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Prevalence of Monoclonal Gammopathy of Undetermined Significance (MGUS) among Elderly People in the Northern Districts of the West Bank-Palestine.

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Declaration

I declare that, except where explicit reference is made to the contribution of others, this thesis is substantially my work and has not been submitted for any other degree at the Arab American University or any other institution.

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Dedication

This work is lovingly dedicated to my husband, Dr. Mustafa Mahamid**,** and my precious sons, Hassan and Omar Mahamid**,** whose unwavering support, patience, and encouragement have been my greatest source of strength throughout this journey. Your belief in me made all of this possible.

To my mother and father**,** who have always been my pillars of love, wisdom, and guidance, and to my sisters and brothers, whose support and encouragement have meant the world to me.

I also dedicate this achievement to my entire family**,** who have stood by me every step of the way, sharing in my challenges and celebrating my successes. This is as much yours as it is mine.

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Prevalence of Monoclonal Gammopathy of Undetermined Significance (MGUS) among Elderly People in the Northern Districts of the West Bank-Palestine.

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Abstract

Background: A plasma cell condition called monoclonal gammopathy of unknown significance (MGUS) is a precursor to multiple myeloma (MM) and other associated cancers. The frequency of MGUS has been thoroughly investigated in populations in the West and Asia, but there is still a dearth of information from the Middle East, especially Palestine(Han et al., 2020; Kyle et al., 2006).

Objectives: The purpose of this study was to ascertain the incidence of MGUS in the older population in the northern West Bank areas of Palestine, as well as to pinpoint possible clinical and demographic risk factors linked to its development.

Methods: 201 people who were 60 years of age or older participated in a cross-sectional study. The Cobas C8000 Roche analyzer was used to measure the total protein concentration. The Sebia Hydrasys 2 system was then used for serum protein electrophoresis (SPE). For confirmation, participants with aberrant gamma region results underwent immunofixation electrophoresis (IFE). Microsoft Excel and Python were used to perform statistical analysis. To evaluate relationships between MGUS and possible risk variables, the analyses used binary logistic regression, chi-square tests, and Mann-Whitney U tests. A 0.05 level of significance was used.

Results: The prevalence of MGUS was 5.97 %overall, and it was considerably greater in men than in women ($p = 0.0466$). With age, the prevalence rose, reaching a peak of 9.09% in people

between the ages of 80 and 89. MGUS was shown to be most strongly associated with anemia or leukemia ($p = 0.0007$). The prevalence of MGUS did not differ significantly between provinces.

Conclusions: The prevalence of MGUS in the West Bank's senior population is somewhat greater than certain international reports, although it is consistent with global trends (Kyle et al., 2006; Kristinsson et al., 2011). The study emphasizes the value of routine screening, especially for high-risk populations including older men and people with hematological disorders. To improve the early detection and management of MGUS in Palestine, it is advised to create focused screening programs and upgrade diagnostic infrastructure.

Keywords: Monoclonal gammopathy of undetermined significance (MGUS), prevalence, Palestine, serum protein electrophoresis.

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List of Definitions of Abbreviations

Abbreviations	Title
MGUS	Monoclonal Gammopathy of Undetermined Significance
MM	Multiple Myeloma
SPE	Serum Protein Electrophoresis
IFE	Immunofixation Electrophoresis
TP	Total Protein
Q1	First Quartile
Q2	Second Quartile (Median)
Q3	Third Quartile
IRB	Institutional Review Board
AAUP	Arab American University-Palestine
RPM	Revolutions Per Minute
SST	Serum Separator Tube
QC	Quality Control
SD	Standard Deviation
N/A	Not Applicable
OR	Odds Ratio
CI	Confidence Interval
M-protein	Monoclonal Protein

Abbreviations	Title
IgG	Immunoglobulin G
IgA	Immunoglobulin A
IgM	Immunoglobulin M
FLC	Free Light Chain
CRAB	Hypercalcemia, Renal insufficiency, Anemia, Bone lesions
A/G Ratio	Albumin-to-Globulin Ratio
CT	Computed Tomography
Ig	Immunoglobulin

Chapter One: Introduction

1.1. Background

Monoclonal gammopathy of undetermined significance (MGUS) is a premalignant plasma cell condition that is characterized by the absence of end-organ damage, less than 10 percent clonal plasma cells in the bone marrow, and a monoclonal protein in the serum (<3 g/dL) or urine (<500 mg per 24 hours). As people age, MGUS becomes more common; roughly 3% of those over 50 and 5% of people over 70 have the condition (Kaseb et al., 2020). According to studies, the prevalence of MGUS is two to three times higher in African Americans than in Caucasians, and it is more common in men and people of African descent(Kaseb et al., 2020). The condition has a 1% annual chance of developing into multiple myeloma or kindred plasma cell proliferative disorders(Kaseb et al., 2020; Lee, n.d.). Although the precise cause of MGUS is still unknown, several risk factors have been found. They include advanced age, male sex, race (African or Black American), family history, infections, inflammatory diseases, chronic antigenic stimulation, exposure to specific chemicals and pesticides, diabetes, and obesity (Joseph et al., 2024). Higher occurrence has also been linked to environmental variables including radiation exposure (Joseph et al., 2024). Interestingly, first-degree relatives of people with myeloma or MGUS have a higher risk of developing MGUS, according to population-based studies from the US and northern Europe. This suggests that germline susceptibility genes, shared environmental factors, or a combination of the two may be at play (Kaseb et al., 2020). Even if MGUS is asymptomatic, it is associated with a higher risk of a number of problems. These consist of infections, fractures, and renal impairment (Kristinsson et al., 2012; Lomas et al., 2020; Van De Donk et al., 2014). MGUS patients have been found to have a 2-fold greater risk of getting a broad range of bacterial infections, including pneumonia, osteomyelitis, septicemia, and meningitis(Kristinsson et al., 2012). Furthermore, MGUS is linked to a higher incidence of fractures and osteoporosis, especially in the axial skeleton (Van De Donk et al., 2014). Patients with osteoporosis have a higher prevalence of MGUS (3.6 percent) than those without (2 percent)(Van De Donk et al., 2014) . Patients with MGUS are also at a higher risk of developing more severe illnesses. Waldenstrom macroglobulinemia, multiple myeloma, light chain amyloidosis,

lymphoma, and other severe illnesses affect approximately 1% of individuals with MGUS year (*Monoclonal Gammopathy of Undetermined Significance (MGUS) - Symptoms and Causes*, 2023). Peripheral neuropathy, kidney issues, and blood clots are additional MGUS complications(*Monoclonal Gammopathy of Undetermined Significance (MGUS) - Symptoms and Causes*, 2023). Globally, the prevalence of MGUS varies; research has shown that rates range from 0.05 percent to 6.1 percent in various populations. The age distribution, racial makeup, and geographic location of the populations under study are some of the factors that contribute to this large range(Castaneda-Avila et al., 2021; Joseph et al., 2024; Kaseb et al., 2020). Given these risks and complications, regular monitoring of MGUS patients is crucial for early detection of disease progression and management of associated conditions. However, there is limited data on MGUS prevalence and characteristics in Middle Eastern populations, particularly in regions like the West Bank, where healthcare infrastructure faces significant challenges.

1.2. Statement of the Problem

The healthcare system in the West Bank faces challenges due to insufficient funding, unstable political conditions, and tough economic times. Serum protein electrophoresis (SPE) and immunofixation electrophoresis (IFE), two diagnostic techniques essential for detecting and monitoring MGUS, are not widely available. This lack of access hampers patient care and delays diagnoses, increasing the risk of MGUS going undetected or leading to more serious conditions like MM. Additionally, a significant knowledge gap about the disease burden in the West Bank arises from the lack of population-based data on MGUS prevalence in the region. Importance of the Study

Improving diagnosis and treatment approaches requires an understanding of the frequency and features of MGUS in the West Bank. This study offers important insights into the difficulties in detecting and treating MGUS, especially in light of the region's limited resources and dearth of sophisticated diagnostic techniques. It also emphasizes the necessity of putting in place comprehensive screening programs and raising healthcare professionals' knowledge of the illness. The study's conclusions will form the basis for next investigations and regional healthcare planning.

1.3. The study's objective

This study's main goal is to determine the prevalence of MGUS in older people living in the northern West Bank regions as well as the clinical and demographic traits that are linked to it. In order to address the diagnostic and management problems of MGUS in settings with low resources, this study aims to close the information gap and influence healthcare policies by providing population-specific data.

1.4. Research Question

What is the prevalence of MGUS among elderly individuals in the northern districts of the West Bank, and what factors are associated with its occurrence?

1.4.1. Hypothesis of the Study

1. What is the overall prevalence of MGUS among elderly individuals in the northern districts of the West Bank-Palestine?

2. Is there a significant difference in the prevalence of MGUS between males and females among the elderly population in the northern districts of the West Bank-Palestine?

3. Is there a relationship between the presence of MGUS and other health conditions such as renal impairment, infections, and fractures among the elderly population in the northern districts of the West Bank-Palestine?

4. Is there a significant difference in the prevalence of MGUS among elderly individuals in different northern districts of the northern districts of the West Bank-Palestine?

1.5. Study Limitations

This study has several drawbacks.

- Sample Size: Because of difficulties recruiting participants brought on by political unrest and restricted access to healthcare, the final sample size is lower than the optimal one determined by the Daniel equation.
- Diagnostic Availability: It's possible that missed or delayed diagnoses resulted from the lack of sophisticated diagnostic techniques like immunofixation electrophoresis.
- Regional Generalizability: The results are unique to the West Bank's northern districts and might not apply to other groups or areas.

- Cross-Sectional Design: Because the study is cross-sectional, it is not possible to determine causal correlations or evaluate the course of MGUS.

1.6. Definitions of Concepts and Procedures

1.6.1. A plasma cell condition known as monoclonal gammopathy of unknown significance (MGUS) is defined by the presence of monoclonal protein in the blood without any indication of end-organ damage (Kyle et al., 2004).

1.6.2. A laboratory procedure called serum protein electrophoresis (SPE) divides serum proteins into fractions in order to identify aberrant monoclonal proteins(Diana et al., 2020).

1.6.3. A confirming technique for locating and categorizing monoclonal proteins in serum samples is immunofixation electrophoresis (IFE)(*Identification of Monoclonal Proteins by Gel Electrophoresis | Sebia*, 2022) .

1.6.4. Prevalence: The percentage of study participants that had an MGUS diagnosis at the time of data collection (O. Landgren et al., 2006).

1.6.5. Elderly Population: Participants who meet the study's definition of being 60 years of age or older.

1.7. The study's structure

The sections of this study are as follows:

1.7.1. Literature Review: A summary of the body of knowledge regarding MGUS, including its prevalence, risk factors, and diagnostic techniques.

1.7.2. Methods: a thorough explanation of the demographic, data collection methods, statistical analysis, and study design.

1.7.3. Results: Key findings from diagnostic testing, participant demographics and clinical features, and the prevalence of MGUS are presented.

1.7.4. Discussion: Limitations of the study, implications for West Bank healthcare, and interpretation of the findings in light of the body of current literature.

1.7.5. Conclusion: An overview of the results, their applicability, and suggestions for further study and medical policy.

Chapter two: Literature Review

2.1 An overview of monoclonal gammopathy of unknown significance (MGUS)

A monoclonal paraprotein in the blood is the hallmark of monoclonal gammopathy of unknown significance (MGUS), a premalignant plasma cell condition that lacks the end-organ damage typical of multiple myeloma(Atkin, 2018) . It is commonly acknowledged that this illness is a prelude to multiple myeloma and other lymphoplasmacytic cancers(Atkin, 2018; A. J. Landgren O. ,. &. Waxman, 2010).

2.2 Historical Background and Findings

The phrase "monoclonal gammopathy of uncertain significance" (MGUS) was first used by Dr. Robert Kyle in 1978 (Baxt, 2021; O. Landgren, 2010). His finding that people with these protein anomalies were more likely to develop multiple myeloma, Waldenström's macroglobulinemia, light-chain amyloidosis, or associated illnesses served as the basis for this (O. Landgren, 2010). Before Kyle's work, the condition was referred to as "benign monoclonal gammopathy" or "essential hypergammaglobulinemia" by Jan Waldenström in 1960. Kyle's research in the 1960s and 1970s led to the recognition that this condition was not always benign(Staff, 2017).

Among Kyle's groundbreaking efforts were the creation of the Special Protein Laboratory, the freezing of serum samples, the establishment of the Myeloma, Amyloidosis, and Dysproteinemia Clinic at the Mayo Clinic, and the gathering of information on all individuals with monoclonal plasma cell disorders(Staff, 2017).

The study of monoclonal gammopathies has been continuously funded since Dr. Kyle and his colleagues received a program project grant from the National Institutes of Health in 1974(Staff, 2017).

Our knowledge of MGUS has significantly increased as a result of later studies. For instance, research has shown that MGUS is common in various groups(O. Landgren, 2010), found risk factors for its advancement (Zingone, 2011), and clarified the condition's genetic and molecular foundation (Kaur, 2023; Zingone, 2011).

Recent developments include the use of low-input whole-genome sequencing technology, which has identified two physiologically and clinically different entities of asymptomatic monoclonal gammopathies and shown notable variations in the genetic landscape of MGUS (Baxt, 2021).

2.3 Pathological and Clinical Features

MGUS is defined by three key diagnostic features:

1. Presence of Monoclonal Paraprotein: MGUS is defined by a serum monoclonal (M) protein level less than 3 g/dL(Kyle & Rajkumar, 2010; Lee, n.d.). This abnormal protein is produced by a clonal population of plasma cells and can be detected through serum protein electrophoresis, where it appears as a characteristic 'band' or 'spike'(Atkin, 2018; Lee, n.d.).

2. Clonal Plasma Cell Population: In MGUS, clonal plasma cells make up less than 10% of the bone marrow cellularity(Go & Rajkumar, 2018; Kyle & Rajkumar, 2010; Lee, n.d.). These plasma cells often have an abnormal immunophenotype (CD38+ CD56+ CD19−) mixed with cells of a normal phenotype(Wikipedia Contributors, 2025).

3. Absence of End-Organ Damage: MGUS is distinguished from multiple myeloma by the absence of CRAB features (hypercalcemia, renal insufficiency, anemia, and bone lesions) that can be attributed to the plasma cell proliferative disorder(Go & Rajkumar, 2018; Kyle & Rajkumar, 2010; Lee, n.d.).

MGUS is typically asymptomatic and often discovered incidentally during routine blood tests(Wikipedia Contributors, 2025). However, some patients may experience a rash or neurological symptoms such as numbness or tingling(Wikipedia Contributors, 2025). The condition carries a risk of progression to multiple myeloma or related disorders at a rate of about 1% per year(Kyle & Rajkumar, 2010; Wikipedia Contributors, 2025).

Risk factors for developing MGUS include being 70 years of age or older, male gender, African descent, and having a family history of MGUS(Lee, n.d.). The prevalence of MGUS increases with age, affecting about 3% of people over 50 and 5% of those over 70(Kyle & Rajkumar, 2010).

Management of MGUS involves regular monitoring. Patients with low-risk MGUS may be reevaluated every 2 years, while those with high-risk MGUS should be followed annually for

life(Kyle & Rajkumar, 2010). This monitoring is crucial to detect any progression to more serious plasma cell disorders before complications occur(Kyle & Rajkumar, 2010).

2.4 Clinical Importance and Progression Risk

The 1% annual risk of progression from MGUS to multiple myeloma or related conditions is confirmed by multiple sources(Kyle et al., 2010; *What Are MGUS, Smoldering Myeloma, and MM?*, n.d.). This risk persists over time, with one study reporting a median time to progression of 44 months (range 4.4-120 months)(Pérez-Persona et al., 2007).

The necessity of long-term monitoring is supported by the fact that the risk of progression remains constant over time. One study found that the interval from MGUS recognition to diagnosis of multiple myeloma or a related disorder ranged from 1 to 32 years, with a median of 10.4 years(Kyle et al., 2010).

Recent research has indeed shown that MGUS precedes multiple myeloma. While the specific study mentioned is not directly cited in the search results, there is evidence that all patients who develop myeloma have previously had MGUS followed by smoldering multiple myeloma (SMM)(*What Are MGUS, Smoldering Myeloma, and MM?*, n.d.).

The role of genetic factors in MGUS progression is supported by several studies. Chromosomal translocations, particularly those involving the immunoglobulin heavy chain gene, are common in MGUS(Mikulasova et al., 2017). The search results also mention that the incidence of IgH translocations increases as the disease progresses(Mikulasova et al., 2017).

However, it's important to note that recent research suggests the risk of progression can change over time, contrary to the idea that the risk remains constant at 1% per year(*Risk of MGUS Progression to Myeloma Can Change - National Cancer Institute*, 2019). Additionally, while chromosomal translocations are common in MGUS, the frequency of certain genetic abnormalities, including hyperdiploidy, gain 1q, and del(13q), is lower in MGUS than in multiple myeloma(Mikulasova et al., 2017).

2.5 Risk Stratification

For monoclonal gammopathy of undetermined significance (MGUS), the Mayo Clinic risk stratification model categorizes patients into four risk groups based on three main risk factors: an abnormal free light chain (FLC) ratio (<0.26 or >1.65), serum M-protein concentration > 1.5 g/dL, and non-IgG isotype. Approximately 38% of MGUS patients fall into the low-risk category, which has no risk factors and a 5% chance of progression over a 20-year period. Typically, these individuals require only minor interventions, with follow-up every two to three years. About 37% of patients are classified as low-intermediate risk, which necessitates annual clinical evaluations due to the presence of one risk factor and a 21% progression risk over 20 years. Roughly 20% of MGUS patients are in the high-intermediate risk group, requiring closer monitoring since they have two risk factors and a 37% risk of advancement over 20 years. Lastly, approximately 5% of cases fall into the high-risk category, which demands the most rigorous monitoring and may include more invasive diagnostic procedures because they have all three risk factors and a significant 58% progression risk over two decades (Korde et al., 2011; O. Landgren, 2013; Mayo Clinic Risk Stratification Model for Progression of Monoclonal Gammopathy of Undetermined Significance — Pathway, 2025).

