SYSTEMATIC REVIEW

The Impact of Vitamin D Supplementation on Postoperative Outcomes Following Total Joint Arthroplasty: A Systematic Review

Ali Salmani, MD; Yashar Khani, MD; Negarsadat Namazi, MD; Sadra Mohebbi, MD; Negin Ashoori, MD; Amir Mehrvar, MD

Research performed at Clinical Research Development Units, Taleghani Hospital, Shahid Beheshti University of Medical Science, Tehran, Iran

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Abstract

Objectives: This systematic review examines the effects of vitamin D supplementation on postoperative outcomes following total knee and hip arthroplasty, taking into account its role in musculoskeletal health and the high prevalence of vitamin D deficiency among arthroplasty patients.

Methods: A comprehensive search of PubMed, Scopus, Embase, and Web of Science was conducted through April 2026. Eligible studies included randomized clinical trials assessing vitamin D supplementation in patients undergoing total knee or hip arthroplasty. Two reviewers independently screened studies, extracted data, and evaluated methodological quality using the Cochrane RoB-2 tool. Due to substantial methodological heterogeneity, a qualitative synthesis was performed.

Results: Five randomized controlled trials comprising 519 patients were included. Higher-dose and oral regimens resulted in greater increases in serum 25(OH)D levels, including higher postoperative concentrations with 2000 IU versus 800 IU at 24 months (45.5 vs. 37.1 ng/mL) and with oral versus intramuscular administration of 600,000 IU on postoperative day 14. However, most studies reported no significant between-group differences in functional outcomes, pain scores, complications, or other clinical endpoints. One study demonstrated significantly greater muscle strength in the supplementation group, including hip abductor strength ($P = 0.03$) and knee extensor strength ($P = 0.01$).

Conclusion: Vitamin D supplementation appears to improve perioperative vitamin D status, particularly with higher-dose and oral regimens. However, current evidence for consistent benefits on broader postoperative functional and clinical outcomes after joint arthroplasty remains limited and inconclusive.

Level of evidence: II

Keywords: Supplementation, Total hip arthroplasty, Total knee arthroplasty, Vitamin D

Introduction

Hypovitaminosis D, or vitamin D deficiency, is one of the most prevalent nutritional deficiencies worldwide, affecting approximately one billion individuals.[1] Vitamin D plays a critical role in maintaining bone mineral density, regulating blood calcium levels, and supporting normal muscle function by modulating creatine phosphate metabolism, phosphorus deposition, and muscle responses to insulin and physical activity.[2-4] Major contributing factors include limited sun exposure due to prolonged indoor stay, a diet low in vitamin D, and insufficient conversion of vitamin D to its active form.[5] Although threshold definitions vary, serum 25(OH)D levels below 25–30 nmol/L are generally considered indicative of vitamin D deficiency.[5,6]

Inadequate vitamin D and calcium levels contribute to osteomalacic myopathy, which may manifest as several symptoms, including increased body sway, muscle weakness, abnormal gait patterns, difficulty rising from a

Corresponding Author: Amir Mehrvar, Clinical Research Development Units, Taleghani Hospital, Shahid Beheshti University of Medical Science, Tehran, Iran

Email: drmehrvar@sbmu.ac.ir

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chair, and diffuse muscle pain.[7,8] Additionally, vitamin D is known to regulate chondrocyte extracellular matrix formation and may therefore be involved in the pathogenesis of osteoarthritis.[9] Patients with osteoarthritis may benefit from vitamin D supplementation, which may improve physical activity and functional status.[10,11] End-stage osteoarthritis is the leading indication for lower-limb arthroplasty, accounting for more than 90% of total hip arthroplasties and approximately 90%–97% of total knee arthroplasties.[12,13]

Vitamin D deficiency is common among arthroplasty patients, with reported prevalence ranging from 13% to 63%.[14,15] Previous reviews have suggested that hypovitaminosis D may be associated with poorer postoperative outcomes, particularly following total knee arthroplasty, including worse functional outcomes, longer hospital stays, increased postoperative stiffness, and potentially higher risks of infection and revision.[16-18] However, these findings are largely derived from heterogeneous observational studies, and the impact of perioperative vitamin D supplementation remains uncertain.

This systematic review aimed to evaluate the effects of vitamin D supplementation on postoperative outcomes following total joint arthroplasty by synthesizing evidence from randomized controlled trials. Specifically, we sought to assess its impact on clinical and functional outcomes, physical performance, pain, complications, inflammatory and laboratory parameters, and other relevant postoperative measures, as well as to determine whether the benefits suggested in previous literature are supported by studies directly evaluating supplementation rather than baseline vitamin D status alone.

