The prevalence of malnutrition in patients requiring total joint arthroplasty in a South African tertiary hospital

Richard P Almeida,* Lipalo Mokete, Nkhodiseni Sikhauli, Josip Cakic, Jurek RT Pietrzak

Department of Orthopaedic Surgery, University of the Witwatersrand, Charlotte Maxeke Johannesburg Academic Hospital, Johannesburg, South Africa

**Corresponding author: rich.almeida11@gmail.com*

Citation: Almeida RP, Mokete L, Sikhauli N, Cakic J, Pietrzak JRT. The prevalence of malnutrition in patients requiring total joint arthroplasty in a South African tertiary hospital. SA Orthop J. 2024;23(3):122-127. http://dx.doi.org/10.17159/2309-8309/2024/v23n3a2

Editor: Dr David North, Private practice, Paarl, South Africa

Received: October 2023

Accepted: June 2024

Published: August 2024

Funding: No funding was received for this study.

Conflict of interest: The authors declare they have no conflicts of interest that are directly or indirectly related to the research.

Abstract

Background

With the global increase in total joint arthroplasty (TJA), including total hip arthroplasty (THA) and total knee arthroplasty (TKA), there has been a parallel increase in complications. Optimising modifiable risk factors preoperatively can limit the impact of postoperative complications. Malnutrition is one such modifiable risk factor. With limited evidence regarding malnutrition in patients undergoing TJA in South Africa, we sought to determine the prevalence of malnutrition in patients presenting for TJA at a single institution in South Africa. The objectives of the study were to determine the prevalence of malnutrition among patients presenting to a South African tertiary institution for TJA, and to determine the relationship between malnutrition and comorbidities and demographics.

Methods

We performed a retrospective review of 414 patients presenting for the first time to an arthroplasty unit over a 15-month period. Patients presenting for primary TJA, revision TJA, and patients presenting for fractured neck of femur (FNF) were included. Serological testing of albumin < 35 g/L and/or low transferrin (< 2 g/L) were used to diagnose malnutrition. The relationship between demographic data, comorbidities, presentation for type of TJA, and malnutrition were evaluated.

Results

In total, 414 patients were included. The mean age was 61.1 ± 10.95 years, and 75% (n = 311) were female. Patients presenting for elective TJA composed 88% (n = 366) of the study population, with 12% (n = 48) patients referred for FNF. The mean BMI was 33.3 ± 8.15 kg/m². The prevalence of malnutrition was 11% (n = 47). Patients presenting for elective TJA had a prevalence of malnutrition of 6% (n = 23), compared to patients presenting with FNF of 50% (n = 24). Hypertension (45%, n = 18), HIV (19%, n = 9), diabetes mellitus (18%, n = 7), chronic kidney disease (18%, n = 7) and inflammatory arthritis (15%, n = 6) were the most common comorbidities in patients with malnutrition. Patients with malnutrition had a higher mean age ($p = 0.024$), lower mean haemoglobin ($p < 0.001$), lower mean BMI ($p = 0.047$) and a lower CD4 in HIV-positive patients ($p = 0.031$).

Conclusion

The prevalence of malnutrition of 11% in this cohort of South African patients presenting for TJA is similar to published results from developed countries. There is a need for high-powered prospective studies to determine the viability of routine preoperative nutritional testing or limit testing of high-risk patients.

Level of evidence: Level 4

Keywords: malnutrition, total hip arthroplasty, total knee arthroplasty, preoperative optimisation

Introduction

Total joint arthroplasty (TJA) is one of the most successful surgical procedures, with 95% survivorship for total hip arthroplasty (THA) and total knee arthroplasty (TKA) at ten years.[1] It has been described as the gold standard surgical procedure for end-stage degenerative joint disease of the hip and knee joints.[2] More than 2 million primary TJAs were estimated to be performed globally in 2011.[3] According to various national joint registries, the annual volume of THA ranges between 9 150 and 630 200, and for TKA ranges between 8 290 and 911 300, with the United States of America (USA) reporting the highest volumes.[2] With our increasingly ageing population and a rise in obesity, the volume of arthroplasty surgery has been increasing and is projected to increase further in the future.[2,3] Sloan et al. predicted the volume of primary THA and TKA to rise 145% and 147%, respectively, by 2030.[4]

With increasing TJA volumes, there has been an associated increase in complications such as periprosthetic joint infection (PJI), the most common mode of failure following TJA.[5] PJI is a devastating complication of TJA, with 1–2% of all primary TJAs developing PJI.[1,5,6] Recently, the risk of revision surgery for PJI has increased, and the incidence of PJI will increase as more TJAs are performed worldwide, with a prediction of 60% of all revision surgery being related to infection over the next decade.[5,7,8] The mortality rate at three months following septic revision surgery for PJI is 2.5 times more than the mortality rate following aseptic revision ($p < 0.001$) and continues to trend higher at one year through to five years.[3] The overall mortality rate for patients requiring revision surgery following PJI is 21.12% (THA) and 21.64% (TKA) at five years, which is higher than many common malignancies.[8-10]

