%	3.04
	Shisha	100%	N/A	N/A	N/A	N/A	0.93 NS
	Both	100%	N/A	N/A	N/A	N/A	

Table 5: Relation between Periodontal Status as assessed by CPI Index and Duration of Smoking.

City	Duration of Smoking Years	Healthy (score 0)	Bleeding (score 1)	Calculus (score 2)	Shallow pockets (score 3)	Deep pockets (score 4)	X^2/ P value
Alexandria	**1 – 9**	3%	N/A	36.4%	34.3%	26.3%	232.61
	10 – 19	0.5%	N/A	25.6%	30.5%	43.5%	
	≥ 20	N/A	N/A	3.2 %	9.7 %	87.1%	< 0.0001*
Benghazi	**1 – 9**	N/A	N/A	40 %	44 %	16%	30.10
	10 – 19	N/A	N/A	12.5%	53.1%	34.4%	
	≥ 20	N/A	N/A	2.6%	23.7%	73.7%	< 0.0001*

* P value is statistically significant at the 5% level (P < 0.05) NS: Not statistically significant

The study also found that non-smokers had the highest percentage of low levels of attachment loss (score 0), which aligns with the results from [15], who demonstrated that non-smokers tend to maintain significantly better attachment levels than smokers. Moreover, a systematic review concluded that smoking negatively affects both clinical attachment level and probing depth, further corroborating the present findings [16].

The current findings reinforce the conclusion that smoking is a major risk factor for periodontal disease, not only affecting the clinical presentation but also influencing disease progression. This is in agreement with the CDC and WHO reports that identify smoking as one of the most important modifiable risk factors in periodontal pathology [17,18].

The study also shows that cigarette smoking was significantly associated with more severe periodontal conditions, particularly deep periodontal pockets. Furthermore, in Benghazi, cigarette smokers exhibited significantly worse periodontal health compared to shisha smokers, with a statistically significant association observed. These results suggest that cigarette smoking may exert a more detrimental impact on periodontal tissues than shisha smoking.

This finding is in line with recent studies which have demonstrated that cigarette smoke, due to its higher concentration of toxicants and direct contact with oral tissues, is more harmful to periodontal structures than other forms of tobacco consumption [9].

In contrast, while shisha smoking has also been linked to periodontal disease, the extent of tissue damage appears to be less severe. Differences in smoking habits, such as duration, frequency, and depth of inhalation, may explain these disparities. However, multiple studies have warned that waterpipe (shisha) use is not without risk, as it also contributes to periodontal inflammation, pocket formation, and bone loss [4],[19]. Public health misconceptions regarding the perceived safety of shisha remain a challenge for prevention efforts.

Interestingly, when evaluating periodontal status based on levels of attachment loss (LOA), cigarette smokers demonstrated greater variation in LOA scores, including higher proportions of moderate to severe cases. However, in contrast to the findings related to periodontal pocket depth, no statistically significant associations were found between the type of smoking (cigarette vs. shisha) and LOA in either Alexandria or Benghazi ($P > 0.05$). This suggests that while smoking type clearly influences the depth of periodontal pockets, its relationship with attachment loss may be more complex and influenced by additional factors such as oral hygiene, genetic susceptibility, and systemic health status.

These findings are partially supported by research indicating that the impact of smoking on LOA can be masked by other variables, particularly in cross-sectional studies. For instance, a stronger association between cigarette smoking and CAL was found, however, the variability among individuals and the importance of long-term exposure in detecting significant LOA changes were highlighted [20].

Moreover, the broader literature reinforces the understanding that cigarette smoking significantly impairs host immune responses, vascularity, and healing capacity,factors that contribute to more severe periodontal destruction, especially in long-term smokers [16].

The current study further demonstrates a strong and statistically significant relationship between the duration of smoking and the severity of periodontal disease. These findings are consistent with the well-documented dose-response relationship between smoking duration and periodontal destruction, where longer exposure to smoking was significantly correlated with worse periodontal outcomes, including increased pocket depth and greater clinical attachment loss [16]. The longer individuals are exposed to tobacco smoke, the more likely they are to experience chronic inflammation, microbial shifts, and impaired immune responses , and both intensity and

duration of tobacco use are predictive of periodontal disease severity [4], [15].

Additionally, evidence from a recent systematic review cpncluded that the periodontal damage from long-term smoking persists even after cessation, although quitting smoking can significantly improve treatment outcomes and reduce further attachment loss [21]. This highlights the critical need for early intervention and smoking cessation programs, especially for individuals with established long-term smoking habits.

The strength of the association in this study is particularly noteworthy, given the consistency of results across two geographically distinct cities, suggesting that the negative impact of smoking on periodontal health transcends regional or local environmental differences. Furthermore, the inclusion of duration and type of smoking adds to the growing body of literature emphasizing the multifactorial risk posed by tobacco use in oral health.

All in all, these findings strongly support the inclusion of smoking duration as a key variable in periodontal risk assessments and underscore the importance of incorporating tobacco-use counselling into routine dental care, particularly in populations with high smoking prevalence. The findings could provide evidence-based guidance for regional oral health policies, enhance smoking cessation programs, and highlight the need for targeted periodontal care in tobacco users within these populations. However, the results should be interpreted cautiously because of the limitations of the cross-sectional study design, which limits the ability to establish causal relationships. Therefore, longitudinal or experimental studies are needed to further explore and validate these findings. Another limitation is the use of a single examiner for clinical assessments, which, while ensuring consistency and eliminating inter-examiner variability, may introduce the potential for examiner bias. Although calibration was performed prior to data collection to ensure intra-examiner reliability, the absence of multiple examiners means that subtle biases in assessment cannot be entirely ruled out. The study did not include multivariate analysis to adjust for potential confounding variables such as age, gender, and socioeconomic status. As a result, some of the observed associations may be influenced by these underlying factors, and caution is needed when interpreting the findings. Future studies incorporating multivariate approaches are recommended to better account for these confounders and strengthen causal inferences. As smoking behavior was assessed through participant questionnaires, there is a risk of inaccurate reporting due to memory lapses or social desirability bias.

5. Conclusions

This study demonstrated a strong association between smoking and periodontal disease severity in Alexandria and Benghazi. Cigarette smokers showed higher rates of deep periodontal pockets and attachment loss compared to non-smokers and shisha users. While cigarette smoking had a more pronounced effect than shisha, the type of smoking did not significantly impact attachment loss. Notably, periodontal deterioration increased sharply with longer smoking duration, showing a statistically significant correlation. These findings reinforce smoking—particularly long-term cigarette use—as a key risk factor for periodontal disease, emphasizing the importance of tobacco cessation in dental care and public health strategies. These findings are consistent with current global evidence demonstrating that smoking is one of the most significant modifiable risk factors for periodontal disease. The results underscore the urgent need for incorporating smoking cessation counseling into dental care protocols, especially in high-risk populations. Public health initiatives targeting tobacco use—along with continuous periodontal monitoring for smokers—are essential to mitigate the burden of periodontal disease and promote better oral and systemic health outcomes.

Acknowledgment: The author would like to express his deepest appreciation to Dr. Hala

Ben Ghasheer, a specialist in dental public health (Department of Dental Public Health and Preventive Dentistry, Faculty of Dentistry, University of Benghazi) for her invaluable assistance and guidance in the preparation and publication of this work.

Conflict of Interest: None

Financial Disclosure: The author did not receive any financial support.

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Libyan Journal of Public Health Practices (LJPHP)

Journal homepage: https://journals.uob.edu.ly/LJPHP
ISSN (Online) 3008-1467

Research article

Feco-prevalence of *Helicobacter Pylori* among symptomatic patients in Al-Marj city

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ARTICLE INFO

Article history:
Received 1/5/2025
Revised , 15/5/2025
Accepted 25/5/2025
Available online June 2025

Keywords:
Helicobacter pylori
Dyspepsia
Stool antigen test
Fluorescence immunoassay
Libya

ABSTRACT

Helicobacter pylori is a bacterium that causes infections in a significant portion of the global population. This study aimed to determine the prevalence of *H. pylori* infection among dyspeptic patients and to investigate its association with age and sex in Al Marj City, Libya. A cross-sectional descriptive study was conducted at Tabebouk Laboratory from January 1, 2023, to December 31, 2024, involving 495 participants. Stool samples were analysed using a fluorescence immunoassay-based technique to detect *H. pylori* antigens. The overall prevalence of *H. pylori* infection was 50.3%, with males showing a higher infection rate (54.22%) than females (45.78%). The highest prevalence was observed in young adults aged 20-45 years (49.40%), followed by middle-aged and elderly individuals (≥46 years; 36.95%). Children and teenagers had significantly lower infection rates (6.83% each). No significant sex differences were found among children and teenagers. In conclusion, *H. pylori* infection rates were higher in males and most prevalent among young adults aged 20–45 years. These findings highlight the need for targeted public health strategies, especially in adult populations, to improve early detection and management of *H. pylori*-related gastrointestinal conditions.