Materials and Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[19] The protocol was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO; registration number CRD42024581659).

Search strategy

In this systematic review, a comprehensive search of databases, including PubMed, Scopus, Web of Science, and Embase, was conducted up to April 2026 using Boolean operators ("AND" and "OR") and relevant keywords, including "vitamin D supplementation," "vitamin D," "cholecalciferol," "ergocalciferol," "knee arthroplasty," "hip arthroplasty," "knee replacement," "hip replacement," "joint arthroplasty," and "joint replacement" [Table S1]. Additionally, the reference lists of included articles were carefully screened to identify any potentially missing studies. No search filters, such as time or language restrictions, were applied. All retrieved records were screened using the Rayyan platform, and duplicates were manually removed.

Eligibility criteria

Randomized clinical trials (RCTs) evaluating the effects of vitamin D supplementation on postoperative outcomes following total knee arthroplasty (TKA) or total hip arthroplasty (THA) were eligible for inclusion. Reviews, case reports, case series, letters, conference abstracts, observational studies, including cross-sectional, case-control, and cohort studies, cadaveric studies, and studies that evaluated vitamin D status without a supplementation intervention were excluded.

Study selection

Duplicates were manually removed from the records, and two reviewers (Y.K. and S.M.) independently screened the search results. Any disagreements regarding study inclusion were resolved through discussion between the reviewers, with unresolved conflicts referred to the corresponding author (A.M.).

Risk of bias assessment

The quality assessment of the included studies was evaluated using the Cochrane Risk-of-Bias Tool for Randomized Trials (RoB 2).[20] Two independent assessors (Y.K., S.M.) performed the quality assessment, and discrepancies were resolved through discussion or referred to a third reviewer (A.M). The overall methodological quality of each included study was determined based on its risk-of-bias ratings. The Risk-of-Bias Visualization (robvis) tool was used to present the bias assessment results graphically.[21]

Data extraction

A pre-specified data extraction sheet was developed, including the following items: year of publication, study sample size, type of arthroplasty, age, baseline body mass index (BMI), sex, dietary information, vitamin D assay method, supplementation dose and form, duration of supplementation, frequency, total dose, timing, exercise or physical therapy, and study outcomes. Two reviewers (A.S. and Y.K.) independently performed the data extraction. Any conflicts were resolved through discussion and, if necessary, referred to a third reviewer (A.M.) for a final decision.

Data synthesis

A quantitative synthesis was not performed because of substantial clinical and methodological heterogeneity in intervention composition, dosing regimens, timing of administration, comparator groups, outcome definitions, and follow-up duration. The results were organized to highlight the characteristics of each study, including the type of arthroplasty, vitamin D dose and route of administration, duration of supplementation, follow-up duration, baseline vitamin D status, and reported clinical outcomes.

Results

Study selection and characteristics

The details of the systematic search are presented in [Figure 1]. Overall, five articles comprising 519 patients (60.7% female) were included.[22-26] Two studies were conducted in Asia,[24,25] two in the USA,[22,26] and one in Switzerland.[23] All included studies were randomized controlled trials (RCTs). One study specifically investigated patients undergoing total hip arthroplasty (THA),[25] whereas the remaining studies focused on total knee arthroplasty (TKA). Most studies had two parallel arms, whereas one study included three arms.[24] Sample sizes ranged from 21 to 273 participants, and the mean age ranged from 62 to 70.9 years across study arms. Among the included studies, one compared different vitamin D doses,[23] one compared oral and intramuscular (IM) vitamin D supplementation,[24] two used placebo-controlled designs, and one compared nutritional supplementation added to the same exercise program with exercise alone.[25] Follow-up duration ranged from 2 weeks to 24 months. Table 1 summarizes the characteristics of the included studies [Table 1].

