



RESEARCH ARTICLE

Analyzing The Prevalence and Risk Factors for Frailty Among Elderly Hospitalized Saudi Patients

Asim Muhammed Alshanberi^{1*}, Jakleen Abujamai², Mohammed Shaikhomer³¹Department of Community Medicine and Pilgrims Health Care, Umm Al-Qura University, Makkah, Saudi Arabia²General Medicine Practice Program, Batterjee Medical College, Jeddah, Saudi Arabia³Department of Internal Medicine, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

ARTICLE INFO	ABSTRACT
Received: Apr 20, 2024 Accepted: Jul 25, 2024	A geriatric clinical condition known as frailty is marked by a heightened susceptibility to a variety of unfavorable consequences, including falls, impairment, institutionalization, and death. With the number of elderly people growing, frailty is becoming a significant public health concern for future planning, intervention, and treatment for the targeted populations. Therefore, the goal of this study was to ascertain the risk factors for frailty in Jeddah, Saudi Arabia, as well as the prevalence of frailty in older hospitalized patients. A cross-sectional study was conducted from December 2023 till May 2024 via convenient sampling method of 302 elderly patients who were admitted to the Saudi German Hospital in Jeddah (Saudi Arabia) who were above 60 years. A two-part data collection form was used. The first part included a patient demographic assessment while the included the FRAIL scale. The current study included 302 senior Saudi patients; 46.7% of the analyzed sample were in the age category of 70–79 years old, and 58.9% of the sample was male. The most significant proportion of participants (33.1%) had completed eighth grade or less, and the majority (77.2%) were not smokers. Additionally, 36.1% of them were employed. Obesity is a major risk factor since a large percentage of the fragile participants, 60.9% gained weight over the course of a year. It was shown that 43.70% of people were prefrail and 10.30% of them were frail. The study found a statistically significant ($P < 0.05$) variation in age, gender, educational attainment, and smoking status among the prefrail, frail, and robust participants. The prevalence of frailty syndrome was 10.30%, with 43.70% being prefrail. Several important risk factors for frailty include age, diabetes, heart failure, angina, and stroke. The effects of frailty syndrome cannot be disregarded, as the number of older adults in Saudi Arabia is increasing along with their lifespan. To confirm our findings in a larger group of older persons and beyond one institution, additional research is required.
Keywords Elderly care Frailty Saudi Arabia	
*Corresponding Author: amshanberi@uqu.edu.sa	

INTRODUCTION

An individual's physiological state declines with age, resulting in frailty, an age-related syndrome that causes unfavourable health effects such as weakness and exhaustion. It is a condition associated with possible medical implications that affects balance and adaptation to stimuli due to ongoing

impairments in numerous organ systems [1,2]. The prevalence of frailty among older adults varies globally, ranging from 4% to 59.1% [3]. In the Riyadh region of Saudi Arabia, the frequency of frailty is particularly high [4]. Among hospitalized elderly individuals receiving potentially inappropriate medications (PIMs), the prevalence of frailty and pre-frailty is 37% and 58%, respectively [5]. Saudi Arabia is expected to experience a significant increase in its aging population, rising from 5.6% in 2017 to 22.9% in 2050 [6,7]. This demographic shift will lead to a higher prevalence of comorbidities and place additional strain on the healthcare system.

Frailty is a complex condition encompassing physical, psychological, and social aspects. It is not solely determined by age and can be assessed using various frameworks and models. The physical aspect of frailty focuses on visible markers such as the Fried Frailty Phenotype and reduced physiological functioning [8]. While the societal element considers the effect of social factors like support, engagement, income level, and living conditions, the psychological dimension looks at how cognitive impairment, anxiety, depressive disorders, and psychosocial triggers affect adaptability. Assessing frailty is crucial in healthcare for hospitalized older adults as it enables informed decision-making regarding treatment strategies, optimal medication management, and prevention of adverse events during hospitalization [9-11]. It includes important details on a person's functional ability, reserves, and susceptibility to stresses, enabling medical professionals to decide on appropriate surgical procedures and achievable treatment objectives.

Frailty assessment also plays a vital role in optimizing medication management. It affects medication metabolism, increases the risk of adverse drug reactions, and impacts treatment response [12,13]. To lower the risk of side effects and medication-related issues, physicians can control prescription doses, take drug interactions into account, and weigh risks and benefits. Frailty assessment helps identify individuals at higher risk of adverse events during hospitalization, such as falls, delirium, functional decline, and longer hospital stays [13,14].

Preventive approaches like prompt mobilization, delirium prevention techniques, falls evaluation, and focused rehabilitation therapies can be put into practice by medical professionals. A critical procedure known as frailty examination entails a thorough examination of a person's health status and highlights the necessity of person-centered care planning, which frequently entails the involvement of multidisciplinary teams to meet needs associated to frailty [15]. For elderly individuals moving from institutions to households or long-term care facilities, frailty evaluation plays a critical role in ensuring seamless care transitions. It facilitates the creation of customized treatment plans and post-discharge support services by assisting medical staff in understanding a patient's functional capacity, support requirements, and stress vulnerability. It assists in managing risks, identifying daily support needs, and determining whether rehabilitation therapies are necessary for a functional recovery [16]. Comprehending the degree of frailty facilitates the process of referring individuals to community and home care services, upholding safety standards, directing the placement of residents in long-term care facilities, raising care coordination, and enhancing the quality of care received [17,18].