Not only is there a significant mortality rate associated with PJI, the management of PJI is resource-intensive, placing a heavy burden on the healthcare system, the patient and the surgeon.[5] Patients with PJI have poor satisfaction rates, lower health-related quality of life and do not achieve the same level of function as equivalent matched populations.[1] It has been projected that by 2030 the annual cost of PJI will exceed $1.85 billion in the USA alone.[6] Therefore, much energy has been expended pursuing various strategies to prevent PJI in TJA, including preoperative, intraoperative and postoperative methods.[1,5,8,11,12]

Preoperative optimisation strategies include identifying and addressing patient-specific modifiable risk factors.[1,11,12] These include active cutaneous or deep tissue infections, *Staphylococcus aureus* colonisation, diabetes, obesity, smoking, alcohol, malnutrition, and immunocompromise associated with diseases such as HIV.[1,12,13]

There has been a rising interest recently in assessing and addressing the modifiable risk factor of malnutrition in patients undergoing TJA.[1,11,14-17] Even in other surgical disciplines, malnutrition has shown its value in predicting deleterious surgical outcomes including delayed wound healing, persistent wound drainage and PJI.[11,13-15,18,19]

Broadly speaking, malnutrition has been defined as any nutritional imbalance.[20] Malnutrition may not always be detected through clinical signs and symptoms; therefore, laboratory measurements, anthropometric data and scoring systems have been used as surrogates.[11,21] Laboratory parameters to assess malnutrition include serum albumin < 35 g/L, transferrin < 2 g/L and/or total lymphocyte count (TLC) < 1 500 cells/mm^3.[11,15,20-22] Hypoalbuminaemia alone has found to be a significant independent predictor of adverse outcomes in arthroplasty surgery, and is reported as the strongest risk factor for complications post TKA.[13,18,22,23] It has been suggested that all patients require nutritional screening prior to TJA; however, there is no clear consensus on how best to assess malnutrition.[20,22,24] Due to the ease of evaluation, the laboratory markers of albumin, transferrin and TLC have been recommended to evaluate nutritional status in patients undergoing TJA.[20-22]

The prevalence of malnutrition in hospitalised patients has been reported to range from 20–50%.[11,14,25] Malnutrition in orthopaedic patients has been reported to range between 8.5 and 39%, including elective TJA patients.[14,17] Some evidence has suggested that in patients undergoing TKA, more than 50% have abnormal nutrition parameters postoperatively.[11] Paradoxical malnutrition may occur in obese patients with high caloric but poor nutritional diets, with malnutrition identified in 42.9% of obese patients.[22]

The majority of studies assessing malnutrition in arthroplasty patients derive information from developed countries, with little evidence published from developing countries such as South Africa.[26] This is important to note as there are geographical differences in the burden of disease which are associated with malnutrition, such as the HIV pandemic, with more than two-thirds of the global HIV population of 38 million arising from sub-Saharan Africa.[27-29]

To the authors' current knowledge, there is limited evidence available regarding the prevalence of malnutrition in patients undergoing TJA in South Africa using the serum markers of albumin and transferrin. The question remains whether it is beneficial and financially viable to routinely use albumin and transferrin to assess nutritional status of all patients undergoing TJA, as has been suggested in the literature. Therefore, the aim of this study is to determine the prevalence of malnutrition, using albumin and transferrin, among patients undergoing TJA at a single institution in South Africa. Secondary objectives were to determine whether malnutrition in patients presenting for arthroplasty surgery is related to comorbidities, demographic factors or type of surgery.

Methods

This retrospective study was conducted at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH), an academic institution in Johannesburg, South Africa. This quaternary, referral institution provides a service to patients within the city, the wider province of Gauteng and neighbouring provinces. Ethical clearance was obtained from the University of the Witwatersrand's Human Research Ethics Committee (Wits HREC) (Medical). The study included 414 consecutive patients presenting to the Arthroplasty Unit at CMJAH from 1 January 2020 to 31 March 2021 on their initial presentation. The study included patients presenting with fractured neck of femur (FNF), as well as primary elective THA and TKA and revision THA and TKA for all causes.

All patients underwent a standardised admission examination as per unit protocol. This admission protocol included clinical interview, examination, radiological and serological special investigations. The demographic data collected included sex (male or female), age (in years), body mass index (BMI) (in kg/m^2) and history of comorbid conditions including diabetes mellitus, epilepsy, asthma, chronic obstructive pulmonary disease (COPD), malignancy, renal disease, rheumatoid arthritis (RA), tuberculosis (TB), hypertension, and human immunodeficiency virus (HIV) infection.

All patients, irrespective of planned surgery, underwent the same serological investigations. All serological testing of patients was performed by the National Health Laboratory Service (NHLS) in Johannesburg, South Africa, with standardised reference values for each test. These tests included full blood count (FBC), urea and electrolytes (UE), HIV serology (HIV-1/2 antigen/antibody enzyme-linked immunosorbent assay [ELISA]), albumin and transferrin.