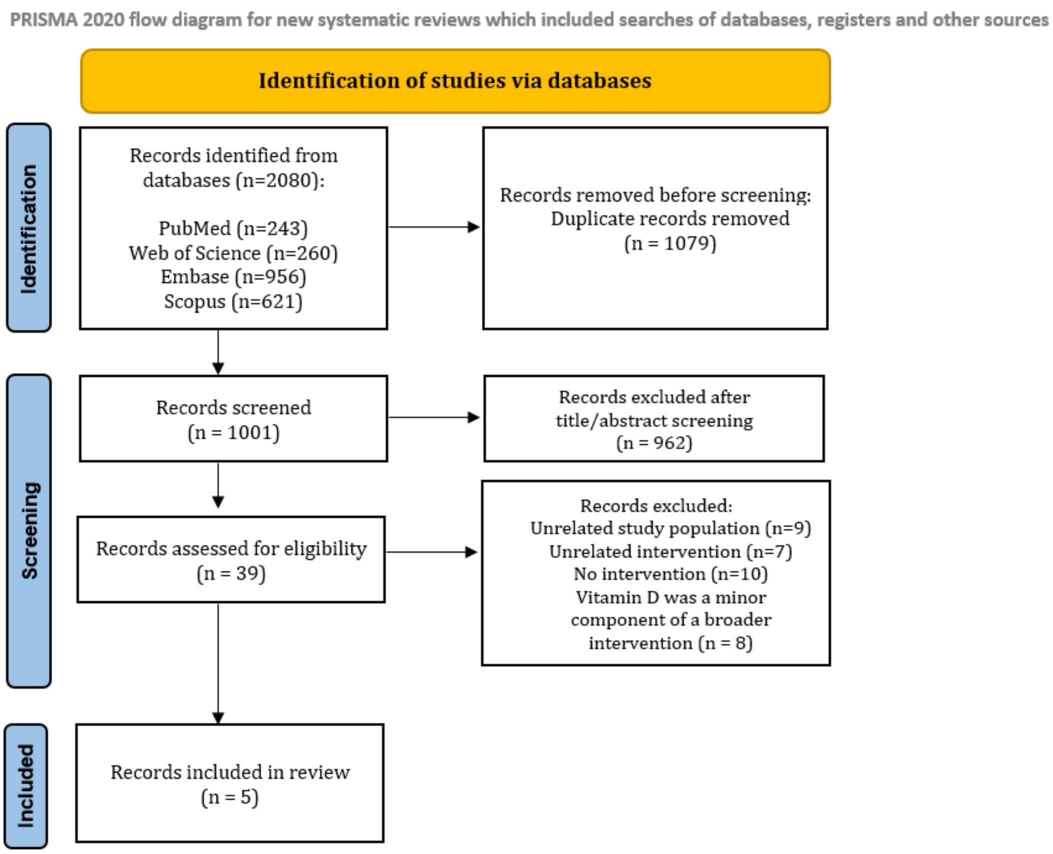

Figure 1. PRISMA flowchart

Table 1. Study characteristics of the included studies

Study, year	Country	Design	Study arms	Total sample (M/F)	Participants per arm, n	Mean age per arm, year	F-U*	Procedure	Outcome Measures
Bischoff-Ferrari, 2018[1]	Switz	RCT	Standard dose vitamin D3/ High-dose vitamin D3	273 (127/146)	136/137	70.5±6.0/ 70.2±6.8	24	TKA	WOMAC pain and function, rate of falls, sit-to-stand performance, gait speed, physical activity, and radiographic progression in the contralateral knee
Ninomiya, 2022[2]	Japan	RCT	Ex + nutritional supp/Ex	58 (0/58)	29/29	70.28 ± 3.26/ 70.86 ± 3.69	3	THA	Hip abductor muscle strength, knee extensor muscle strength, TUG-t, Harris Hip Score, JHEQ, grip strength, quadriceps muscle thickness, intramuscular adipose tissue, VAS hip pain, ALB, Hb, CRP

Table 1. Continued

Weintraub, 2023[3]	USA	RCT	VitaminD3/ Placebo	107 (51/56)	57/50	63.7±9.5/ 64.5±8.5	3	TKA	Functional KSS, TUG-t, Complications
Maniar, 2021[4]	India	RCT	Vit D sufficient/ Vit D insufficient + IM supp/ Vit D insufficient + oral supp	60 (16/44)	20/20/20	66.0 ± 5.2/ 64.5 ± 8.3/ 65.1 ± 7.9	0.5	TKA	Vitamin D level, TUG-t, VAS pain, Knee flexion
Barker, 2021[5]	USA	RCT	Multivitamin mineral supp/ Placebo	21 (10/11)	10/11	62 ± 5/ 63 ± 7	6	TKA	Vitamin D level, vitamin C level, IL-6/IL-10 ratio, IL-8, vitamin E level, TNF-α, CRP, IL-6, IL-10