In this study, we investigate the applicability and diagnostic limitations of specific frailty assessment criteria for hospitalized patients in a geriatric subacute unit. In order to assess the frequency of frailty among elderly individuals admitted to the hospital and identify common risk factors of frailty, we also employ a frailty scale designed especially for this population.

METHODOLOGY

BMC "Ethics and Scientific Committees" granted the approval of the study through the proposal "Assessing risk of falls in elderly frail population" (RES-2023-0046). A cross-sectional research of elderly Saudi patients admitted to the Saudi German Hospital in Jeddah, Saudi Arabia, was carried out between December 23, 2023, and May 1, 2024. Convenience sampling was used to select the

present study population from elderly individuals admitted to Saudi German Hospital in Jeddah, Saudi Arabia, who were 60 years of age or older. The study excluded patients who were bedridden or wheelchair-bound, had significant cognitive impairment or hearing loss, were unable to comply with the assessment process, or were unable to provide written informed consent because of a language barrier or an underlying medical condition (e.g., severe aphasia, severe cognitive impairment/dementia, or significant vision or hearing impairment). Individuals who went to outpatient clinics but were not hospitalized or refused to sign the consent form were also excluded. A two-part data collection form was used to gather the data; the first section evaluated the patient's demographics, and the second section included the FRAIL scale [16]. The patients were divided into three categories by the FRAIL scale (a brief 5-question evaluation of fatigue, resistance, aerobic capacity, illnesses, and weight loss): robust (score = 0), prefrail (score = 1-2), and frail (score = 3-5). Arabic version of this scale which was adjusted for Saudi elderly culture was used in this study [18]. Face-to-face interviews were used to gather the data, and the participant in the interview completed a data collecting form.

RESULTS

The present study involved 302 elderly inpatients admitted in Saudi German Hospital in Jeddah, Saudi Arabia. Among the participants, 58.9% were male, while 46.7% belonged to the age group of 70-79 years. Most of the participants (78.1%) were married, and a significant proportion (77.2%) were nonsmokers. Approximately one-third of the participants had an education level of 8th grade or lower (33.1%), whereas 28.5% held a bachelor's degree. The demographic data is shown in table 1.

Table 1: Sociodemographic characteristics

	n	% of total
Age		
60-69	136	45%
70-79	141	46.7%
80+	25	8.3%
Sex		
Male	178	58.9%
Female	124	41.1%
Nationality		
Saudi	217	71.9%
Non-Saudi	85	28.1%
Marital Status		
Single	21	7%
Married/Remarried	236	78.1%
Divorced/Separated	13	4.3%
Widowed	32	10.6%
Highest level of education		
8th grade/less	100	33.1%
High School	93	30.8%
College	86	28.5%
Post-graduate	23	7.6%
Employment status		
Unemployed	109	36.1%
Employed	93	30.8%
Retired	100	33.1%
Smoker		
Yes	69	22.8%

No	233	77.2%
Illnesses		
0-4	245	81.1%
5-11	57	18.9%
Weight change		
>5%	197	65.2%
<5%	105	34.8%

Study population composed of elderly inpatients at Saudi German Hospital

Table 2 presents the prevalence of frailty among the elderly population in Saudi Arabia being researched. The results show that 10.3% of the population were identified as frail, while 43.7% were classified as prefrail.

Table 2: FRAIL Score

	n	% Of total
Robust	31	46%
Pre-frail	132	43.70%
Frail	139	10.30%

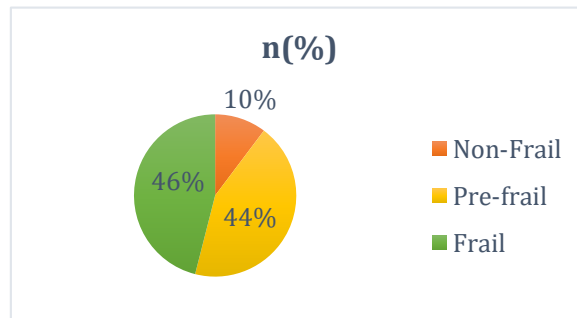


Table 3 illustrates that the study cohort consisted primarily of individuals with hypertension and diabetes, accounting for 72.5% and 68.5% of the participants, respectively. Furthermore, approximately 20% of the subjects experienced heart attacks and angina, whereas 12.9% suffered from strokes.

Table 3: Chronic Diseases

	Robust 31(10.26%)	Pre-frail 132(43.71%)	Frail 139(46.03%)	P value
Hypertension	19(61.3%)	103(78%)	97(69.8%)	0.106
Diabetes Mellites type 2	11(35.5%)	95(72%)	101(72.7%)	<0.001
Cancer (other than a minor skin cancer)	0(0%)	2(1.5%)	9(6.5%)	0.049
Chronic lung disease	1(3.2%)	5(3.8%)	21(15.1%)	0.002
Heart attack	0(0%)	3(2.3%)	55(39.6%)	<0.001
Congestive heart failure	1(3.2%)	5(3.8%)	13(9.4%)	0.128
Angina	0(0%)	1(0.8%)	50(36%)	<0.001
Asthma	3(9.7%)	3(2.3%)	18(12.9%)	0.005

Arthritis	1(3.2%)	0(0%)	7(5%)	0.035
Stroke	1(3.2%)	0(0%)	38(27.3%)	<0.001
Kidney disease.	0(0%)	0(0%)	6(4.3%)	0.028

The Prevalence of comorbidities among the participants as well as frailty prevalence in elderly population according to participant characteristics is shown in table 3 and table 4, respectively.