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1. Introduction

Helicobacter pylori is classified as a Gram-negative, helical, microaerophilic microorganism that is a member of the *Helicobacteraceae* family. It predominantly targets the gastric mucosa, inhabiting the protective mucus layer that envelops the gastric epithelial cells. Although few bacteria interact directly with epithelial cells, *H. pylori* is recognized as a major pathogen associated with various gastroduodenal diseases, including ulcer dyspepsia, upper gastrointestinal haemorrhage, and gastric tumors such as mucosa-associated lymphoid tissue (MALT) lymphoma. It is additionally categorized as a Group 1 carcinogen by the International Agency for Research on Cancer, signifying a robust correlation with the etiology of gastric cancer [1].

The exact mode of *H. pylori* infection transmission is not fully understood, but it is believed to occur primarily through direct contact between individuals (oral-oral or fecal-oral), as well as through contaminated food and water sources [2]. Notably, *H. pylori* infection tends to cluster within families. Previous studies have demonstrated that children whose parents infected with *H. pylori* exhibit a markedly elevated incidence of infection, particularly when both parental figures test positive [3-5]. This observed familial aggregation implies a plausible mechanism for direct transmission between individuals or shared exposure to a common source within domestic environments. One investigation revealed that 68% of partners of infected individuals also harbored the infection, in stark contrast to only 9% of partners of uninfected individuals [6]. This evidence highlights the importance of family-based management strategies for controlling *H. pylori* infections [7].

Diagnosis of *H. pylori* infection employs various methods, including urea breath tests, blood tests, stool tests, and endoscopic examinations [8]. The stool antigen test (SAT) is the commonly used non-invasive technique for identifying *H. pylori* in stool samples. The prevalence of *H. pylori* infection can vary widely depending on the diagnostic techniques employed. For instance, studies report a prevalence range of 47.8% to 70.4% in Iraqi patients based on the diagnostic method used [9]. In patients with MALT lymphoma, reported prevalence rates vary from 79% to 85%, depending on whether multiple diagnostic methods were utilized [10].

The prevalence of *H. pylori* infection varies significantly across different populations and is influenced by several factors, including age, socioeconomic status, and sanitation conditions [11]. An estimated that approximately 4.4 billion people are infected [12]. In developing countries, over 80% of middle-aged individuals are affected, with rates exceeding 50% in regions with poor sanitation, such as parts of Africa and Asia [13].

In Africa, the prevalence averages around 90%, with specific rates in Nigeria 93.6% [14], Ghana 75.4% [15], and Egypt 90% [16]. In Asia, the seroprevalence rate is 44.2% in China, 37.6%-43.2% in Japan, and 51.0% in South Korea [17]. While in Libya, various reports reveal disparate prevalence rates, including 17.2% in Tripoli, 74% in Bani Waleed, and notably concerning rates of 83% in Sirte among patients exhibiting symptoms [18, 19].

This study aimed to assess the prevalence of *H. pylori* infection among dyspeptic patients in Al Marj City, Libya, and to investigate the relationship between age, sex, and infection rates. Understanding these variables is essential for developing effective public health interventions and improving diagnostic strategies.

2. Methodology

A cross-sectional descriptive study was undertaken to evaluate the prevalence of *H. pylori* infection and its association with demographic factors. The investigation took place at Tabebouk Laboratory in Al-Marj City, focusing on individuals presenting with dyspepsia from January 1, 2023, to December 31, 2024

Of the 508 initially examined patients, 13 were excluded due to incomplete information,

resulting in a final sample size of 495 participants. Participants were systematically recruited and analysed to ensure the representativeness of the population.

Stool samples were collected from all participants using a standardized protocol and were subsequently analysed for *H. pylori* antigens utilizing a fluorescence immunoassay-based technique. *H. pylori* stool antigen levels were quantified using the Chroma™ fluorescence immunoassay system and an i-CHROMA reader, following the manufacturer's instructions.

The assay provided quantitative measurements of stool antigen. Results were interpreted based on a reference value: concentrations below 1 ng/ml were classified as negative, while values equal to or exceeding this threshold indicated a positive result.

Demographic factors (age and sex) and diagnostic outcomes were recorded. Participants were stratified into age groups: children (1–12 years), adolescents (13–19 years), young adults (20–45 years), and middle-aged or elderly individuals (≥46 years). Data were analysed by SPSS software version 21. The chi-square statistical test was implemented to examine the relationship between demographic factors and the prevalence of *H. pylori*, with statistical significance determined at $P < 0.05$.

3. Results

Out of the 495 patients, 249 positive cases were identified, as shown in Table 1. Among these, the overall incidence of infected males was 135 out of 249 (54.22%), while the infection rate for females was 114 (45.78%), as presented in Table 2.

The distribution of *H. pylori* positive cases across age groups showed the highest prevalence among young adults (20–45 years), accounting for 49.40% of the total positive cases. This was followed by middle-aged and elderly individuals (≥46 years) at 36.95%. Both children (1–12 years) and teenagers (13–19 years) had the lowest prevalence, each comprising 6.83% of the positive cases. These findings suggest that *H. pylori* infection is significantly more common in adults, particularly those in early to middle adulthood as shown in Table 3

Table 1: Prevalence of *H. pylori* infections among the patients

Results	Frequency (No)	Percentage (%)
Negative	246	49.7%
Positive	249	50.3%
Total	495	100%

Table 2: Prevalence of *H. pylori* infection per sex

Sex	Results (Positive)	
	Frequency (No)	Percentage (%)
Male	135	54.22%
Female	114	45.78%
Total	249	100.00%

The age and sex distribution of participants shows variation across groups. Among males, the highest representation was in the 20–45 years and >46 years age groups, with 55 % each. For females, the largest group was 13–19 years, comprising 64 %, followed by the >46 years group with 43 %. In the 1–12 years group, there were slightly more males 53% than females 47%. Overall, males were more prevalent in the adult age groups, while females were more represented among teenagers as shown in Figure 1.

5. Discussion

This study investigated the prevalence of *H. pylori* infection among 495 patients, revealing an overall infection rate of 50.3%. This prevalence aligns with findings from other studies in similar settings, although regional variations are notable due to differences in diagnostic methods, socioeconomic factors, and environmental conditions [11].

Sex differences were significant, with males (54.22%) exhibiting a higher prevalence than females (45.78%).

Table 3 Distribution of *H. pylori* Infection Across Age Groups

Age Groups (Year)	Results (Positive)	
	Frequency (No)	Percentage (%)
Children 1 – 12	17	6.83%
Teenagers 13 – 19	17	6.83%
Young adult 20 – 45	123	49.40%
Middle age + elderly 46 ≥	92	36.95%
Total	249	100%

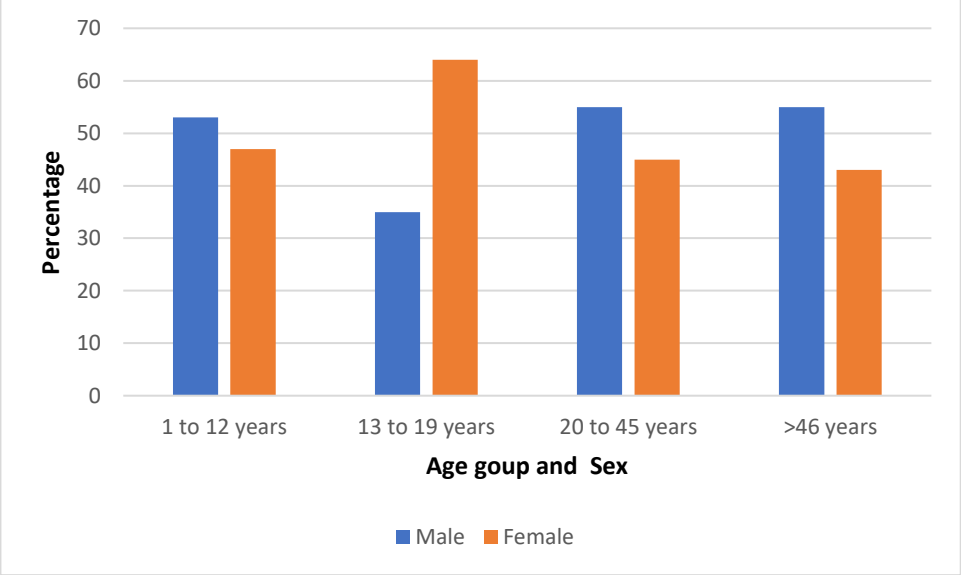

Figure 1: Relationship between *H. pylori* Infection and Demographic Factors (Age and Sex)

Similar trends have been reported in other studies, suggesting that lifestyle factors, such as smoking and alcohol consumption—more common among men—could elevate the risk of infection. Biological factors, including hormonal influences on the immune response, may also play a role [20].