TKA, total knee arthroplasty; THA, total hip arthroplasty; LOE, level of evidence; IM, intramuscular; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; TUG-t, Timed Up and Go test; KSS, Knee Society Score; HHS, Harris Hip Score; JHEQ, Japanese Orthopaedic Association Hip Disease Evaluation Questionnaire; VAS, visual analogue scale; ALB, albumin; Hb, hemoglobin; CRP, C-reactive protein

1.Bischoff-Ferrari HA, Orav EJ, Egli A, et al. Recovery after unilateral knee replacement due to severe osteoarthritis and progression in the contralateral knee: a randomised clinical trial comparing daily 2000 IU versus 800 IU vitamin D. RMD Open. 2018;4(2):e000678. doi:10.1136/rmdopen-2018-000678

2. Ninomiya K, Takahira N, Ikeda T, Suzuki K, Sato R, Mihara M. Effects of perioperative exercise therapy combined with nutritional supplementation on functional recovery after fast-track total hip arthroplasty. Journal of orthopaedic science : official journal of the Japanese Orthopaedic Association. 2023;28(6):1291-1297. doi:10.1016/j.jos.2022.09.012

3. Weintraub MT, Guntin J, Yang J, et al. Vitamin D3 Supplementation Prior to Total Knee Arthroplasty: A Randomized Controlled Trial. J Arthroplasty. 2023;38(6):S114-S119. doi:10.1016/j.arth.2022.08.020

4. Maniar RN, Maniar AR, Jain D, Bhatnagar N, Gajjar A. Vitamin D trajectory after total knee arthroplasty: A method for quick correction in deficient patients. CIOS Clin Orthop Surg. 2021;13(3):336-343. doi:10.4055/cios20147

5.Barker T, Henriksen VT, Rogers VE, Trawick RH, Momberger NG, Lynn Rasmussen G. Multi-vitamin supplementation blunts the circulating IL-6/IL-10 ratio increase after knee arthroplasty: A randomized, double-blind, placebo controlled study. Cytokine. 2021;140doi:10.1016/j.cyto.2021.155435

Characteristics of vitamin D supplementation

Vitamin D supplementation protocols varied in terms of dose, route, and timing. Dosages ranged from 800 to 600,000 international units (IU). Supplementation was administered orally in most studies, while one study also evaluated intramuscular (IM) administration. Regimens included single-dose, daily, and twice-daily schedules, with intervention durations ranging from a single perioperative dose to 24 months. In studies using single-dose regimens, supplementation was administered on the morning of surgery, whereas longer protocols were initiated up to 4 weeks preoperatively and continued for as long as 24 months postoperatively. Vitamin D was administered either alone or as part of a broader nutritional supplement formulation [Table 2].

Table 2. Vitamin D supplementation protocols of the included studies

Study	Vitamin D dose (IU)	Form	Frequency	Duration of supplementation	Timing relative to surgery	Additional components
Bischoff-Ferrari, 2018	800/2000	Oral	Daily	24 m	6 w postoperatively	Calcium
Ninomiya, 2022	800	Oral	Twice a day	12 w	4 w pre-op to 8 w post-op	Whey protein, carbohydrate, calcium, vitamins B1/B2/B6
Weintraub, 2023	50,000	Oral	Once	Single dose	Morning of surgery	None
Maniar, 2021	600,000	IM/Oral	Once	Single dose	Morning of surgery	None
Barker, 2021	900	Oral	Twice a day	30 w	6 w pre-op to 6 m post-op (not taken on the day of surgery and 2d postoperatively)	vitamin C, vitamin E, vitamin A, calcium, magnesium, zinc, selenium, copper, manganese, chromium, and other ingredients

IU, international units; IM, intramuscular; pre-op, preoperative; post-op, postoperative; w, weeks; d, day.

Risk of Bias Assessment

The RoB 2 assessment indicated that two studies had a low risk of bias, while three studies raised some concerns. These concerns primarily arose from the randomization process and deviations from the intended interventions. The risk-of-bias assessment is presented in [Figure 2].