Malnutrition was defined as serum albumin less than or equal to 35 g/L and/or transferrin levels below 2 g/L.[15,21] Patients presenting for arthroplasty below 55 years of age were grouped as young patients.[21] All patients identified as HIV positive had a positive recorded HIV ELISA result. HIV-positive patients with viral loads lower than detectable limits were grouped as virally suppressed. Patients with BMI > 30 kg/m^2 were classified as obese and divided into type I (30–34.9 kg/m^2), type II (35–39.9 kg/m^2) and type III (> 40 kg/m^2), according to the World Health Organization (WHO).[30] Patient comorbidities were identified and recorded using a standardised admission form used by the arthroplasty unit for all cases. Patients having undergone or planned for elective primary TKA and THA, for any reason, were grouped together as 'primary TJA'. Patients were grouped as 'revision TJA' when one or more components were removed at revision surgery or were planned for revision TJA. Patients who presented with trauma-related intracapsular FNF were grouped as 'FNF'. These three groups were compared descriptively with one another.

Statistical analysis was performed using IBM SPSS (version 28). Continuous variables were reported as mean or median, and categorical variables as number and percentages. The differences in continuous variables were compared using unpaired t-test or the Mann-Whitney U test. Multivariate logistic regression analysis was used to determine the association of malnutrition and categorical variables. Categorical data were compared using the chi-squared test or Fisher's exact test. The level of significance was set at $p < 0.05$.

Results

This study included 414 patients with a mean age of 61.1 ± 11.0 years. In total, there were 103 (25%) male patients and 311 (75%) female patients. The mean BMI was 33.3 kg/m^2 ± 8.15 kg/m^2. The mean haemoglobin was 13.1 g/dL ± 1.85 g/dL, the mean albumin was 43.3 g/L ± 7.65 g/L, and the mean transferrin was 2.6 g/L ± 0.55 g/L. Overall there were 73 (18%) patients with no comorbidities, 184 (58%) patients with hypertension, 59 (14%) patients with HIV infection, 53 (17%) patients with diabetes mellitus, and 35 (11%) with inflammatory arthropathy. The patient demographic details, type of surgeries and comorbidities are summarised in *Table I*.

Comparison of primary TJA, revision TJA and FNF patients

There were 12% (n = 48) patients who were referred for FNF, 7% (n = 27) required revision TJA, with 82% (n = 339) of patients needing elective primary TKA and THA. The mean age for primary TJA was 60.7 ± 9.3 years, compared to revision TJA of 61 ± 7.4 years and FNF of 65.8 ± 7.4 years. All three surgical groups had a higher population of female patients, with 77% females needing primary TJA, 67% females needing revision TJA, and 69% females presenting with FNF. The mean BMI for primary and revision TJA was 35.7 ± 8.2 kg/m^2 and 36.3 ± 7.3 kg/m^2, respectively. The mean haemoglobin was 13.9 ± 1.8 g/dL for primary TJA, 13.2 ± 1.6 g/dL for revision TJA, and 13.0 ± 1.9 g/dL for FNF. The mean albumin was 43.7 ± 4.0 g/L for primary TJA, 44.1 ± 4.6 g/L for revision TJA, and 39.6 ± 5.2 g/L for FNF. The mean transferrin was 2.7 ± 0.5 g/L for primary TJA, 2.6 ± 0.6 g/L for revision TJA, and 2.1 ± 0.5 g/L for FNF (*Table I*).

Prevalence of malnutrition, hypoalbuminaemia and low transferrin

Among primary TJA, revision TJA and FNF patients, there were 22 (5%) patients with serum albumin < 35 g/L, and 38 (9%) patients with a transferrin level < 2 g/L. The overall prevalence of malnutrition in all patients was 11% (n = 47, 95% confidence interval [CI] 9–15%). The prevalence of malnutrition in patients presenting for primary TJA and revision TJA was 6% (n = 21) and 7% (n = 2), respectively. The prevalence of malnutrition in patients presenting with FNF was 50% (n = 24). Hypoalbuminaemia was present in 5% (n = 22) of all patients, with 25% (n = 12) of patients presenting with FNF having hypoalbuminaemia (*Table I*).

Comparison of patients with and without malnutrition

Patients identified as having malnutrition were compared to patients without malnutrition. Patients with malnutrition had a higher mean age of 64.4 years compared to patients without malnutrition of 60.6 years ($p = 0.024$). There was no significant difference in HIV infection rate between the two groups ($p = 0.425$). Patients with HIV infection within the malnutrition group had a significantly lower mean CD4 count of 361 cells/uL compared to patients with HIV infection without malnutrition of 629.9 cells/uL ($p = 0.031$). The mean haemoglobin of 11.8 g/dL was lower among patients with malnutrition, compared to patients without malnutrition with haemoglobin of 13.6 g/dL ($p < 0.001$). Patients with malnutrition had a lower mean BMI of 29.8 kg/m^2 compared to patients without malnutrition of 33.6 kg/m^2 ($p = 0.047$) (*Table II*).

