

Role of Nutritional Status, Dietary Habits, Supplements, and Metabolic Predictors in Healing and Early Recovery After Rotator Cuff Repair: A Systematic Review

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"Cite this Article" Received: 08 December 2025; Accepted: 30 December 2025; Published: 15 January 2026

Author Contributions: Concept: UAMY, FHA; Design: UAMY, FHA, NMA; Data Collection: UAMY, FHA, NMA, AMH; Analysis: UAMY, FHA, AMH; Drafting: UAMY, FHA, NMA, AMH **Ethical Approval:** Government Hospitals. **Informed Consent:** Written informed consent was obtained from all participants; **Conflict of Interest:** The authors declare no conflict of interest. **Funding:** No external funding; **Data Availability:** Available from the corresponding author on reasonable request; **Acknowledgments:** NA

ABSTRACT

Background: Nutritional and metabolic status may influence tendon-to-bone healing and early functional recovery after rotator cuff repair, but the clinical evidence is dispersed across heterogeneous exposures. **Objective:** To synthesize reported associations of vitamin D status, nutritional risk, and dietary habits with healing or recovery after rotator cuff repair. **Methods:** Human clinical studies reporting a nutritional, dietary, supplement, or metabolic exposure and a postoperative healing or recovery outcome were reviewed. Study characteristics, effect estimates, and Newcastle–Ottawa Scale domains were summarized without pooling clinically dissimilar exposures. **Results:** Three cohort studies comprising 287 patients were included. Vitamin D deficiency was associated with a higher retear rate than sufficiency (26.67% vs 9.09%; OR 3.64, 95% CI 1.07 to 12.41). In adults aged at least 65 years, lower GNRI was associated with two-year retear, with ORs from 3.39 to 5.62 across reported contrasts. In one 55-patient cohort, habitual meat, fruit, and wheat-flour intake was associated with rapid recovery; ORs ranged from 1.62 to 4.69. Study quality was moderate to moderate-good. **Conclusion:** Nutritional status and dietary patterns were associated with postoperative outcomes, but the evidence is sparse, observational, and clinically heterogeneous. Findings are hypothesis-generating and do not establish a supplement or dietary treatment effect. **Keywords:** rotator cuff repair; nutrition; vitamin D; GNRI; diet; tendon healing.

INTRODUCTION

Failure of tendon-to-bone healing remains an important limitation after arthroscopic rotator cuff repair. Patients may obtain pain relief and functional improvement despite incomplete structural healing, while others develop persistent symptoms, retear, or delayed recovery. Established predictors include age, tear size, tendon retraction, fatty degeneration, bone quality, diabetes, smoking, surgical configuration, and rehabilitation exposure (1,2). Many of these factors cannot be modified immediately before surgery, creating interest in nutritional and metabolic characteristics that can be measured and potentially optimized.

Tendon-to-bone repair requires coordinated inflammation, collagen synthesis, extracellular-matrix remodeling, mineral metabolism, muscle function, and progressive mechanical loading. Vitamin D deficiency may influence bone and muscle physiology, inflammatory pathways, and tendon healing. One clinical cohort reported a higher retear rate and greater early postoperative pain among patients with preoperative vitamin D deficiency, although another study found no association with structural failure,

indicating uncertainty across populations and definitions (3,6). Broader reviews have consequently identified vitamin D as a plausible but incompletely established predictor of tendon recovery (7,8).

Overall nutritional status may provide information beyond a single micronutrient. The Geriatric Nutritional Risk Index combines serum albumin and body-size information and may identify nutritional vulnerability in older surgical patients who do not appear overtly malnourished. Lower preoperative GNRI has been associated with retear after arthroscopic repair (4). Habitual dietary patterns may also be relevant: a prospective cohort reported associations between consumption of meat, fruit, and selected wheat-flour foods and rapid functional recovery after repair (5). These observations raise clinically important questions but remain vulnerable to confounding by age, socioeconomic circumstances, comorbidity, rehabilitation adherence, and overall lifestyle.

Evidence regarding perioperative supplements is similarly fragmented. Vitamin C, collagen-based products, amino acids, and related formulations have biological plausibility, but available clinical studies are small and heterogeneous in composition, dose, timing, and outcome assessment (9). Metabolic conditions linked to nutrition, including dyslipidemia, diabetes, obesity, and low bone quality, may further impair tendon healing through chronic inflammation, microvascular dysfunction, altered matrix turnover, and impaired enthesis integration (10-13). A focused synthesis is therefore needed to distinguish direct clinical evidence from mechanistic or preclinical support.

This systematic review evaluated the association of nutritional status, dietary habits, vitamin status, supplements, and related metabolic predictors with tendon healing and early recovery after rotator cuff repair. The principal outcomes were imaging-defined retear or healing failure, postoperative pain, functional recovery, validated shoulder scores, and revision surgery. The review also aimed to identify evidence gaps and priorities for future prospective and interventional research.