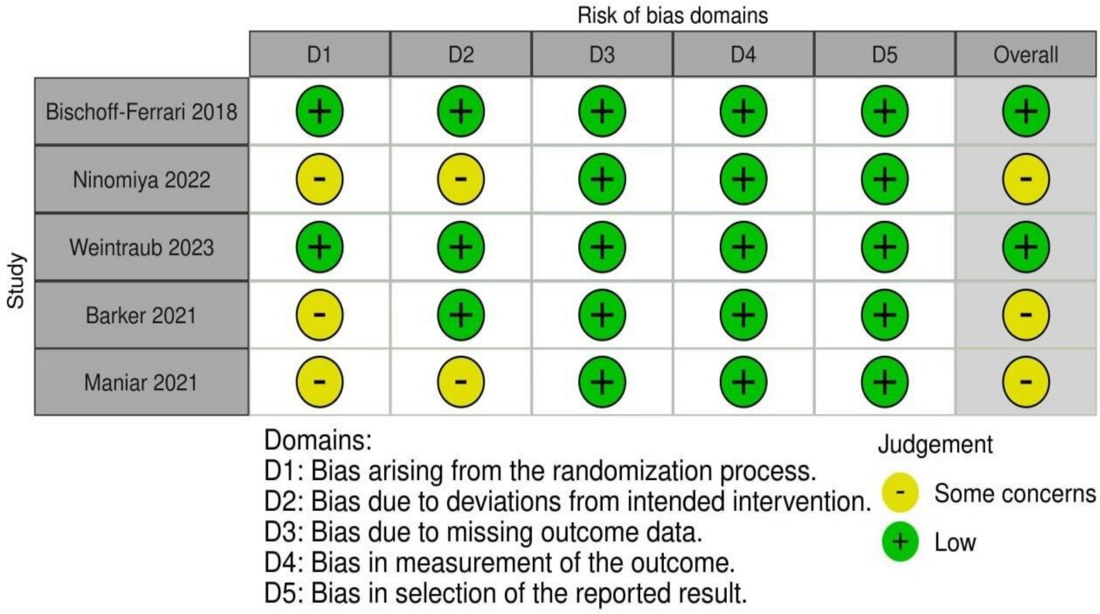

Figure 2. Risk of bias assessment in randomized controlled trials based on RoB2

Synthesis of study findings

The findings of the included studies were synthesized according to serum vitamin D response, functional and clinical outcomes, performance- or strength-related outcomes, laboratory or inflammatory markers, and complications. Three studies reported the serum 25(OH)D response following supplementation. Bischoff-Ferrari et al. reported significantly higher postoperative 25(OH)D concentrations with 2,000 IU compared with 800 IU at 24 months (45.5 vs. 37.1 ng/mL).[23] Similarly, Maniar et al. found that a single oral dose of 600,000 IU increased vitamin D levels more rapidly and to significantly higher concentrations than intramuscular supplementation on postoperative day 14 (68.5 vs. 38.9 ng/mL).[24] In contrast, Barker et al. reported that although multivitamin and mineral supplementation tended to increase serum 25(OH)D preoperatively, no significant between-group differences were observed at 24 or 48 hours postoperatively.[22]

Three studies reported Timed Up and Go test (TUG) outcomes. Ninomiya et al. found no significant between-group differences at 12 weeks postoperatively.[25] Weintraub et al. also reported no significant differences between 50,000 IU vitamin D_3 and placebo at either three or six weeks.[26] In Maniar et al., overall TUG values were not significantly different across groups on postoperative days three and 14; however, the change from baseline to postoperative day three was significantly greater in the intramuscular (IM) group than in the vitamin D-sufficient group (48.5 vs. 35.5 seconds, $P = 0.009$).[24]

With respect to muscle strength, Ninomiya et al. reported significantly greater contralateral hip abductor strength (0.80 vs. 0.68 Nm/kg; $P = 0.03$), operated-leg knee extensor strength (1.19 vs. 0.97 Nm/kg; $P = 0.01$), and contralateral knee extensor strength (1.36 vs. 1.13 Nm/kg; $P = 0.01$) in the supplementation group (1,600 IU daily) compared with exercise alone at 12 weeks postoperatively.[25] However, no significant between-group differences were observed in grip strength or quadriceps muscle thickness.

Three studies reported patient-reported functional outcomes, including the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain and function subscales, Harris Hip Score, Japanese Orthopaedic Association Hip Disease Evaluation Questionnaire (JHEQ), and functional Knee Society Score (KSS); none found significant between-group differences after supplementation.[23,25,26] Similarly, Ninomiya et al. and Maniar et al. reported no significant differences in visual analogue scale (VAS) pain scores at 12 weeks, postoperative day three, or postoperative day 14.[24,25] Other outcomes, including gait speed, physical activity, sit-to-stand performance, complications, falls, and radiographic progression, were also not significantly different in the studies that assessed them [Table 3].