Simplified Risk Stratification Table for MGUS (Mayo Clinic Model) Table 2.1 This table outlines the risk of progression from Monoclonal Gammopathy of Undetermined Significance (MGUS) to multiple myeloma or related disorders over a 20-year period. The stratification is based on the number of key risks factors a patient has:

Risk Group	Risk Factors	Progression Risk (20 Years)	Follow-up Guidelines
Low Risk	0	**5%**	Follow-up every **2–3 years**
Low-Intermediate	1	**21%**	**Annual follow-up**
High-Intermediate	2	**37%**	**Stricter monitoring**
High Risk	3	**58%**	**Intensive monitoring & additional diagnostics**

2.6 Progression Risk Factors

Monoclonal gammopathy of unknown significance (MGUS) progression risk factors have been thoroughly investigated and confirmed in several cohorts. Three main risk variables are identified by the Mayo Clinic risk stratification model: aberrant free light chain (FLC) ratio (<0.26 or >1.65), serum M-protein concentration > 1.5 g/dL, and non-IgG isotype(Korde et al., 2011). Patients are divided into four risk groups based on these variables, and the chance of advancement over the next 20 years' ranges from 5% for those without risk factors to 58% for those who have all three(Korde et al., 2011). The number of bone marrow plasma cells has also been identified as a risk factor, with ≥10 percent being linked to an increased risk of progression (Rajkumar, 2022). Risk stratification is also influenced by cytogenetic abnormalities, with quicker advancement linked to high-risk cytogenetics including chromosome 17p deletion and t (4;14) (Castaneda-Avila et al., 2021) . The likelihood of advancement is also influenced by the type of MGUS; IgM MGUS is more likely to occur (2 percent annually in the first 10 years) than non-IgG MGUS (0.5–1 percent annually)(Castaneda-Avila et al., 2021) . A higher incidence of MGUS has also been linked to smoking, some infections, inflammatory diseases, older age, male sex, black race, and a familial history of MGUS (Kyle et al., 2010). It's crucial to remember that risk classification is dynamic and should be reviewed on a regular basis since modifications to FLC ratios, M-protein levels, or the emergence of new symptoms may call for a review of risk and management tactics (Castaneda-Avila et al., 2021; Rajkumar, 2022).

2.7 Monoclonal Gammopathy of Undetermined Significance(MGUS): Prevalence and Epidemiology

The premalignant plasma cell condition known as monoclonal gammopathy of unknown significance (MGUS) varies significantly in occurrence among various demographic groups and geographical areas. The prevalence of this illness rises with age, and there are noticeable variations according to geography, gender, and ethnicity. The frequency of MGUS in Western populations has been extensively studied, but there is still a substantial information gap due to the paucity of thorough investigations in underrepresented populations, especially among the elderly in Palestine and the Middle East. In order to comprehend MGUS epidemiology and its effects in these areas, it is imperative that this gap be filled. Age-Related Prevalence

The prevalence of MGUS increases significantly with age and is very age-dependent. This trend has been emphasized by important studies: - The proportion of people ≥ 50 years is about 3% (Zuern et al., 2024). Approximately 5% of people ≥70 years (Zuern et al., 2024). In people aged 85 and older, it reached 7.5%(Abeykoon et al., 2022).

A thorough investigation carried out in Olmsted County, Minnesota, found that the overall frequency among people aged 50 and older was 3.2 percent(Abeykoon et al., 2022). This study showed a definite rise in prevalence rates with age:

1.7% in the 50–59 age range. 3.0% among those aged 60-69. 4.6% in the 70–79 age range. 6.6% among people 80 years of age and older (Marinac et al., 2020).

Similar studies have not been carried out in many developing regions, such as Palestine and surrounding Middle Eastern nations, despite the fact that these findings highlight the crucial role that age plays as a risk factor for MGUS. Therefore, it is unknown how much MGUS actually affects older people in these populations.

2.7.1 Disparities by Gender

The prevalence of MGUS varies greatly by gender, with men continuously having greater rates than women. Research indicates: The age-adjusted prevalence is 4.0 percent for males and 2.7 percent for women overall (Abeykoon et al., 2022; Marinac et al., 2020). Men’s prevalence rates are comparable to those of women who are about ten years older (Abeykoon et al., 2022).

This gender gap has significant ramifications for screening and risk stratification and may be caused by biological, hormonal, or genetic variations. Designing focused public health interventions requires an understanding of gender-based variations in MGUS prevalence, particularly in areas where there are gender-based variances in healthcare access.

2.7.2 Ethnic Variations

Several studies have found significant ethnic differences in the frequency of MGUS. When compared to white people, African Americans have continuously demonstrated a 2-3 fold higher prevalence; An age-adjusted prevalence ratio of 3.0 for MGUS among African Americans as opposed to Whites was found in a study of US veterans(Kyle & Rajkumar, 2010). Researchers in Ghana discovered that Black men had an age-adjusted frequency of 5.8 percent, which is almost twice as high as that of Caucasians(Zuern et al., 2024).The difference is more noticeable at younger ages: Among those between the ages of 40 and 49, 3.26 percent of Black people and 0.53 percent of White people(Kyle et al., 2006).

Prevalence rates differ among other ethnic groups: In comparison to non-Hispanic Whites, the incidence is somewhat greater among Hispanics(Kyle et al., 2006). Compared to White people, Asians often exhibit lower prevalence rates(Kyle et al., 2006; Zuern et al., 2024). The observed differences in MGUS prevalence between ethnic groups could be caused by access to healthcare, environmental exposures, and genetic predispositions. In order to gain a better understanding of MGUS epidemiology in certain populations, such as Middle Eastern and Palestinian communities, where ethnic and environmental factors may play unique roles, it is crucial to perform localized studies.

2.7.3 Geographic Variations

MGUS prevalence varies geographically, which emphasizes the necessity of region-specific research. As an example: Prevalence rates have been reported to be lower in Japanese populations(Marinac et al., 2020). In Nagasaki City, Japan, a study of people aged 50 and older revealed a frequency of 2.4% (Marinac et al., 2020). Alternatively, research in the United States and Europe have shown that prevalence rates are far greater among Western populations. Comprehensive information on the prevalence of MGUS is, however, unavailable in many areas, including Palestine and the Middle East's bordering nations. It is crucial to comprehend the

geographic variance in MGUS prevalence in order to customize screening methods for particular demographics.

2.7.4 Various other factors

It has been demonstrated that a number of other factors affect the occurrence of MGUS:

1. Family History: People who have first-degree relatives with multiple myeloma or MGUS are more vulnerable(Zuern et al., 2024).

2. Obesity: MGUS is more prevalent in those who are obese, a condition that is more prevalent among African Americans and may be a factor in racial differences(Kyle et al., 2006).

The multifaceted character of MGUS and its possible correlations with modifiable risk factors are highlighted by these studies.

2.7.5 Knowledge Gaps and Significance of the Study

In the Middle East, the prevalence and epidemiology of MGUS are still mostly unknown, despite a great deal of study being done on Western populations. This knowledge gap is especially noticeable in Palestine, where no extensive research has been done to assess the prevalence of MGUS in the elderly. The paucity of data from this area makes it more difficult to understand the impact of MGUS and to create specialized healthcare plans.

This study attempts to close this gap by offering the first thorough evaluation of the prevalence of MGUS in Palestine's senior population. This study could help guide clinical decision-making, enhance screening programs, and enhance healthcare planning in the area by advancing our understanding of MGUS epidemiology globally.

2.8 Risk factors and pathophysiology of Monoclonal Gammopathy of Undetermined Significance (MGUS)

The clonal proliferation of plasma cells and the buildup of monoclonal proteins are the results of a complicated interaction between molecular and cellular mechanisms in the pathophysiology of monoclonal gammopathy of unknown significance (MGUS) (M-proteins). These processes are essential for comprehending how diseases progress and creating plans for early care and identification.

2.8.1 The pathophysiology of MGUS

MGUS develops as a result of a sequence of genetic and epigenetic alterations that cause the bone marrow's plasma cells to proliferate clonally. M-proteins are produced as a result of these modifications, which also affect plasma cell survival and proliferation.

The pathogenesis of MGUS is characterized by early genetic changes. One of the main genetic events linked to MGUS is chromosomal translocations involving the immunoglobulin heavy chain (IGH) locus on chromosome 14q32. Cyclin D1 (t(11;14)), FGFR-3 and MMSET (t(4;14)), cyclin D3 (t(6;14)), c-maf (t(14;16)), and mafB (t(14;20)) are examples of common translocation partners. Oncogenes are activated and plasma cell activity is dysregulated as a result of these translocations' disruption of regulatory processes(Abeykoon et al., 2022; Zuern et al., 2024) .

In addition to translocations, MGUS is often associated with chromosomal abnormalities, including aneuploidy. An additional chromosome is a sign of hyperdiploidy, which is present in about half of MGUS cases. Despite being less than the 75 percent seen in multiple myeloma, this rate highlights how chromosomal defects contribute to the development of MGUS into cancer (Abeykoon et al., 2022; Zuern et al., 2024). Clonal plasma cells become immortalized and grow out of control as a result of these genetic changes. The creation of monoclonal immunoglobulins or their constituents, which results in the buildup of M-proteins in the serum, depends on this clonal growth, which is a characteristic of MGUS (Abeykoon et al., 2022).

2.8.2 M-protein accumulation

Monoclonal immunoglobulins are produced by the clonal plasma cells in MGUS and build up as M-proteins in the serum. IgG is the most often generated monoclonal immunoglobulin among these, making up 68.9% of cases. Other subtypes of immunoglobulins include IgA (10.8 %) and

IgM (17.2 %)(*Standing in the Gaap*, 2021). Another important aspect of MGUS is the creation of light chains. While lambda light chains are seen in 37.9 percent of instances, kappa light chains are seen in 62.0 percent of cases(*Standing in the Gaap*, 2021).

An essential biomarker for determining who is more likely to develop more severe plasma cell diseases is the serum free light chain (FLC) ratio. An imbalance in the kappa and lambda light chain synthesis is reflected in an aberrant FLC ratio, which indicates the activation of clonal plasma cells(*What Are MGUS, Smoldering Myeloma, and MM?*, n.d.).

2.9 MGUS Risk Factors

Numerous risk variables, such as age, genetic predisposition, environmental exposures, and concomitant illnesses, can have an impact on MGUS.

Age The biggest risk factor for MGUS is age. As people age, the prevalence of MGUS rises significantly, from around 3 percent in people 50 years of age or older to 7.5 percent in people 85 years of age or older. The high correlation between MGUS and aging is highlighted by the diagnosis's median age of 72 years(*Standing in the Gaap*, 2021; *What Are MGUS, Smoldering Myeloma, and MM?*, n.d.).

Genetic predispositionThe development of MGUS is also significantly influenced by genetic predisposition. The risk of acquiring multiple myeloma or MGUS is considerably increased for those who have a first-degree relative with the disease. Disparities by ethnicity emphasize the genetic component of MGUS even more. The prevalence of MGUS is 2-3 times higher in African Americans than in Caucasians, indicating a population-specific or genetic predisposition(*What Are MGUS, Smoldering Myeloma, and MM?*, n.d.).

Environmental Exposures: Exposures to the environment have been identified as possible risk factors for MGUS. A higher incidence of MGUS is linked to the frequent use of pesticides and herbicides in agricultural settings. Another major factor has been found to be long-term exposure to ionizing radiation. Increased rates of MGUS have been observed in occupational risks, especially in sectors like agriculture and leatherwork, most likely as a result of extended exposure to dangerous substances (*What Are MGUS, Smoldering Myeloma, and MM?*, n.d.).

Certain medical conditions There is a correlation between an increased risk of MGUS and specific medical problems. MGUS development has been associated with autoimmune disorders, including systemic lupus erythematosus and rheumatoid arthritis. The illness process may be exacerbated by persistent infections that encourage plasma cell clonal growth. Additionally, obesity has been linked to a higher prevalence of MGUS, especially in African Americans, who already have a higher baseline risk(*What Are MGUS, Smoldering Myeloma, and MM?*, n.d.).

2.10 Diagnosis and Clinical Management of Monoclonal Gammopathy of Undetermined Significance (MGUS)

To achieve precise identification, the diagnosis and clinical treatment of Monoclonal Gammopathy of Undetermined Significance (MGUS) depend on clearly established criteria and diagnostic instruments. Clear diagnostic guidelines developed by the International Myeloma Working Group (IMWG) are widely used in clinical and research settings(Rajkumar, 2016; Zuern et al., 2024).

Based on the following three criteria, MGUS is diagnosed. Initially, the concentration of serum monoclonal protein (M-protein) needs to be below 3 g/dL (30 g/L). This threshold distinguishes MGUS from other plasma cell illnesses with higher protein levels, such as smoldering multiple myeloma (SMM). Second, the bone marrow must have less than 10% clonal plasma cells, which indicates restricted clonal proliferation. Finally, there must be no indication of end-organ damage caused by the plasma cell abnormality, which is shown by the lack of the CRAB characteristics, which include bone lesions, anemia, renal failure, and hypercalcemia. All of these factors work together to guarantee that MGUS is identified as a premalignant illness that is different from malignant plasma cell diseases like multiple myeloma(*International Myeloma Working Group (IMWG) Criteria for the Diagnosis of Multiple Myeloma*, n.d.; Rajkumar, 2016; Zuern et al., 2024).

A number of diagnostic instruments are necessary to detect MGUS. The main screening method is serum protein electrophoresis (SPE), which separates serum proteins according to their electrical charge and enables the detection of M-proteins. This method detects aberrant gamma-region bands that are suggestive of monoclonal immunoglobulins (O'connell et al., 2005). A more sensitive technique for confirming the existence of M-proteins and identifying their type—such as IgG, IgA, or IgM—is immunofixation electrophoresis (IFE)(Barwick et al., 2019; Zuern

et al., 2024). The serum free light chain (FLC) test, which measures the amount of kappa and lambda light chains in the serum, is another essential instrument. One important indicator for determining the likelihood that MGUS would proceed to multiple myeloma or kindred illnesses is an aberrant FLC ratio (A. J. Landgren O. ,. &. Waxman, 2010; *Standing in the Gaap*, 2021).

There are difficulties in diagnosing MGUS. Since the disorder is usually asymptomatic, it is challenging to identify without regular screening or assessment for unrelated medical conditions (Barwick et al., 2019; Zuern et al., 2024). Identification is made more difficult in environments with limited resources since access to specialized diagnostic methods like SPE, IFE, and FLC tests is frequently limited (A. J. Landgren O. ,. &. Waxman, 2010; *What Are MGUS, Smoldering Myeloma, and MM?*, n.d.). The interpretation of SPE and IFE results necessitates specific knowledge, which may not always be accessible, even in well-equipped healthcare facilities. (Barwick et al., 2019; *International Myeloma Working Group (IMWG) Criteria for the Diagnosis of Multiple Myeloma*, n.d.). Healthcare resources may also be severely strained by the lengthy follow-up needed to track the progression of MGUS patients, especially in underprivileged areas(*International Myeloma Working Group (IMWG) Criteria for the Diagnosis of Multiple Myeloma*, n.d.; Rajkumar, 2016).

Additionally, the cost of follow-up care and diagnostic testing might be prohibitive, particularly in areas with limited healthcare resources.(A. J. Landgren O. ,. &. Waxman, 2010; *What Are MGUS, Smoldering Myeloma, and MM?*, n.d.). Furthermore, underdiagnosis or incorrect classification may result from healthcare personnel' ignorance of MGUS, underscoring the need for improved education and training(Barwick et al., 2019). Finally, to distinguish MGUS from other plasma cell diseases including light chain amyloidosis or early-stage multiple myeloma, additional testing and information are often required(Rajkumar, 2016; *Standing in the Gaap*, 2021). In conclusion, although though MGUS has well-established diagnostic criteria, it is nevertheless difficult to identify in clinical practice, especially in settings with limited resources. Improving MGUS identification and management worldwide requires addressing these issues through increased knowledge, easier access to diagnostic resources, and the creation of economical solutions(*International Myeloma Working Group (IMWG) Criteria for the Diagnosis of Multiple Myeloma*, n.d.; *What Are MGUS, Smoldering Myeloma, and MM?*, n.d.; A. J. Landgren O. ,. &. Waxman, 2010).

2.11 Justification for Investigating Palestinian Populations for Monoclonal Gammopathy of Undetermined Significance (MGUS)

Monoclonal Gammopathy of Undetermined Significance (MGUS) among the Palestinian population is being studied because of the great information gaps in this area and the urgent need for early detection, especially among the elderly living in the northern West Bank. Better patient outcomes, resource allocation, and healthcare interventions may result from an understanding of the prevalence and features of MGUS in this population.

2.12 The Value of Early Detection

For the purpose of managing and reducing the hazards connected with MGUS, early identification is essential. About 1% of people with MGUS, a premalignant plasma cell condition, will develop multiple myeloma or other associated cancers in the future(Clinic, 2019). Closer monitoring is made possible by early detection of MGUS, which may slow or stop the development of more serious disorders.

Compared to patients who are diagnosed with MGUS after the progression has already occurred, those who have regular yearly exams before to developing multiple myeloma are far less likely to suffer from serious problems. Frequent monitoring enables measures that enhance overall prognosis by facilitating the timely detection of changes in disease status(Clinic, 2019). Additionally, early detection of MGUS may facilitate earlier therapeutic measures. Deep and long-lasting therapeutic responses could drastically change the course of the disease, according to recent advancements in therapy choices, including extremely effective medications (Clinic, 2019).

2.13 Addressing Knowledge Gaps

There is a notable dearth of information about MGUS in Palestine, especially among the elderly in the northern West Bank, despite a wealth of study on the disease's prevalence and risk factors in Western populations. There are various reasons why this knowledge gap is alarming. The prevalence of MGUS varies greatly among populations; in primarily white populations, a crude frequency of 3.2 percent has been found in people over 50. Prevalence rates among African Americans, on the other hand, vary from 5.9 to 8.4 percent, highlighting the impact of regional, environmental, and genetic factors (Rajkumar, 2009).

The correlation between age and MGUS prevalence highlights the necessity for focused studies in this population. With a median diagnostic age of about 70 years, studies consistently demonstrate that the prevalence of MGUS rises with age (Rajkumar, 2009). This pattern emphasizes how crucial it is to research MGUS in older adults, especially in areas with low screening program knowledge and availability. Underdiagnosis and delayed discovery of associated cancers, like multiple myeloma, are probably caused by Palestine's lack of standardized MGUS screening procedures (Rajkumar, 2009).