Age-specific trends indicated that young adults (20–45 years) had the highest infection rate (49.40%), followed by middle-aged and elderly individuals (≥46 years; 36.95%). Children and teenagers showed a significantly lower prevalence (6.83% each). These findings support evidence suggesting that *H. pylori* acquisition often occurs in childhood but may remain latent or asymptomatic until later in life [21]. The lower prevalence among older adults compared to young adults could reflect cohort effects, including improved hygiene standards or healthcare access over time.

The diagnostic test employed in this study was critical in determining the observed prevalence. Although the specific test type was not detailed

in the results, different diagnostic methods vary in sensitivity and specificity, which can significantly influence prevalence estimates. For instance, serological tests, while convenient, may overestimate prevalence as they detect both past and current infections. In contrast, urea breath tests and SAT provide more accurate measures of active infections but may require advanced infrastructure and incur higher costs [22].

Given the reported prevalence, it is essential to evaluate whether the diagnostic method used is optimally suited for detecting active infections. Misclassification due to test limitations could lead to either underestimation or overestimation of the true infection burden.

4. Conclusions

This study shows a high prevalence of *H. pylori* infection among dyspeptic patients in Al Marj City, Libya, especially among young adults aged 20–45 years. The findings underscore the importance of implementing targeted public health strategies to address this infection in high-risk age groups. Moreover, the observed age-related and sex-related patterns emphasize the need for continued surveillance to guide prevention and treatment efforts effectively.

Acknowledgement

The authors extend their sincere gratitude to the management of Tabebouk Laboratory in Al-Marj City, as well as the laboratory staff, for their support and cooperation throughout the research period.

Conflict of Interest

The authors report no conflicts of interest.

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Libyan Journal of Public Health Practices (LJPHP)

Journal home page: https://journals.uob.edu.ly/LJPHP
ISSN (Online) 3008-1467

Research article

Prevalence of multi-ingredient pre-workout ergogenic and protein supplement use and effect on kidney function among university students and athletes in Benghazi, Libya

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ARTICLE INFO

Article history:
Received 20/5/2025
Revised 25/5/2025
Accepted 30/5/2025
Available online June 2025

Keywords:
Multi-Ingredient Pre-Workout Ergogenic Supplements
Athletes
University students
Kidney function
Protein

ABSTRACT

The use of multi-ingredient pre-workout supplements (MIPS) is becoming increasingly common among university students and athletes, driven by the perceived benefits of increased energy, endurance, and muscle performance. However, the overuse of protein, particularly in this context, raises concerns regarding renal health. Few studies have addressed this issue in North African populations. A cross-sectional study was conducted among 244 students and athletes in Benghazi (56.6% males, 43.4% females). Data were collected via online questionnaire and analyzed using SPSS v22. A subgroup (n=30) underwent renal function testing, including serum urea, creatinine, uric acid, and electrolytes. Chi-square tests and Pearson correlations were used ($P < 0.05$).

Male participants reported significantly higher supplement use (71.02%) than females (41.51%, $P < 0.001$). Nevertheless, (37.68%) of males compared to females (42.45%) reported that they would consume ergogenic supplements if they were encouraged by their coaches. Protein supplement use was positively associated with income ($r = 0.229$, $P = 0.001$). As for the detrimental effects on kidney function, renal testing indicated elevated urea and uric acid among MIPS users, suggesting potential kidney strain.

MIPS are widely used among students and athletes in Benghazi, with notable gender differences in usage and perception. MIPS potential detrimental effects on kidney function raise concerns about safety and health risks among younger users. A deeper understanding of these supplements' risks and benefits is crucial for informed decision-making. This study is among the first in Libya to examine the physiological effects of MIPS use, offering critical insight into an under-researched population.

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1. Introduction

Multi-ingredient pre-workout Ergogenic supplements (MIPS) are dietary supplements that are taken before a workout and consist of stimulants, amino acids, creatinine, beta-alanine, nitric oxide precursors, electrolytes and vitamins to enhance performance during training or competition. For this reason, these supplements are commonly referred to as "ergogenic," which translates to means they enhance the strength, endurance,, and concentration levels of the human body [1]. However, there are concerns regarding the efficacy and safety of MIPS especially for the categories of users that are adolescents and young adults [2]. The application of MIPS can be decided by the athlete's tolerance level, training, and general health. At the same time, there is a high variability of the effectiveness of these supplements depending on the composition and concentration of additives in them [3]. Such nutrients as caffeine and creatine have been known to boost muscular force, power and endurance [2, 3], but it comes with the risk of using prohibited ergogenic agents that are unhealthy and against the ethics of competitions [1].

Caffeine is widely used in MIPS because they have been scientifically confirmed to improve performance during tasks. It acts mostly by blocking adenosine receptors in the brain which causes increased wakefulness and decrease in the feeling of tiredness [4]. Also, a review in 2016 clarified that caffeine has the effect of acting on the central nervous system and providing an increase in the levels of concentration, reaction, and overall mental activity [5]. In 2023 another review was conducted to clarify how stimulating the emission of dopamine and norepinephrine neurotransmitters are associated with improved mood and attention [6]. It was also reported that Caffeine ingestion (5–6 mg/kg) significantly increased endurance time and fat oxidation in both rats and athletes during exercise ($p < 0.05$). Furthermore, It also elevate blood FFA and lactate levels while reducing glycogen utilization, enhancing performance efficiency [7]. Additionally, it enhances muscle contractility, calcium release in muscle fibers [8], and increases metabolic rate, thermogenesis thus raises calorie utilization levels [9]. Effective use of caffeine in MIPS requires careful consideration of dosage and timing, tailored to individual tolerance and specific training needs [10]. While generally safe in moderate amounts, excessive caffeine intake can lead to side effects such as jitteriness, increased heart rate, gastrointestinal discomfort, and insomnia [11]. Athletes should monitor their intake to avoid adverse effects.

Beta-alanine is a naturally occurring amino acid that elevates muscle carnosine levels, acting as an intracellular buffer to maintain pH balance during high-intensity exercise [12]. This buffering effect is particularly beneficial for delaying muscle fatigue. Beta-alanine is commonly included in MIPS for performance enhancement by increasing carnosine levels, thus extending periods of high-intensity activity [12]. It is often combined with other ingredients like caffeine and creatine to synergistically improve overall performance [13, 14]. Another scientific studies as the one conducted in 2019 supported the beta-alanine's role in enhancing exercise capacity and muscle power output [15]. A systematic review and meta-Analysis in 2020 showed that athletes use MIPS containing beta-alanine to optimize their training and competitive performance [16]. However, Beta-alanine supplementation typically involves daily doses of 3 to 6 grams over several weeks to achieve optimal muscle carnosine levels [12]. Common side effects include paresthesia, a temporary tingling sensation, which is generally harmless [17]. To investigate the individual responses a GRADE-assessed systematic review and meta-analysis was done and found out that the responses may vary, necessitating adjustments in dosage for different athletes [18].

A single-blind, placebo-controlled, crossover trial concluded that creatine monohydrate is renowned for its ability to enhance athletic performance by increasing muscle phosphocreatine levels, which are crucial for rapid ATP replenishment during high-intensity activities [19]. Research indicates that creatine supplementation can also buffer lactic acid

buildup, thereby delaying fatigue [20]. In MIPS formulations, creatine enhances muscle strength and power output, supports anaerobic performance, and promotes muscle cell hydration and volume [21-23] When combined with other ingredients, creatine can provide a synergistic effect on performance by targeting different aspects of energy metabolism and muscle function [24]. To optimize these performance-enhancing effects, creatine supplementation typically involves a loading phase—consuming approximately 20 grams per day for 5–7 days—followed by a maintenance phase of 3–5 grams per day to sustain elevated muscle creatine stores [24], athlete's knowledge in this area might be very limited in this area . This protocol has been widely adopted across various athletic disciplines to improve training adaptations and competitive performance [25]. When included in MIPS, creatine's efficacy may be further amplified through synergistic interactions with other active compounds; however, attention to dosage, safety, and individual tolerance remains essential [20, 26].

BCAAs, comprising leucine, isoleucine, and valine, are essential for muscle protein synthesis (MPS) and the reduction of muscle protein breakdown (MPB) [26, 27]. BCAAs stimulate MPS through the mTOR pathway and help reduce MPB by inhibiting the ubiquitin-proteasome pathway, which is critical for muscle maintenance [28, 29]. They also provide an additional energy source during prolonged exercise, reduce central fatigue, and support immune function [30-32]. In MIPS, BCAAs are often combined with other ingredients to enhance performance and recovery [2]. They also contribute to cell volumization and hydration, which support muscle size and appearance [33]. To fully harness these benefits, BCAAs are commonly consumed before, during, or after exercise to support MPS, reduce MPB, and enhance recovery [34]. Their combination with other nutrients is frequently employed to maximize their physiological impact [26]. However, adherence to recommended dosages and timing strategies is essential for optimizing their effectiveness in athletic and training contexts.