Barker et al. found that multivitamin and mineral supplementation significantly increased serum vitamin C and vitamin E concentrations and significantly attenuated the postoperative increase in the IL-6/IL-10 ratio, although IL-6, IL-10, IL-8, TNF-α, and hsCRP levels did not differ significantly between groups.[22] Ninomiya et al. also reported significantly lower CRP levels in the supplementation group ($P = 0.05$).[25]

Table 3. Summary of overall findings of the included studies

Study	Overall findings
Bischoff-Ferrari, 2018	No baseline difference in 25(OH) D; higher 25(OH) D with 2000 IU at 6 and 24 months. No significant difference in WOMAC pain or function at 24 months. No significant difference in sit-to-stand, gait speed, or physical activity at 24 months. No significant difference in falls or contralateral radiographic progression at 24 months.
Ninomiya, 2022	No significant difference in HHS, JHEQ, VAS pain, or TUG-t at 12 weeks. Contralateral hip abductor and bilateral knee extensor strength improved significantly more in patients with vitamin D supplementation at 12 weeks. CRP was significantly lower in patients taking vitamin D; no significant difference in ALB or Hb.
Weintraub, 2023	No significant difference in improvement in KSS at 3- or 6-weeks PO. No significant difference in the change in TUG-t at 3- or 6-weeks PO. No significant difference in 90-day complication rates.
Maniar, 2021	Oral supplementation raised vitamin D levels more rapidly and more effectively than IM. (19/20 orally supplemented patients were sufficient by POD3 and 20/20 by POD14, compared with 11/20 in the IM group by POD14) POD14 knee flexion differed significantly, but the change in flexion from baseline was not significantly different. Overall, TUG-t and VAS pain were not significantly different across groups, although the change in TUG-t at POD3 was significantly worse in the IM group than in the vitamin D-sufficient group.
Barker, 2021	MV supplementation tended to increase serum 25(OH) D and significantly increased vitamin C and vitamin E before surgery. The postoperative increase in IL-6/IL-10 ratio was significantly blunted in the MV group. No significant difference in IL-6, IL-10, IL-8, TNF-α or hsCRP.

25(OH)D, 25-hydroxyvitamin D; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; TUG-t, Timed Up and Go test; KSS, Knee Society Score; HHS, Harris Hip Score; JHEQ, Japanese Orthopaedic Association Hip Disease Evaluation Questionnaire; VAS, visual analogue scale; ALB, albumin; Hb, hemoglobin; CRP, C-reactive protein; hsCRP, high-sensitivity C-reactive protein; TNF-α, tumor necrosis factor alpha; IL, interleukin; MV, multivitamin/mineral supplement; IM, intramuscular; POD, postoperative day; NR, not reported.

Discussion

This review suggests that the clinical effects of vitamin D supplementation after arthroplasty are more nuanced than its biochemical effects. Patient-reported outcomes and routine timed functional tests generally did not differ significantly between groups, although selected muscle strength outcomes showed improvement. Similarly, Hussain et al., in a review of five RCTs in knee osteoarthritis, found no significant overall improvement in WOMAC pain, function, or stiffness with vitamin D supplementation.[27] In the arthroplasty setting, Maniar et al. reported that vitamin D-deficient patients had worse preoperative WOMAC scores, whereas postoperative differences were no longer significant after supplementation, suggesting that deficiency may be associated with poorer baseline function but that this difference is not consistently maintained after surgery.[27,28] The strength benefit reported by Ninomiya et al. should be interpreted cautiously, as supplementation was combined with pre- and postoperative resistance and kinetic-chain exercises, limiting attribution to vitamin D alone.[25] Similarly, Schiavo et al. found a smaller decline in muscle strength after sleeve gastrectomy when whey protein, branched-chain amino acids, and vitamin D were combined compared with protein alone (3.8% vs. 18.5%), supporting the possibility that vitamin D may be more effective within a broader nutritional and rehabilitation strategy than as an isolated determinant of recovery.[29]

Oral high-dose vitamin D increased serum levels more rapidly than intramuscular (IM) administration at two weeks, and daily 2,000 IU produced higher serum concentrations than 800 IU. Previous consensus suggests that both routes can effectively raise serum 25(OH)D, although IM dosing may provide more sustained exposure in certain settings.[6] Although higher-dose supplementation may achieve stronger biochemical correction, safety remains an important consideration. An international consensus reported that daily vitamin D at 2,000 IU appears safe for long-term use, whereas higher doses and intermittent bolus regimens may carry a greater risk of adverse effects.[30] Timing and duration may also influence response. Chao et al. reported that interventions lasting less than two months resulted in minimal increases in serum 25(OH)D levels, whereas those extending beyond five months showed significantly greater increases.[31] Wang et al., in a systematic review on vitamin D supplementation for enhancing postoperative muscle strength, reported that the benefit may vary according to baseline vitamin D status, surgical type, obesity, and body composition, as higher adipose tissue and fat mass may reduce vitamin D bioavailability.[32] Additionally, Kong et al. reported that sustained elevation of vitamin D levels may be more important than peak levels achieved through single large dosing.[33]

