*Original Article*

# *Hand grip strength as a functional predictor after hip fracture surgery in Egyptian older adults*

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**ABSTRACT**

***Background:*** Elderly hip fractures can result in mortality and impairment, which is a serious health concern. Reduced muscle strength exposes elderly to risk for hip fractures and affects how they regain physical function. Since handgrip strength (HGS) is a measure of overall muscle strength, it may be a valuable parameter to predict functional outcome after hip fractures.

***Objective***: to evaluate the impact of HGS measured early after a hip fracture and its role in predicting the 3-month functional outcome by assessing the activity of daily living (ADL) following hip fracture surgery.

***Methods***: This is a prospective cohort study with a 3-month follow-up after hip fracture surgery involving 40 elderly aged ≥60 years admitted to the orthopedic department of Ain Shams University Hospital. Demographic characteristics, cognitive state, and ADL of the elderly are considered in a comprehensive geriatric evaluation. Muscle strength was assessed by JMAR Hydraulic Hand Dynamometer early after the hip fracture and the postoperative functional outcome was followed by using ADL.

***Results***: There is a statistically significant relation between patients' HGS and ADL before and after surgery, where 95.5% of patients with weak HGS having assisted ADL after 3 months of operation, while those with normal HGS showed 38.9% with independent ADL and 61.1% having assisted ADL.

***Conclusion***: The current study confirms that HGS evaluated at hospital admission in patients with hip fractures, plays a predictive role in the postoperative functional outcome. Therefore, it's necessary to incorporate HGS assessment into the evaluation of hip fracture patients in the acute phase.

***Key words:*** Hip fracture; Hand grip strength; Activity of daily living.

## INTRODUCTION

Hip fractures in elderly adults are serious fractures that can lead to immobility and long-term dependency, which has a negative impact on the quality of the patient's life and creates an economic burden on healthcare systems and societies **[1].** These facts are challenging to clinicians in determining who is at risk of a poor prognosis early during hip fracture treatment in order to set appropriate rehabilitation objectives, improve perioperative care, and define the best rehabilitation procedures in order to prevent poor outcome **[2].**

Egypt is expected to have close to 130 million residents by 2050, with more than 30% of its population aged 50 and over **[3].**

Age-related reductions in physiological abilities like coordination, vision, motor function, executive function, muscular strength, and bone strength all increase the risk of hip fractures **[4].**Despite the fact that hip replacement is one of the most effective surgeries performed in health centers, there are several surgical and nonsurgical factors that affect the success of the performed surgery **[5] .**

Functional evaluation in hip fracture patients is an important aspect of multidisciplinary assessment and has a significant prognostic value. Muscle weakness is seen as an important determinant of frailty **[6].** HGS has frequently been used as a measure of muscle strength because it is an objective measurement that is quick, simple to determine, independent of observation variance, and affordable, It is also correlated to frailty indicators other than chronological age **[7].** Various studies have shown the prognostic value of HGS in patients with hip fractures **[8].** However, few studies have been carried out in the acute phase **[2].**

As a result, the purpose of this study was to evaluate the role of HGS as a predictor of muscle strength measured early within 5 days of hip fracture, as well as postoperative of 3-month functional outcome after hip fracture surgery measured by using ADL via telephone.

## OBJECTIVE

To evaluate the impact of HGS measured early after a hip fracture and prediction the 3-month functional outcome by assessing the ADL following hip fracture surgery.

## METHODS

This is a prospective observational cohort study with a 3-month follow-up by assessing ADL via telephone after hip fracture surgery. All participants were interviewed after giving informed oral consent. A comprehensive geriatric assessment that included demographic data, past medical history, and drug history was done.

40 elderly patients, 60 years of age or older, male or female, with hip fractures who were admitted to the orthopedic department of Ain Shams University Hospital for surgical repair of a femur fracture by fixation or arthroplasty were included in the study. Those who were known to have rheumatoid arthritis, peripheral neuropathy, any deformity that interferes with the strength of the muscle, cancer or terminal illnesses with a life expectancy of less than 6 months, or patients with moderate to severe dementia were excluded from the study.