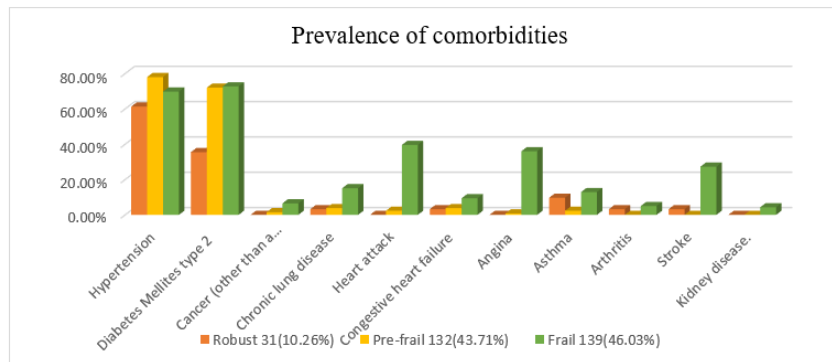


Table 4: Frailty prevalence in Saudi Arabia's elderly population according to participant characteristics

N (%)	Robust 31(10.26%)	Pre-frail 132(43.71%)	Frail 139(46.03%)	P value
Age				
60-69	13(9.6%)	60(44.1)	63(46.3)	<0.001
70-79	9(6.4)	64(45.4)	68(48.2)	
80+	9(36)	8(32)	8(32)	
Gender				
Male	20(11.2)	61(34.3)	97(54.5)	<0.001
Female	11(8.9)	21(57.3)	42(33.9)	
Nationality				
Saudi	22(10.1)	95(43.8)	100(46.1)	0.0993
Non-Saudi	9(10.6)	37(43.5)	39(45.9)	
Marital status				
Single	1 (4.8)	8(38.1)	12(57.1)	0.195
Married	22(9.3)	101(42.8)	113(47.9)	
Divorced	2(15.4)	5(38.5)	6(46.2)	
Widowed	6(18.8)	18(56.3)	8(25)	
Education				
8th grade/less	19(19)	40(40)	41(41)	<0.001
High School	5(5.4)	66(71)	22(23.7)	
College	4(4.7)	22(25.6)	60(69.8)	
Post-graduate	3(13)	4(17.4)	16(69.6)	
Employment				
Employed	7(7.5%)	31(33.3%)	55(59.1%)	0.035
Unemployed	11(10.1%)	56(51.4%)	42(38.5%)	
Retired	13(13%)	45(45%)	42(42%)	
Smoking				
Smokers	3(4.3%)	11(15.9%)	55(79.9%)	<0.001

Non-Smokers	28(12%)	121(51.9%)	84(36.1%)	
Illnesses				
0-4	31(12.7%)	131(53.5%)	83(33.9%)	<0.001
5-11	0(0%)	1(1.8%)	56(98.2%)	
Weight gain				
>5%	0(0%)	77(39.1%)	120(60.9%)	<0.001
<5%	31(29.5%)	55(52.4%)	19(18.1%)	

DISCUSSION

The prevalence of frailty among older hospitalized patients in Saudi Arabia was investigated in this study, along with the factors associated with it. The findings revealed that the overall prevalence of pre-frailty was 43.7%, while frailty was observed in 10.3% of the participants. Additionally, it was observed that individuals aged between 70 -79, those with diabetes, a history of stroke or heart attacks, five or more comorbidities, or weight gain, were significantly more susceptible to developing frailty. In contrast to research conducted in the South Island of New Zealand, which found that 48.8% of all inpatients had frailty [19], the prevalence of frailty in this study was 10.3%. Since our study included elderly patients, who are typically more prone to being fragile, and the study covered all inpatients over the age of 18, we are unable to fully compare the results. As predicted and shown in several research, the frequency of frailty rose rapidly with advancing age [20-22]. Contrarily, there was a difference in the prevalence of frailty between males and females in our study; the prevalence of frailty in men was 54.5%, compared to 33.9% in women. This contrasts with other studies' findings, which indicated that women were more likely than males to have frailty [23-25]. Pre-frailty was shown to be 43.7% prevalent, which is in line with other research' findings [26-31]. Preventive initiatives should be started as soon as possible because pre-frailty is a common condition and should be viewed as a sign of eventual frailty.

A noteworthy correlation found in our research indicates that diabetes is a major risk factor for frailty. 72.7% of the trial participants had diabetes and were frail. Compared to Japanese research that found a prevalence of frail 32.4% among individuals with diabetes, our percentage of 72.7% is greater (32). Type 2 diabetes is estimated to affect 462 million people globally (33). The World Health Organization (WHO) reports that Saudi Arabia has the second-highest diabetes prevalence in the Middle East and the seventh-highest rate globally. Worldwide, 7 million individuals are estimated to have diabetes, and an additional 3 million are pre-diabetic (34). This could be because of poor glucose regulation, ongoing inflammation, effects on the heart and microvascular system, weakening and atrophy of the muscles, an increased risk of fractures and falls, and the co-occurrence of medical conditions. Frailty can be carried on by diabetes. These factors can exacerbate overall health, increase physical demands on the body, and increase the risk of frailty in the aged (35-38). This is in line with a study that found improved glycemic control in older adults with type 2 diabetes was associated with a lower likelihood of experiencing physical weakness (39). A large proportion of type 2 diabetics in Saudi Arabia have insufficient glycemic control, according to research done there (40). This is because eating foods high in fat and leading an unhealthy lifestyle have contributed to an increase in the incidence of diabetes and obesity in Saudi Arabia. According to research in KSA, the country's general population has a substantially lower frequency of obesity than does the group with diabetes (41). Additionally, study from Bahrain (42), with a culture comparable to Saudi Arabia, showed a link between poor eating habits and a rise in HbA1c in individuals with type 2 diabetes. Low levels of physical activity have also been linked to poor glycemic management, according to Saudi Arabian research (43-45). The results of this study also showed that 72% of diabetics were pre-frail. Patients with diabetes and prefrail must take preventive actions to preserve their health and lower their chance of becoming frail. The healthcare system should prioritize diabetes prevention strategies, including intensive care and proactive testing to people who are at risk. Furthermore, more has to be

done by the health system to assist diabetics who reside in faraway regions in improving their glycemic control. Additionally, a highly beneficial addition in the form of a preventative measure, since it assesses diabetes patients' awareness of controlling their condition and examines how they practice disease control when traveling (46).