In patients without malnutrition, the most common comorbidities

Table I: Patient characteristics and comorbidities according to surgical groups

	Total	1° TJA[a]	Revision TJA surgery	FNF[b]
Total population	n = 414	82% (n = 339)	7% (n = 27)	12% (n = 48)
Age in years (mean)	61.1 ± 11.0	60.7 ± 9.3	61 ± 7.4	65.8 ± 7.4
Male	25% (n = 103)	23% (n = 79)	33% (n = 9)	31% (n = 15)
BMI[c] (mean) kg/m^2	33.3 ± 8.2	35.7 ± 8.2	36.3 ± 7.3	Not calculated
Hb[d] (mean) g/dL	13.1 ± 1.9	13.9 ± 1.8	13.2 ± 1.6	13.0 ± 1.9
Albumin (mean) g/L	43.3 ± 7.7	43.7 ± 3.4	44.1 ± 4.6	39.6 ± 5.2
Transferrin (mean) g/L	2.6 ± 0.6	2.7 ± 0.5	2.6 ± 0.6	2.1 ± 0.5
Malnutrition	11% (n = 47) (CI 7–15%)	6% (n = 21) (CI 4–9%)	7% (n = 2) (CI 2–22%)	50% (n = 24) (CI 36–64%)
Hypoalbuminaemia	6% (n = 23)	3% (n = 9)	7% (n = 2)	25% (n = 12)
Low transferrin	9% (n = 38)	6% (n = 19)	7% (n = 2)	35% (n = 17)
HIV[e] positive	14% (n = 59)	14% (n = 48)	19% (n = 5)	13% (n = 6)
Hypertension	58% (n = 184)	62% (n = 162)	59% (n = 10)	31% (n = 12)
Diabetes mellitus	17% (n = 53)	16% (n = 43)	18% (n = 3)	18% (n = 7)
Inflammatory disease	11% (n = 35)	12% (n = 31)	18% (n = 3)	3% (n = 1)
Hypothyroidism	3% (n = 11)	4% (n = 11)	0	0
Renal disease	3% (n = 11)	3% (n = 7)	4% (n = 1)	6% (n = 3)
COPD[f]	3% (n = 9)	1% (n = 4)	7% (n = 2)	6% (n = 3)
Epilepsy	2% (n = 8)	2% (n = 8)	0	0
Malignancy	3% (n = 8)	1% (n = 3)	0	13% (n = 5)
Asthma	5% (n = 15)	6% (n = 15)	0	0
Pulmonary tuberculosis	1% (n = 6)	2% (n = 5)	0	2% (n = 1)
No comorbidities	18% (n = 73)	21% (n = 55)	12% (n = 2)	41% (n = 16)
Comorbidities not recorded	23% (n = 95)	22% (n = 76)	37% (n = 10)	19% (n = 9)

[a] primary total joint arthroplasty; [b] femoral neck fracture; [c] body mass index; [d] haemoglobin; [e] human immunodeficiency virus; [f] chronic obstructive lung disease

Table II: Comparison of patients with malnutrition versus non-malnutrition

	Non-malnutrition	Malnutrition	p-value
Population	89% (n = 367)	11% (n = 47)	–
Age (years)	61.6 (± 10.7)	64.4 (± 12.0)	**0.024**
Male	24% (n = 88)	32% (n = 15)	0.236
BMI (mean) kg/m^2	33.6 (± 8.2)	29.8 (± 6.2)	**0.047**
Haemoglobin (mean) g/dL	13.3 (± 1.7)	11.8 (± 2.1)	**< 0.001**
CD4 count cells/uL (mean)	629.9 (± 348)	361.0 (± 189.0)	**0.031**
HIV positive	14% (n = 50)	19% (n = 9)	0.425
Hypertension	60% (n = 166)	45% (n = 18)	0.75
Diabetes mellitus	17% (n = 46)	18% (n = 7)	0.97
Inflammatory arthropathy	10% (n = 29)	15% (n = 6)	0.65
Hypothyroidism	4% (n = 10)	3% (n = 1)	0.87
Renal disease	1% (n = 4)	18% (n = 7)	< 0.001
COPD	3% (n = 8)	3% (n = 1)	0.91
Malignancy	1% (n = 3)	13% (n = 5)	0.001
Asthma	5% (n = 13)	5% (n = 2)	0.92