MIPS can present several health risks due to their complex formulations. Potential side effects include gastrointestinal issues, cardiovascular effects, adverse interactions with medications, mislabeling and contamination, long-term health effects, insomnia, dehydration, nervousness, dependency, and strain on kidneys and liver [34-37]. These risks underscore the importance of careful use and consideration of individual health conditions.

Knowledge of MIPS ingredients and risks varies, with many users unaware of proper usage [38, 39]. Attitudes range from strong belief in benefits to concerns over safety and credibility [40-42]. Practices are inconsistent, with users often misusing dosage or timing [43, 44]. Poor dietary habits and low physical activity, especially among university students, further impact supplement use [45-47].

The use of MIPS among student-athletes warrants investigation due to mixed evidence on their efficacy and safety. While some studies report benefits such as increased endurance and strength, others present contradictory results and highlight potential health risks, especially for young users [2, 3, 48]. Additionally, there are concerns about the regulatory oversight of these supplements and their impact on kidney function and overall health [1]. The prevalence of MIPS use, the motivations behind their consumption, and their effects on kidney function and overall health are crucial areas for further research.

Therefore, the objective of this study was to assess the prevalence of pre-workout ergogenic and protein supplements use among university students and athletes across genders, to assess knowledge, attitudes, and practices related to protein and supplement use among both genders in the target group and to evaluate their association with changes in kidney function.

The results of this study could assist universities and athletic programs in crafting customized nutritional guidelines and interventions. Knowing the extent and consequences of the use of supplements among this population group will help in interventions in the areas of public health, nutrition and

education with regard to safe use of supplements.

3. Methodology

3.1. Study Design and Participants

This study employed a cross-sectional, observational design to assess the use of multi-ingredient pre-workout supplements (MIPS) among students and athletes in Benghazi, Libya. Data collection was conducted over a four-week period using an online questionnaire distributed via Google Forms. The study aimed to explore the prevalence and patterns of MIPS usage, as well as associated attitudes and practices within this population.

3.2. Study Participants

To determine the appropriate sample size, a confidence interval of 95% and a margin of error of 5% were used. The calculation indicated that a sample of 230 participants would provide sufficient statistical power to detect meaningful variations and represent the student population at the University of Benghazi. Ultimately, 275 individuals completed the questionnaire, of which 244 responses were valid and used for analysis. Participants were required to be between 17 and 35 years old and either enrolled at the University of Benghazi or regular attendees at gyms in Benghazi. Both male and female participants were included in the study.

3.3. Data Collection

Data were gathered through an internet-based validated questionnaire (Google Forms), which was designed to be accessible and user-friendly. The survey included sections on demographic characteristics, sports participation, and MIPS usage. Supplement use was evaluated by asking participants if they had used any dietary or ergogenic supplements in the past six months. For those who reported supplement use, additional questions explored the types of supplements used, reasons for use, and sources of information regarding the supplements. The questionnaire link was disseminated among students and gym-goers in Benghazi.

3.4. Kidney Function Assessment

A subsample of participants (n=30) who regularly attended gyms was invited to undergo renal function testing. These included measurements of serum creatinine, albumin, electrolytes (sodium, potassium), and uric acid to investigate potential relationships between MIPS use and any association with adverse effects on kidney function.

3.5. Knowledge, Attitudes, and Practices (KAP) Framework

The study utilized the Knowledge, Attitudes, and Practices (KAP) framework to evaluate participants' understanding, perceptions, and behaviors regarding MIPS. A structured questionnaire was developed to assess the following:

Knowledge: Awareness of MIPS components, benefits, risks, and appropriate usage.

Attitudes: Perceptions of the effectiveness and safety of MIPS.

Practices: Actual usage patterns, adherence to guidelines, and perceived outcomes.

3.6. Data Analysis

Data analysis was conducted using SPSS version 22. Descriptive statistics, cross-tabulations, and Pearson correlations were employed to describe the patterns of MIPS use and examine relationships between variables. Chi-square tests were used to assess differences between male and female participants. A p-value of less than 0.05 was considered to be statistically significant.

3.7. Ethical Statement

Approval for the study was obtained from the Research and Studies Department of the University of Benghazi. Informed consent was secured from all participants, who were provided with detailed information about the study's purpose, procedures, potential risks, and benefits. Participants had the option to withdraw from the study at any time. Confidentiality was maintained by anonymizing personal information and securely storing data to prevent unauthorized access. Data were reported in aggregate form to ensure participant anonymity.

4. Results

4.1. Demographical characteristics

Table 1 shows the demographic characteristics of the study participants relative to gender. The study collected data from 275 students. Data from only 244 participants was used for the study analysis. 36 participants were excluded either because of repeated data or uncompleted questionnaires. Out of the 244 participants, where 56.6% of the participants were males and 43.4% were females.

Age distribution: The distribution of males and females among the age groups were as following: Group-1: (17-20 years) represented 7.38% of the sample, 7.97% of them were males and 6.6% were females. Age group-2 (21-25 years) represented 7.38% of the sample, 31.95% of them were males and 58.5% were females. Age group-3 (26 – 30 year) represented 24.6% of the sample, 27.5% of them were males and 20.8% were females. Age group-4 (above 30 years) represented 23.8% of the sample, 31.95% were males and 13.2% were females as shown in table-1. Females were significantly younger than the male participants (P=0.001).

Marital status: table -2 shows the marital status of participant. The majority of participants were single (82%) and higher proportion of males were married compared to the females (P=0.001).

Income: Males had significantly higher income compared to females (P=0.001). The income was divided into five categories:- Category 1, (no income) 9.8% of the participants were in this category, 15.9% were males and 1.9% were females. Category 2, (income less than 500) 11.5% of the participants were in this category, 5.8% were males and 20.8% were females. Category 3 (500- 1000) 23.4% of the participants were in this category, 25.4% were males and 20.8% were females. Category 4, (1000- 2000) 28.3% of the participants were in this category, 30.4% were males and 25.5% were females. As for the last category 5, (greater than 2000) only 26.2% of the participants were in this category, 32.6% were males and 17.95% were females.

Body mass index (BMI): no significant differences in BMI between males and females (P=0.08). Eighty two percent of the participants has a BMI < 18.5 (0.72% of males 0.96% of the female). The BMI among participants age (18.5 – 24.9) was 47.9%, (43.48% of the males and 53.77% of the females). 35.25%, of the participants had a BMI (25 – 29.9) (21.74% of males and 52.83% of female. 15.98% of the participants had a BMI (≤ 30) (10.87% of males and 22.6 of females). 22.64% of females and 10.85% of males were classified as obese according to their BMI.

Table 1. Demographic characteristics of study participants relative to gender

	Variable	All	Male	Female	P. Value*
	Gender	244 (100%)	138 (56.6%)	106 (43.4%)	0.001
Age groups	1 (17-20) 2 (21-25) 3 (26-30) 4 (>30)	18 (7.38%) 106 (73.6%) 60 (24.6%) 58 (23.8%)	11 (7.97%) 44 (31.95) 38 (27.5%) 44 (31.95)	7 (6.6%) 62 (58.5%) 22 (20.8%) 14 (13.2%)	0.001
Marital status	Single Married	200 (82%) 44 (18%)	110 (79.7%) 28 (20.3%)	91 (85.9) 15 (14.1%)	0.001
Income	No income < 500 500-1000 1000-2000 >2000	24 (9.8%) 30 (11.5%) 57 (23.4%) 69 (28.3) 64 (26.2%)	22 (15.9%) 8 (5.8%) 35 (25.4%) 42 (30.4%) 45 (32.6%)	2 (1.9%) 22 (20.8%) 22 (20.8%) 27 (25.5%) 19 (17.95)	0.001
BMI	1 (<18.5) 2 (18.5-24.9) 3 (25-29.9) 4 (30 and above)	2 (0.82%) 117 (47.9%) 86 (35.25%) 39 (15.98%)	1 (0.96%) 57 (53.77%) 56 (52.83%) 24 (22.64%)	1 (0.72%) 60 (43.48%) 30 (21.74%) 15 (10.87%)	0.08

(*) Chi squares test for the proportion between males and females

4.2. Uses of nutritional/ ergogenic supplements

Figure 1 shows the number of participants that used nutritional supplements to improve their sport performance. 71.02% of males and 41.51% of females and percentage of people who didn't consume nutritional supplements was 28.98% of males and 58.49% of females (P<0.001).