39.6% of the study's participants experienced heart attacks and were considered frail. Frailty can result from heart attacks for a variety of reasons, including reduced oxygen delivery, medications, lifestyle modifications, psychological consequences such as despair and anxiety, and physical damage [47]. These variables may affect energy levels, muscular strength, and physical function in addition to raising the chance of repeated cardiovascular episodes. Maintaining a healthy lifestyle can be difficult as well, which exacerbates the cycle of aging and physical deterioration. Heart failure patients are more susceptible to falls and memory loss due to reduced blood flow to the brain, which accelerates the onset of frailty (48). The pathobiology's of heart failure and frailty share several common pathways, one of which is a persistent association with inflammatory biomarkers. It is well known that during frailty, TNF- α , IL-6, IFN- γ , and CRP circulate more often, and HF patients also have greater levels of these mediators (49-51). According to the Prospective Urban Rural Epidemiology (PURE) study, cardiovascular disease is the leading cause of death in Saudi Arabia (52). 15% to 74% of heart failure patients have frailty syndrome, which is a valid predictor of death in cardiovascular disease (53). The importance of frailty in cardiology and cardiac surgery has been highlighted by the discovery that a considerable proportion of individuals with cardiac diseases experience frailty syndrome (FS), with an incidence of between 25% to 62%(54).Frailty has a predictive importance across a range of stable cardiovascular illnesses, acute coronary syndromes, heart failure, and surgical and transcatheter procedures, with a relative risk of >2 for both death and morbidity[55-57]. The odds of a frail person with continuous heart failure were higher for one year (17% vs. 5%), hospitalization (21% vs. 13%), and decreased quality of life (58).

Compared to the findings of Evans et al., which revealed that 54.04% of patients with ischemic stroke were frail, the study's results indicate that there was a significant association between stroke and frailty for 27.3% of the patients (59). This finding is consistent with a meta-analysis that found 27% of stroke patients to be frail (60). When the frequency of frailty in stroke patients was compared to a multicenter survey conducted in China (61), the findings revealed that it was 22.5%. On the other hand, a second meta-analysis found that 22% of stroke patients were frail (62). The primary cause of this discrepancy might be attributed to age, as the average age range in our study included participants in the 70–79 age range, which is consistent with the study that found the average age to be 72.73 years for patients (63). Aside from age, other factors that might influence prevalence reports are the disease's severity and the tools employed to measure frailty. The probability of frailty in stroke patients is influenced by several factors. Some of these variables include growing older, the degree of severity of a cerebral infarction, physical and mental limitations, long-term medical disorders, psychological issues, food habits, and medication use. There is a higher chance of fragility and stroke with age. The issue is made worse by chronic diseases, cognitive deterioration, and weakness [64].

Our data show a 69.8% frequency of frailty in people with hypertension. Our investigation did not find a significant link between frailty and hypertension, despite the high frequency. This could be the result of leading a healthy lifestyle, receiving well-managed, closely monitored hypertension treatment, and having the elderly patient adhere to prescribed medication regimens. This is supported by research that indicates that the beneficial effects of antihypertensive medication in very old patients do not always make frailty worse (65). Elderly patients with hypertension should receive individualized treatment plans that consider their unique requirements and circumstances, including medical comorbidities, psychosocial disorders, and frailty. Hypertension in elderly patients may be treated with pharmaceuticals or non-pharmacological. It is advised to prevent and treat hypertension with non-pharmacologic lifestyle therapies such as daily physical activity, controlling

one's weight, quitting smoking, handling stress, and eating a diet that is beneficial to the heart [65]. Factors such as comorbidities, patient fragility, capacity to follow instructions, complexity of the regimen, and supportive care should be considered while managing older persons with uncontrolled hypertension (HTN). ACEI, CCF, ARB, and thiazide diuretics have had beneficial effects on CVD outcomes. For blood pressure regulation, it is recommended to combine these drugs.

In older persons 80 years of age and older, the HYVET trial investigated the relationship between frailty and therapy for hypertension. In extremely elderly people, there was no correlation between baseline FI and antihypertensive medication on stroke, death, or cardiovascular events. Reliability of the HYVET sample in terms of frailty was higher than previously held, and blood pressure-lowering medications are beneficial to both healthier and frailer patients. To completely comprehend the benefit-risk balance in this age group, more study is required [66,67].