Mini-mental state examination: A mini-mental state examination (MMSE) was performed as a baseline of cognition to exclude dementia. The MMSE will be administered on the third day of the patient's stay to allow the patient to become acquainted with the unit. The scale runs from one to thirty. A MMSE score of 20 or below indicated cognitive impairment, a score of 20 to 27 suggested potential cognitive impairment, and a score of 27 or higher showed normal cognitive function (Arabic version) **[9].**

Handgrip strength: A standardized examination of HGS will be done early after hip fracture within 5 days of operation. HGS will be measured at the second handle position with a JMAR hydraulic hand dynamometer **(Sammons Preston Inc., Bolingbrook, IL, USA**). Patients will be seated, with their shoulders adducted and in neutral rotation, their elbows flexed at 90 degrees, their wrists flexed between 0 and 30 degrees, and their ulnar deviation between 0 and 15 degrees. Following physiotherapy staff guidance, three trials at maximal voluntary squeezing will be done on both hands, with the greatest result of the dominant hand utilized for statistical analysis **[10].**

Activity of daily living: score (0–6) is based on independence in feeding, continence, transfer from bed to chair, going to the toilet, bathing, and dressing. We compare it before and after surgery because if ADL after surgery returns to the same level as before surgery, it indicates full recovery; if it diminishes, it suggests incomplete recovery **[11].**

We follow up the function outcome of the patients after 3 months of operation by assessing ADL via telephone call.

Data entry and statistical analysis were on a personal computer using Statistical Package for Social Science (SPSS) (version 26) Quantitative variables were presented in the form of means and standard deviation. Qualitative variables were presented in the form of frequency tables (number and percent). A comparison between quantitative variables was carried out. A comparison between qualitative variables was carried out using Pearson's $\chi 2$ test. Correlation between two quantitative variables was carried out using the Spearman correlation coefficient. The statistical difference was accepted when $P < 0.05$ and $P < 0.001$ is considered highly significant.

**Ethical considerations**

The study was performed in adherence to the principles established by the Declaration of Helsinki, and the study methodology was reviewed and approved by the Ethical Committee of Scientific Research and the Research Review Board of the Geriatrics and Gerontology Department, Faculty of Medicine, Ain Shams University.

Informed verbal consent was obtained from all the participants because some of the participants were illiterate and could not provide signed consent. The ethics committee approved using verbal consent.

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## RESULTS

The current study is a prospective observational cohort study. The study sample finally included 40 elderly patients, 60 years or older, with hip fractures who were admitted to the orthopedic department of Ain Shams University Hospital, with the mean age being 69±9 years 55% of them were males and 45 % were females, 42.5% of the study population were retired and 45% of them were housewives, 52.5% of the study population were illiterate and 85% of the study populations lived with their families, the majority of the patients were non-smokers [ table 1].

The frequency of comorbidities among cases was 50% of patients had HTN, 30% of patients had visual impairment, and around a quarter of them had a previous history of fracture [table 1].

There is no statistically significant relationship between patients' HGS and their past medical history, with the exception of those with hypertension and ischemic heart disease, where the majority of these patients had a weak hand grip [table 2].

Environmental causes such as slippery floors and stairs were the most common cause of hip fracture 33% of patients with hip fracture were using walking aids before surgery [table 3].

There is a statistically significant relationship between patients' HGS and

patients' ADL and IADL before surgery [table 4].
Additionally, there is a statistically significant relationship between patients' HGS and their functional recovery from surgery, as determined by ADL. After 3 months following surgery, 95.5% of patients with poor HGS demonstrated assisted ADL, compared to 38.9% of patients with normal HGS had independent ADL and 61.1% of them showed assisted AD [table 5].

According to type of operation there is no statistically significant relationship between the type of operation and surgery outcomes (as ADL after 3 months of operation and walking aid after surgery). But there is a clinically significant difference between fixation operation and arthroplasty operation, where about 87.5% of patients who underwent arthroplasty versus 75% of patients who underwent fixation reported assisted ADL after 3 months of surgery. Also, 54.2% of patients who underwent fixation operations became bedridden versus 25% of patients who underwent arthroplasty [table 6].