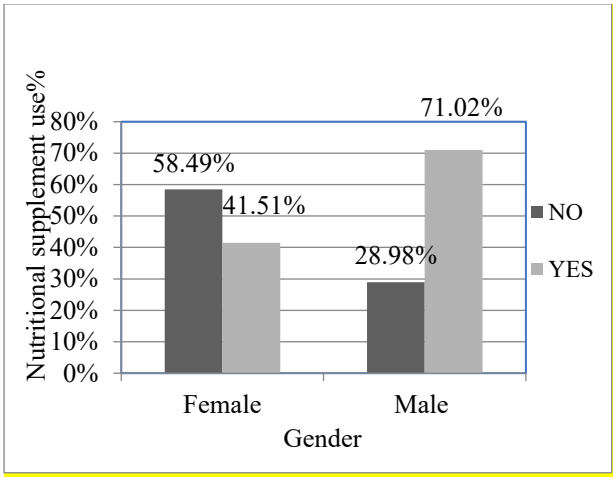

Figure 1. Nutritional supplement use across genders

Figure 2 shows the number of participants that used ergogenic supplements to improve their performance was 2.83% of females and 15.94% of males from 244 of total pooled data. 97.16% of female and 84.05% of males who never consumed ergogenic supplements

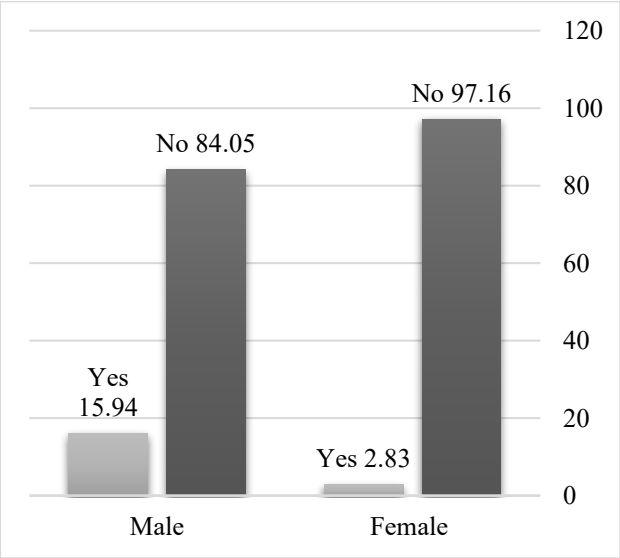

Figure 2. Use of ergogenic supplements by gender

4.3. Opinion of participants towards pre-workout supplements

Figure 3 shows attitude of participants towards pre-workout supplements. 9.43% of females and 12.31% of males strongly agree that pre-workout supplements enhance their athlete performance. 50% of females and 71.73% of males agrees and 32.07% of female and 13.76% of males disagree and 6.60% of female and 2.17 % of males strongly disagree agree that pre-workout supplements enhance their athlete performance, as shown below: significant differences between male and females who agrees on that pre-workout supplements enhances their athlete performance (P<0.001), where a larger proportion of males (71.73%) compared to females (50%) agreed on his statement.

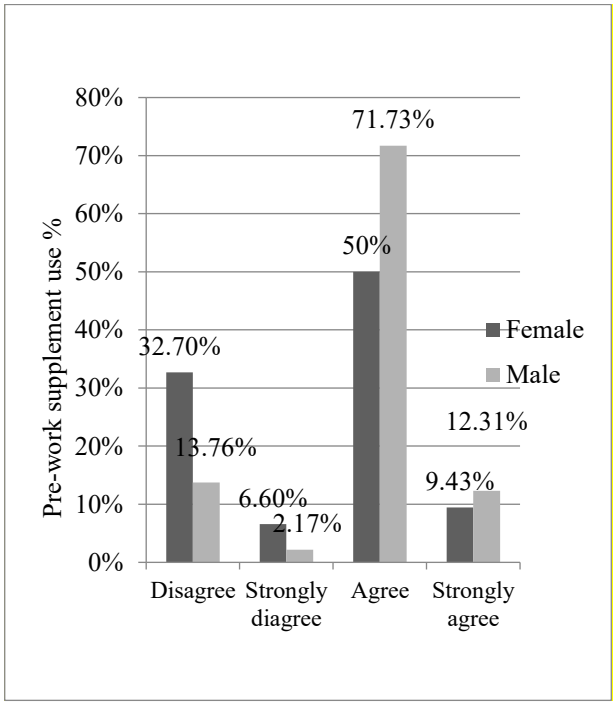

Figure 3. Attitude of participants towards pre-workout supplements

4.4. Participants food practice rate

Figure 4 shows the total participants that assessed the rate of their healthy food from 1- 5 was (n=243) people, which was the majority of answers for females 55.2% and 57.2% for males choose rate 3, And the least of male 2.17% and 1.90% of females choose rate 1, and 21.90% for females and 21.73% for males

choose rate 4, and 17.14% of females and 11.59% of males choose rate 2, and 7.24% of males and 3.80% of females choose rate 5. No significant differences between males and females (p >0.05) as shown below:

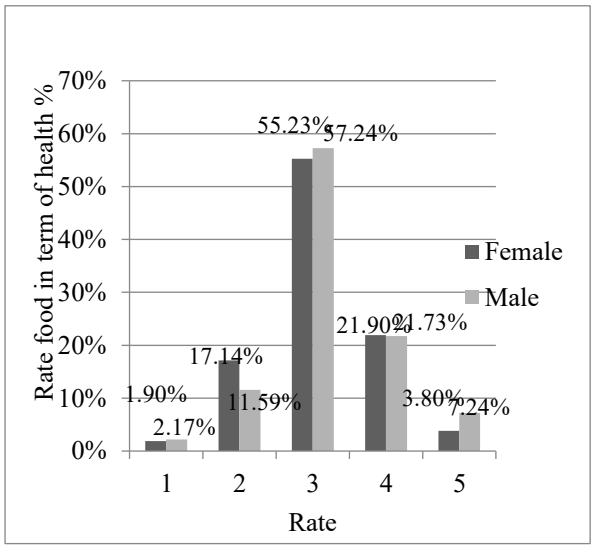

Figure 4. Rate your food practice response

4.5. Consuming ergogenic supplements based on coaches' encouragement

Figure 5 shows that lower proportion of males (37.68%) compared to females (42.45%) (P<0.05) would consume ergogenic supplements if they were encouraged by their coaches, as shown below:

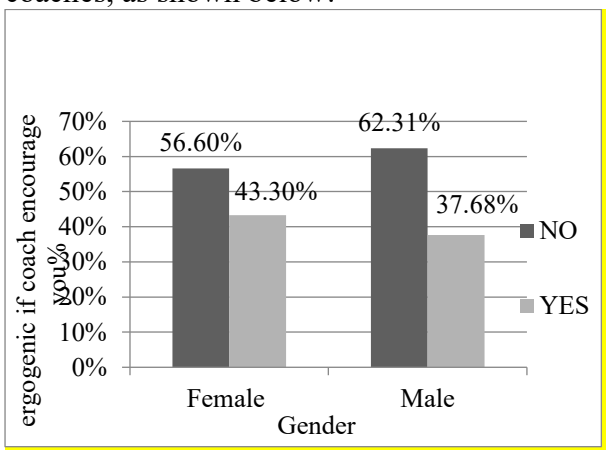

Figure 5. Would you take ergogenic supplements if your coach encouraged you (practice)

4.6. Knowledge question about ergogenic supplements and muscle building /fat loss

Figure 6 a larger proportion of males (55.79%) compared to females (29.24%) agreed that ergogenic supplement will accelerate muscle building and fat loss (P=0.001). 42.45% of female and 28.98% of male had intermediate agreement, and 26.4% of females and 15.21% of male s disagreed. Males appeared to have higher believes and expectations regarding the effects of ergogenic and protein supplements compared to females (P=0.001).

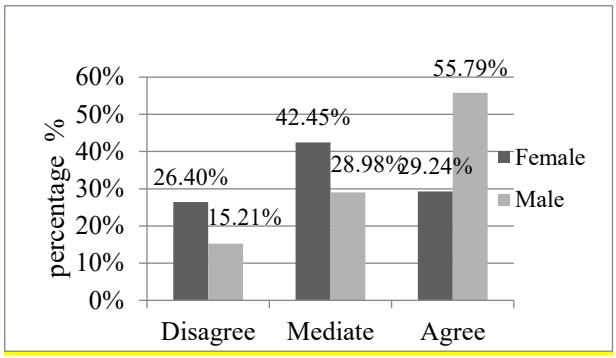

Figure 6. Opinion of participants regarding the knowledge question (Ergogenic supplements will accelerate muscle building and fat loss)

4.7. Participants believes

Figure.7 The number of people believe that nutritional supplements are necessary even if the diet is sufficient to meet nutritional needs was 35.27%, 27.35% of them were females and 41.30% were males who agreed on that. 33.37% of males and 29.24% of females had mediate of agreement and 42.45% of females and 24.63% of males disagreed with the statement, significant differences between males and females in responding to this question (P=0.001) as show below.