2.14 Relevance to the Palestinian Healthcare System

Particularly pertinent to the local healthcare system is the study of MGUS in the Palestinian environment. Resources for monitoring and possible interventions can be allocated more efficiently if the prevalence of MGUS and the risk factors linked to it are understood. The importance of this study is further highlighted by Palestine's aging population, since age is a major risk factor for MGUS (Rajkumar, 2009). Policies and healthcare planning can be informed by accurate prevalence statistics to meet the unique needs of this population.

Furthermore, this study can point up areas where the healthcare system lacks adequate diagnostic capabilities. Not all medical facilities may have easy access to diagnostic techniques such serum protein electrophoresis and immunofixation, which are crucial for identifying MGUS(Marinac et al., 2020). The study can promote investments in diagnostic capability by highlighting the necessity of these tools, which will shorten the time it takes to identify and treat plasma cell abnormalities.

The lengthy diagnostic period for myeloma, which is one of the longest for tumors, is one of the most urgent issues. In order to reduce this time, lessen the problems that occur with a delayed diagnosis, and enhance patient outcomes, early detection of MGUS may be essential (Atkin, 2018)[1]. Additionally, researching MGUS in Palestinians may uncover distinct genetic, cultural, or environmental factors that affect the frequency of the disease. In addition to improving healthcare locally, these discoveries would advance knowledge of MGUS epidemiology worldwide(Wadhera & Rajkumar, 2010).

2.15 Study Objectives

2.15.1 Main Goal

to ascertain the MGUS frequency among senior citizens in the northern West Bank. In order to evaluate the burden of MGUS in the Palestinian context, this objective offers baseline epidemiological data.

2.15.2 Secondary Goals

- Determine Clinical and Demographic Associations: In order to determine local risk factors, the study intends to look into possible connections between MGUS and variables like age, gender, comorbidities, and lifestyle choices.
- Stress the Value of Diagnostic Tools: The study highlights the need to enhance diagnostic capacities in Palestine for the early detection and management of MGUS by assessing the efficacy of diagnostic procedures such as SPE and IFE.

2.16 Relevance of the Research

This study is important because it could fill important knowledge gaps about Monoclonal Gammopathy of Undetermined Significance (MGUS) in Palestine and further our understanding of this premalignant illness worldwide. This study has ramifications that go beyond local healthcare, affecting global epidemiology, resource allocation, and future research paths by examining the prevalence and features of MGUS among the senior population in Tubas and the neighboring regions.

2.17 Adding to the Worldwide Knowledge of MGUS Epidemiology

This study offers useful information that advances our understanding of MGUS epidemiology worldwide. The majority of the study that has been done on the prevalence of MGUS has focused on Western populations, with little information coming from places like the Middle East. This study addresses a major gap in the literature by offering the first thorough analysis of MGUS in Palestine. The results can shed insight on distinct environmental, genetic, or demographic factors that affect the prevalence of MGUS in specific area, providing a fresh viewpoint on the disease's worldwide spread and related risks.

2.18 Giving Palestine Access to Baseline Data for Healthcare Planning and Resource Allocation

Planning for treatment and allocating resources are made more difficult by the lack of information on the prevalence of MGUS in Palestine. By providing baseline epidemiological data that can guide decision-making in the Palestinian healthcare system, this study fills this knowledge vacuum. The distribution of funds for monitoring and diagnostic technologies such serum protein electrophoresis and immunofixation can be guided by knowledge of the prevalence of MGUS in the elderly population. Additionally, the information can help with the development of focused screening initiatives and public health interventions, guaranteeing prompt identification and treatment of MGUS and its possible progression to multiple myeloma or associated conditions.

2.19 Promoting Upcoming Studies and Screening Programs in Underprivileged Groups

This study, which is the first of its kind in Palestine, lays the groundwork for further research on abnormalities of plasma cells in marginalized communities. It highlights how crucial localized research is to comprehending illness incidence and region-specific risk factors. In Palestine and other comparable areas, the results may stimulate additional investigation into the genetic, environmental, and clinical facets of MGUS, advancing a more thorough understanding of the illness worldwide. The study also promotes the creation of affordable screening programs in underprivileged communities, which could speed up diagnosis and enhance patient outcomes.

Chapter Three: Methodology and Materials

3.1 Study Design

This study used an observational cross-sectional design to find out how common monoclonal gammopathy of undetermined significance (MGUS) is among the elderly in the northern West Bank like Tubas and the adjacent areas, such as Jenin and the other villages. The cross-sectional method was selected because it enables the concurrent gathering of clinical and demographic information, offering a thorough overview of the prevalence of MGUS in this group.

Prevalence studies benefit greatly from this design since it makes it easier to find correlations between MGUS and pertinent clinical and demographic characteristics. Additionally, it provides vital baseline data for the area and lays the groundwork for future research and healthcare planning as the first study to examine the prevalence of MGUS in Palestine.

Since the study lasted a year, there was enough time to enroll participants and finish comprehensive laboratory tests such serum protein electrophoresis (SPE) and immunofixation electrophoresis (IFE). The Arab American University-Palestine (AAUP) Ethical Review Committee granted ethical permission for all procedures, which were carried out in conformity with the Declaration of Helsinki's ethical principles. This guaranteed that the research complied with the strictest ethical guidelines, protecting each participant's rights and welfare.

3.2 Study Population and Recruitment

The study's target sample consisted of people 60 years of age or older who visited the Turkish Hospital and the Central Health Clinic, two of Tubas' main medical institutions, for treatment. While the Central Health Clinic serves as a primary care facility for rural communities and the surrounding areas, the Turkish Hospital is a regional healthcare facility that offers both inpatient and outpatient services to both urban and rural populations. A representative sample of both urban and rural inhabitants was ensured by recruiting participants from these facilities when they went for routine medical care. This method made it possible to conduct a thorough evaluation of MGUS prevalence in a variety of demographic and geographic contexts.

The study's initial goal was to enlist 323 participants. This number was determined using Daniel's method for cross-sectional research, which was predicated on a 5% margin of error, a

95% confidence interval, and a presumed MGUS prevalence of 3%. However, it was not possible to reach the estimated sample size because of the restrictions placed on it by the ongoing war during the study time. Therefore, 100 people were chosen from each healthcare facility to make up the final sample, which had 201 participants. Despite several drawbacks, the smaller sample size was adequate to offer valuable information about the frequency of MGUS in this population.

3.3 Inlusion Criteria

Participants were included in the study if they met the following criteria:

- Age: Because MGUS is uncommon in younger people and more common in those 60 and older, participants had to be at least 60 years old to be eligible.
- Clinical Features Indicative of MGUS: To identify a group with possible risk factors for the illness, individuals exhibiting clinical symptoms that may be linked to MGUS, such as renal impairment, recurrent infections, unexplained fractures, or bone pain, were included.
- Serum Volume: Adequate serum volume was required for laboratory analysis, including serum, Total protein, protein electrophoresis (SPE) and immunofixation electrophoresis (IFE).
- Informed Consent: Participants needed to provide written informed consent, demonstrating their willingness and ability to comply with study procedures.

3.4 Exclusion Criteria

To guarantee the precision and dependability of the study's findings, the following exclusion criteria were used:

- Age: Since MGUS is extremely uncommon in people under 60, those individuals were not included.
- Autoimmune Diseases: Due to the possibility of false-positive results in laboratory tests, participants with autoimmune disorders were not allowed to participate.
- Hematological Malignancies: Because leukemia and lymphoma might mimic MGUS, those with a diagnosis of one of these diseases were not allowed to participate in the study.

- Active Malignancies and Severe Medical Conditions: Because of the higher risk of problems and possible requirement for specialist care, participants with active malignancies, uncontrolled hypertension, significant cardiovascular disease, or severe organ failure were not allowed to participate.
- Hemolyzed or Improperly Stored Samples: To maintain the integrity of laboratory studies, serum samples that had been hemolyzed or improperly stored were not included.
- Mental Health Disorders: Individuals who had significant mental health conditions or cognitive impairments that would have affected their capacity to give informed permission or adhere to study protocols were not allowed to participate.

3.5 Sampling Method

Convenience sampling was used to select participants as they sought medical attention at Tubas' Turkish Hospital and Central Health Clinic. This strategy made it possible to get samples from a population that represented both urban and rural populations in an effective manner. The goal of the recruitment method was to guarantee that a varied population that reflected the healthcare-seeking trends in the area was represented.

3.6 The size of the sample

Daniel's method for cross-sectional studies was used to estimate the initial goal sample size for this study, which was 323 participants. This was based on a 95 percent confidence interval, a 5 percent margin of error, and an expected MGUS prevalence of 3% in the community. However, during the study period, the conflict limited access to medical facilities and decreased the number of opportunities for recruiting participants. As a result, 201 people made up the final sample size of the study, which was split equally between the Central Health Clinic and the Turkish Hospital. Even with the smaller sample size, it was adequate to meet the main goals of the study and yield useful information on the prevalence of MGUS in this community.

3.7 Ethical Considerations

The rights, safety, and welfare of every participant were given first priority during the whole research process since this study was carried out in compliance with the ethical guidelines

specified in the Declaration of Helsinki. The Arab American University-Palestine (AAUP) Ethical Review Committee granted ethical approval for the study, confirming that all practices adhered to accepted ethical norms.

All participants received a thorough description of the study's goals, methods, possible risks, and advantages prior to recruitment. A Participant Information Sheet was used to convey this information, and each participant went over it to make sure they understood it. All subjects provided written informed permission attesting to their voluntary participation in the study. Verbal explanations were given to people with low reading levels, and ethical documentation of consent was done.

To maintain confidentiality, each participant was assigned a unique identification code. All data collected, including demographic information, clinical details, and laboratory results, were anonymized and securely stored. Access to identifiable participant information was restricted to authorized research personnel only. Additionally, all electronic data were stored on password-protected devices, and hard copies of consent forms and related documents were securely locked in the principal investigator’s office.

By following these ethical guidelines, the study promoted the validity and dependability of the research while guaranteeing the protection of participants' rights and privacy.

3.8 Data Collection

3.8.1 Sample Collection and Handling

Biological samples from the participants were gathered at the Central Health Clinic and Turkish Hospital in Tubas. Blood samples were taken using conventional venipuncture techniques by trained medical professionals, who made sure sterile procedures were followed to maintain sample integrity. Blood was extracted from each participant in serum separator tubes, containing around 5 mL. (SST).

The samples were centrifuged for 10 minutes at 3,000 RPM to separate the serum from cellular components after being allowed to clot at room temperature. The serum was then immediately kept at -80°C after being aliquoted into labeled cryovials to preserve protein integrity until

analysis. For later laboratory procedures, such as immunofixation electrophoresis (IFE) and serum protein electrophoresis, this storage method guaranteed the preservation of serum proteins (SPE).

Standardized laboratory procedures were followed in the processing of 201 samples in total. Samples were transported in cold chains when required, which maintained constant temperature control to stop degradation. Serum samples that had been frozen were thawed at room temperature for half an hour prior to laboratory examination. The study's goals were supported by the precise analytical results and protein stability that were guaranteed by this carefully regulated thawing process.

3.8.2 Demographic and Clinical Data Collection

A standardized questionnaire designed specifically for this study was used to ask participants questions in order to gather demographic and clinical information. The questionnaire asked about age, gender, medical history, and clinical symptoms that could indicate MGUS, such as bone pain, recurring infections, renal impairment, or unexplained fractures. The interviews were performed in a private location within the medical institution by qualified research workers to ensure confidentiality and encourage honest reporting. Medical records of the individuals were reviewed, if available, to verify self-reported clinical information and to gather further information on comorbidities, medication history, and laboratory results. Distinct participant identification codes were used to document all information obtained during interviews and record reviews in order to ensure anonymity.

The study used a combination of systematic sample collection and structured data gathering to get comprehensive and reliable data capture to support the research goals.

3.9 Materials and Equipment

3.9.1 Laboratory Equipment

To provide accurate and trustworthy results, sophisticated equipment was used for the laboratory analyses in this study. The Cobas 8000 Analyzer from Roche Diagnostics, which accurately measures serum protein levels using the Biuret colorimetric method, was used to quantify total protein. The Sebia Hydrasys 2 System was used to evaluate serum protein patterns. With its ability to carry out both serum protein electrophoresis (SPE) and immunofixation electrophoresis (IFE), this semi-automated device makes it easier to discover and precisely characterize monoclonal proteins. The serum samples were prepared using a high-speed centrifuge in addition to these analytical tools. The centrifuge's ability to reach 3,500 revolutions per minute (RPM) guaranteed that the serum and blood cells were successfully separated, which is an essential step in acquiring

3.10 Reagents

The study's reagents included Acid Violet Petals, which was used to stain antigen-antibody complexes during immunofixation electrophoresis, and Amido Black Stain, which was used to stain protein bands in serum protein electrophoresis (SPE) (IFE). Serum was prepared at specific dilutions using an immunofixation diluent supplied by Sebia. Following antigen-antibody reactions in IFE, a wash solution with a buffered formulation was used to guarantee the elimination of unattached proteins. Protein bands were clearly visible when excess stain was removed from the gels using a destaining solution. Furthermore, IFE antisera were used to identify particular immunoglobulins, such as kappa and lambda light chains, IgG, IgA, and IgM. As the medium, pre-cast agarose gels were used for the procedures.

3.11 Laboratory Procedures

3.11.1 Serum Protein Electrophoresis (SPE)

Using serum protein electrophoresis, a fundamental analytical technique, blood proteins can be separated and measured based on their electrical charge, size, and shape (SPE). This method is highly helpful in clinical diagnostics for detecting and monitoring a variety of diseases, including multiple myeloma and other plasma cell abnormalities (O'connell et al., 2005). There are several

crucial processes in the Sebia Hydrasys 2 machine's serum protein electrophoresis process. First, a small amount of serum (about 10 μL) is carefully added to a specific medium, like cellulose acetate or agarose gel, using an applicator (HYDRASYS 2-SCAN - Agarose Gel Electrophoresis System by Sebia | MedicalExpo, n.d.; Serum Protein Electrophoresis, Total Protein, Albumin and Globulin - Labpedia.Net, 2020; O'connell et al., 2005). The sample is then exposed to an electric field under carefully regulated conditions, usually at pH 9.1, with a constant power of 20 W and a temperature of 20°C (HYDRASYS 2 SCAN - Agarose Gel Electrophoresis System by Sebia | MedicalExpo, n.d.; Identification of Monoclonal Proteins by Gel Electrophoresis | Sebia, 2022). Based on their electrical characteristics, proteins segregate throughout the roughly 30-minute electrophoretic migration process. Alpha-1, alpha-2, beta, and gamma globulin fractions separate based on their individual charges, whereas albumin, which is negatively charged, migrates the furthest towards the anode(HYDRASYS LC TECHNICAL MANUAL, n.d.) (O'connell et al., 2005).

The gel is automatically processed by the Hydrasys 2 system after the migration. The protein fractions are stabilized by a drying stage at 65°C (HYDRASYS LC TECHNICAL MANUAL, n.d.). After drying, the gel is moved to the staining area and automatically stained with amido black dye. For the separated protein bands to be seen, this step is essential(Gersten et al., 2022; HYDRASYS LC TECHNICAL MANUAL, n.d.) (Diana et al., 2020).

The technique destains after staining to remove excess dye, which enhances the protein bands' sharpness and clarity. The last drying stage is then finished (Diana et al., 2020). Following treatment, the treated gel is scanned using the integrated Phoresis densitometer, which employs a high-resolution CCD sensor (HYDRASYS 2 SCAN - Agarose Gel Electrophoresis System by Sebia | MedicalExpo, n.d.; HYDRASYS 2 SCAN FOCUSING • MAGIRAS DIAGNOSTICS, 2019). [39][42]. The PHORESIS software generates quantitative and qualitative data regarding the protein fractions after examining the scanned image. The program typically separates five major fractions from blood proteins: albumin, beta, gamma, alpha-1, and alpha-2 globulins (Diana et al., 2020; Gersten et al., 2022; HYDRASYS 2 SCAN FOCUSING • MAGIRAS DIAGNOSTICS, 2019). The typical ranges for the relative amounts of these fractions include albumin (50–60 percent), beta (8–12 percent), gamma (8–16 percent), alpha-1 (2–3 percent), and alpha-2 (6–9 percent) (O'connell et al., 2005). Serum protein electrophoresis is a comprehensive,

semi-automated protein analysis technique provided by the Sebia Hydrasys 2 system. It is a vital tool in clinical diagnostics because of its capacity to separate and measure serum proteins, especially in the screening and surveillance of illnesses involving plasma cells and other protein-related pathologies (O'connell et al., 2005).

3.11.2 Immunofixation Electrophoresis (IFE)

For all samples identified as positive during SPE, immunofixation electrophoresis was conducted using the Sebia Hydrasys 2 system to confirm and characterize the monoclonal proteins. This method employed targeted antisera to determine the immunoglobulin class and light chain type of the monoclonal protein. The procedure involved:

The first step in the procedure is sample preparation, in which serum is usually diluted with a particular diluent that Sebia supplies. Standardizing protein concentration and guaranteeing the best possible separation during electrophoresis depend on this dilution stage. Following dilution, an agarose gel is coated with a specific volume of the sample, typically 10 μL (*HYDRASYS 2 SCAN FOCUSING, All-in-One Gel Agarose Electrophoresis Analyser | SEBIA*, 2022).

The serum proteins are then automatically separated by electrophoresis using the Hydrasys 2 system. At pH 9.1, a constant power of 20 W, and a temperature of 20°C, this separation takes place in an alkaline buffer (Diana et al., 2020; Thoren et al., 2021; *TP2*, 2025)(*HYDRASYS 2 SCAN FOCUSING, All-in-One Gel Agarose Electrophoresis Analyser | SEBIA*, 2022). Proteins move throughout this process according to their molecular weight and electrical charge.

The gel goes through the immunofixation procedure after the electrophoretic separation. The operator's job becomes vital at this point. Certain antisera against immunoglobulin heavy chains (IgG, IgA, and IgM) and light chains are treated with the separated proteins (kappa and lambda). These antisera are manually applied to the gel's specific lanes by the operator(HYDRASYS LC TECHNICAL MANUAL, n.d.). If there is a monoclonal protein present, this step is essential for determining its kind.