**Table (1): Demographic characteristics of the study population:**

| | | N | % |
|---|---|---|---|
| **Age**<br>***Mean ± SD (min – max) / Median (IQR)*** | | 69± 9 (60- 90) | 67 (62-74) |
| **Gender** | **Male** | 22 | 55.0% |
| | **Female** | 18 | 45.0% |
| **Occupation** | **Retired** | 17 | 42.5% |
| | **Manual labor** | 1 | 2.5% |
| | **Job office** | 4 | 10.0% |
| | **Housewife** | 18 | 45.0% |
| **Educational level** | **Illiterate** | 21 | 52.5% |
| | **Primary < 6 years** | 4 | 10.0% |
| | **Middle 6 - 12 years** | 7 | 17.5% |
| | **Highly educated > 12 years** | 8 | 20.0% |
| **Residency** | **Lives alone** | 6 | 15.0% |
| | **Lives with his family** | 34 | 85.0% |
| | **Institutionalized** | 0 | 0.0% |
| **Smoking** | **Non-smoker** | 24 | 60.0% |
| | **Smoker** | 7 | 17.5% |
| | **Ex-smoker** | 9 | 22.5% |

## Table (2): The Frequency of comorbidities in study population:

| | | N | % |
|---|---|---|---|
| **DM** | **No** | 25 | 62.5% |
| | **Yes** | 15 | 37.5% |
| **HTN** | **No** | 20 | 50.0% |
| | **Yes** | 20 | 50.0% |
| **AF** | **No** | 39 | 97.5% |
| | **Yes** | 1 | 2.5% |
| **HF** | **No** | 36 | 90.0% |
| | **Yes** | 4 | 10.0% |
| **ISHD** | **No** | 31 | 77.5% |
| | **Yes** | 9 | 22.5% |
| **Visual impairment** | **No** | 28 | 70.0% |
| | **Yes** | 12 | 30.0% |
| **Peripheral neuropathy** | **No** | 39 | 97.5% |
| | **Yes** | 1 | 2.5% |
| **Previous fracture** | **No** | 31 | 77.5% |
| | **Yes** | 9 | 22.5% |
| **Parents history of hip fracture** | **No** | 40 | 100.0% |
| | **Yes** | 0 | 0.0% |

DM: Diabetes mellitus, HTN: Hypertension, HF: Heart Failure, AF : atrial fibrillation ,ISHD: ischemic heart disease.

## Table (3): Relation of Patients HGS level and patients' medical past history :

| | | HGS Score | | | | P |
|---|---|---|---|---|---|---|
| | | Normal | | Weak | | |
| | | N | Row % | N | Row % | |
| **Special Habits #** | **Non-smoker** | 10 | 41.7% | 14 | 58.3% | .371 |
| | **Smoker** | 5 | 71.4% | 2 | 28.6% | |
| | **Ex-smoker** | 3 | 33.3% | 6 | 66.7% | |
| **DM !** | **No** | 12 | 48.0% | 13 | 52.0% | .622 |
| | **Yes** | 6 | 40.0% | 9 | 60.0% | |
| **HTN #** | **No** | 13 | 65.0% | 7 | 35.0% | .011* |
| | **Yes** | 5 | 25.0% | 15 | 75.0% | |
| **AF #** | **No** | 18 | 46.2% | 21 | 53.8% | .360 |
| | **Yes** | 0 | 0.0% | 1 | 100.0% | |
| **HF #** | **No** | 18 | 50.0% | 18 | 50.0% | .114 |
| | **Yes** | 0 | 0.0% | 4 | 100.0% | |
| **ISHD #** | **No** | 17 | 54.8% | 14 | 45.2% | .027* |
| | **Yes** | 1 | 11.1% | 8 | 88.9% | |
| **CKD #** | **No** | 18 | 47.4% | 20 | 52.6% | .492 |
| | **Yes** | 0 | 0.0% | 2 | 100.0% | |
| **Visual impairment #** | **No** | 15 | 53.6% | 13 | 46.4% | .165 |
| | **Yes** | 3 | 25.0% | 9 | 75.0% | |
| **Peripheral neuropathy #** | **No** | 17 | 43.6% | 22 | 56.4% | .450 |
| | **Yes** | 1 | 100.0% | 0 | 0.0% | |
| **Previous fracture #** | **No** | 16 | 51.6% | 15 | 48.4% | .149 |
| | **Yes** | 2 | 22.2% | 7 | 77.8% | |

*Chi square test and (#) Fisher exact test were used, P-value ≤ 0.05 is considered statistically significant.*