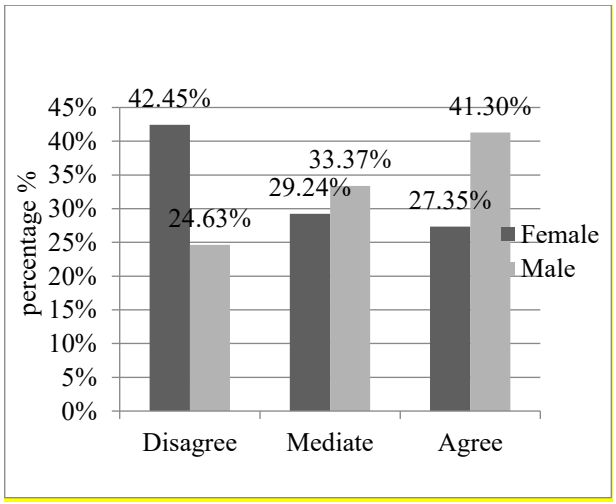

Figure 7. Believes of participants that supplements would be necessary even if that diet was sufficient

4.8. Income and protein supplements intake

Table- 2 shows that there a weak positive but significant correlations (r=.229) between income and protein supplements consumption (P=0.001). The higher the income the more proteins supplement were used among participants.

Table 2. Correlation between income score and protein supplements consumption

		Protein scoops score	Income score
Protein scoops score	Pearson Correlation	1	.229**
	Sig. (2-tailed)		.001
	N	244	220
Income score	Pearson Correlation	.229**	1
	Sig. (2-tailed)	.001	
	N	220	220

** P value less than 0.05

4.9. Participants age and protein scoops per day

Table 3 shows that there no correlation (P= 0.79) between the number of protein scoops and the age of participants (R=0.17).

Table 3. The correlation between the number of protein scoops and the age of participants

		Protein scoops score	Age
Protein scoops core	Pearson Correlation	1	.017
	Sig. (2-tailed)		.796
	N	244	242
Age	Pearson Correlation	.017	1
	Sig. (2-tailed)	.796	
	N	242	242

4.10. Hormone uses among males

Figure- 8 shows that 90.5% of male participants didn't consume hormones, while 5.1% of males were using anabolic steroids and 2.5% of males were using growth hormones and 1.8% of males were using Dianabol and 4% were using androlic and only 0.7% of male were using insulin hormone during the time of the study.

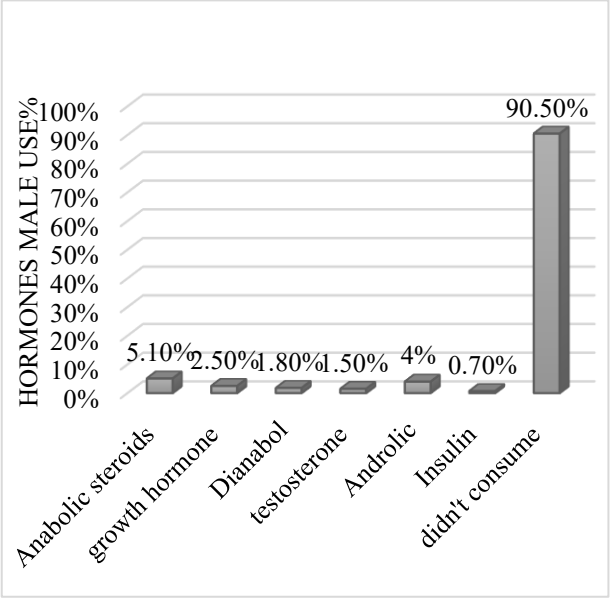

Figure 8. The use of hormones among male participants

4.11. Biomarkers of kidney function

Table 4 shows function compared to normal value among sub-sample (n=30) gym users taking different Multi-Ingredient Pre-Workout Ergogenic and protein supplements

Table 4. Changes in biomarkers of kidney

Kidney function biomarker	Mean for participants	Normal value	P val ue
Urea(Mg\dl)	31.78	5 to 20	**
Creatinine(Mg\dl)	0.87	0.74 to 1.35	
Sodium(mmol\L)	140.95	135 to 145	
Potassium(mmol\L)	4.454	3.5-5.2	
Chloride(meq\L)	100.14	96-106	
Uric Acid(Mg\dl)	6.30	2. 4 to 6. 0	**
ALBUMIN(g\dl)	5.17	3.5 to 5.5	

** P value less than 0.05

Table 5. Frequency of protein intake

Score (number of scoops/day)	Frequency	Percent (%)	Valid Percent	Cumulative Percent
0 (not taking protein)	147	60.2	60.2	60.2
1.0 (taking one scoop/day)	31	12.7	12.7	73.0
2.0 (taking two scoops/day)	53	21.7	21.7	94.7
3.0 (taking 3 scoops/day)	13	5.3	5.3	100.0
Total	244	100.0	100.0	

4.12. Frequency of protein supplements intake

Table- 5. Shows the number of proteins scoops used among participants. 60% of participants didn't use protein supplement. 12.7% reported that they consumed 1 scoop/day. 21.7% consumed scoops/day and only 5.3% consumed 3 scoops/day of proteins supplement

5. Discussion

This study aimed to assess the prevalence of pre-workout ergogenic and protein supplements use among university students and athletes across genders, to assess knowledge, attitudes, and practices related to protein supplement use among both genders in the target group and to evaluate their association with changes in kidney function. With a sample of 244 participants (56.6% males and 43.4% females), the study provided a balanced representation of both genders, essential for achieving the research objectives.

1. Perceived Differences concerning supplements and supplement use between male and female athletes

This study revealed that men and women used supplements differently. Protein and nutritional supplement intake show a higher intake for males than for females with a difference of 10.8 %. Specifically, 71. 02% male used nutritional supplement when compared to 41. 51% of females. These findings are similar to other research conducted in Saudi Arabia and Canada which also reported that there was a higher consumption of protein and ergogenic supplement among males [49-51]. The higher intake in protein supplement consumption among male consumers has been supported by data in other populations in which consumption of many performance-enhancing substances is higher among males [49-51].

The study also found that a larger proportion of males (71.73%) agreed that pre-workout supplements enhance athletic performance, compared to 50% of females ($P < 0.001$). Additionally, 55.79% of males believed that ergogenic supplements accelerate muscle building and fat loss, while only 29.24% of females shared this belief. This difference highlights a gender-specific perception of the benefits of these supplements. However, lack of knowledge around the proper use of these supplements was very evident throughout the group and further education programs around the safe use of supplements among university students are needed.

2. Potential Risks and Health Concerns

A significant portion of the study's participants (40%) used protein supplements, with 26% consuming more than the recommended two scoops per day. Excessive protein intake has been associated with potential health risks, including kidney damage. The current study noted elevated serum urea and uric acid levels among users of Multi-Ingredient Pre-Workout Supplements (MIPS) and protein supplements, corroborating findings that suggest increased risks of micro-albuminuria and interference with thyroid medication [52, 53].

While our study indicated a higher serum urea and uric acid values among MIPS users and

protein supplement users as indicators of potential risks like kidney stress or kidney damage, these increases could be due to other causes other than supplement for instant dehydration could increase in athletes who lose fluid as sweat, potentially concentrating blood components and transiently increasing urea and uric acid levels [54]. Both dehydration and reduced renal filtration efficacy decrease the effectiveness of kidney filtration, causing spurious increases in renal markers without injury. the exercise intensity can lead to prolonged muscle breakdown and waste nitrogen production, transiently elevating blood levels of urea and creatinine on blood work [55]. It also could be increased d as a result of nutritional Intake by consuming a high-protein foods, particularly purine-rich foods (seafood, red meat, or legumes), can raise the level of uric acid [56]. Similarly, high salt or processed food consumption can affect markers of kidney function [57, 58]. These factors of diet may independently result in biochemical changes as described. Moreover, there some certain drugs / medication such NSAIDs and diuretics drug used by athletes can has a huge impact on the kidney function and this will affect the biomedical parameters [59]. In terms of hormone use, approximately 10% of male participants reported consuming hormones, including anabolic steroids, growth hormones, and other substances. This prevalence is lower but still notable compared to a study conducted in Riyadh, Saudi Arabia, where 47.9% of gym members used nutritional supplements and 7.9% used hormones [60]. This suggests a broad spectrum of supplement and hormone use among gym-goers, with potential implications for health and performance.