CONCLUSION

The study on frailty among elderly hospitalized patients in Saudi Arabia raises major concerns with a frequency of 10.3%. Multiple medical conditions, age, type 2 diabetes, a history of cardiovascular disease or strokes, and gaining weight have all been found to increase the risk of frailty. Pre-frailty was present in 43.7% of patients, highlighting the need for early prophylactic interventions to halt the progression of frailty. Diabetes and frailty are tightly associated; 72.7% of people with diabetes are also feeble. This highlights the need for improved glycemic control and diabetes prevention strategies. Additionally, efforts must be undertaken to educate and assist diabetics in remote locations so they may better control their illness. Furthermore, the study reveals a high association between frailty and heart attacks, with 39.6% of individuals classed as feeble after experiencing a heart attack. This highlights the need for all-encompassing therapeutic approaches and the importance of heart disease in preventing frailty. Stroke is also linked to frailty; contributing factors include old age, serious disease, disability, and other causes. Individualized treatment plans and lifestyle modifications should be implemented to manage these disorders and lower the risk of frailty.

ACKNOWLEDGMENTS

This project was approved by Batterjee Medical College (BMC), Jeddah, Saudi Arabia via project no. RES-2023-0046. Therefore, the authors gratefully acknowledge BMC for its technical and financial support. The authors would like to acknowledge Ms. Sahar Al-Tawil, Ms. Fatin Alkhdaidi, Ms. Yaqeen Al Muwais and Ms. Rafal Hassan Daghri for helping us in data collection.

REFERENCES

1. Alshanberi AM. Frailty in Kingdom of Saudi Arabia-Prevalence and management, Where are we? *Healthcare (Basel)*. 2023 Jun 12;11(12):1715. doi: 10.3390/healthcare11121715. PMID: 37372833; PMCID: PMC10298653.
2. Iriarte, E.; Cianelli, R.; De Santis, J.P.; Baeza, M.J.; Alamian, A.; Castro, J.G.; Matsuda, Y.; Araya, A.X. Frailty among older Hispanics living in the United States: A scoping review. *Geriatr. Nurs.* 2022, 48, 287–295
3. Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: a systematic review. *J Am Geriatr Soc.* 2012 Aug;60(8):1487-92. doi: 10.1111/j.1532-5415.2012.04054.x. Epub 2012 Aug 6. PMID: 22881367.
4. Alqahtani, B. A., Alenazi, A. M., Alshehri, M. M., Osailan, A. M., Alsubaie, S. F., & Alqahtani, M. A. (2021). Prevalence of frailty and associated factors among Saudi community-dwelling older adults: A cross-sectional study. *BMC geriatrics*, 21, 1-8.
5. Alsaad SM, AlEraj S, Alsaad AM, AlSaif HI, Bawazeer G. Potentially Inappropriate Medications among Elderly with Frailty in a Tertiary Care Academic Medical Centre in Saudi Arabia. *Healthcare (Basel)*. 2022 Jul 31;10(8):1440. doi: 10.3390/healthcare10081440. PMID: 36011096; PMCID: PMC9408046.

6. Karlin NJ, Weil J, Felmban W. Aging in Saudi Arabia: An Exploratory Study of Contemporary Older Persons' Views About Daily Life, Health, and the Experience of Aging. *Gerontol Geriatr Med.* 2016 Jan 19;2:2333721415623911. doi: 10.1177/2333721415623911. PMID: 28138483; PMCID: PMC5119868.
7. Salam AA. Ageing in Saudi Arabia: new dimensions and intervention strategies. *Sci Rep.* 2023 Mar 10;13(1):4035. doi: 10.1038/s41598-022-25639-8. PMID: 36899041; PMCID: PMC10006203.
8. Fried, L.P., Cohen, A.A., Xue, Q.L. et al. The physical frailty syndrome as a transition from homeostatic symphony to cacophony. *Nat Aging* 1, 36–46 (2021). <https://doi.org/10.1038/s43587-020-00017-z>
9. Rezaei-Shahsavarloo, Z., Atashzadeh-Shoorideh, F., Gobbens, R.J.J. et al. The impact of interventions on management of frailty in hospitalized frail older adults: a systematic review and meta-analysis. *BMC Geriatr* 20, 526 (2020). <https://doi.org/10.1186/s12877-020-01935-8>
10. Wald, H., Hall, K. K., & Fitall, E. (2019). Patient safety in frail older patients.
11. Walston J, Buta B, Xue QL. Frailty Screening and Interventions: Considerations for Clinical Practice. *Clin Geriatr Med.* 2018 Feb;34(1):25-38. doi: 10.1016/j.cger.2017.09.004. PMID: 29129215; PMCID: PMC5726589.
12. Ma, W., Wang, H., Wen, Z., Liu, L., & Zhang, X. (2023). Potentially inappropriate medication and frailty in older adults: A systematic review and meta-analysis. *Archives of Gerontology and Geriatrics*, 105087.
13. Liao, S. J., Lalic, S., Sluggett, J. K., Cesari, M., Onder, G., Vetrano, D. L., ... & Bell, J. S. (2021). Medication management in frail older people: consensus principles for clinical practice, research, and education. *Journal of the American Medical Directors Association*, 22(1), 43-49.
14. Cunha, A. I. L., Veronese, N., de Melo Borges, S., & Ricci, N. A. (2019). Frailty as a predictor of adverse outcomes in hospitalized older adults: a systematic review and meta-analysis. *Ageing research reviews*, 56, 100960.
15. Joosten, E., Demuynck, M., Destroyer, E., & Milisen, K. (2014). Prevalence of frailty and its ability to predict in hospital delirium, falls, and 6-month mortality in hospitalized older patients. *BMC geriatrics*, 14, 1-9.
16. Boreskie KF, Hay JL, Boreskie PE, Arora RC, Duhamel TA. Frailty-aware care: giving value to frailty assessment across different healthcare settings. *BMC Geriatr.* 2022 Jan 3;22(1):13. doi: 10.1186/s12877-021-02722-9. PMID: 34979966; PMCID: PMC8722007.
17. Lee H, Lee E, Jang IY. Frailty and Comprehensive Geriatric Assessment. *J Korean Med Sci.* 2020 Jan 20;35(3):e16. doi: 10.3346/jkms.2020.35.e16. PMID: 31950775; PMCID: PMC6970074.
18. Montgomery, C. L., Hopkin, G., Bagshaw, S. M., Hessey, E., & Rolfson, D. B. (2021). Frailty inclusive care in acute and community-based settings: a systematic review protocol. *Systematic Reviews*, 10, 1-12.
19. Richards SJG, D'Souza J, Pascoe R, Falloon M, Frizelle FA. Prevalence of frailty in a tertiary hospital: A point prevalence observational study. *PLoS One.* 2019 Jul 1;14(7):e0219083. doi: 10.1371/journal.pone.0219083. PMID: 31260483; PMCID: PMC6602419.
20. Bergman H, Ferrucci L, Guralnik J, Hogan DB, Hummel S, Karunanathan S, Wolfson C. Frailty: an emerging research and clinical paradigm--issues and controversies. *J Gerontol A Biol Sci Med Sci.* 2007 Jul;62(7):731-7. doi: 10.1093/gerona/62.7.731. PMID: 17634320; PMCID: PMC2645660.
21. Kwak, D., & Thompson, L. V. (2021). Frailty: Past, present, and future?. *Sports Medicine and Health Science*, 3(1), 1-10.
22. Santamaría-Ulloa, C., Lehning, A. J., Cortés-Ortiz, M. V., & Méndez-Chacón, E. (2023). Frailty as a predictor of mortality: a comparative cohort study of older adults in Costa Rica and the United States. *BMC Public Health*, 23(1), 1960.