Table III: Analysis of risk factors associated with malnutrition

	Odds ratio	95% CI	p-value
1° TJA	**0.1**	0.1–0.2	**< 0.001**
Revision TJA surgery	0.6	0.1–2.7	0.504
FNF	**14.9**	7.4–30.2	**< 0.001**
Age > 55 years	1.4	0.7–2.9	0.392
Male	1.5	0.8–2.9	0.236
BMI < 18.5 and > 40 kg/m^2	0.7	0.2–2.2	0.574
Haemoglobin < 12 g/dL	3.9	2.1–7.4	**< 0.001**
HIV not virally suppressed	3.2	0.3–40.3	0.342
CD4 count < 350 cells/uL	**7.0**	7.0–1.4	**0.009**
HIV positive	1.4	0.6–3.0	0.425
Hypertension	0.8	0.4–1.4	0.368
Diabetes mellitus	1.2	0.5–2.9	0.648
Inflammatory arthropathy	1.7	0.7–4.4	0.259
Hypothyroidism	0.8	0.1–6.2	0.811
Renal disease	**15.9**	4.5–56.6	**< 0.001**
COPD	1.0	0.1–8.0	0.982
Malignancy	**14.4**	3.3–62.6	**< 0.001**
Asthma	1.2	0.3–5.5	0.805

recorded were hypertension (60%, n = 166), diabetes mellitus (17%, n = 46), HIV (14%, n = 50), and inflammatory arthropathy (10%, n = 29). In those diagnosed with malnutrition, the commonest comorbidities included hypertension (45%, n = 18), HIV (19%, n = 9), diabetes mellitus (18%, n = 7), chronic kidney disease (18%, n = 7), inflammatory arthritis (15%, n = 6), and history of malignancy (13%, n = 5). The comparisons between patients with malnutrition and no malnutrition are reported in *Table II*.

Odds ratios for risk factors of malnutrition

The odds ratios (ORs) of the risk factors for malnutrition can be found summarised in *Table III*. The odds for malnutrition are as follows: FNF (OR 14.9, p < 0.001), CD4 count < 350 cells/uL (OR 7.0, p = 0.009), haemoglobin < 12 g/dL (OR 3.9, p < 0.001), renal disease (OR 15.9, p < 0.001), and malignancy (OR 14.4, p < 0.001) have higher ORs for malnutrition.

Discussion

In this retrospective review, the overall prevalence of malnutrition in patients presenting for TJA at a single institution in South Africa was 11%. Half the patients presenting with FNF were malnourished according to the definition used. The prevalence of malnutrition in patients undergoing primary TJA and revision TJA was 6% and 7%, respectively.

Van Tonder et al. described high malnutrition prevalence, and a risk of malnutrition of 72.3% among adult patients in public hospitals in an urban setting within South Africa, although laboratory markers were not used in the assessment.[31] This high prevalence is similar to Blaauw et al. who reported 60.6% patients being admitted to hospital being at risk of malnutrition.[32] These studies did not use laboratory markers and included all patients admitted to hospital, not just orthopaedic patients. A wide range of 9–39% prevalence of malnutrition in orthopaedic patients has been documented in the literature.[14] The prevalence of malnutrition in the findings of this study do fall within this documented broad range of malnutrition; it should be noted that the broad range may be attributed to the heterogenicity of the studies with different definitions and with diverse assessment tools being utilised to determine malnutrition.

In orthopaedic surgery literature, malnutrition has been defined using serological measurements of albumin (< 35 g/L) and/or low transferrin (< 2 g/L) and/or TLC (< 1 500 cells/mm^3).[20-22] Huang et al., in a retrospective review of 2 161 patients requiring elective primary TJA, defined malnutrition as albumin (< 35 g/L) and/or low transferrin (< 2 g/L).[22] They subsequently reported a prevalence of malnutrition of 8.5%. Since it is known that albumin and transferrin are negative acute phase reactants, when trauma is excluded (patients with FNFs) from this study population, the prevalence of malnutrition in this study using the same definition reduces to 6%, which is comparable to the 8.5% reported by Huang et al.[21]

It is important to note that albumin is a non-specific indicator of malnutrition; however, it does aid in assessing risk for postoperative complications in the absence of causes of acute phase reaction.[33] Blevins et al. reported that serum albumin levels had the highest specificity and highest predictive value for the development of PJI when compared to platelets, white blood cells, haemoglobin and BMI.[11] It has been reported that hypoalbuminaemia is a significant predictor of complications in TJA, and a more significant risk factor for postoperative complications than obesity.[13,14,34] With the increased risk of postoperative complications in patients with malnutrition, specifically hypoalbuminaemia, an increase in the cost of 90 days total care for TJA has been found.[35] Rudasill et al. reported that hypoalbuminaemia is associated with significantly increased healthcare costs, with hypoalbuminaemia associated with 16.2% increase in costs. Alternatively, each 1.0 g/dL increase in preoperative serum albumin level was subsequently associated with 14.9% reduction in costs.[36]

Hypoalbuminaemia has, in isolation, previously been recognised as a surrogate marker for malnutrition. In a retrospective review of 49 603 patients by Bohl et al. using the American College of Surgeons National Surgical Quality Improvement Project (NSQIP) database, hypoalbuminaemia was identified in 4% of cases.[37] Fryhofer et al., in a retrospective review of 65 023 patients using the same NSQIP database over the period of 2010 to 2016, reported 4.2% and 4.3% for TKA and THA, respectively.[18] These findings are comparable to this study in a South African context in which we showed an overall prevalence of hypoalbuminaemia of 6%. Rao et al. retrospectively reviewed 819 cases of primary TJA and reported hypoalbuminaemia of 2.6 % and low transferrin of 5.6 %, which is again is similar to the results of patients requiring primary TJA in this study with a prevalence of 3% for hypoalbuminaemia and 6% low transferrin.[24] Despite the comparison of developing and developed world populations, with differences in population sizes and geographical locations, the prevalence of malnutrition and hypoalbuminaemia remain interestingly comparable.