3. Perceptions and Implications

Gender differences were also evident in perceptions of supplement effectiveness. Males were more likely to view pre-workout supplements as beneficial for performance enhancement compared to females. This discrepancy indicates that males may be more inclined to use supplements based on their perceived benefits, while females may be more skeptical or cautious. Similar patterns were observed in a 2022 study of NCAA student-athletes, where males reported higher rates of supplement use compared to females and showed greater disordered eating attitudes and behaviors associated with supplement use [61]. These findings underscore the need for targeted educational and intervention strategies to address the specific attitudes and behaviors related to supplement use among different genders.

4. Recommendations for Practice and Future Research

Given the widespread use of MIPS and protein supplements, it is crucial for student-athletes and gym-goers to consult healthcare professionals before starting any supplements use.

The results of the research targeted health policy, particularly in the university setting. Educational programs that raise awareness about the risks of high-level supplement use, with particular emphasis on male students who recorded higher supplement use rates, need to be established. University guidelines that render medical consultation mandatory prior to supplement use must be established. Gender-sensitive awareness raising and periodic health checkups can alleviate health risks, especially those associated with kidney function. Finally, there is a need for more studies to provide evidence-based policy regarding supplement use among young adults. Control of the advised dosages and knowledge of potential side effects must be ensured to avoid health risk. Education regarding the risks and advantages of the supplements must be in advance and alternative interventions to performance improvement through nutrition and sleep optimization must be promoted. Further research is needed to explore the long-term health effects of MIPS and to develop safe and effective supplement formulations. Continued investigation into the gender-specific attitudes and health outcomes associated with supplement use will help tailor educational interventions, clinical guidelines, and policy

recommendations that address the distinct needs and behaviors of male and female users more effectively.

6. Conclusion

This study highlights the prevalent use of MIPS among students and athletes in Benghazi, with a notable gender disparity in supplement use patterns and perceptions. While MIPS offers potential performance benefits, concerns about safety and health risks persist, particularly for younger users. A deeper understanding of these supplements' risks and benefits is crucial for informed decision-making. The authors recommended that before taking MIPS, people must visit a healthcare provider or sports dietitian to assess individual needs, risk, and interactions with medication or medical conditions. Take as directed and not exceeding the daily guideline. Monitor for any adverse effects and discontinue if symptoms are observed. Educate student-athletes on MIPS benefits and risks, side effects, so they can make informed choices about supplementation. Compare performance and recovery optimization alternatives with healthcare providers and certified sport nutritionists, including nutritional optimization, hydration, and rest. Encourage student-athletes to prioritize nutrition, hydration, and adequate rest as a baseline to optimize performance. Offer ongoing support for research to continue building our understanding of how MIPES affects.

Study limitation

Cross-sectional studies frequently depend on self-reported data, which can be prone to errors and inconsistencies, thus compromising the reliability of the findings.

The lack of longitudinal data makes it challenging to account for confounding variables that might influence both the exposure and the outcome, resulting in potentially misleading associations. The kidney function in this study required significant financial investment and are time-intensive. The stages of planning, recruitment, execution, and data analysis can take long time and demand considerable resources.

Acknowledgements:
The authors would like to thank Dr.Ghada Elgadi and all the participants who generously volunteered their time and effort to take part in this study.

Conflict of Interest and Financial Disclosure The author(s) declare no conflict of interest regarding the publication of this paper. Additionally, no financial support, grants, or funding was received from any organization or individual that could influence the outcomes or interpretations of this study

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Libyan Journal of Public Health Practices (LJPHP)

Journal homepage:https://journals.uob.edu.ly/LJPHP/index

ISSN (Online) 3008-1467

Research Article

Predictors of Severity in Autism Spectrum Disorders among Libyan Children: Cross-sectional analysis in Almarj

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ARTICLE INFO

Article history:
Received 27/5/2025
Revised 10/6/2025
Accepted 21/6/2025
Available online June 2025

Keywords:
ASD
Libya
Severity
Predicators
Autism

ABSTRACT

Today, autism spectrum disorders (ASD) are among the most prevalent neurodevelopmental illnesses. Their varied degrees of severity influence and determine the necessary support and intervention. Risk elements of severity include the child's gender, parental age, and parental educational levels. In Libya, such factors are under-examined. This study aimed to identify predictors of autism severity in Libyan children diagnosed with ASD attending rehabilitation centers in Almarj. It adhered to ethical considerations by submitting a formal application to the centers and obtaining consent from participants. A cross-sectional study included 119 children diagnosed by the Childhood Autism Rating Scale(C.A.R.S) .Demographic information, including child gender, age, educational level, parental age, and education, was gathered through parent interviews. The 2 to 12 year-old sample comprised 73% males and 27% females, with a mean of 7.3 years. About 73.1% had their diagnosis after two years of age. The school achievement of the majority of them affected by Autism, as about 69% (N=82) were not at the appropriate school level for their age. Paternal age over 40 years was notably linked to affect autism severity (OR = 0.198, 95% CI: 0.059–0.661, p = 0.008). Child gender, maternal age, and parental education exhibited no significant connection. Although all registered children with ASD was included, the small sample size limit the ability to generalize the results. Early screening might help families with older fathers to get benefit from advantages of early Autism diagnosis in Libya. This study helps to optimize clinical management and improve regional outcomes for children with ASD.

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1. Introduction

Among the most common neurodevelopmental diseases, autism spectrum disorders (ASD) have different degrees of severity and functional impairments that affect the extent of support and rehabilitation needed[1,2]. Typically, severity is classified by deficiencies in two fundamental areas: social communication difficulties and restricted, repetitive behaviors, as outlined in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5).ASD severity, ranges from Level 1 (requiring assistance) to Level3 (requiring substantial support)[1]. The impact of ASD severity is affecting individuals with their families, schools, and communities[1,2].The prevalence of ASD has been rising worldwide. With estimates ranging from 1% to 5.3%, with a consistent predominance of males in the majority of literature[2,3,4,5] The male-female ratio varies widely and ranges from 3:1 to 17:1. This variability may stem from disparities in diagnostic practices, genetic reasons, or gender-related differences in symptom expression.[2,5] Enhancing early diagnosis and prompt management of ASD relies on the early screening, which should be prioritized in all aspects related to autism[6].While several screening methods are available, there is a remarkable lack of tools aimed specifically at detecting individuals at high risk of having a positive predictor variable especially at children under age five[6,7,8]. Addressing this gap through improvement of early identification tools can facilitate individualized care and early intervention, which are crucial for improving long-term outcomes for affected children[8,9] .

Studies reveal that some family features are important in predicting ASD severity since both genetic and non-genetic factors greatly help to explain variations in symptoms and their severity[10]. Elevated ASD severity in form of more marked behavioral and language deficits has been linked to a family history of psychiatric diseases such as depression and bipolar disorder[7,8,10,11].Furthermore, parental mental health problems, especially depression and anxiety are commonly related to greater repetitive activities and lower social communication abilities in children with ASD[7, 8, 11] .

Higher parental age -both maternal and paternal -is another important factor; reliably linked with increased risk and severity of ASD. Maternal age over 35 and paternal age over 40 are significant predictors commonly reported in literature[7,8,10,12]. Obstetric complications such as preterm birth and low birth weight have also been correlated with greater ASD severity, suggesting that prenatal factors play a significant role in neurodevelopmental sequels[12,13].

With regard to the criteria of familial social class, certain research suggested that children with autism predominantly originate from families of elevated socioeconomic status. This is not a definitive conclusion, as autism is not uniquely associated with the superior class, as some autistic children originate from families with lower socioeconomic status (SES)[14].

Although family elements are significant, environmental factors and individual genetic disparities also significantly influence the expression and severity of ASD[15]. Recognizing social and cultural elements linked with ASD can help to develop improved evaluation practices and successful management, reducing symptom severity and improving the quality of life of the affected individuals. [16] .

Although many international studies have looked at factors of ASD severity, data specific to Libya are still limited. This emphasizes how much research on the Libyan people is needed to better understand local traits of ASD and improve clinical management and resource allocation.

Objective:

To identify and analyze demographic and parental factors that predict the severity of autism spectrum disorders among Libyan children in Almarj City.

2. Methodology

An approach cross-sectional design , descriptive study was employed. It was carried out in four public and private rehabilitation facilities in Almarj City. Coordination with the administrators of each center took place, including multiple visits, the collection children's lists, and face-to-face interviews conducted with parents accessible on the visit day. The researcher collected all participants' data eligible with the inclusion criteria, which included Libyan nationality and providing consent for participation. One of the private centers rejected the direct interview technique for confidentiality reasons. Therefore, the questionnaire was translated into Arabic using a forward-backward translation method to ensure linguistic and conceptual similarity. This version was reviewed by bilingual expert members at the family and community medicine department to verify face and content validity, then presented to the administration of the private center, who coded these children to ensure anonymity, and the questionnaires were self-completed in the above-mentioned center.