Complication-related outcomes were not clearly improved in the limited randomized evidence included in this review; however, observational studies have suggested a possible benefit of vitamin D supplementation on more definitive postoperative endpoints. Kong et al., in a nationwide population-based cohort study of patients undergoing primary TKA, reported a lower revision risk and improved implant survival with calcium and vitamin D supplementation, particularly when treatment was continued for more than one year.[33] This finding is clinically relevant given the substantial morbidity and healthcare costs associated with revision procedures.[34] Birinci et al. also reported lower rates of selected postoperative complications, including superficial surgical site infection, as well as shorter hospital stays.[35] The reduction in length of hospital stay may have practical implications for healthcare resource utilization and patient satisfaction. Mansour et al. suggested a similar signal in a higher-risk transplant population.[36] Taken together, these findings raise the possibility that vitamin D optimization may influence complications and implant-related outcomes beyond symptom recovery alone, although these associations remain largely based on observational evidence and should therefore be interpreted cautiously.

The mixed findings of this review are likely explained, at least in part, by substantial heterogeneity across the included studies. Supplementation protocols varied markedly in dose, route, timing, duration, and whether vitamin D was administered alone or as part of a broader nutritional intervention, limiting direct comparability between studies. Regimens ranged from modest daily dosing to single high-dose administration, with treatment duration extending from the immediate perioperative period to long-term follow-up. In addition, baseline vitamin D status, type of arthroplasty, coexisting nutritional support, and assessed outcomes differed considerably across studies. Because postoperative recovery after arthroplasty is influenced by multiple factors beyond vitamin D status alone, factors such as limb alignment and surgical technique may also have contributed to the inconsistent effects observed across functional, clinical, and complication-related outcomes.[37] Taken together, the current evidence may reflect not only true variation in treatment effects but also uncertainty regarding the most appropriate strategy for vitamin D optimization in surgical patients.

Clinical Implications and Future Directions

Vitamin D remains a potentially modifiable perioperative factor in arthroplasty patients because of its low cost, wide availability, and generally favorable safety profile.[6,38] However, current evidence is insufficient to strongly recommend routine supplementation alone within perioperative care pathways for improving postoperative outcomes. A more practical implication is that assessment and correction of deficiency may be considered in patients at risk of low vitamin D status, particularly as part of broader perioperative optimization. Such optimization should also account for the substantial variation in real-world arthroplasty practice, including differences in indications, implant selection, and perioperative protocols.[39] Key questions remain regarding the optimal timing of initiation, treatment duration, and target vitamin D levels in surgical patients. More individualized approaches based on baseline vitamin D status, comorbidities, obesity or body composition, and surgical complexity also warrant further study. Future research should use standardized supplementation protocols, consistent outcome measures, longer follow-up to assess sustained benefit, and cost-effectiveness analyses to clarify the role of targeted vitamin D optimization in arthroplasty care.

Limitations

This review has several limitations. First, the small number of included studies limits the strength of the overall conclusions. Second, substantial heterogeneity in supplementation protocols, including dose, route, timing, duration, and whether vitamin D was administered alone or within a broader nutritional intervention, reduced direct comparability between studies and limited attribution of observed effects to vitamin D in some cases. Third, reported outcomes and follow-up durations varied considerably, making synthesis difficult and limiting the identification of a consistent effect on postoperative recovery. Finally, the predominance of TKA studies, with limited THA-specific evidence, restricts generalizability to the broader arthroplasty population, as differences in surgical approach, patient characteristics, and recovery patterns may influence the effects of supplementation.

Conclusion

This systematic review suggests that vitamin D supplementation may help optimize perioperative vitamin D status in patients undergoing total joint arthroplasty, with some studies also reporting benefits in selected muscle strength and implant-related outcomes. However, evidence for consistent improvement in broader functional recovery, pain, and complications remains limited and mixed. Although the optimal dosing regimen, timing, and duration of supplementation remain unclear, vitamin D represents a low-cost and potentially modifiable perioperative factor that warrants further investigation. Larger, well-designed randomized trials with standardized supplementation protocols, consistent outcome measures, and adequate follow-up are needed to clarify its clinical role in arthroplasty care.