## Table (4): Description of environmental causes in the studied elderly patients:

| | | N | % |
|---|---|---|---|
| **Illumination** | **No** | 35 | 87.5% |
| | **Yes** | 5 | 12.5% |
| **Slippery floor** | **No** | 6 | 15.0% |
| | **Yes** | 34 | 85.0% |
| **Crowded place** | **No** | 33 | 82.5% |
| | **Yes** | 7 | 17.5% |
| **Stairs** | **No** | 10 | 25.0% |
| | **Yes** | 30 | 75.0% |
| **Walking aid before surgery** | **No** | 27 | 67.5% |
| | **Yes** | 13 | 32.5% |

## Table (5): Relation of Patients HGS level and patients' ADL, IADL and use of walking aid

| | | HGS Score | | | | P |
|---|---|---|---|---|---|---|
| | | Normal 45% | | Weak 55% | | |
| | | N | % | N | % | |
| **Walking aid before surgery !** | **No** | 16 | 88.9% | 11 | 50.0% | .009* |
| | **Yes** | 2 | 11.1% | 11 | 50.0% | |
| **ADL before surgery !** | **Independent** | 15 | 83.3% | 9 | 40.9% | .006* |
| | **Assisted** | 3 | 16.7% | 13 | 59.1% | |
| | **Dependent** | 0 | 0.0% | 0 | 0.0% | |
| **IADL before surgery !** | **Independent** | 15 | 83.3% | 9 | 40.9% | .006* |
| | **Assisted** | 3 | 16.7% | 13 | 59.1% | |
| | **Dependent** | 0 | 0.0% | 0 | 0.0% | |
| **ADL after 3 months of operation #** | **Independent** | 7 | 38.9% | 0 | 0.0% | .002* |
| | **Assisted** | 11 | 61.1% | 21 | 95.5% | |
| | **Dependent** | 0 | 0.0% | 1 | 4.5% | |
| **Walking aid after surgery #** | **No aid** | 2 | 11.1% | 0 | 0.0% | .020* |
| | **Assisted by aid** | 12 | 66.7% | 9 | 40.9% | |
| | **Bed ridden** | 4 | 22.2% | 13 | 59.1% | |

*Chi square test and (#) Fisher exact test were used, P-value $\leq$ 0.05 is considered statistically significant.*

## Table (6): Type of operation in relation to ADL and walking aid before and after surgery

| | | Operation Type | | | | P |
|---|---|---|---|---|---|---|
| | | Fixation | | Orthoplasty | | |
| | | N | % | N | % | |
| Walking aid before surgery | No | 15 | 62.5% | 12 | 75.0% | .408 |
| | Yes | 9 | 37.5% | 4 | 25.0% | |
| ADL before surgery | Independent | 13 | 54.2% | 11 | 68.8% | .356 |
| | Assisted | 11 | 45.8% | 5 | 31.2% | |
| | Dependent | 0 | 0.0% | 0 | 0.0% | |
| ADL after 3 months of operation | Independent | 5 | 20.8% | 2 | 12.5% | .807 |
| | Assisted | 18 | 75.0% | 14 | 87.5% | |
| | Dependent | 1 | 4.2% | 0 | 0.0% | |
| Walking aid after surgery | No aid | 1 | 4.2% | 1 | 6.2% | .133 |
| | Assisted by aid | 10 | 41.7% | 11 | 68.8% | |
| | Bed ridden | 13 | 54.2% | 4 | 25.0% | |

*Chi square test and (#) Fisher exact test were used, P-value $\leq$ 0.05 is considered statistically significant.*

## DISCUSSION

The most common reason for older patients to be admitted to trauma units is hip fractures. There is general agreement that surgery is the best option for treating hip fractures and aims to restore function as much as possible to pre-injury levels **[12].** According to estimates, there would be 4.5 million hip fractures worldwide by 2050, up from 1.26 million in 1990 **[13].** Hip fractures occur in about 14% of women and 6% of men during the course of their lifetimes **[14].** There is very little information available about the epidemiology of hip fractures in Egypt.
In the Middle East, around 52,000 hip fractures were documented in 1990, and this number is expected to increase to 192,000 by 2025 and 435,000 by 2050 **[15].**
The mean age of cases in the current study was (69±9) years old and this goes by other studies which evidenced increasing age as a major risk factor for non-pathological fragile fractures, such as ***Al-algawi et al. (2019),*** who found that most of the population study was older (70 –79) age group and **Alpantaki et al. (2020**) who *confirmed that the incidence of hip fractures was higher in the "older" elderly than the "younger" one* **[16,17].**