23. Corbi, G., Cacciatore, F., Komici, K., Rengo, G., Vitale, D. F., Furgi, G., ... & Ferrara, N. (2019). Inter-relationships between Gender, Frailty and 10-Year Survival in Older Italian Adults: an observational longitudinal study. *Scientific reports*, 9(1), 18416.
24. Park C, Ko FC. The Science of Frailty: Sex Differences. *Clin Geriatr Med*. 2021 Nov;37(4):625-638. doi: 10.1016/j.cger.2021.05.008. PMID: 34600727; PMCID: PMC8493788.
25. Swannell, C. (2020). Women more frail but more resilient than men. *The Medical Journal of Australia*, 1.
26. Curcio C, Henao G, Gomez F. Frailty among rural elderly adults. 2014.
27. Jürschik Giménez P, Escobar Bravo MÁ, Nuin Orrio C, Botigué Satorra T. Frailty criteria in the elderly: a pilot study. *Aten Primaria*. 2011;43(4):190–196. doi: 10.1016/j.aprim.2010.03.020.
28. Garcia-Garcia FJ, Gutierrez Avila G, Alfaro-Acha A, Amor Andres MS, de Los Angeles de la Torre Lanza M, Escribano Aparicio MV, Humanes Aparicio S, Larrion Zugasti JL, Gomez-Serranillo Reus M, Rodriguez-Artalejo F, Rodriguez-Manas L. The prevalence of frailty syndrome in an older population from Spain. *The Toledo study for healthy aging. J Nutr Health Aging*. 2011;15(10):852–856. doi: 10.1007/s12603-011-0075-8.
29. Ottenbacher KJ, Graham JE, Al Snih S, et al. Mexican Americans and frailty: findings from the hispanic established populations epidemiologic studies of the elderly. *Am J Public Health*. 2009;99(4):673–679. doi: 10.2105/AJPH.2008.143958.
30. Espinoza SE, Hazuda HP. Frailty in older Mexican-American and European-American adults: is there an ethnic disparity? *J Am Geriatr Soc*. 2008;56(9):1744–1749. doi: 10.1111/j.1532-5415.2008.01845.x.
31. Alqahtani BA, Alenazi AM, Alshehri MM, Osailan AM, Alsubaie SF, Alqahtani MA. Prevalence of frailty and associated factors among Saudi community-dwelling older adults: a cross-sectional study. *BMC Geriatr*. 2021 Mar 17;21(1):185. doi: 10.1186/s12877-021-02142-9. PMID: 33731034; PMCID: PMC7972196.
32. Tamura Y, Omura T, Toyoshima K, Araki A. Nutrition Management in Older Adults with Diabetes: A Review on the Importance of Shifting Prevention Strategies from Metabolic Syndrome to Frailty. *Nutrients*. 2020 Nov 1;12(11):3367. doi: 10.3390/nu12113367. PMID: 33139628; PMCID: PMC7693664.
33. Khan MAB, Hashim MJ, King JK, Govender RD, Mustafa H, Al Kaabi J. Epidemiology of Type 2 Diabetes - Global Burden of Disease and Forecasted Trends. *J Epidemiol Glob Health*. 2020 Mar;10(1):107-111. doi: 10.2991/jeqh.k.191028.001. PMID: 32175717; PMCID: PMC7310804.
34. Al Dawish MA, Robert AA, Braham R, Al Hayek AA, Al Saeed A, Ahmed RA, Al Sabaan FS. Diabetes Mellitus in Saudi Arabia: A Review of the Recent Literature. *Curr Diabetes Rev*. 2016;12(4):359-368. doi: 10.2174/1573399811666150724095130. PMID: 26206092.
35. Leung E, Wongrakpanich S, Munshi MN. Diabetes Management in the Elderly. *Diabetes Spectr*. 2018 Aug;31(3):245-253. doi: 10.2337/ds18-0033. PMID: 30140140; PMCID: PMC6092888.
36. Ferrucci, L., Fabbri, E. Inflammageing: chronic inflammation in ageing, cardiovascular disease, and frailty. *Nat Rev Cardiol* 15, 505–522 (2018). <https://doi.org/10.1038/s41569-018-0064-2>
37. García-Esquinas E, Graciani A, Guallar-Castillón P, López-García E, Rodríguez-Mañas L, Rodríguez-Artalejo F. Diabetes and risk of frailty and its potential mechanisms: a prospective cohort study of older adults. *J Am Med Dir Assoc*. 2015 Sep 1;16(9):748-54. doi: 10.1016/j.jamda.2015.04.008. Epub 2015 May 16. PMID: 25986874.
38. Abdelhafiz AH, Peters S, Sinclair AJ. Low glycaemic state increases risk of frailty and functional decline in older people with type 2 diabetes mellitus - Evidence from a systematic review. *Diabetes Res Clin Pract*. 2021 Nov;181:109085. doi: 10.1016/j.diabres.2021.109085. Epub 2021 Oct 9. PMID: 34634389.