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Ali Salmani MD [5]
Yashar Khani MD [1]
Negarsadat Namazi MD [1]
Sadra Mohebbi MD [2]
Negin Ashoori MD [3]
Amir Mehrvar MD [4]

1 Student Research Committee, Shahid Beheshti University of Medical Sciences, Tehran, Iran

2 School of Medicine, Tehran University of Medical Sciences, Tehran, Iran

3 Department of Medicine, Ardabil branch, Islamic Azad University, Ardabil, Iran

4 Clinical Research Development Units, Taleghani Hospital, Shahid Beheshti University of Medical Science, Tehran, Iran

5 Student Research Committee, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

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Supplementary Table

Table S1. Systematic search protocol

Database	Search Query	Results
PubMed	("Vitamin D"[Mesh] OR "Cholecalciferol"[Mesh] OR "Ergocalciferols"[Mesh] OR "vitamin D"[tiab] OR "vitamin D3"[tiab] OR "vitamin D2"[tiab] OR "vit-d"[tiab] OR "vit d"[tiab] OR cholecalciferol[tiab] OR ergocalciferol[tiab] OR calcifediol[tiab] OR calcitriol[tiab] OR "25-hydroxyvitamin D"[tiab] OR "25 hydroxyvitamin D"[tiab] OR "25 hydroxy vitamin D"[tiab] OR "25(OH)D"[tiab]) AND ("Arthroplasty, Replacement, Knee"[Mesh] OR "Arthroplasty, Replacement, Hip"[Mesh] OR "total knee arthroplasty"[tiab] OR "total hip arthroplasty"[tiab] OR "total joint arthroplasty"[tiab] OR "knee arthroplasty"[tiab] OR "hip arthroplasty"[tiab] OR "knee replacement"[tiab] OR "hip replacement"[tiab] OR TKA[tiab] OR THA[tiab] OR TJA[tiab])	243

Table S1. Continued

Scopus	TITLE-ABS-KEY(("vitamin d" OR "vitamin d3" OR "vitamin d2" OR "vit-d" OR "vit d" OR cholecalciferol OR ergocalciferol OR calcifediol OR calcitriol OR "25-hydroxyvitamin d" OR "25 hydroxyvitamin d" OR "25 hydroxy vitamin d" OR "25(OH)D") AND ("total knee arthroplasty" OR "total hip arthroplasty" OR "total joint arthroplasty" OR "knee arthroplasty" OR "hip arthroplasty" OR "knee replacement" OR "hip replacement" OR TKA OR THA OR TJA))	621
Embase	('vitamin d'/exp OR 'cholecalciferol'/exp OR 'ergocalciferol'/exp OR 'vitamin d':ti,ab OR 'vitamin d3':ti,ab OR 'vitamin d2':ti,ab OR 'vit-d':ti,ab OR 'vit d':ti,ab OR cholecalciferol:ti,ab OR ergocalciferol:ti,ab OR calcifediol:ti,ab OR calcitriol:ti,ab OR '25-hydroxyvitamin d':ti,ab OR '25 hydroxyvitamin d':ti,ab OR '25 hydroxy vitamin d':ti,ab OR '25(OH)D':ti,ab) AND ('knee arthroplasty'/exp OR 'hip arthroplasty'/exp OR 'total knee arthroplasty':ti,ab OR 'total hip arthroplasty':ti,ab OR 'total joint arthroplasty':ti,ab OR 'knee arthroplasty':ti,ab OR 'hip arthroplasty':ti,ab OR 'knee replacement':ti,ab OR 'hip replacement':ti,ab OR TKA:ti,ab OR THA:ti,ab OR TJA:ti,ab)	956
WOS	TS=(("vitamin d" OR "vitamin d3" OR "vitamin d2" OR "vit-d" OR "vit d" OR cholecalciferol OR ergocalciferol OR calcifediol OR calcitriol OR "25-hydroxyvitamin d" OR "25 hydroxyvitamin d" OR "25 hydroxy vitamin d" OR "25(OH)D") AND ("total knee arthroplasty" OR "total hip arthroplasty" OR "total joint arthroplasty" OR "knee arthroplasty" OR "hip arthroplasty" OR "knee replacement" OR "hip replacement" OR TKA OR THA OR TJA))	260
Total		2,080
Duplicate		1,079
Reviewed		1,001
Included		5