In the current study, there was a positive association between a low level of education and hip fracture, That was consistent with the findings of other researchers abroad **[18,19].** These results were different from some previous studies such as **Colais, et al. (2013**) who found decreased incidence of hip fractures with low education and socioeconomic status **[20].**
In the current study, we discovered that numerous medical diseases, such as ISHD and HTN, are regarded as risk factors for hip fracture in older adults. This supports the findings of **Valentin et al. (2021),** who discovered that the risk of hip fracture is enhanced by co-morbid medical disorders such AF and the usage of antihypertensive medications **[19].** This goes with **Al-algawy et al. (2019)** observations that comorbid medical conditions were strongly linked to higher risk factors for hip fractures in the elderly support this as wel **[16].**
The goal of recovery following a hip fracture is to regain baseline functional activities, but Prior findings show a significant gap between this goal and reality. A large number of older adults surviving hip fractures suffer decreased

functional ability (up to 50% in prior studies) **[21].**

In the current study, we found that elderly patients who had hip fracture surgery dramatically worsened in ADL following surgery. Even after a 3-month follow-up, the ADL decline persisted because most patients were doing ADL independently before the surgery. After surgery, 70.8% of them needed assistance. The majority of people who received assistance prior to surgery 93.8% of them continued to receive it following surgery, while 6.2% developed dependency.

In another study, **Tanaka et al. (2016)** found that factors like age, the type of fracture, and pre-rehabilitation activities of daily living were indicators of a decline in activities of daily living at six months, with 37.2% of patients with hip fractures failing to return to their pre-fracture levels six months after surgery **[22].**

According to **Chang et al. (2019**), after a hip fracture was repaired, up to 80% of elderly patients were unable to return to their pre-injury ADLs during a 6-month follow-up **[23]**.

In comparison to the type of operation in the current study 60% of the patients had fixation operation and 40% of them had arthroplasty operation, the current study showed that there is no statistically significant relationship between the type of operation and surgery outcomes (as ADL after 3 months of operation and Walking aid after surgery). But there is a clinical significance difference between type of operation and function, where about 87.5% of patients underwent arthroplasty versus 75% of patients who underwent fixation reported assisted ADL after 3 months of surgery. Also, 54.2% of patients who underwent fixation operations became bedridden versus 25% of patients who underwent arthroplasty.

HGS is measured noninvasively, making it suitable for repeated measurements. It is not only part of the sarcopenia diagnostic criteria, but it has recently gained attention as a prognostic predictor for postoperative ADL **[24].**

Based on HGS, the current study found that 55% of the study population showed clinically significant weakness. Patients with weak grip strength were older, more comorbid, functionally impaired, and had reduced quality of life at admission.

This clearly indicates a decline of reserve and function across multiple physiological systems in this group of patients, this result agreed with ***Selakovic et al.,(2019)*** *who showed that hip fracture patients with* a validated threshold for clinically weak grip strength assessed at an early stage had significantly poorer functional recovery after 3 and 6 months compared to patients with a grip strength above the cutoff points **[2].** Furthermore, the current findings provide evidence that HGS along with several other prognostic factors, such as age, pre-injury residence, functional status and health-related quality of life, presence of comorbidities, and postoperative complications, traditionally considered in clinical practice can independently predict short- and long-term functional outcome**.**

HGS was assessed at various time points in different studies. There are several studies evaluating the prognostic value of HGS measured in the acute setting after hip fracture. **Savino et al. (2013)** showed that HGS measured at hospital admission significantly predicted walking recovery after hip fracture **,Alvarez MN et al .(2016)** also concluded that HGS assessed in the first hours after hospital admission for hip fracture surgery is an indicator of functional recovery after three months ***and*** **Wehren et al. (2005)** found that HGS predicted the self-reported ability to perform activities of daily living during a 12-month follow-up period **[25,26,27].**

All the other studies assessed grip strength later point after hip fracture such as **Beloosesky et al. (2010)** who showed that HGS was significantly associated with functional independence 6 months after hip fracture and **Di Monaco et al. (2015)** reported a significant association between grip strength at admission to a rehabilitation hospital and functional outcome at the end of inpatient rehabilitation and at a 6-month follow-up **[8,28].**

With the use of a hand dynamometer, **Choi et al. (2021)** measured the HGS of 242 elderly people who had hip fractures. They suggested that HGS is a reliable indicator of postoperative

problems, making it valuable for preoperative screening **[29].**
In contrast, **Steihaug et al. (2005)** who investigated the impact of HGS early after fracture was the only one who found no association between grip strength and short- and long-term functional outcomes **[30].**
The current study has identified HGS assessed in the acute setting as a potential prognostic predictor of functional outcome in patients with hip fractures. This was in agreement with ***Savino et al. (2013)*** who also discovered a link between decreased grip strength and poor lower extremity performance **[25].** .
In conclusion, there is a significant focus on the importance of HGS as a prognostic marker following hip fracture in older persons. The results of the current study confirm that there is a strong relationship between postoperative ADL alterations and HGS.