It has been suggested that identifying patients with malnutrition may benefit from preoperative optimisation in preventing postoperative complications in orthopaedic surgery.[14,19,22] Johnson et al. found that hypoalbuminaemia could be reversed with protein supplementation.[13] This highlights the importance of identifying the modifiable risk factor of malnutrition and optimising patients prior to TJA.

In this study, patients presenting for surgery for FNFs had a prevalence of hypoalbuminaemia of 25%. This is similar to hypoalbuminaemia in orthopaedic trauma patients admitted to a regional hospital in rural South Africa reported by Maimin et al. of 29%.[26] There were also similarities between the two studies with regard to mean albumin of 37 g/L (± 5.6), and mean haemoglobin 12.8 g/dL (± 0.1), compared to this study in patients presenting with FNF with albumin of 39.6 g/L, and haemoglobin of 13.0 g/dL (± 2.1).

It has been reported that arthroplasty surgery is effective and safe to perform in the presence of HIV infection, as the complication rate remains acceptable, provided patients are receiving treatment and are virally suppressed.[28] There is limited published evidence on HIV and malnutrition in orthopaedic surgery. In our study, there was a higher percentage of patients with malnutrition having HIV infection compared to patients without malnutrition, but this was not found to be statistically significant. HIV as a risk factor for malnutrition was found to have an OR of 1.4 (95% CI 0.6–3.0) in this cohort of patients, which is comparable to the OR of 1.87 (95% CI 0.94–3.72) reported by Maimin et al., although there are notable differences between the studies, such as population size, geographic location of a rural population and higher HIV infection of 24.4%. This study showed that a seven-fold increased likelihood of malnutrition exists in an HIV-infected patient with CD4+ count lower than 350 cells/uL. The relationship of decreased albumin and reduced CD4 count has been noted in other studies evaluating nutrition in HIV-infected patients, and it has been suggested that decreased albumin may be due to the pathophysiologic processes involved in the depletion of CD4 cells.[38-40]

Haemoglobin < 12 g/dL was found to have an OR of 3.9 ($p < 0.001$) with malnutrition. This is in keeping with previous publications that malnutrition is associated with anaemia.[19,41] Frangos et al. reported similar results in a study including 392 patients, that patients with anaemia were more significantly malnourished and had lower albumin and transferrin levels.[41] In their study, low albumin was associated with anaemia and was independent from iron and vitamin deficiencies and inflammatory status.[41] Inadequate protein intake in malnutrition may be responsible for reduced haemoglobin, albumin and transferrin.[41] Therefore, in patients with haemoglobin less than 12 g/dL, the cause of anaemia should be assessed as well as the nutritional status with the use of laboratory markers such as albumin and transferrin.

There are limitations to consider with respect to the study. Albumin and transferrin are just two elements used in the assessment of malnutrition; however, they have been identified in the literature as independent risk factors for postoperative complications in arthroplasty surgery.[14] TLC is another serological marker used to evaluate malnutrition; however, due to the retrospective nature of the study these markers were not included as they were not available.[22] Transferrin and albumin levels, while not a gold standard for the definition of malnutrition, are also negative acute phase reactants and may be unreliable in the setting of trauma, infection or stress.[15,33] In addition to being negative acute phase reactants, transferrin and albumin are affected by renal disease, liver failure and iron status.[42,43] These factors need to be considered when interpreting results.

Conclusion

Universally, there's a lack of consensus over the definition of malnutrition and the best screening methods to use, and current literature is not clear on which patients to screen for malnutrition prior to TJA. The prevalence of malnutrition using serological markers in patients undergoing TJA is similar to previous publications. This study highlighted the highest risk of malnutrition in patients presenting with FNF, HIV infection with CD4 < 350 cells/uL, anaemia, renal disease and history of malignancy. Serological assessment of malnutrition should be targeted at these groups, with nutritional optimisation where possible before TJA to mitigate the risk of complications. Future high-powered prospective studies are necessary to determine the financial feasibility of assessing these nutritional markers in all patients undergoing TJA, and whether interventions targeting malnutrition diagnosed using these markers can result in improved clinical outcomes.

Ethics statement

The authors declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010.

Prior to commencement of the study, ethical approval was obtained from the University of the Witwatersrand's Human Research Ethics Committee (Wits HREC) (Medical) – clearance certificate number M210909. All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. Patient consent was not required as this was a retrospective review of patient files.

Declaration

The authors declare authorship of this article and that they have followed sound scientific research practice. This research is original and does not transgress plagiarism policies.