The Hydrasys 2 system automates the next processes when antisera are applied. Gel drying, destaining to eliminate background staining, staining the gel with acid violet dye to see the

immunoprecipitates, and removing excess and unbound antisera are some of these(Cawley et al., 1976).

The integrated Phoresis densitometer, which uses a high-resolution CCD sensor, is subsequently used to scan the treated gel(Diamedix Diagnostica, 2023). PHORESIS software is used to analyze the scanned image and help explain the results.

Visually assessing the gel for the existence of monoclonal bands is necessary for the interpretation of IFE data. In one or more immunoglobulin lanes, these show up as distinct, thin bands. A monoclonal protein is indicated by the existence of such bands, whereas a polyclonal pattern characteristic of reactive or normal conditions is suggested by their absence(Cawley et al., 1976).

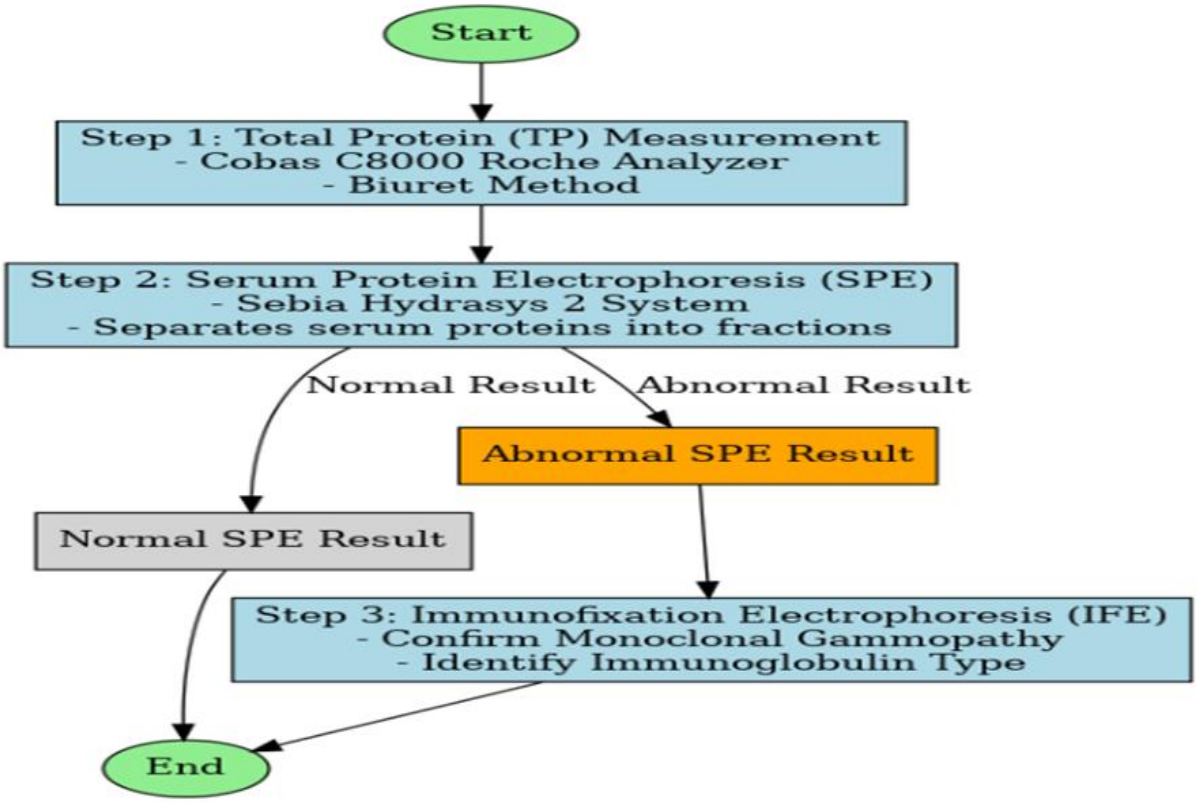
This technology provided precise monoclonal protein identification and characterisation by combining SPE and IFE. Quantitative measurements were obtained from the first screening in SPE, and the type of monoclonal protein found was confirmed and described by the subsequent IFE.

3.11.3 Total Protein Measurement

The total protein concentration in serum samples was measured using the Cobas C8000 Roche analyzer, which utilizes the biuret technique, an automated colorimetric assay designed for precise protein quantification. Prior to initiating the sample analyses, calibration was performed using standard protein solutions to ensure the accuracy of the measurements. Additionally, quality control (QC) procedures were conducted daily to verify the analyzer's performance. This involved running high and low control samples with known protein concentrations, and the QC results were compared against predefined acceptable ranges to confirm optimal functionality.

Once the calibration and QC procedures were successfully completed, the Cobas C8000 analyzer carried out the entire analytical process automatically. Serum samples were loaded into the analyzer, and the biuret reaction was initiated within the system. In this reaction, serum proteins interacted with copper ions in an alkaline solution, forming a blue-violet complex. The analyzer then performed spectrophotometric measurements, detecting the absorbance of the complex at wavelengths between 540 and 670 nm. The total protein concentration for each sample was automatically calculated based on the calibration curve, ensuring consistent and accurate results

without the need for manual intervention during the measurement process.(Order Information, n.d.; *TP2*, 2025).



Flowchart Illustrating the Step-by-Step Laboratory Process for MGUS Detection Fig.3.1, starting with total protein measurement, followed by serum protein electrophoresis (SPE) to assess protein distribution. Participants with normal SPE results required no further testing, while those with abnormal gamma region findings proceeded to immunofixation electrophoresis (IFE) for confirmation of monoclonal gammopathy."

3.12 Integration of Results

The integration of results from SPE, IFE, and total protein measurement allowed for a comprehensive analysis of serum proteins. SPE identified potential monoclonal proteins, and samples with spikes were quantitatively measured using densitometry. Positive samples underwent IFE for detailed characterization of the monoclonal proteins. This combined approach ensured a thorough and accurate diagnosis of plasma cell disorders.

3.13 Ethical Considerations

From the AAUP Ethical Review Committee, ethical approval was received. All participants supplied written informed consent. Through anonymization, participant confidentiality was protected.

3.14 Statistical Analysis Methods

The statistical analysis for this study was conducted to rigorously evaluate the prevalence of monoclonal gammopathy of undetermined significance (MGUS) among elderly individuals in the northern districts of the West Bank-Palestine and to investigate potential associations with demographic and clinical variables. The study was structured around the null hypothesis (H_0), which posited that the prevalence of MGUS in this population is not statistically higher than what has been reported in international studies. To ensure the reliability of findings, a combination of descriptive statistics, inferential tests, and regression modeling was employed.

Descriptive statistical methods were first applied to summarize key characteristics of the study population. Measures of central tendency, such as the mean and median, were used to describe continuous variables, including age and total protein concentration, while standard deviation and interquartile ranges provided insights into data variability. Categorical variables, such as gender distribution, smoking status, and the presence of underlying diseases, were summarized using frequency distributions and percentages to present a comprehensive demographic and clinical profile of the participants.

To assess the overall prevalence of MGUS in the study cohort, the proportion of diagnosed cases was calculated relative to the total sample. To determine whether the observed prevalence differed significantly from internationally reported prevalence rates, a Chi-square goodness-of-fit test was conducted. This test allowed for a statistical comparison between the observed MGUS prevalence and expected values derived from literature-based prevalence rates, assessing whether the study population exhibited a significantly higher or lower prevalence than what has been previously documented.

Further statistical analyses were conducted to examine gender-based differences in MGUS prevalence. A Chi-square test of independence was employed to determine whether MGUS occurrence was significantly associated with gender. This test compared the frequency distributions of MGUS cases between males and females, identifying whether the prevalence varied significantly between the two groups. This analysis was essential in exploring potential gender-specific risk factors and epidemiological trends.

In addition to demographic factors, the study sought to explore associations between MGUS and various clinical conditions, including anemia, renal disease, diabetes, fractures, and other chronic illnesses. To examine these relationships, a Chi-square test of independence was conducted for categorical health variables. This test assessed whether there was a statistically significant association between MGUS status and specific medical conditions, providing insights into potential comorbidities that may contribute to or result from MGUS.

To further quantify the impact of clinical and demographic factors on MGUS risk, a binary logistic regression analysis was performed. In this model, MGUS status (presence or absence) was treated as the dependent variable, while independent variables included key demographic and health-related factors, such as gender, anemia, renal disease, diabetes, osteoporosis, and frequent bone pain. Logistic regression was used to estimate odds ratios (ORs) with 95% confidence intervals (CIs), quantifying the likelihood of MGUS occurrence among individuals with specific health conditions relative to those without. This analysis provided an advanced statistical approach to adjusting for potential confounding variables, offering a clearer understanding of independent risk factors for MGUS.

Geographic variations in MGUS prevalence were also explored to determine whether specific provinces exhibited higher or lower prevalence rates. To achieve this, a Chi-square test of

independence was performed to compare MGUS occurrence across different northern districts of the West Bank. This test evaluated whether significant regional disparities in MGUS prevalence existed, potentially indicating differences in environmental exposures, healthcare access, or genetic predispositions.

A significance level of $\alpha = 0.05$ was used for all statistical analyses. A statistically significant association or difference was shown by a p-value that was less than this cutoff. To guarantee accuracy, repeatability, and robustness of results, data analysis was carried out using the proper statistical software, Microsoft Excel and Python, to assess the prevalence of monoclonal gammopathy of undetermined significance (MGUS) among senior citizens in the northern districts of the West Bank, Palestine. A thorough evaluation of the prevalence of MGUS and its relationships to demographic and clinical factors in the research population was made possible by the combination of descriptive, inferential, and multivariate statistical approaches, which offered a rigorous analytical framework. By ensuring that the results were both statistically valid and clinically significant, this systematic statistical method improved our knowledge of the epidemiology of MGUS in the area.

Chapter Four: Results

4.1 Laboratory Analysis

Overview

The laboratory analysis used a three-step procedure to establish monoclonal gammopathy, detect aberrant protein patterns, and evaluate total protein levels in an organized manner. This scientific technique guaranteed thorough screening and precise MGUS case classification.

Step 1: Measurement of Total Protein (TP): Using the Cobas C8000 Roche analyzer and the biuret method for quantification, the total protein concentration was determined for each of the 201 participants.

Step 2: Electrophoresis of serum proteins (SPE): Following TP measurement, all participants underwent serum protein electrophoresis (SPE) using the Sebia Hydrasys 2 system. This technique separates serum proteins into major fractions—albumin, alpha-1, alpha-2, beta, and gamma globulins.

step 3: Immunofixation for Confirmation: Participants exhibiting abnormal gamma region findings on SPE were further analyzed using immunofixation electrophoresis (IFE) to confirm the presence of monoclonal

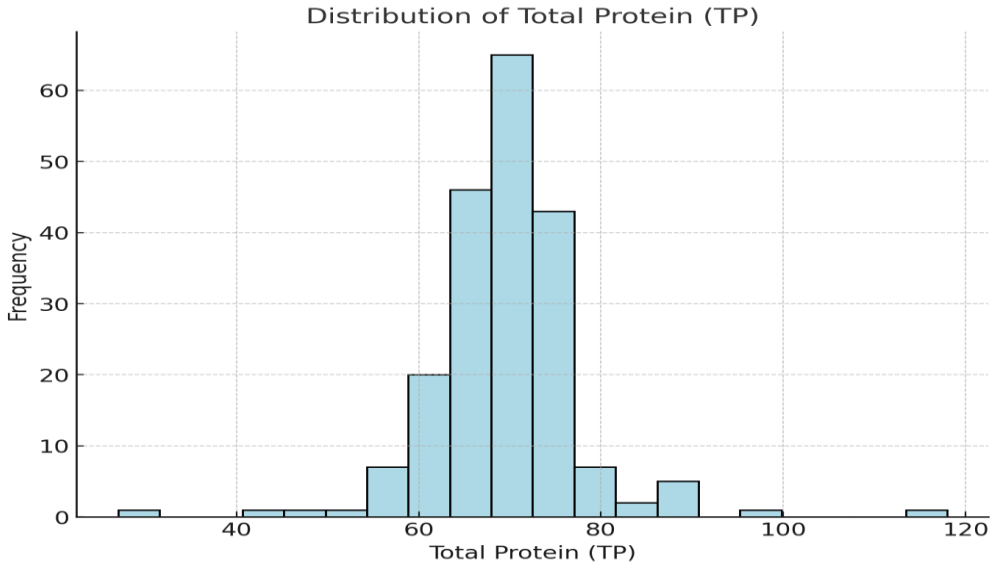
4.2 Results of Total Protein Measurement

Total protein concentration was measured for all 201 participants using the Cobas C8000 Roche analyzer, employing the biuret method for quantification. This colorimetric assay enabled precise determination of total protein levels, providing a comprehensive overview of the participants' protein profiles.

The descriptive statistics for total protein (TP) are as follows: Mean Total Protein: 69.44 g/Standard Deviation: 8.26 g/Minimum Value: 27 g/L,25th Percentile (Q1): 65 g/L, Median (50th Percentile): 69 g/L, 75th Percentile (Q3): 73 g/Maximum Value: 118 g/L These results demonstrate that the majority of participants had total protein levels within a normal range, with some variability as indicated by the standard deviation. A small number of participants exhibited extreme values

Distribution of Total Protein Levels Among Study Participants Table4.1, this table provides a clear summary of the distribution of total protein levels among the study participants.

Statistic	Value (g/L)
Mean Total Protein	69.44
Standard Deviation	8.26
Minimum Value	27.00
25th Percentile (Q1)	65.00
Median (50th Percentile)	69.00
75th Percentile (Q3)	73.00
Maximum Value	118.00



Histogram Figure 4.1 Showing the Distribution of Total Protein (TP) Levels Among Study Participants.

4.3 Protein Electrophoresis Results

4.3.1 Serum protein electrophoresis (SPE):

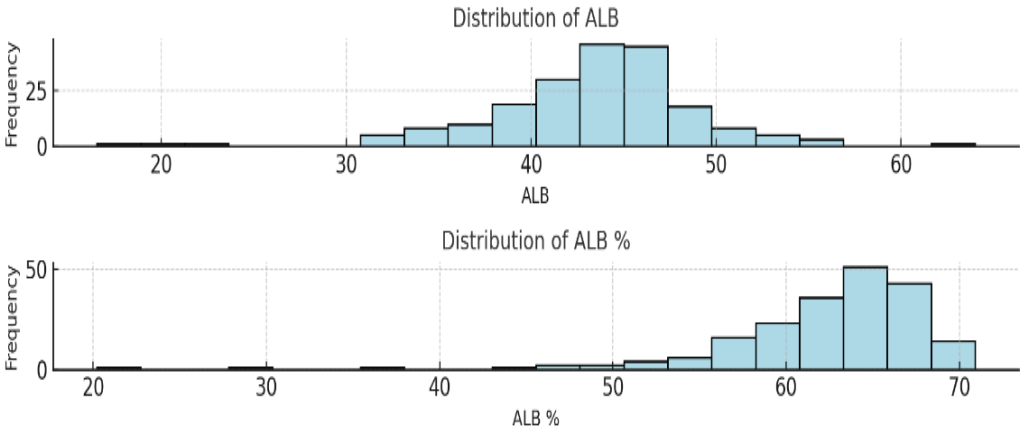
Serum protein electrophoresis (SPE) was conducted for all 201 participants using the Sebia Hydrasys 2 system. This procedure was designed to separate serum proteins into fractions and identify abnormalities, specifically focusing on the gamma region, where monoclonal gammopathies are typically observed.

4.3.2 Summary of Key Test Results

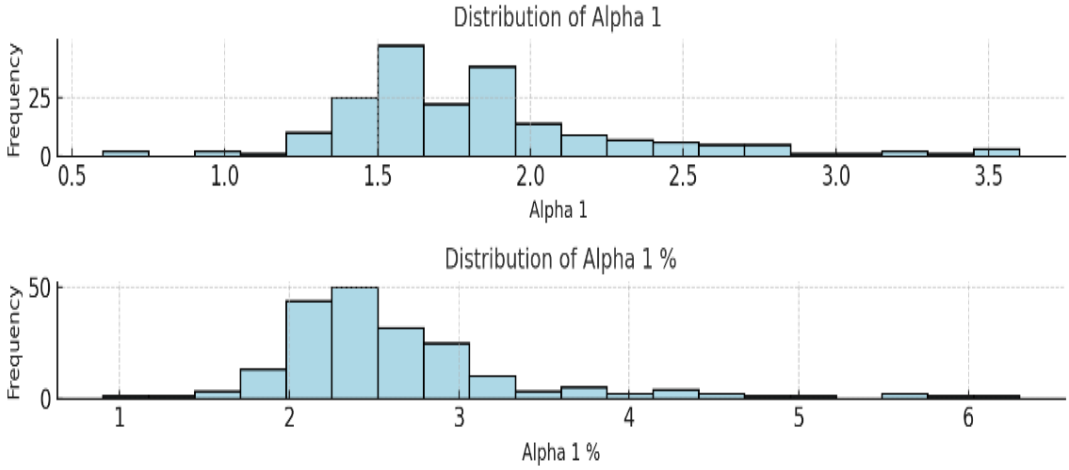
The results of the serum protein electrophoresis (SPE) analysis are supported by the summary statistics of serum protein fractions among research participants, which offer important insights into protein distribution. With an average of 69.44 g/L and a standard deviation of 12.31 g/L, total protein (TP) levels varied moderately within the population, ranging from 27 g/L to 118 g/L. As the predominant serum protein, albumin levels ranged from 16.5 g/L to 64 g/L, with a mean of 43.35 g/L and a standard deviation of 6.87 g/L. The alpha-1 and alpha-2 fractions had mean concentrations of 2.8 g/L (range: 0.7–5.2 g/L) and 7.4 g/L (range: 3.3–12.0 g/L), respectively. The beta fraction ranged from 3.8 g/L to 12.3 g/L, with a mean value of 7.1 g/L. The gamma fraction, which is particularly noteworthy because it is closely linked to monoclonal gammopathies, had an average concentration of 10.7 g/L, with a range of 3.1 g/L to 21.7 g/L. Furthermore, the balance between albumin and globulin proteins in the individuals' serum was indicated by the albumin-to-globulin (A/G) ratio, which showed a mean of 1.4 with values ranging from 0.6 to 2.7 and a standard deviation of 0.4. These figures offer a thorough picture of the distribution of serum proteins, which helps detect anomalies connected to diseases like MGUS.