From March to June 2018, the data gathering was carried out, including the pilot phase. Children of both genders from all centers that use the Childhood Autism Rating Scale (CARS), a widely validated tool for diagnosing and measuring ASD severity that was only used to verify the diagnosis inclusion criteria while the evaluation of severity in this study were judged by information of gender of the patient ,timing of diagnosis and the educational attainment of the affected child .

A convenience sample of 119 children, ranging in age from 1 to 12 years, was included. This research adhered to ethical guidelines by gaining permission from all parents included in the study and making a formal request for permission to perform the study to the appropriate administrative locations. Parents completed a questionnaire created for the purpose of this study, and data on the child's demographics, parental ages, education levels, and age at delivery were collected. SPSS version 20 was used to conduct an analysis of the data. Evaluating the relationship between these factors and ASD severity used descriptive statistics and logistic regression analysis. Statistical significance was set at $p < 0.05$.

3.Results

3.1.Demographic Characteristics

Out of the 119 children diagnosed with ASD, the male: female ratio was approximately 3:1. This figure is consistent with the global trends. The gender percentage is shown in Figure 1.

The age distribution ranged from 2 to 12 years, with a mean age of 7.3 years (SD = 2.12). Further age distribution description is shown in Table 1. In terms of birth order, 73.1% of the children were amongst the first three born in their families, and 33.6% were firstborn.

3.2.Educational status

The educational attainment for these children is shown in Table (1). A considerable fraction (68. 9%) of individuals were not enrolled in educational programs corresponding to their age group. While certain individuals were enrolled in preschool or primary education, the disparity between anticipated and realized educational attainment underscores the developmental issues linked to ASD and its level of severity.

3.3.Gender disparities and age at diagnosis

The age at diagnosis was assessed as an indicator of ASD severity. Statistical estimates showed no significant difference between males and females regarding the age at diagnosis ($\chi^2 = 1.2$, $df = 1$, $p = 0.271$), as shown in Table 2.

Additionally, variances in educational achievement across gender were not statistically significant ($\chi^2 = 1.8$, $df = 2$, $p = 0.402$), as presented inTable 3. These findings suggest that, within this sample, gender does not significantly affect the severity measured by these parameters.

3.4.Predicators of severity

Further analysis using logistic regression estimated whether gender, parental age, and parental education levels predicted ASD severity. The merely significant predictor was paternal age, where advanced paternal age was associated with higher odds of increased ASD severity. (Odds Ratio = 0.198, 95% CI: 0.059–0.661, p = 0.008). Other variables, including maternal age and parents' educational levels, showed no significant predictive value. Table 4.

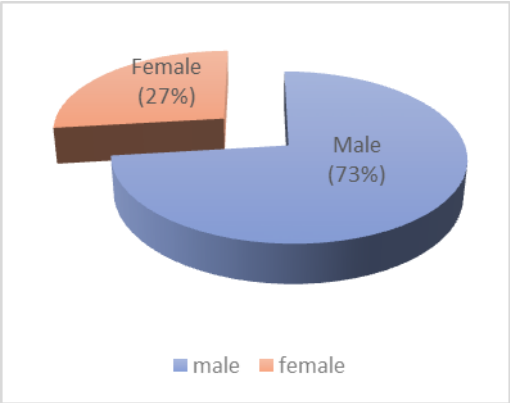

Figure 1. Distribution of ASDs in children according to Gender.

Table 1. Distribution of ASDs children according to the age classes. (years)

Age category (years) (Mean = 7.26, S.D = 2.12.)		
	No.	**%**
2-4	14	11.8
5-7	44	37.0
8-10	55	46.2
11-13	6	5.0
Total	**119**	**100.0**
Child 's School Level	**No.**	**%**
Not corresponding to age	82	68.9
Preschool	33	27.7
Primary	4	3.4
Total	**119**	**100.0**

S.D: Standard deviation

Table 2. The relation between child gender and the time of autism diagnosis

Age at Diagnosis	Male (n,%)	Female (n,%)
≤ 2 years	62 (75%)	26 (29.5%)
> 2 years	25 (80.6%)	6 (19.4%)

($\chi^2 = 1.2$, $df = 1$, $p = 0.271$ — Not statistically significant)

Table 3. Differences in educational attainment relative to age and gender

Educational Level	Male (n,%)	Female (n,%)
Not age-appropriate	58 (70.7%)	24 (29.3%)
Preschool	25 (75.8%)	8 (24.2%)
Primary	4 (100%)	0 (0%)

($\chi^2 = 1.8$, $df = 2$, $p = 0.402$ — Not statistically significant)

Table 4. Binary logistic regression analysis of the predictors of severity of autistic condition among the population sample (summary with controlling for background variables.)

Variable	Odds ratio (95% CI)*	P-value
Gender	1.847 (0.621 - 5.494)	0.270
Mother's education (high vs. Low)	1.196 (0.484 - 2.954)	0.699
Father's education (high vs. Low)	1.227 (0.494 - 3.047)	0.659
Mother's age > 35 vs 1-35	1.000 (0.293 - 3.414)	1.000
Father's age > 40 vs 1-40	0.198 (0.059 - 0.661)	0.008

*CI,confidence interval

4- Discussion

Among Libyan children in Almarj, the analysis shows a strong link between older paternal age (more than 40) and high degree of ASD severity. These results fit with international conclusions indicating that genetic mutations accumulating with paternal age may help explain more serious forms of autism. In other words, the effect of paternal age might be linked to the expectancies of mutations in sperm that could lead to neurodevelopmental diseases. [17]. For instance, study by Kong et al. (2018) have consistently linked paternal age to increased autism risk and severity, likely due to age-related changes in sperm DNA integrity.[8]

In contrast to some earlier studies that suggest more serious behavioral symptoms in males, an absence of gender differences in the analysis of this study in severity contrast was reported; this may be explained by variability across groups and research methods. Furthermore, the findings indicate no statistically significant influence of a child's gender, maternal age, or parents' education level on severity[18].These findings are consistent with results from Lawson et al. (2018), who found limited predictive power for these variables in determining ASD severity across diverse populations.[19]. Moreover, there is no marked variation in age at diagnosis or educational completion between males and females. Likewise, Dehesh et al. (2024), in a meta-analysis and systematic review looking at

the impact of parental age on autism progress, found that although parental age assumes autism risk as assessed in our study, their results exposed that other variables like gender, maternal age, and parental education levels did not display a statistically significant power on autism severity determination. [20]. This could be attributed to the similarity of parental education levels and the somewhat small sample size.

Unlike certain other studies, maternal age and child gender in this study were of little predictive value among the sample.

Modifying early interventions and support programs-which are critical for enhancing long-term results-depends on an understanding of ASD severity predictors. This research underlines how crucial it is to factor paternal age into scientific evaluations and the provision of resources for ASD-affected children.

However, this survey has some limitations . The cross-sectional project eliminates causal suggestion. The convenience sampling and focus on a single geographic area (Almarj) may introduce regional bias and limit generalizability. Additionally, variability in data collection methods across centers-such as face-to-face interviews versus self-administered questionnaires-could have introduced measurement inconsistencies. The absence of genetic and environmental data further constrains the interpretation of severity predictors.

Still, the study offers insightful early analysis of components affecting ASD severity in Libya. Future research should incorporate larger, multi-regional samples, longitudinal tracking, and biomarker data to more comprehensively assess risk factors in autism.

5. Conclusions

Appropriate interventions and care for ASD affected children depend on the guidance provided by the identification of factors related to ASD severity. In this sample of Libyan children, advanced paternal age is a major predictor of ASD severity. These results point out the need to consider of paternal age in early screening and development evaluations as long as the need of more investigation into underlying processes and support targeted early intervention plans. It's also important to inform healthcare providers and families about these risks. Resources should be allocated to intervention programs based on risk severity to improve long-term outcomes. Further research is needed to better understand the factors involved and to create effective health policies.

Recommendations

•Early ASD screening programs should include variables related to parental age to identify children at risk.

•Encourage public awareness initiatives aimed at families with older fathers, as early detection and intervention could be achieved through these efforts.

•More extensive, long-term research using genetic analysis can help in clarifying the processes underlying the connection found by the study.

•Increased Libyan policymakers and healthcare professionals' responsiveness.

Acknowledgments

We would like to express our deepest gratitude to the staff and administration of the rehabilitation centers, to the children and their families, and to our colleagues at the Department of Family and Community Medicine for their generous assistance with the translation of the questionnaire. for all of those for their invaluable support and collaboration in this study.

Conflict of Interest

The authors did not disclose any conflicts of interest.

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