**CONCLUSION**

The current study validates that HGS is an easily available, reasonably priced, and accessible objective assessment of physical performance for bedridden patients. In order to improve prognosis assessment and treatment of high-risk patients, doctors should be encouraged to incorporate HGS into their assessment of hip fracture patients at admission to the acute setting. Further studies are required to determine the significance of the early implementation of strength training regimens in hip fracture patients with significant low muscle strength.

## REFERENCE


1. *Tan, L. T. J., Wong, S. J., & Kwek, E. B. K. (2017). Inpatient cost for hip fracture patients managed with an orthogeriatric care model in Singapore. Singapore medical journal, 58(3), 139.*
2. *Selakovic, I., Dubljanin-Raspopovic, E., Markovic-Denic, L., Marusic, V., Cirkovic, A., Kadija, M., ... & Tulic, G. (2019). Can early assessment of hand grip strength in older hip fracture patients predict functional outcome?. PLoS One, 14(8), e0213223.*
3. *Tamer A. Gheita & Nevin Hammam, (2018): Epidemiology and awareness of osteoporosis: a viewpoint from the Middle East and North Africa. nt. J. Clin. Rheumatol. (2018) 13(3), 134-147 ISSN 1758-4272*
4. *Kleiven, S. (2020). Hip fracture risk functions for elderly men and women in sideways falls. Journal of biomechanics, 105, 109771.*
5. *Zhang, X., Shi, G., Sun, X., Zheng, W., Lin, X., & Chen, G. (2018). Factors influencing the outcomes of artificial hip replacements. Cells Tissues Organs, 206(4-5), 254-262.*
6. *Bandeen-Roche, K., Xue, Q. L., Ferrucci, L., Walston, J., Guralnik, J. M., Chaves, P., ... & Fried, L. P. (2006). Phenotype of frailty: characterization in the women's health and aging studies. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 61(3), 262-266.*
7. *Syddall H, Cooper C, Martin F, Briggs R, Aihie Sayer A (2003) Is grip strength a useful single marker of frailty? Age Ageing 32:650–656.*
8. *Di Monaco, M., Castiglioni, C., De Toma, E., Gardin, L., Giordano, S., & Tappero, R. (2015). Handgrip strength is an independent predictor of functional outcome in hip-fracture women: a prospective study with 6-month follow-up. Medicine, 94(6).*
9. *El-Okl MA (2002):Prevalence of Alzheimer dementia and other causes of dementia in Egyptian elderly. MD Thesis, Faculty of Medicine, Ain Shams University.*
10. *Gleich, J., Pfeufer, D., Keppler, A. M., Mehaffey, S., Fürmetz, J., Böcker, W., ... & Neuerburg, C. (2022). Identification of hip fracture patients at risk for postoperative mobilisation complications via handgrip strength assessment. Archives of orthopaedic and trauma surgery, 142(6), 997-1002.*
11. *Katz, S. (1983). assessing self-maintenance: activities of daily living, mobility and instrumental activities of daily living. JAGS, 31(12), 712-726.*
12. *Amarilla-Donoso, F. J., López-Espuela, F., Roncero-Martín, R., Leal-Hernandez, O., Puerto-Parejo, L. M., Aliaga-Vera, I., ... & Lavado-García, J. M. (2020). Quality of life in elderly people after a hip fracture: a prospective study. Health and quality of life outcomes, 18(1), 1-10.*
13. *Lu, Y., & Uppal, H. S. (2019). Hip fractures: relevant anatomy, classification, and biomechanics of fracture and fixation. Geriatr Orthop Surg Rehabilit 10: 2151459319859139.*
14. *Sanford, A. M., Morley, J. E., & McKee, A. (2018). Orthogeriatrics and hip fractures. The journal of nutrition, health & aging, 22(4), 457-462.*
15. *Cooper, C., Campion, G., & Melton, L. 3. (1992). Hip fractures in the elderly: a world-wide projection. Osteoporosis international, 2(6), 285-289.*