Summary Statistics for Serum Protein Fractions, Table 4.2 Including Total Protein (TP), Albumin (ALB), Alpha-1, Alpha-2, Beta, Gamma, and Albumin-to-Globulin (A/G) Ratio

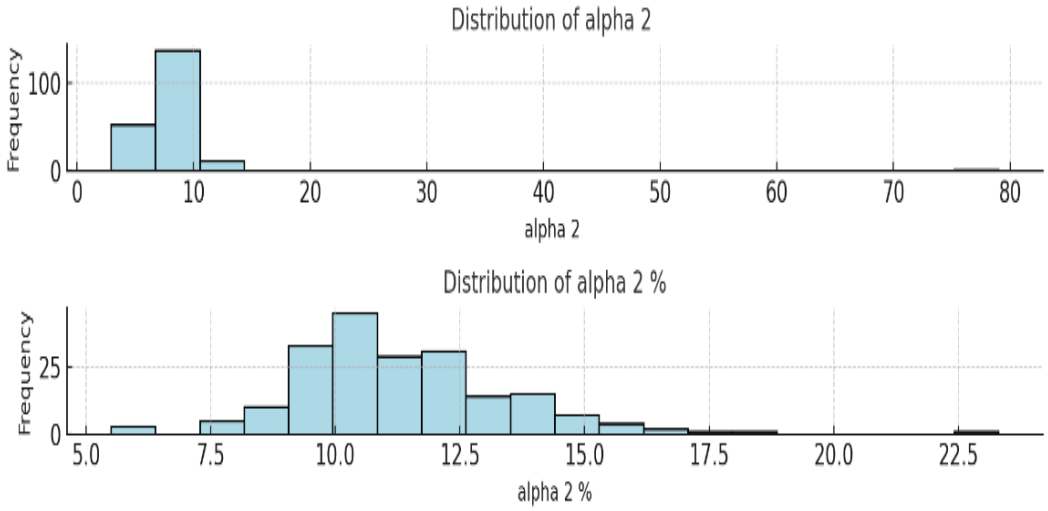
Fraction	Mean (g/L)	SD (g/L)	Min (g/L)	Q1 (g/L)	Median (g/L)	Q3 (g/L)	Max (g/L)
Total Protein	69.4	8.26	27	65	69	73	118
Albumin	43.4	5.73	16.5	40.8	43.9	46.3	64
Alpha-1	1.8	0.48	0.6	1.5	1.7	2	3.6
Alpha-2	8.2	5.28	2.9	6.7	7.6	9	79
Beta	7.1	1.24	3.1	6.3	7.1	7.8	11.3
Gamma	9.5	5.31	3.9	7.2	8.6	10.4	70
A/G Ratio	1.7	0.35	0.38	1.52	1.74	1.95	2.44



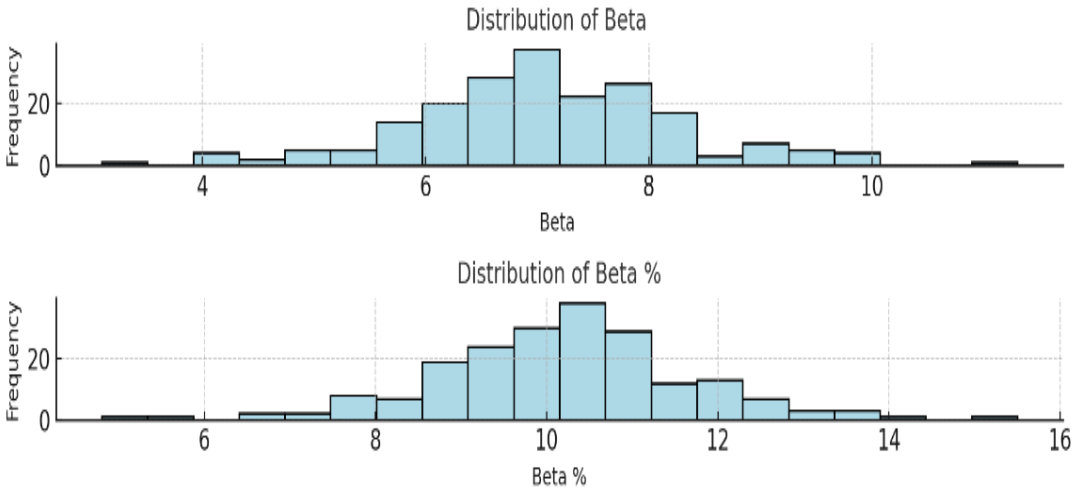
Histograms Fig.4.2 Showing the Distribution of Albumin calculated and Albumin Ratio**.**



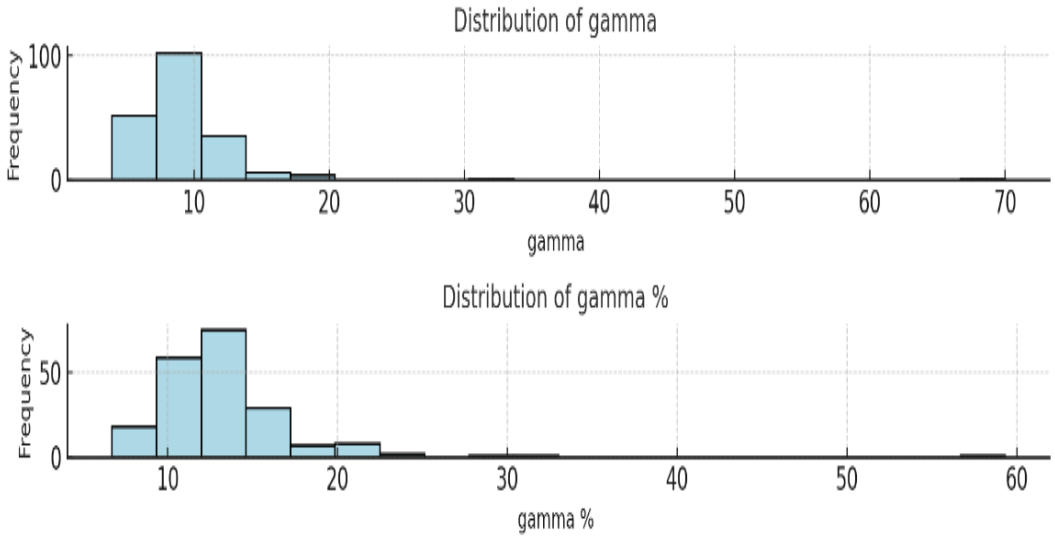
Histograms Fig.4.3 Showing the Distribution of Alpha 1 calculated and Alpha 1 Ratio.



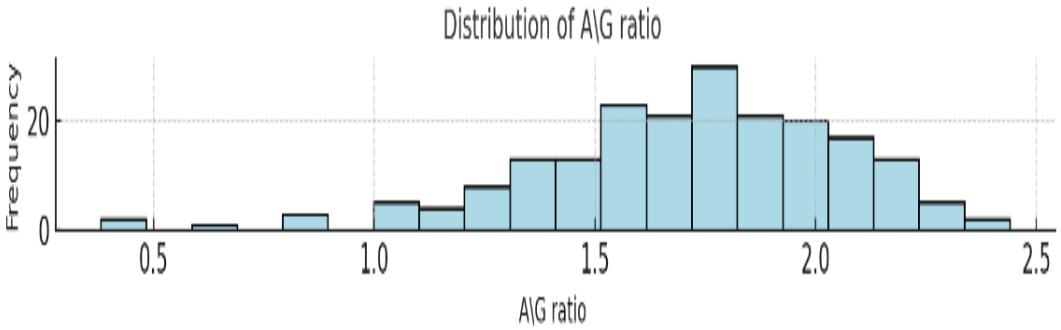
Histograms Fig.4.4 Showing the Distribution of Alpha calculated and Alpha 2 Ratio.



Histograms Fig.4.5 Showing the Distribution of Beta calculated and Beta Ratio.



Histograms Fig.4.6 Showing the Distribution of gamma calculated and Gamma Ratio.



Histograms Fig.4.7 Showing the Distribution of Albumin to globulin Ratio.

4.4 Findings from Protein Electrophoresis

- **Normal Results:** Among the 201 participants, **182 individuals** had normal protein electrophoresis results, indicating no abnormal protein bands or spikes. These participants did not require further immunofixation testing.
- **Abnormal Results: 19 participants** exhibited abnormalities in the gamma region, such as:
    - A distinct band or spike in the gamma region.
    - Low concentrations in specific fractions.
    - Uncharacteristic or abnormal patterns in protein distribution.

4.5 Criteria for Immunofixation Testing

To refine the diagnosis, participants with the following conditions were considered for immunofixation testing:

- Gamma Band Abnormality: All participants with gamma band abnormalities underwent further analysis. After scanning the gamma bands:
- 3 participants were excluded because their gamma spike concentrations exceeded 3.3 g/dL, with values of 7.1 g/dL, 6.3 g/dL, and 66.2 g/dL. These individuals were

considered more indicative of multiple myeloma (MM) and excluded from further MGUS-focused analysis.

- Unusual Bands: One participant presented with an unknown band between the alpha-1 and alpha-2 regions. This case warranted further investigation through immunofixation.
- Low Alpha-1 Fraction: A specific focus was placed on participants exhibiting a low alpha-1 fraction. Two individuals meeting this condition were considered for immunofixation testing, one of whom was ultimately included in further analysis. (**Table4.3)**

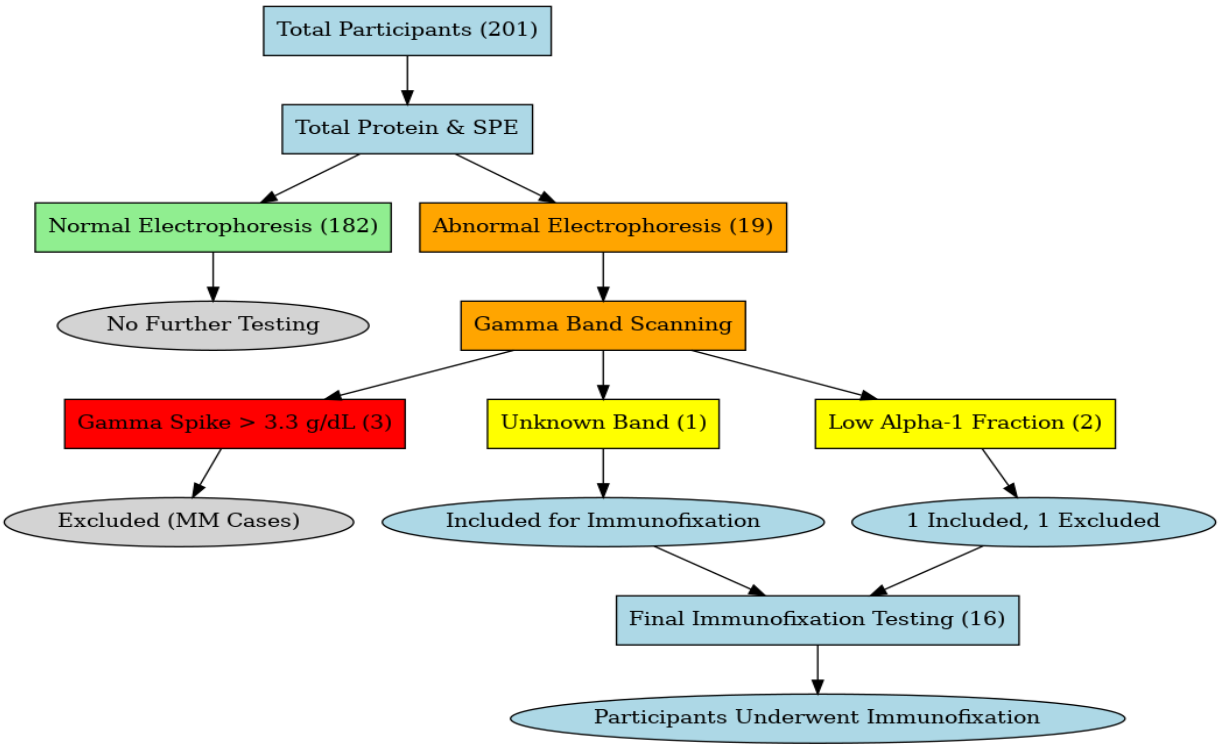
4.6 Final Immunofixation Testing

- Out of the initial 19 participants with abnormal electrophoresis findings, **16 participants** were ultimately taken forward for immunofixation testing.
- The criteria for selecting these participants ensured the exclusion of cases indicative of multiple myeloma or irrelevant protein abnormalities.

This approach allowed for a targeted analysis of participants potentially exhibiting monoclonal gammopathy of undetermined significance (MGUS) while minimizing confounding from unrelated conditions or disorders. **(Figure 4.8)**

Overview of the Testing Process, Including Steps, Criteria, and Decision-Making Pathways. Table4.3 This table provides a clear visual breakdown of the steps, criteria, and decisions made during the testing process.

Step	Criteria/Findings	Number of Participants	Action Taken
Total Participants	-	201	All participants underwent total protein measurements and serum protein electrophoresis (SPE).
Normal Electrophoresis Results	No abnormalities in protein fractions.	182	No further testing required.
Abnormal Electrophoresis Results	Abnormalities in the gamma region or protein distribution.	19	Participants considered for immunofixation testing.
Gamma Band Scanning	Gamma spike > 3.3 g/dL.	3	Excluded (values: 7.1 g/dL, 6.3 g/dL, 66.2 g/dL).
Unknown Band	Unusual band between alpha-1 and alpha-2 regions.	1	Included for immunofixation.
Low Alpha-1 Fraction	Participants with low alpha-1 fraction.	2	1 included for immunofixation; the other excluded.
Final Immunofixation Testing	Gamma band abnormalities or meeting other selection criteria.	16	Participants underwent immunofixation testing.



Flowchart Representing the Stepwise Process of Protein Electrophoresis and Immunofixation Testing. Fig. 4.8 The flowchart visually represents the stepwise process of protein electrophoresis and immunofixation testing, starting with total protein measurement for all participants, identifying abnormalities in the gamma region through serum protein electrophoresis (SPE), and selecting specific cases for immunofixation to confirm or exclude monoclonal gammopathy.

Immunofixation Results:

Out of the 16 participants, 12 showed **positive** results, and 4 showed **negative** results. One of the **negative** results had a band concentration of **1.9** on the scanning, but it was later determined that this band was caused by **fibrinogen contamination**, leading to a false positive result. (**Table 4.4).**

Summary of Immunofixation Results for 16 Participants, Table 4.4 Including Band Type, Spike Concentration, and Relevant Observations.

P. ID	Medical Center	type of the band	spike Concentration	Note
5	Turkey Hospital	IgG lambda	1.2	
10	Turkey Hospital	IgG Kappa	3.3	
13	Turkey Hospital	Negative	0	unknown band between alpha 1 and alpha 2
36	Turkey Hospital	IgG Kappa	1.3	
59	Turkey Hospital	IgG Kappa + IgG lambda	two spikes <1	
73	Turkey Hospital	Negative	1.9	band was caused by fibrinogen contamination
89	Turkey Hospital	IgG lambda	2.1	
114	Central Health Clinic	Negative	0	hyper gamma
115	Central Health Clinic	IgG Lambda	<1	
118	Central Health Clinic	IgM Kappa	<1	
150	Central Health Clinic	Negative	low alpha 1	
170	Central Health Clinic	Free Lambda	2	
172	Central Health Clinic	IgG Lambda	2.4	
177	Central Health Clinic	IgG Kappa + IgA Kappa (Hidden in Beta)	<1	two spikes <1 in Gamma Region (IgG Kappa) and one spike hidden in Beta
178	Central Health Clinic	IgG Kappa	<1	

203	Central Health Clinic	IgG Kappa	1.1	

4.7 Statistical analysis

4.7.1 Overview

This section presents a detailed summary of the study findings, focusing on participant demographics, clinical characteristics, prevalence of **Monoclonal Gammopathy of Undetermined Significance (MGUS)**, and associations with various health conditions. Additionally, statistical analyses, including chi-square tests, Mann-Whitney U tests, and regression models, are discussed to evaluate potential predictors of MGUS.

4.8 Participant Demographics

The study included **201 unique participants**, all aged 60 years or older, with an average age of **69.46 years** (SD = ±8.9). The gender distribution indicated that **37.3% were male** and **62.7% were female**. Participants were nearly evenly distributed across the two medical centers included in the study (Medical Center 0 and Medical Center 1), with a mean distribution of **0.498** (SD = 0.501). The majority of participants resided in the **Tubas province** (Mean = 1.36, SD = 0.88), indicating a predominantly local sample.

4.9 Clinical Features of the Study Population

The study population's clinical characteristics were evaluated in order to determine possible risk factors and provide a thorough grasp of the participants' health attributes. The prevalence of chronic illnesses or other medical disorders that may affect the likelihood of developing monoclonal gammopathy of unknown importance was indicated by the noteworthy 18.9% of individuals who reported having underlying medical conditions (MGUS). The smoking status of the participants showed that 31.3% reported either active or passive smoking, but the majority were non-smokers when lifestyle factors were taken into account. The aforementioned indicates that a considerable segment of the populace is subjected to risk factors associated with tobacco use, which could potentially impact general health.

63.7 %of participants have received an X-ray or CT scan, indicating a comparatively high incidence of use of diagnostic imaging in the medical field. This points to possible health issues that need imaging for diagnosis purposes or routine medical checkups.

Given that only 24.4% of individuals had their vitamin D levels examined in the previous 12 months, preventive health measures seemed to be lacking. This suggests a lack of regular monitoring for vitamin D deficiency, which is important for immune system and bone health.

Furthermore, 17.4% of participants said they took iron supplements, indicating that anemia or iron deficiency may be common in the general population. Reliance on supplements suggests underlying health issues or nutritional deficits that need to be treated by a doctor. When combined, these clinical characteristics offer crucial background information for comprehending the research population's health state and possible risk factors for MGUS.