Author contributions

RPA: study conceptualisation, data capture, data analysis, first draft preparation
LM: manuscript revision
NS: manuscript revision
JC: manuscript revision
JRTP: study conceptualisation, data analysis, manuscript revision

ORCID

Almeida RP https://orcid.org/0009-0004-4252-0036
Mokete L https://orcid.org/0000-0001-9227-0515
Sikhauli N https://orcid.org/0000-0002-0862-8615
Cakic J https://orcid.org/0000-0003-3650-9266
Pietrzak JRT https://orcid.org/0000-0001-5694-0016

References

1. Kapadia BH, Berg RA, Daley JA, et al. Periprosthetic joint infection. Lancet. 2016;387:386-94.
2. Abdelaal MS, Restrepo C, Sharkey PF. Global perspectives on arthroplasty of hip and knee joints. Orthop Clin North Am. 2020 Apr 1;51(2):169-76.
3. Malizos KN. Global forum: The burden of bone and joint infections: A growing demand for more resources. J Bone Joint Surg Am. 2017;99:e20.1-e20.7.
4. Sloan M, Premkumar A, Sheth NP. Projected volume of primary total joint arthroplasty in the U.S., 2014 to 2030. J Bone Joint Surg Am. 2018;100(17):1455-60.
5. Springer BD, Cahue S, Etkin CD, et al. Infection burden in total hip and knee arthroplasties: an international registry-based perspective. Arthroplast Today [Internet]. 2017;3(2):137-40. http://dx.doi.org/10.1016/j.artd.2017.05.003
6. Premkumar A, Kolin DA, Farley KX, et al. Projected economic burden of periprosthetic joint infection of the hip and knee in the United States. J Arthroplasty. 2021 May 1;36(5):1484-89. e3.
7. Lenguerrand E, Whitehouse MR, Beswick AD, et al. Revision for prosthetic joint infection following hip arthroplasty evidence from the National Joint Registry. Bone Joint Res. 2017;6:391-98.
8. Kurtz SM, Lau EC, Son MS, et al. Are we winning or losing the battle with periprosthetic joint infection: trends in periprosthetic joint infection and mortality risk for the medicare population. J Arthroplasty. 2018;33(10):3238-45. https://doi.org/10.1016/j.arth.2018.05.042
9. Lum ZC, Natsuhara KM, Shelton TJ, et al. Mortality during total knee periprosthetic joint infection. J Arthroplasty. 2018 Dec 1;33(12):3783-88.
10. Natsuhara KM, Shelton TJ, Meehan JP, Lum ZC. Mortality during total hip periprosthetic joint infection. J Arthroplasty. 2019 Jul 1;34(7):S337-42.
11. Blevins K, Aalirezaie A, Shohat N, Parvizi J. Malnutrition and the development of periprosthetic joint infection in patients undergoing primary elective total joint arthroplasty. J Arthroplasty. 2018;33(9):2971-75. https://doi.org/10.1016/j.arth.2018.04.027
12. Alamanda VK, Springer BD. The prevention of infection 12: Modifiable risk factors. Bone Joint J. 2019;101B(1):3-9.
13. Johnson NR, Statz JM, Odum SM, Otero JE. Failure to optimize before total knee arthroplasty: which modifiable risk factor is the most dangerous? J Arthroplasty. 2021 Jul 1;36(7):2452-57.
14. Golladay GJ, Satpathy J, Jiranek WA. Patient optimization—strategies that work: malnutrition. J Arthroplasty.2016;31(8):1631-34. http://dx.doi.org/10.1016/j.arth.2016.03.027
15. Ellsworth B, Kamath AF. Malnutrition and total joint arthroplasty. J Nat Sci. 2016;2(3):e179. http://www.ncbi.nlm.nih.gov/pubmed/27376151%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC4926871
16. Connor MIO, Bernstein J, Huff T. Optimizing total hip and knee arthroplasty patients: Malnutrition, disparities, and total hip and knee arthroplasty. J Am Acad Orthop Surg. 2021;00:1-4.
17. Eminovic S, Vincze G, Eglseer D, et al. Malnutrition as predictor of poor outcome after total hip arthroplasty. Int Orthop. 2021;45:51-56. https://doi.org/10.1007/s00264-020-04892-4
18. Fryhofer GW, Sloan M, Sheth NP. Hypoalbuminemia remains an independent predictor of complications following total joint arthroplasty. J Orthop. 2019;16(6):552-58. https://doi.org/10.1016/j.jor.2019.04.019
19. Antonelli B, Chen AF. Reducing the risk of infection after total joint arthroplasty : preoperative optimization. Arthroplasty. 2019;1(4):1-13.
20. Phillips JLH, Ennis HE, Jennings JM, Dennis DA. Screening and management of malnutrition in total joint arthroplasty. J Am Acad Orthop Surg. 2023;31(7):319-25. http://journals.lww.com/jaaos