39. Strain WD, Down S, Brown P, Puttanna A, Sinclair A. Diabetes and Frailty: An Expert Consensus Statement on the Management of Older Adults with Type 2 Diabetes. *Diabetes Ther.* 2021 May;12(5):1227-1247. doi: 10.1007/s13300-021-01035-9. Epub 2021 Apr 8. PMID: 33830409; PMCID: PMC8099963.
40. Alramadan MJ, Magliano DJ, Almigbal TH, Batais MA, Afroz A, Alramadhan HJ, Mahfoud WF, Alragas AM, Billah B. Glycaemic control for people with type 2 diabetes in Saudi Arabia - an urgent need for a review of management plan. *BMC Endocr Disord.* 2018 Sep 10;18(1):62. doi: 10.1186/s12902-018-0292-9. PMID: 30200959; PMCID: PMC6131885.
41. Alqurashi K, Aljabri K, Bokhari S. Prevalence of diabetes mellitus in a Saudi community. *Ann Saudi Med.* 2011;31(1):19. doi: 10.5144/0256-4947.2011.19
42. Shamsi N, Shehab Z, AlNahash Z, AlMuhanadi S, Al-Nasir F. Factors influencing dietary practice among type 2 diabetics. *Bahrain Med Bull.* 2013;35:3. doi: 10.12816/0000752.
43. Al-Hayek AA, Robert AA, Alzaid AA, Nusair HM, Zbaidi NS, Al-Eithan MH, et al. Association between diabetes self-care, medication adherence, anxiety, depression, and glycemic control in type 2 diabetes. *Saudi Med J.* 2012;33(6):681-683.
44. Alzaheb RA, Altemani AH. The prevalence and determinants of poor glycemic control among adults with type 2 diabetes mellitus in Saudi Arabia. *Diabetes Metab Syndr Obes.* 2018;11:15. doi: 10.2147/DMSO.S156214.
45. Al Baghli N, Al Turki K, Al Ghamdi A, El Zubaier A, Al Ameer M, Al BF. Control of diabetes mellitus in the eastern province of Saudi Arabia: results of screening campaign. 2010.
46. Younis AS, Abouammoh NA, AlBreacan LM, Aldigi Y, Kadi A, Almohideb N, AlAmari N, Almigbal TH. Safe Travel Practices and Awareness among Diabetic Patients. *J Environ Public Health.* 2023 Jan 31;2023:6353086. doi: 10.1155/2023/6353086. PMID: 36761247; PMCID: PMC9904899.
47. Woolford SJ, Sohan O, Dennison EM, Cooper C, Patel HP. Approaches to the diagnosis and prevention of frailty. *Aging Clin Exp Res.* 2020 Sep;32(9):1629-1637. doi: 10.1007/s40520-020-01559-3. Epub 2020 Apr 30. PMID: 32356135; PMCID: PMC7508740.
48. Uchmanowicz, I., Nessler, J., Gobbens, R., Gackowski, A., Kurpas, D., Straburzynska-Migaj, E., ... & Jankowska, E. A. (2019). Coexisting frailty with heart failure. *Frontiers in Physiology*, 10, 423909.
49. Bellumkonda L, Tyrrell D, Hummel SL, Goldstein DR. Pathophysiology of heart failure and frailty: a common inflammatory origin? *Aging Cell.* 2017 Jun;16(3):444-450. doi: 10.1111/accel.12581. Epub 2017 Mar 7. PMID: 28266167; PMCID: PMC5418206.
50. Talha KM, Pandey A, Fudim M, Butler J, Anker SD, Khan MS. Frailty and heart failure: State-of-the-art review. *J Cachexia Sarcopenia Muscle.* 2023 Oct;14(5):1959-1972. doi: 10.1002/jcsm.13306. Epub 2023 Aug 16. PMID: 37586848; PMCID: PMC10570089.
51. Uchmanowicz I, Nessler J, Gobbens R, Gackowski A, Kurpas D, Straburzynska-Migaj E, Kałuzna-Oleksy M, Jankowska EA. Coexisting Frailty With Heart Failure. *Front Physiol.* 2019 Jul 3;10:791. doi: 10.3389/fphys.2019.00791. PMID: 31333480; PMCID: PMC6616269.
52. Alhabib, K.F., Batais, M.A., Almigbal, T.H. et al. Demographic, behavioral, and cardiovascular disease risk factors in the Saudi population: results from the Prospective Urban Rural Epidemiology study (PURE-Saudi). *BMC Public Health* 20, 1213 (2020). <https://doi.org/10.1186/s12889-020-09298-w>
53. Uchmanowicz I, Młynarska A, Lisiak M, Kałuzna-Oleksy M, Wleklík M, Chudiak A, Dudek M, Migaj J, Hinterbuchner L, Gobbens R. Heart Failure and Problems with Frailty Syndrome: Why it is Time to Care About Frailty Syndrome in Heart Failure. *Card Fail Rev.* 2019 Feb;5(1):37-43. doi: 10.15420/cfr.2018.37.1. PMID: 30847244; PMCID: PMC6396065.
54. Wleklík M, Denfeld Q, Lisiak M, Czapla M, Kałuzna-Oleksy M, Uchmanowicz I. Frailty Syndrome in Older Adults with Cardiovascular Diseases-What Do We Know and What