4.10 Prevalence of Medical Conditions in the Study Population

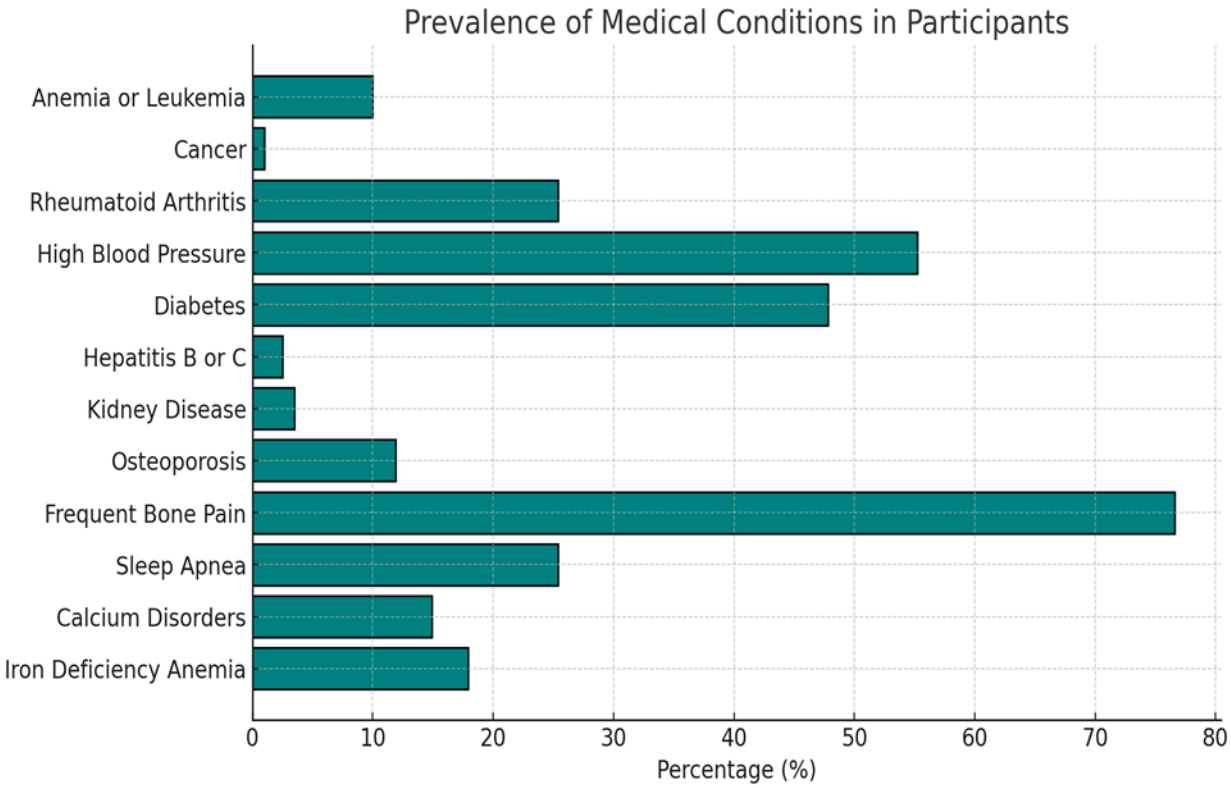
The study also looked at the patients' prevalence of a number of medical illnesses, with a particular emphasis on anemia, metabolic abnormalities, and chronic diseases in order to identify any possible health hazards related to monoclonal gammopathy of unknown relevance (MGUS). 17.9% of subjects had iron deficiency anemia, indicating a prevalent nutritional deficiency that could affect general health. In terms of metabolic problems, modest knowledge and monitoring of bone health was demonstrated by the fact that 14.9% of participants had diseases connected to calcium and 44.3% had examined their calcium levels in the previous year. The prevalence of sleep apnea, a respiratory disorder with established links to a number of systemic health problems, was found to be substantial, with 25.4% of participants reporting having it. A remarkable 76.6% of individuals also reported having frequent bone discomfort, which could be a sign of underlying hematological or musculoskeletal disorders. The prevalence of osteoporosis was 11.9%, while kidney disease was reported in only 3.5% of the population, suggesting relatively low rates of renal impairment. Hepatitis B or C was identified in a small fraction of participants (2.5%), indicating limited viral hepatitis prevalence in this cohort.

The prevalence of metabolic and cardiovascular problems was particularly high, with 55.2% having high blood pressure and 47.8% with diabetes, highlighting the burden of chronic diseases among the elderly. The presence of rheumatoid arthritis in 25.4% of patients indicates a

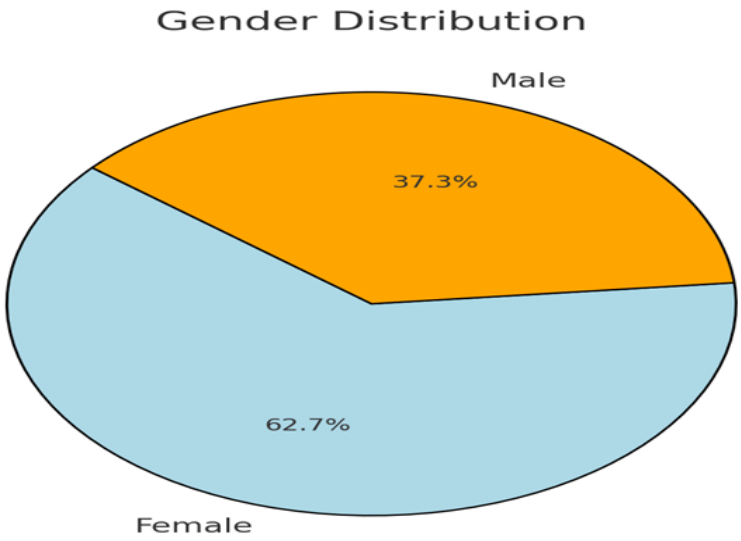
significant prevalence of autoimmune diseases. Regarding malignancies, nearly all participants **(**99%**)** were cancer-free, with only two individuals reporting a history of cancer. Furthermore, 10% of participants were diagnosed with anemia**,** while no cases of leukemia were reported**.** These findings provide a comprehensive overview of the participants' health status, highlighting conditions that could potentially influence the risk or progression of MGUS. These findings indicate a high prevalence of chronic conditions, particularly diabetes (47.8%), high blood pressure (55.2%), and frequent bone pain (76.6%), suggesting an overall burden of metabolic and musculoskeletal disorders within this elderly population. (Table 4.5)

Prevalence of Medical Conditions Among Study Participants, Table 4.5 Including Anemia, Metabolic Disorders, and Chronic Diseases.

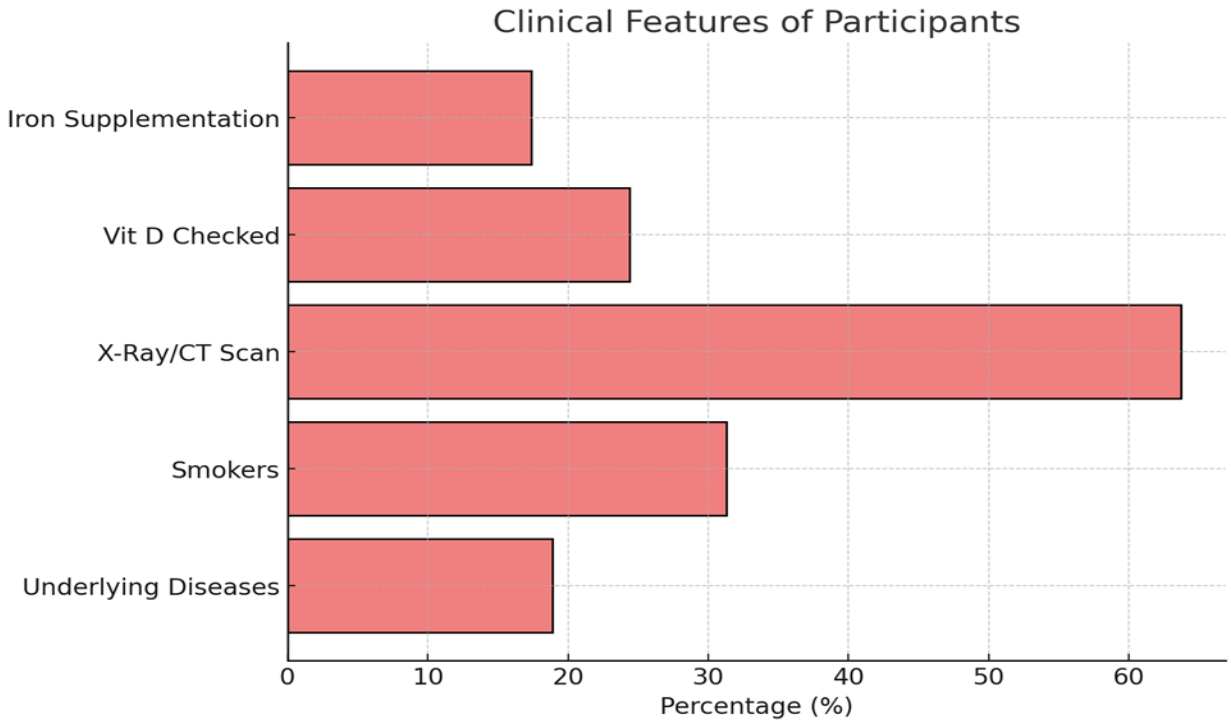
Medical Condition	**Prevalence (%)**
Iron Deficiency Anemia	17.9%
Calcium Disorders	14.9%
Sleep Apnea	25.4%
Frequent Bone Pain	76.6%
Osteoporosis	11.9%
Kidney Disease	3.5%
Hepatitis B or C	2.5%
Diabetes	47.8%
High Blood Pressure	55.2%
Rheumatoid Arthritis	25.4%
Cancer	1.0% (2 participants)
Anemia or Leukemia	10.0% (Anemia only, no leukemia cases)



Prevalence of Medical Conditions (Horizontal Bar Chart) Fig.4.9 - Representing conditions such as anemia, calcium disorders, diabetes, osteoporosis, and more.



Gender Distribution (Pie Chart) Fig.4.10 - Showing the proportion of male and female participants.



Clinical Features (Horizontal Bar Chart) Fig 4.11 - Displaying percentages of participants with underlying diseases, smoking status, medical imaging, vitamin D testing, and iron supplementation.

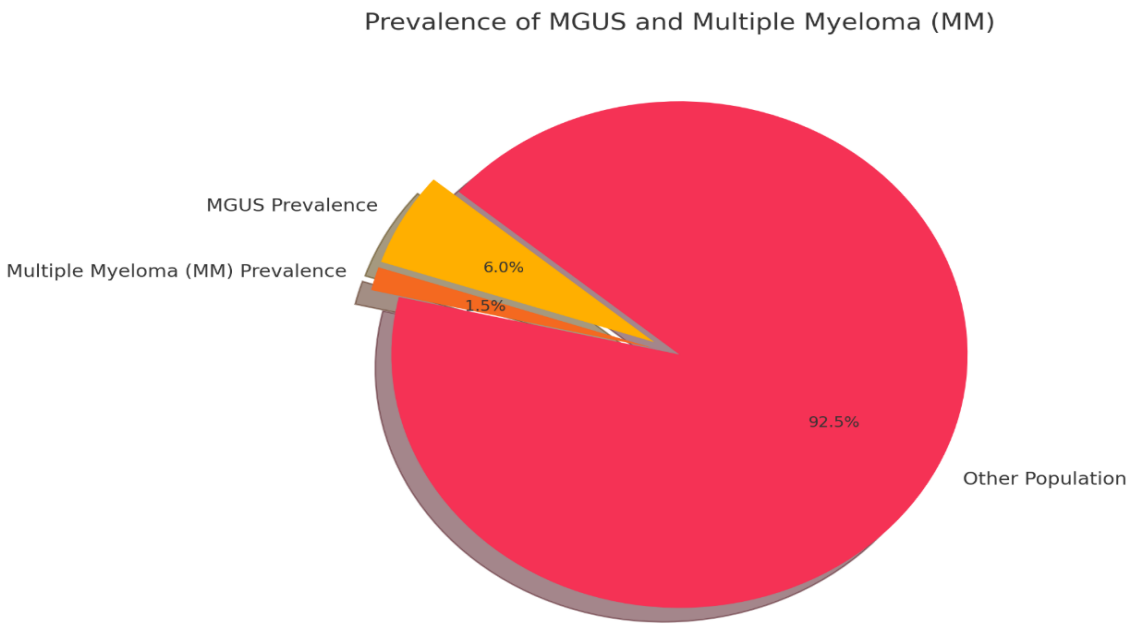
4.11 Comprehensive Analysis of MGUS Prevalence and Risk Factors

4.11.1 Introduction

This study aims to assess the prevalence of monoclonal gammopathy of undetermined significance (MGUS) among elderly individuals in the northern districts of the West Bank-Palestine and examine potential risk factors. We utilized prevalence calculations, chi-square tests, and logistic regression modeling to analyze the data and identify significant associations.

4.11.2 Prevalence of MGUS and MM

- MGUS Prevalence: 5.97%
- Multiple Myeloma (MM) Prevalence: 1.49%
  These findings serve as a baseline for comparison with existing literature on MGUS prevalence.

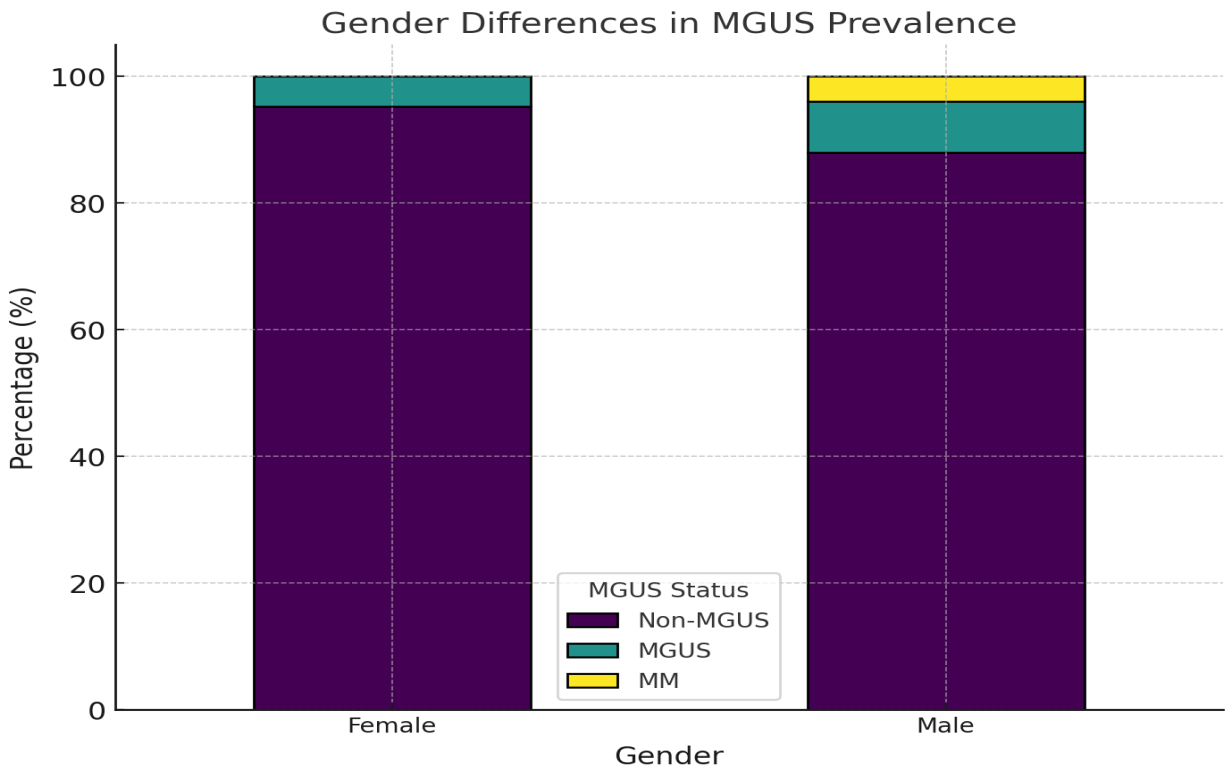


pie chart Fig.4.12 showing the prevalence of MGUS, MM, and Non-MGUS in the study population.

4.12 Gender Differences in MGUS Prevalence

A chi-square test was conducted to assess gender differences. The results indicated:

- Males had a significantly higher MGUS prevalence than females.
- p-value = 0.0466 (statistically significant at the 5% level).
- This suggests that males may have a higher susceptibility to MGUS.



bar chart Fig.4.13 showing Gender Differences in MGUS Prevalence**,** illustrating the proportions of Non-MGUS, MGUS, and MM among males and females.