16. *Al-algawy AAH, Baiee HA, Hasan S, Jassim I, Razaq M, Kamel F, Ali A & Khudhair E (2019 ): Risk Factors Associated With Hip Fractures Among Adult People in Babylon City,Iraq. Open Access Maced J Med Sci. Nov 15; 7(21):3608- 3614.*
17. *Alpantaki, K., Papadaki, C., Raptis, K., Dretakis, K., Samonis, G., & Koutserimpas, C. (2020). Gender and Age Differences in Hip Fracture Types among Elderly: a Retrospective Cohort Study. Maedica, 15(2), 185.*
18. *Valentin G, Pedersen SE & Christensen R (2020): Socioeconomic inequalities in fragility fracture outcomes: a systematic review and meta-analysis of prognostic observational studies. Osteoporos Int 31, 31–42.*
19. *Valentin G, Ravn M & Jensen E (2021): Socio-economic inequalities in fragility fracture incidence: a systematic review and meta-analysis of 61 observational studies. OsteoporosInt 32, 2433–2448.*
20. *Colais P, Agabiti N, Fusco D, Pinnarelli L, Sorge C, Perucci CA & Davoli M (2013): Inequality in 30-day mortality and the wait for surgery after hip fracture: the impact of the regional health care evaluation program in Lazio (Italy). Int J Qual Health Care 25:239–247.*
21. *Halm EA, Magaziner J, Hannan EL, et al. Frequency and impact of active clinical issues and new impairments on hospital discharge in patients with hip fracture. Arch Int Med 2003;163:107-12.*
22. *Tanaka, R., Umehara, T., Fujimura, T., & Ozawa, J. (2016). Clinical prediction rule for declines in activities of daily living at 6 months after surgery for hip fracture repair. Archives of physical medicine and rehabilitation, 97(12), 2076-2084.*
23. *Chang, W. T., Kuo, Y. J., Huang, Y. Y., Tsai, M. J., & Chen, Y. P. (2019). Poor activities of daily living function reflect poor quality of life after hip fracture surgery for geriatric patients. Social Health and Behavior, 2(2), 41.*
24. *Chiang, M. H., Huang, Y. Y., Kuo, Y. J., Huang, S. W., Jang, Y. C., Chu, F. L., & Chen, Y. P. (2022). prognostic factors for mortality, activity of daily living, and quality of life in Taiwanese older patients within 1 year following hip fracture surgery. Journal of personalized medicine, 12(1), 102..*
25. *Savino, E., Martini, E., Lauretani, F., Pioli, G., Zagatti, A. M., Frondini, C., ... & Volpato, S. (2013). Handgrip strength predicts persistent walking recovery after hip fracture surgery. The American journal of medicine, 126(12), 1068-1075.*
26. *Alvarez MN, Bonnardeaux P L.D, Thuissard IJ, Sanz-Rosa D, Muñana EA, Galindo RB, et al. Grip strength and functional recovery after hip fracture: An observational study in elderly population. Eur Geriatr Med. 2016 Dec 1;7(6):556–60.*
27. *Wehren, L. E., Hawkes, W. G., Hebel, J. R., Orwig, D. L., & Magaziner, J. (2005). Bone mineral density, soft tissue body composition, strength, and functioning after hip fracture. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 60(1), 80-84.*
28. *Beloosesky, Y., Weiss, A., Manasian, M., & Salai, M. (2010). Handgrip strength of the elderly after hip fracture repair correlates with functional outcome. Disability and rehabilitation, 32(5), 367-373.*
29. *Choi, J.Y.; Kim, J.K.; Kim, K.I.; Lee, Y.K.; Koo, K.H.; Kim, C.H. How does the multidimensional frailty score compare with grip strength for predicting outcomes after hip fracture surgery in older patients? A retrospective cohort study. BMC Geriatr. 2021, 21, 234.*
30. *Steihaug, O. M., Gjesdal, C. G., Bogen, B., Kristoffersen, M. H., Lien, G., & Ranhoff, A. H. (2017). Sarcopenia in patients with hip fracture: a multicenter cross-sectional study. PloS one, 12(9), e0184780.*