- Requires Further Research? *Int J Environ Res Public Health*. 2022 Feb 16;19(4):2234. doi: 10.3390/ijerph19042234. PMID: 35206422; PMCID: PMC8872246.
55. Rowe, R., Iqbal, J., Murali-Krishnan, R., Sultan, A., Orme, R., Briffa, N., ... & Gunn, J. (2014). Role of frailty assessment in patients undergoing cardiac interventions. *Open heart*, 1(1), e000033.
 56. Dou, Q., Wang, W., Wang, H. et al. Prognostic value of frailty in elderly patients with acute coronary syndrome: a systematic review and meta-analysis. *BMC Geriatr* 19, 222 (2019). <https://doi.org/10.1186/s12877-019-1242-8>
 57. Lee, J. A., Yanagawa, B., An, K. R., Arora, R. C., Verma, S., Friedrich, J. O., & Canadian Cardiovascular Surgery Meta-Analysis Working Group. (2021). Frailty and pre-frailty in cardiac surgery: a systematic review and meta-analysis of 66,448 patients. *Journal of cardiothoracic surgery*, 16(1), 184.
 58. Bytyci I, Bajraktari G. Mortality in heart failure patients. *Anatol J Cardiol*. 2015 Jan;15(1):63-8. doi: 10.5152/akd.2014.5731. Epub 2014 Aug 19. PMID: 25550250; PMCID: PMC5336901.
 59. Evans N.R., Wall J., To B., Wallis S.J., Romero-Ortuno R., Warburton E.A. Clinical frailty independently predicts early mortality after ischaemic stroke. *Age Ageing*. 2020;49(4):588–591.
 60. Huang YN, Yan FH, Wang XY, Chen XL, Chong HY, Su WL, Chen YR, Han L, Ma YX. Prevalence and Risk Factors of Frailty in Stroke Patients: A Meta-Analysis and Systematic Review. *J Nutr Health Aging*. 2023;27(2):96-102. doi: 10.1007/s12603-023-1879-z. PMID: 36806864.
 61. Zhang XM, Jiao J, Xu T, Wu XJ. The association between frailty of older stroke patients during hospitalization and one-year all-cause mortality: A multicenter survey in China. *Int J Nurs Sci*. 2022 Feb 20;9(2):162-168. doi: 10.1016/j.ijnss.2022.02.001. PMID: 35509704; PMCID: PMC9052266.
 62. Palmer K, Vetrano DL, Padua L, Romano V, Rivoiro C, Scelfo B, Marengoni A, Bernabei R, Onder G. Frailty Syndromes in Persons With Cerebrovascular Disease: A Systematic Review and Meta-Analysis. *Front Neurol*. 2019 Nov 29;10:1255. doi: 10.3389/fneur.2019.01255. PMID: 31849819; PMCID: PMC6896936.
 63. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. *Lancet*. 2013 Mar 2;381(9868):752-62. doi: 10.1016/S0140-6736(12)62167-9. Epub 2013 Feb 8. Erratum in: *Lancet*. 2013 Oct 19;382(9901):1328. PMID: 23395245; PMCID: PMC4098658.
 64. Hassan, E. B., Phu, S., Warburton, E., Humaith, N., & Wijeratne, T. (2021). Frailty in Stroke—A Narrated Review. *Life*, 11(9), 891.
 65. Oliveros E, Patel H, Kyung S, Fugar S, Goldberg A, Madan N, Williams KA. Hypertension in older adults: Assessment, management, and challenges. *Clin Cardiol*. 2020 Feb;43(2):99-107. doi: 10.1002/clc.23303. Epub 2019 Dec 11. PMID: 31825114; PMCID: PMC7021657.
 66. Warwick J, Falaschetti E, Rockwood K, Mitnitski A, Thijs L, Beckett N, Bulpitt C, Peters R. No evidence that frailty modifies the positive impact of antihypertensive treatment in very elderly people: an investigation of the impact of frailty upon treatment effect in the Hypertension in the Very Elderly Trial (HYVET) study, a double-blind, placebo-controlled study of antihypertensives in people with hypertension aged 80 and over. *BMC Med*. 2015 Apr 9;13:78. doi: 10.1186/s12916-015-0328-1. PMID: 25880068; PMCID: PMC4404571.
 67. Alshanberi AM. Recent updates on risk and management plans associated with polypharmacy in older population. *Geriatrics (Basel)*. 2022 Sep 13;7(5):97. doi: 10.3390/geriatrics7050097. PMID: 36136806; PMCID: PMC9498769.