4.13 Association Between MGUS and Health Conditions

We conducted chi-square tests to determine whether MGUS was significantly associated with various health conditions(Table4.6)

Association Between MGUS and Various Health Conditions Table4. 6 with Corresponding p-Values

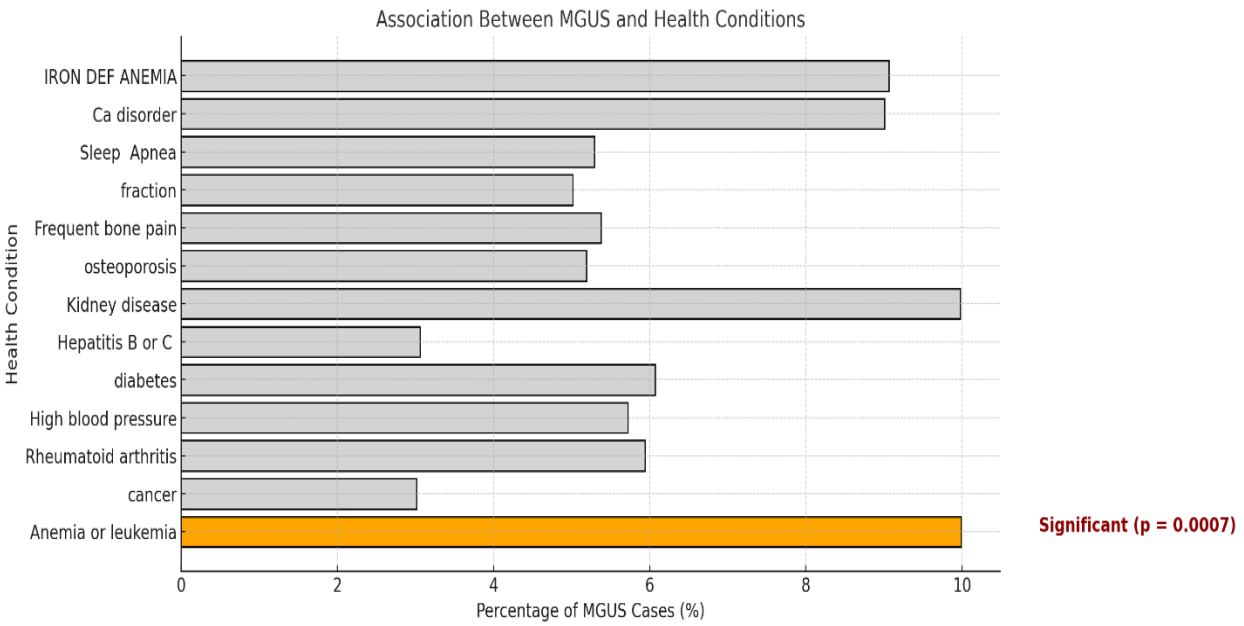
Health Condition	**p-value**	**Significant (p < 0.05)?**
Anemia	**0.0007**	Yes
Cancer	0.9218	No
Rheumatoid Arthritis	0.5947	No
High Blood Pressure	0.0605	No
Diabetes	0.3602	No
Hepatitis B or C	0.9996	No
Kidney Disease	0.8700	No
Osteoporosis	0.4846	No
Frequent Bone Pain	0.1400	No
Fractures	0.6120	No
Sleep Apnea	0.3987	No
Calcium Disorder	0.1474	No

Health Condition	p-value	Significant (p < 0.05)?
Iron Deficiency Anemia	0.2685	No

The statistical analysis assessed the association between MGUS and various health conditions. Among all the conditions analyzed, anemia or leukemia was the only health condition that showed a statistically significant association with MGUS, with a p-value of 0.0007, indicating a strong correlation. This suggests that individuals with anemia or leukemia are significantly more likely to have MGUS compared to those without these conditions.

In contrast, other health conditions, including cancer ($p = 0.9218$), rheumatoid arthritis ($p = 0.5947$), high blood pressure ($p = 0.0605$), diabetes ($p = 0.3602$), hepatitis B or C ($p = 0.9996$), kidney disease ($p = 0.8700$), osteoporosis ($p = 0.4846$), frequent bone pain ($p = 0.1400$), fractures ($p = 0.6120$), sleep apnea ($p = 0.3987$), calcium disorders ($p = 0.1474$), and iron deficiency anemia ($p = 0.2685$) did not show statistically significant associations with MGUS. Although some conditions, such as high blood pressure and frequent bone pain, had p-values approaching significance, they did not meet the threshold of $p < 0.05$.

These findings highlight anemia or leukemia as the primary health condition significantly associated with MGUS in this study($P=0.0007$), while other chronic diseases and metabolic disorders did not demonstrate strong statistical correlations. (Fig.4.12)



Bar Chart Fig.4.14 Illustrating the Association Between MGUS and Various Health Conditions, Highlighting Statistically Significant and Non-Significant Results

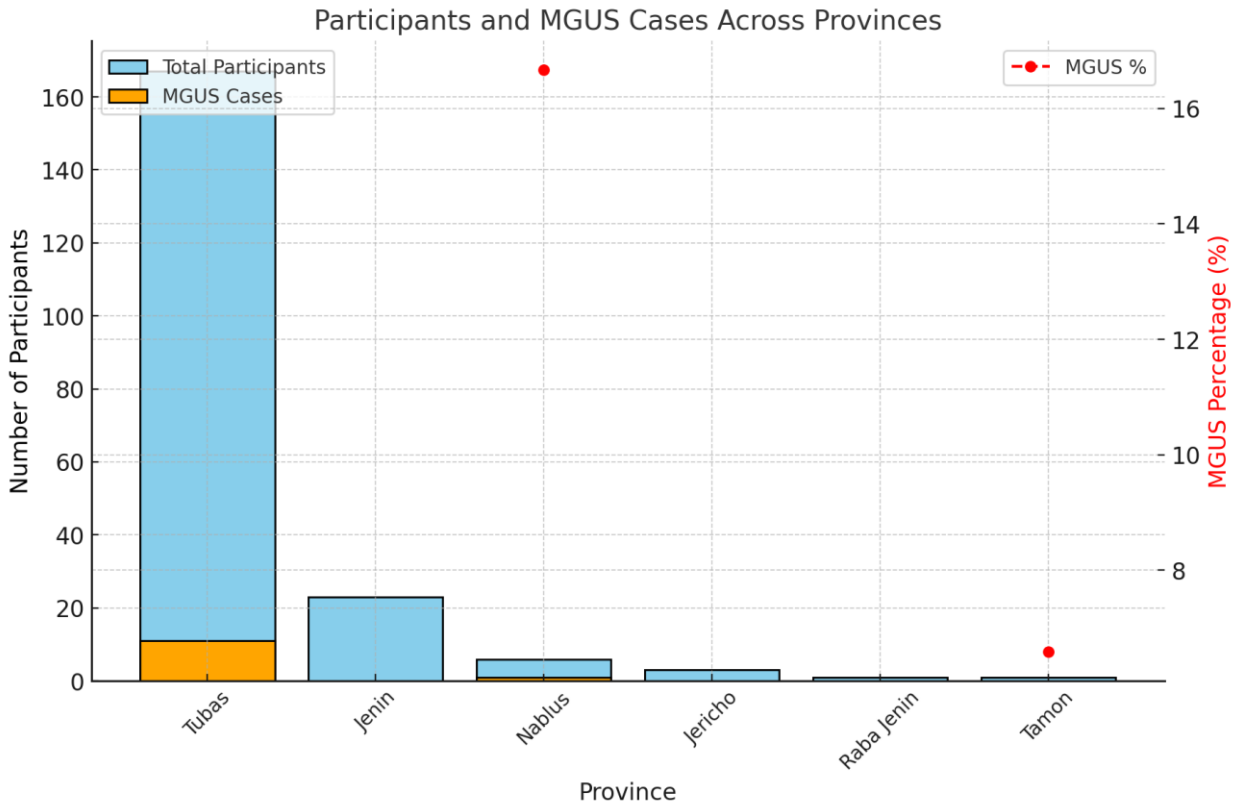
4.14 MGUS Prevalence Across Different Provinces

The analysis of MGUS prevalence across different provinces revealed notable regional variations. Nablus exhibited the highest MGUS prevalence at 16.67%, followed by Tubas with a prevalence of 6.59%. In Jenin, no MGUS cases were identified; however, the province showed a notable prevalence of multiple myeloma (MM) at 8.7%, indicating potential underlying risk factors specific to this region. Interestingly, no cases of MGUS or MM were detected in Raba Jenin and Jericho, suggesting either a lower prevalence or potential limitations in case detection within these areas.

To evaluate whether these differences were statistically significant, a chi-square test was conducted, yielding a p-value of 0.2803. This result indicates that there is no significant difference in MGUS prevalence across the provinces. Therefore, geographic location alone may not be a major determinant of MGUS prevalence in this population, suggesting that other factors, such as genetic predisposition, environmental exposures, or healthcare access, may play a more significant role in disease distribution.

MGUS and Multiple Myeloma (MM) Prevalence Across Different Provinces Table 4.7with Statistical Significance Assessment

Province	MGUS Prevalence (%)
Tubas	6.59%
Nablus	16.67%
Jenin	No MGUS cases, 8.7% MM
Raba Jenin & Jericho	No MGUS or MM cases



Bar and Line Chart Figure 4.15 Showing the Total Number of Participants, MGUS Cases, and MGUS Prevalence Percentage Across Provinces.

4.15 MGUS Prevalence by Ages

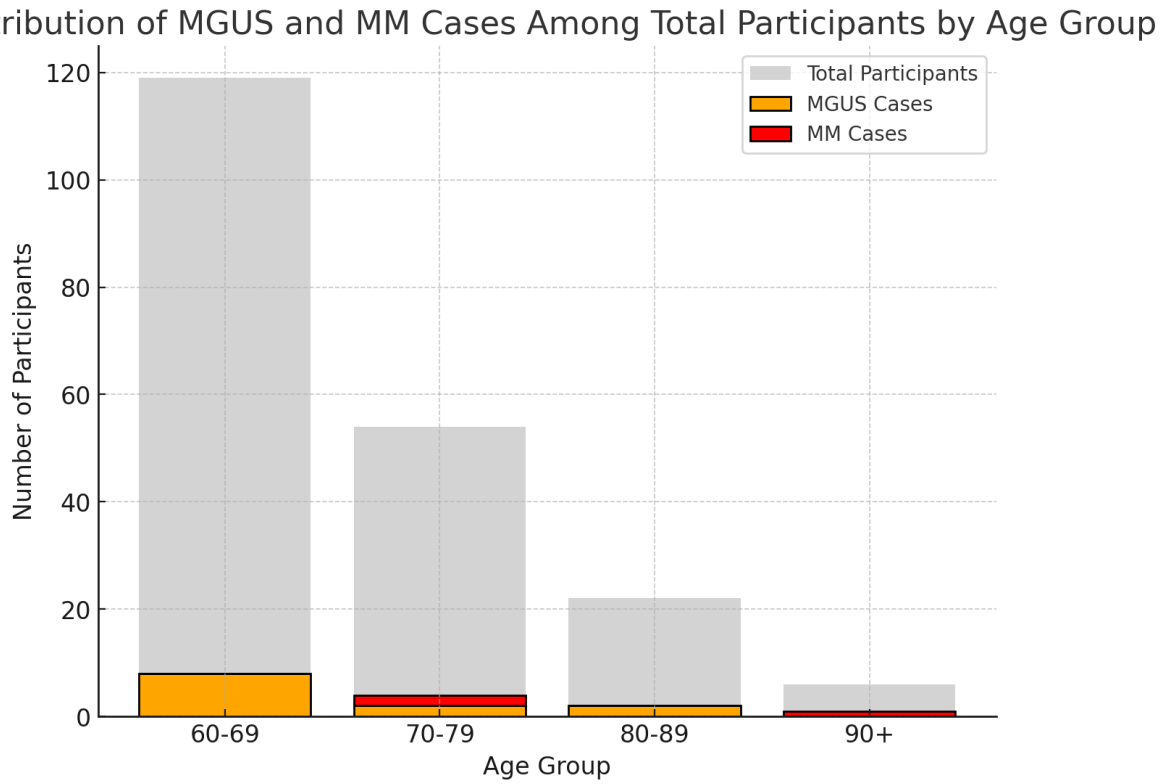
The analysis of MGUS and multiple myeloma (MM) prevalence across different age groups reveals notable trends. Among the study population, the highest MGUS prevalence (9.09%) was observed in the 80–89 age group, followed by 6.72% in the 60–69 age group. The 70–79 age group exhibited a moderate MGUS prevalence of 3.70%, while no cases of MGUS were identified in participants aged 90 and above or in the 50–59 age group.

In contrast, MM prevalence was most prominent in the 90+ age group (16.67%), although this group had a small sample size. The 70–79 age group also showed a notable MM prevalence of 3.70%, while no MM cases were detected in the 60–69 and 80–89 age groups.

These findings indicate that MGUS prevalence increases with age, peaking in the 80–89 age group, while MM cases tend to appear in the oldest age groups, particularly in individuals aged 90 and above. This pattern underscores the importance of age as a significant risk factor for both MGUS and MM, highlighting the need for routine screening and monitoring in the elderly population to facilitate early detection and intervention.

MGUS and MM Prevalence by Age Group Table 4.8

Age Group	Non-MGUS	MGUS	MM	Total Participants	MGUS Prevalence (%)	MM Prevalence (%)
60–69	111	8	0	119	6.72%	0.00%
70–79	50	2	2	54	3.70%	3.70%
80–89	20	2	0	22	9.09%	0.00%
90+	5	0	1	6	0.00%	16.67%



Stacked Bar Graph Fig4.16 Showing the Prevalence of MGUS and MM Across Different Age Groups

4.16 Logistic Regression Analysis: Identifying MGUS Risk Factors

A binary logistic regression analysis was conducted to identify significant predictors of monoclonal gammopathy of undetermined significance (MGUS) based on demographic and clinical variables. The overall model was valid, as indicated by a highly significant intercept ($p < 0.001$), suggesting a reliable baseline probability for MGUS occurrence within the study population.

Among the predictors, anemia or leukemia emerged as the strongest potential risk factor for MGUS, with a coefficient (β) of 1.6570 and a p-value of 0.0625. Although this result indicates a notable trend, it did not reach the conventional threshold for statistical significance ($p < 0.05$), suggesting that further studies with larger sample sizes may be needed to confirm this association.

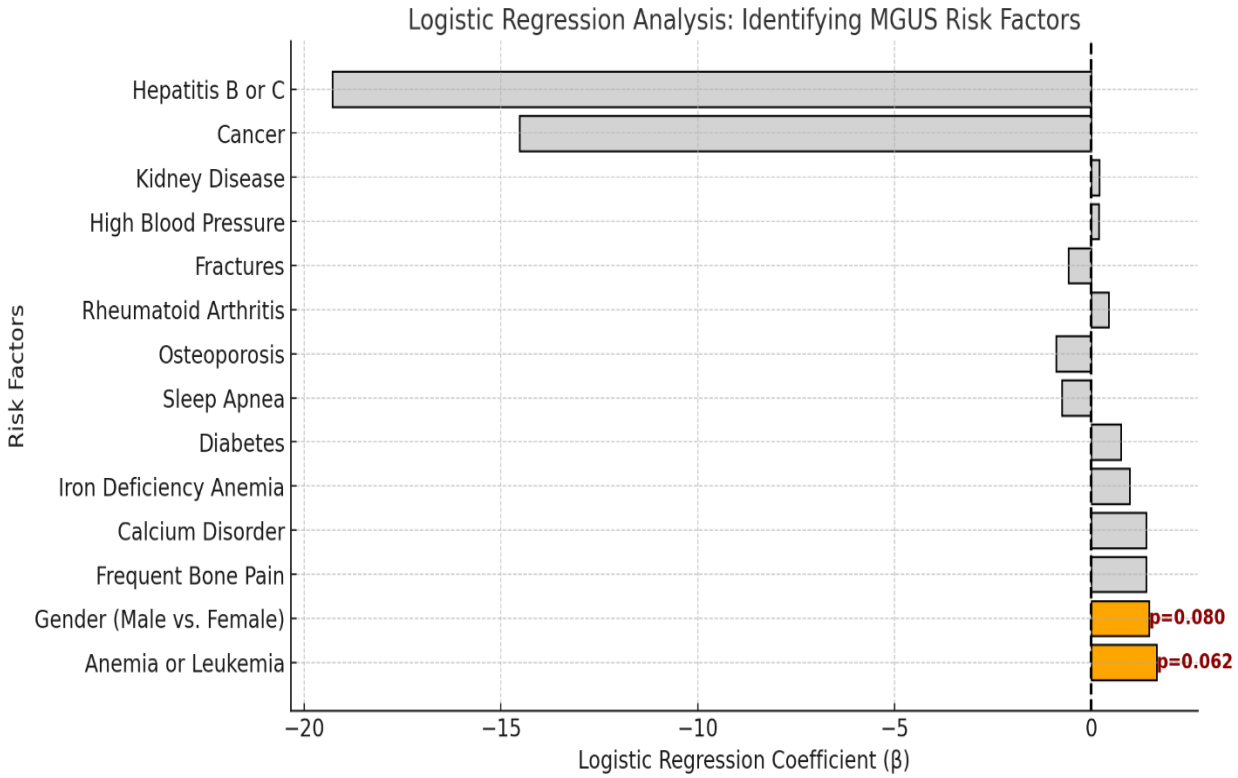
Gender also showed a trend toward significance, with males exhibiting a higher likelihood of MGUS compared to females ($\beta = 1.4653$, $p = 0.0801$). While not statistically significant, this finding aligns with epidemiological data suggesting gender-based differences in MGUS prevalence.

Other variables, including frequent bone pain ($p = 0.1400$), calcium disorders ($p = 0.1474$), iron deficiency anemia ($p = 0.2685$), diabetes ($p = 0.3091$), sleep apnea ($p = 0.3987$), and osteoporosis ($p = 0.4846$), did not show significant associations with MGUS. Additionally, conditions such as rheumatoid arthritis, fractures, high blood pressure, kidney disease, cancer, and hepatitis B or C had p-values well above 0.05, indicating no meaningful predictive relationship with MGUS in this cohort.