21. Huang R, Greenky M, Kerr GJ, et al. The effect of malnutrition on patients undergoing elective joint arthroplasty. J Arthroplasty. 2013;28(8 suppl):21-24.
22. Cross MB, Thomas CF, Garcia J, Valle CJ Della. Evaluation of malnutrition in orthopaedic surgery. J Am Acad Orthop Surg. 2014;22(3):193-99.
23. Kishawi D, Schwarzman G, Mejia A, et al. Low preoperative albumin levels predict adverse outcomes after total joint arthroplasty. J Bone Joint Surg Am. 2020;102(10):889-95.
24. Rao SS, Chaudhry YP, Solano MA, et al. Routine preoperative nutritional screening in all primary total joint arthroplasty patients has little utility. J Arthroplasty. 2020 Dec 1;35(12):3505-11.
25. Tobert CM, Mott SL, Nepple KG. Malnutrition diagnosis during adult inpatient hospitalizations: analysis of a multi-institutional collaborative database of academic medical centers. J Acad Nutr Diet. 2018;118(1):125-31. https://doi.org/10.1016/j.jand.2016.12.019
26. Maimin DG, Laubscher M, Maqungo S, Marais LC. Hypoalbuminaemia in orthopaedic trauma patients in a rural hospital in South Africa. Int Orthop. 2021;4-9.
27. UNAIDS. Global HIV and AIDS statistics 2019 Fact sheet. Global HIV and AIDs statistics, World AIDS day 2019 Fact Sheet. 2019;1(June):1-6.
28. Rajcoomar S, Rajcoomar R, Rafferty M, et al. Good functional outcomes and low infection rates in total hip arthroplasty in HIV-positive patients, provided there is strict compliance with highly active antiretroviral therapy. J Arthroplasty. 2021 Feb 1;36(2):593-99.
29. Fuseini H, Gyan BA, Kyei GB, et al. Undernutrition and HIV infection in Sub-Saharan Africa: health outcomes and therapeutic interventions. Current HIV/ADS Reports [Internet]. 2021;18:87-97. https://doi.org/10.1007/s11904-021-00541-6
30. Vasarhelyi EM, Macdonald SJ. The influence of obesity on total joint arthroplasty. J Bone Joint Surg Br. 2012 Nov;94(11 Suppl A):100-102.
31. Van Tonder E, Gardner L, Cressey S, et al. Adult malnutrition: prevalence and use of nutrition-related quality indicators in South African public-sector hospitals. South Afr J Clin Nutr. [Internet]. 2019;32(1):1-7. http://doi.org/10.1080/16070658.2017.1410003
32. Blaauw R, Achar E, Dolman RC, et al. The problem of hospital malnutrition in the African continent. Nutrients. 2019;11(9):15-18.
33. Deren ME, Huleatt J, Winkler MF, et al. Assessment and treatment of malnutrition in orthopaedic surgery. JBJS Rev. 2014;2(9):1.
34. Morey VM, Song YD, Whang JS, et al. Can serum albumin level and total lymphocyte count be surrogates for malnutrition to predict wound complications after total knee arthroplasty? J Arthroplasty [Internet]. 2016;31(6):1317-21. http://dx.doi.org/10.1016/j.arth.2015.12.004
35. Bala A, Ivanov DV, Huddleston JI, et al. The cost of malnutrition in total joint arthroplasty. J Arthroplasty [Internet]. 2020;35(4):926-32. e1. https://doi.org/10.1016/j.arth.2019.11.018
36. Rudasill SE, Ng A, Kamath AF. Preoperative serum albumin levels predict treatment cost in total hip and knee arthroplasty. CiOS Clin Orthop Surg. 2018;10(4):398-406.
37. Bohl DD, Shen MR, Kayupov E, Della Valle CJ. Hypoalbuminemia independently predicts surgical site infection, pneumonia, length of stay, and readmission after total joint arthroplasty. J Arthroplasty. 2016;31(1):15-21.
38. Liu X, Cao J, Zhu Z, et al. Nutritional risk and nutritional status in hospitalized older adults living with HIV in Shenzhen, China: a cross-sectional study. BMC Infect Dis. 2021 Dec 1;21(1).
39. Sunil Pralhadrao H, Kant C, Phepale K, Kumar Mali M. Role of serum albumin level compared to CD4+ cell count as a marker of immunosuppression in HIV infection. IJBAMR [Internet]. 2016;(5):495-502. www.ijbamr.com
40. Obiako R, Akase I, Hassan A, et al. Malnutrition in HIV: Are patients in early stages of disease and with high CD4 counts spared? Sub-Saharan African Journal of Medicine. 2019;6(1):43.
41. Frangos E, Trombetti A, Graf CE, et al. Malnutrition in very old hospitalised patients: a new etiologic factor of anemia. J Nutr Health Aging. 2016;20(7):705-13.
42. Keller U. Nutritional laboratory markers in malnutrition. J Clin Med. 2019;8(6):775.
43. Bharadwaj S, Ginoya S, Tandon P, et al. Malnutrition: Laboratory markers vs nutritional assessment. Gastroenterol Rep (Oxf). 2016;4(4):272-80.