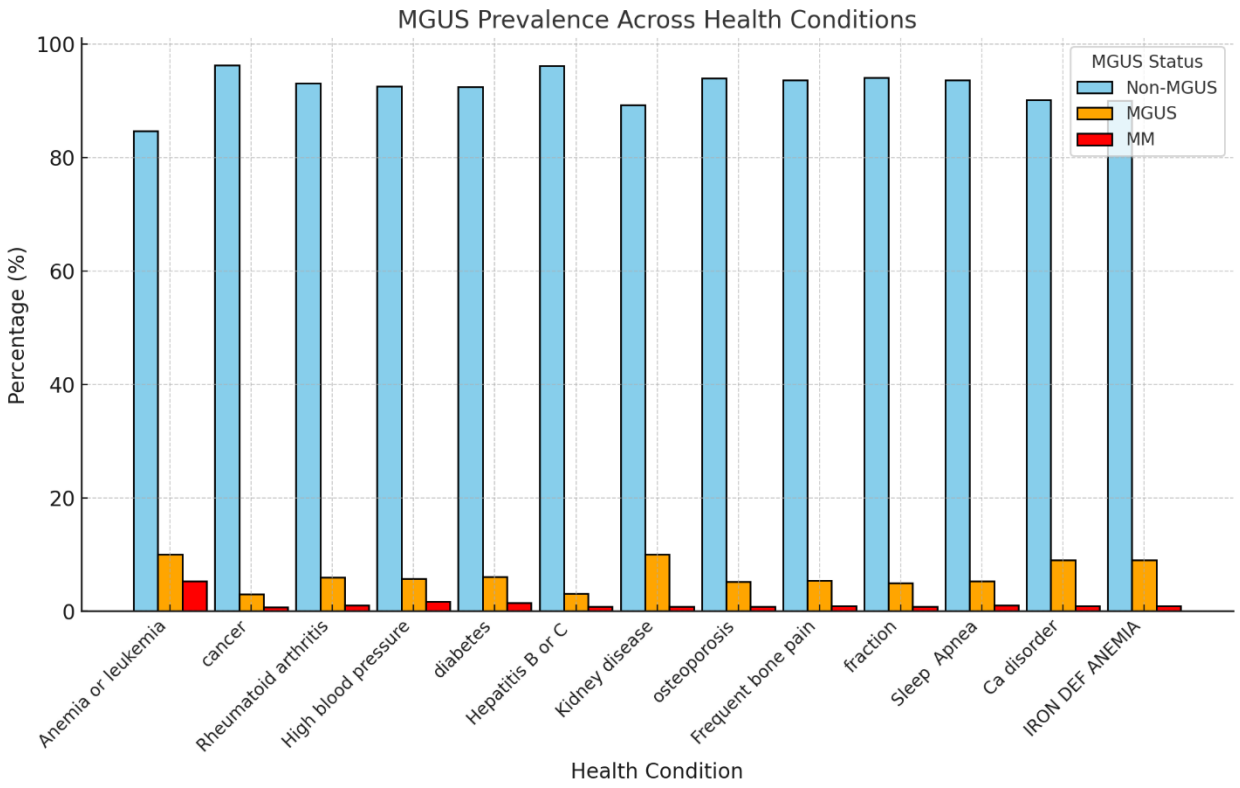
While no clinical variable reached statistical significance aside from the intercept, the trends observed—particularly for anemia or leukemia and gender—highlight potential risk factors that warrant further investigation in larger, more diverse populations.

Binary Logistic Regression Analysis Table 4.9 of Potential Predictors for MGUS

Variable	Coefficient (β)	Standard Error	p-value	Significant (p < 0.05)?
Intercept (Baseline MGUS Probability)	-5.6698	1.3393	<0.001 ***	Yes
Anemia or Leukemia	1.6570	0.8895	0.0625	No
Gender (Male vs. Female)	1.4653	0.8374	0.0801	No
Frequent Bone Pain	1.3936	0.9443	0.1400	No
Calcium Disorder	1.3919	0.9607	0.1474	No
Iron Deficiency Anemia	0.9838	0.8892	0.2685	No
Diabetes	0.7573	0.7445	0.3091	No
Sleep Apnea	-0.7447	0.8825	0.3987	No
Osteoporosis	-0.8948	1.2804	0.4846	No
Rheumatoid Arthritis	0.4441	0.8299	0.5926	No
Fractures	-0.5841	1.1513	0.6120	No
High Blood Pressure	0.1964	0.8277	0.8124	No
Kidney Disease	0.2019	1.2337	0.8700	No
Cancer	-14.5214	3293.4361	0.9965	No
Hepatitis B or C	-19.2930	37987.8221	0.9996	No



Horizontal Bar Chart Figure.4.17 Illustrating Logistic Regression Analysis of MGUS Risk Factors with Highlighted Near-Significant Variables



Grouped Bar Chart Figure 4.18 Showing MGUS, Non-MGUS, and MM Prevalence Across Various Health Conditions

4.17 Result summary

The results of this study show that 5.97% of the aged population in the northern West Bank-Palestine districts had an MGUS diagnosis, which is higher than some other worldwide studies but consistent with others. The highest rate of MGUS was found in people aged 80–89 years (9.09 %), followed by those aged 60–69 years (6.72 %), and the lowest prevalence was seen in people aged 70–79 years (3.70 %). It's interesting to note that, despite having the greatest prevalence of multiple myeloma (MM) at 16.67 percent, no MGUS cases were found in volunteers aged 90 and more.

According to the study, there is a statistically significant gender difference in the prevalence of MGUS between males and girls. Furthermore, the strongest possible risk factor for MGUS was found to be anemia or leukemia, which approached statistical significance in logistic regression analysis ($p = 0.0625$). Although they were investigated, other chronic illnesses such diabetes,

high blood pressure, kidney disease, and osteoporosis did not exhibit statistically significant associations with MGUS.

There was no discernible variation in MGUS prevalence among the provinces under study, according to geographic analysis ($p = 0.2803$), indicating that geographical characteristics might not be important predictors of MGUS incidence. Additionally, gender differences were close to statistical significance ($p = 0.0801$), suggesting possible biological or environmental factors, whereas logistic regression analysis indicated that the biggest associations with MGUS were anemia or leukemia.

These results highlight significant epidemiological patterns in the prevalence of MGUS, especially with regard to hematological disorders, age-related risk, and gender-based susceptibility. In order to investigate the processes behind these connections, they further stress the necessity of targeted screening and more study.

Chapter Five: Conclusion and Recommendations

5.1 Conclusion

Monoclonal gammopathy of unknown significance affects 5.97 percent of the aged population in the West Bank, Palestine, according to this study (MGUS). Although this incidence is consistent with certain international reports, additional regional comparisons are required to ascertain whether the findings are influenced by particular environmental or genetic factors. Important risk factors and medical issues about MGUS detection and treatment in the area are also highlighted in the study.

The gender-based difference in MGUS prevalence males having a much higher frequency than females is among the most important findings. This raises the possibility of biological, lifestyle, or healthcare access inequalities that need more research. Furthermore, the largest potential risk factor for MGUS was found to be anemia or leukemia, indicating that people with hematological problems might need to be closely monitored for plasma cell disorders.

These epidemiological trends are further supported by the laboratory results, which emphasize the use of immunofixation electrophoresis (IFE) and serum protein electrophoresis (SPE) in the diagnosis process. Twelve cases of MGUS were confirmed out of the 201 subjects, of which 19 had anomalies in the gamma region on SPE and 16 underwent IFE testing. Since MGUS detection mostly depends on the detection of aberrant monoclonal protein patterns, the laboratory results support the need for systematic protein electrophoresis testing.

The identification of three individuals who first satisfied the requirements for inclusion but were subsequently disqualified because of extremely high gamma band concentrations, which are suggestive of undetected multiple myeloma, was a crucial finding (MM). These individuals are considered more susceptible to MM based on their laboratory profiles; however, no definitive diagnosis can be made in this context, as that falls under the responsibility of licensed medical professionals. These instances demonstrate the limitations of early plasma cell disease discovery in the absence of

standard screening programs. Many MGUS and MM cases might go undiagnosed until later in life without the use of sophisticated diagnostic technologies, which would worsen patient outcomes and increase the disease burden.

The study's age-related patterns showed that the prevalence of MGUS rises with age, reaching a peak of 9.09 percent in those between the ages of 80 and 89. This result is consistent with evidence from around the world, highlighting the importance of aging as a risk factor for the development of MGUS. This trend highlights the necessity of targeted screening in older populations and is probably caused by the accumulation of genetic mutations, immune system alterations, and chronic antigenic stimulation with age.

There were no discernible regional variations in the prevalence of MGUS across the provinces under study, according to the geographic analysis. This shows that the prevalence of MGUS may be impacted by broader population-wide characteristics such socioeconomic status, healthcare accessibility, and genetics rather than being localized in particular areas. However, regional discrepancies might exist but go unnoticed because of uneven screening procedures given Palestine's limited access to healthcare and diagnostic facilities.

The lack of access to sophisticated diagnostic methods like SPE and IFE, as well as the lack of routine MGUS screening, remain significant obstacles. Many cases might not be identified until they develop into more serious illnesses like multiple myeloma if these crucial tests are not performed (MM).

It is also worth noting that the relatively high prevalence observed in this study might be influenced by the fact that the sample population was recruited from hospitals and medical centers, where individuals are more likely to present with underlying conditions or clinical symptoms that prompt diagnostic investigation. This hospital-based sampling could result in an overestimation of MGUS prevalence compared to the general population.

The study's findings demonstrate how urgently the West Bank requires regular MGUS screening and improved diagnostic accessibility. The study had logistical and accessibility issues, which resulted in a smaller than expected sample size of 201 participants despite these important findings. This restriction lowers the statistical power of some analyses and emphasizes how bigger-scale research with larger population samples is required to get more reliable results.

5.2 Recommendations

To mitigate the risks associated with MGUS and plasma cell disorders, healthcare system improvements are essential. These include:

- Investing in Diagnostic Infrastructure**:** Standard clinical practice should incorporate advanced diagnostic techniques including immunofixation electrophoresis (IFE) and serum protein electrophoresis (SPE). To guarantee early disease detection, diagnostic tools must also be made available in basic healthcare settings.
- Serum protein electrophoresis and immunofixation electrophoresis (IFE) are two sophisticated diagnostic methods that should be included into routine clinical practice (SPE). Basic healthcare facilities must also have access to diagnostic technologies in order to ensure early disease diagnosis.
- Specialized Training for Healthcare Professionals: For early diagnosis and prompt action, healthcare professionals must receive specialized training and greater understanding of MGUS detection and plasma cell disorder management.
- Strengthening International Collaborations: By obtaining funds, tools, and knowledge to better MGUS and MM detection throughout Palestine, collaborating with international organizations can increase diagnostic accessibility.

This study emphasizes that the occurrence of MGUS is a wider public health issue as well as a medical one. Underreporting of plasma cell disorders results from limited access to diagnostics, and healthcare inequalities in Palestine affect patient survival and disease management. In order to guarantee fair access to healthcare and better patient outcomes, the

results highlight the critical need for systematic MGUS screening, enhanced diagnostic infrastructure, and more international collaboration.

Future Research Directions:

- **Expanding Sample Sizes:** To improve statistical power and provide more robust prevalence estimates.
- **Investigating Genetic and Environmental Factors:** To better understand the underlying causes of MGUS in the Palestinian population.
- **Developing Innovative Data Collection Strategies:** To overcome logistical barriers in research settings with limited resources.

Healthcare providers and legislators can enhance early MGUS detection, stop the disease from progressing to MM, and lessen general public health inequalities in the West Bank by putting these methods into practice. In order to improve healthcare outcomes for those at risk of plasma cell disorders, the study emphasizes the need of laboratory-based screening techniques and the need to increase diagnostic accessibility.

Discussion

The purpose of this study was to assess the incidence of monoclonal gammopathy of unknown significance (MGUS) in the aged population in the northern West Bank districts of Palestine and investigate the relationship between MGUS and clinical and demographic characteristics. To put the results in context and draw attention to the parallels and differences in MGUS epidemiology across different groups, the findings are compared with the body of existing literature.

This study's total MGUS prevalence of 5.97 percent is similar to other reports from a variety of populations. For example, a large population-based study conducted in the United States that focused on those aged 50 and over found that the prevalence was 3.2 percent (Kyle et al., 2006). Similarly, in a large Chinese cohort, Han et al. (2020) found a prevalence of 4.6%. This study's somewhat greater incidence, however, might be due to regional variations in genetic predisposition, environmental exposures, or diagnostic procedures. This may also imply that in other areas with less developed systematic screening procedures, MGUS may go undiagnosed.

There were clear age-related trends, with the prevalence of MGUS rising with age and reaching a peak of 9.09 % in the 80–89 age range. These findings were in line with those of Kyle et al. (2006), who showed that the prevalence of MGUS increases noticeably in people over 80. Age-related immune system changes, long-term exposure to environmental risk factors, and the accumulation of genetic mutations over time could all be responsible for this age-related rise. The observed pattern is also consistent with research indicating that clonal plasma cell growth in older persons may be influenced by immunological senescence and prolonged antigenic stimulation (Kaur et al., 2023).

Males had a higher prevalence of MGUS than females, indicating a substantial gender difference. This is consistent with research by Kristinsson et al. (2011), which found that men were more likely than women to have MGUS, pointing to possible hormonal and biological factors. Although the exact causes of this gender gap remain unknown, they may have to do with variations in hormone levels, immune system function, and exposure to risk factors at work. According to some research, testosterone levels may have an impact on plasma cell proliferation, which could raise the incidence of MGUS in men (Go & Rajkumar, 2018).

After looking at clinical risk factors, the strongest possible risk factor for MGUS was found to be anemia , with a significant correlation. This is in line with the findings of Lomas et al. (2020), who pointed out that MGUS patients frequently have hematological abnormalities, especially anemia, as a result of the underlying clonal plasma cell disease that impairs bone marrow function. Furthermore, even in the absence of obvious multiple myeloma, anemia may indicate early marrow involvement.

Remarkably, there were no appreciable regional variations in the frequency of MGUS across the provinces under investigation. This stands in contrast to research such as Marinac et al. (2020), which found geographical differences in the prevalence of MGUS that may be related to healthcare access and environmental factors. This study's lack of notable regional variation may be due to a very similar population in terms of genetic and environmental risk factors, or it may indicate consistent healthcare access issues throughout the West Bank. It is crucial to remember that in some areas, underreporting or a lack of diagnostic resources may conceal possible regional differences.

Following serum protein electrophoresis (SPE), three subjects who were initially accepted for the study met the inclusion criteria for MGUS but showed gamma region concentrations surpassing 3 g/dL, which is more indicative of multiple myeloma (MM). Because of their increased values, these participants who had not previously received a diagnosis of MM were evaluated further. This demonstrates how important SPE is for the early detection of plasma cell abnormalities, which enables the identification of possible MM patients that could otherwise go undetected. The discovery of these cases emphasizes how crucial it is to use thorough diagnostic procedures, including immunofixation electrophoresis (IFE), in order to distinguish MGUS from other illnesses of the plasma cells.

Additionally, a laboratory-related issue is brought to light by the discovery of fibrinogen contamination in one of the immunofixation test negative instances. This highlights how crucial it is to handle samples correctly and analyze electrophoretic patterns in order to prevent diagnostic errors (Diana et al., 2020).

The study's conclusions, which emphasize the impact of age, gender, and hematological abnormalities, provide important new information about the epidemiology of MGUS in Palestine. The findings highlight the necessity of enhanced diagnostic facilities and focused

screening initiatives, particularly for high-risk populations, in order to promote early identification and stop the development of multiple myeloma. Additionally, future research should focus on larger sample sizes, longitudinal follow-up of MGUS cases, and exploration of genetic and environmental risk factors specific to the Palestinian population.

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Appendices

1. **Appendix A: Participant Questionnaire**

   ..\master\thesis doc\Questionnaire about MGUS 25.05.2024.docx

2. **Appendix B: Total Protein (TP) Kit Insert**

TP.pdf

3. **Appendix C: Institutional Review Board (IRB) Approval**

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4. **Appendix D: Task Facilitation Document (تسهيل المهمة)**

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5. **Appendix E: Hydrasys 2 System Kit Insert**

HYDRASYS 2
SCAN.pdf

مدى انتشار الاعتلال الجامائي وحيد النسيلة ذو الخطورة غير المحددة بين كبار السن في المناطق الشمالية من الضفة الغربية–فلسطين

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ملخص

الخلفية :تعد الاضطرابات البلازمية مثل الاعتلال الجامائي وحيد النسيلة ذو الخطورة غير المحددة (MGUS) حالة تمهيدية للإصابة بالورم النخاعي المتعدد (MM) وغيره من أنواع السرطان المرتبطة به. على الرغم من دراسة انتشار MGUS بشكل واسع في السكان في الغرب وآسيا، إلا أن هناك نقصًا في المعلومات من منطقة الشرق الأوسط، خاصةً في فلسطين

الأهداف :هدفت هذه الدراسة إلى تحديد معدل انتشار MGUS بين السكان المسنين في المناطق الشمالية من الضفة الغربية في فلسطين، بالإضافة إلى تحديد العوامل السريرية والديموغرافية المرتبطة بظهوره.

المنهجية :شملت الدراسة المقطعية 201 مشاركًا تبلغ أعمارهم 60عامًا فأكثر. تم قياس تركيز البروتين الكلي باستخدام جهاز Cobas C8000 منRoche ، تلا ذلك إجراء الرحلان الكهربائي لبروتينات المصل (SPE)باستخدام نظام .Sebia Hydrasys 2 ولتأكيد التشخيص، خضع المشاركون الذين أظهرت نتائجهم اضطرابات في منطقة الغاما لاختبار التثبيت المناعي الكهربائي .(IFE) تم إجراء التحليل الإحصائي باستخدام برنامجي Microsoft Excel و .Pythonشملت التحليلات الانحدار اللوجستي الثنائي، واختبارات كاي-تربيع(Chi-square) ، واختبار مان-ويتني (Mann-Whitney U) لتقييم العلاقات بين MGUS والعوامل المحتملة المرتبطة به، مع استخدام مستوى دلالة إحصائية 0.05.

النتائج :بلغ معدل انتشار MGUS بشكل عام 5.97%، وكان أعلى بشكل ملحوظ بين الرجال مقارنة بالنساء (P= = 0.0466)ازداد معدل الانتشار مع التقدم في العمر، وبلغ ذروته بنسبة 9.09% بين الأفراد الذين تتراوح أعمارهم بين 80 و89 عامًا. أظهرت الدراسة أن فقر الدم كان أكثر العوامل ارتباطًا بـ MGUS. (p = 0.0007)لم يكن هناك اختلاف كبير في معدل انتشار MGUS بين المحافظات المختلفة.

الاستنتاجات :يتماشى معدل انتشار MGUS بين كبار السن في الضفة الغربية مع الاتجاهات العالمية، على الرغم من كونه أعلى قليلًا مقارنة ببعض التقارير الدولية .تؤكد الدراسة على أهمية الفحص الروتيني، خاصة بين الفئات عالية الخطورة مثل الرجال المسنين والأشخاص المصابين بأمراض دموية. يوصى بتطوير

برامج فحص مستهدفة وتحسين البنية التحتية التشخيصية لتعزيز الكشف المبكر وإدارة MGUS بشكل فعال في فلسطين.

الكلمات المفتاحية :الاعتلال الجامائي وحيد النسيلة ذو الخطورة غير المحددة (MGUS)، الانتشار، فلسطين، الرحلان الكهربائي لبروتينات المصل.