MATERIAL AND METHODS

A systematic review was undertaken to identify human clinical studies examining nutritional, dietary, vitamin, supplement, or metabolic predictors of healing and recovery after rotator cuff repair. PubMed, Google Scholar, and Semantic Scholar were searched through 1 June 2026. Search concepts combined terms for rotator cuff tear or arthroscopic repair with tendon healing, nutrition, diet, dietary pattern, supplements, vitamin D, vitamin C, collagen, amino acids, albumin, Geriatric Nutritional Risk Index, lipids, obesity, diabetes, metabolic status, postoperative recovery, and retear. Reference lists of relevant reports were also screened for additional eligible studies.

Eligible studies included adults with rotator cuff pathology or patients undergoing rotator cuff repair and reported at least one nutritional, dietary, supplement-related, vitamin, or metabolic exposure. Comparators were participants without the exposure, with adequate nutritional or vitamin status, with a different dietary pattern, or in an alternative risk category. Eligible outcomes included imaging-confirmed tendon integrity or retear, healing failure, postoperative pain, functional recovery, validated shoulder scores, and revision surgery. Randomized studies and observational cohorts were eligible. Animal studies, purely mechanistic investigations, surgical-technique comparisons without a relevant exposure, and studies without extractable clinical outcomes were excluded from the main quantitative synthesis.

The documented search identified 1,190 records. After removal of 400 duplicates, 790 titles and abstracts were screened, 17 full-text reports were assessed, and three clinical studies met the final quantitative eligibility criteria. Two reviewers independently screened records and full texts, with disagreements resolved through discussion. A structured form was used to extract author, year, country, study design, sample size, age and sex distribution, exposure definition, follow-up, outcome definition, event counts, effect estimates, and 95% confidence intervals. The final quantitative evidence comprised 287

participants across studies of vitamin D status, GNRI-based nutritional status, and habitual dietary intake (3-5).

Methodological quality was assessed using the Newcastle-Ottawa Scale for observational studies. Selection, comparability, and outcome domains were evaluated, and studies were categorized as high quality at 7-9 points, moderate quality at 5-6 points, and low quality below 5 points. Particular attention was given to retrospective design, exposure measurement, outcome ascertainment, confounder adjustment, and the external validity of study-specific cut-offs.

Data were analysed using Review Manager version 5.4. Dichotomous associations were expressed as odds ratios with 95% confidence intervals. Where compatible continuous outcomes were available, mean differences with 95% confidence intervals were planned. Reported adjusted estimates were retained when they more appropriately accounted for confounding; event-based odds ratios were calculated only when complete group counts were available. Forest plots were used to display retear-related and dietary estimates. Because the included studies evaluated clinically distinct exposures and outcomes, estimates were interpreted individually, and any random-effects summary across retear-related nutritional predictors was considered exploratory rather than a common causal effect. Heterogeneity was assessed using the I-squared statistic, with values above 50% considered substantial. Funnel plots and regression-based tests for publication bias were not undertaken because fewer than 10 studies contributed to any comparable outcome.

RESULTS

Three eligible cohort studies comprising 287 patients were included: two from China and one from Japan. The studies evaluated distinct preoperative exposures—vitamin D status, GNRI-based nutritional risk, and habitual dietary intake—and therefore their effect estimates were retained as separate associations rather than combined across clinically heterogeneous exposures.

Table 1. Characteristics of included quantitative studies

Study	Country	Design	n	Exposure	Outcome
Chen et al. (1)	China	Retrospective cohort	89	Vitamin D deficiency (<20 µg/L)	Retear; early pain
Liu et al. (2)	China	Cohort follow-up	55	Habitual dietary intake	Rapid vs slow recovery
Shitara et al. (3)	Japan	Retrospective cohort	143	GNRI and albumin	Retear on 2-year MRI

GNRI, Geriatric Nutritional Risk Index; MRI, magnetic resonance imaging.

In Chen et al. (1), retear occurred in 26.67% of patients with vitamin D deficiency and 9.09% of those with sufficient vitamin D, corresponding to an odds ratio of 3.64 (95% CI 1.07 to 12.41). Early postoperative pain at one and three months was also higher in the deficient group, whereas no difference in longer-term functional outcome was reported.

Among 143 patients aged 65 years or older in Shitara et al. (3), the two-year retear rate was 20.3%. Lower GNRI was associated with retear: the low-risk category had 3.39-fold higher odds than the no-risk category (95% CI 1.22 to 9.41). GNRI <103 was associated with higher odds of retear than GNRI 103 to <109 (OR 3.88, 95% CI 1.14 to 13.16) and GNRI ≥109 (OR 5.62, 95% CI 1.58 to 20.00).

Liu et al. (2) classified 35 of 55 patients as having rapid recovery and 20 as having slow recovery. Habitual intake of meat, fruit, and wheat-flour foods was positively associated with rapid recovery. Steamed flour products and soup-mixed flour foods had the largest reported estimates, although all dietary estimates were derived from a single cohort.

Table 2. Reported nutritional and dietary associations with postoperative outcomes

Study	Exposure comparison	Outcome	OR	95% CI
Chen et al. (1)	Vitamin D deficiency vs sufficiency	Retear	3.64	1.07 to 12.41
Shitara et al. (3)	GNRI low-risk vs no-risk	Retear	3.39	1.22 to 9.41

Shitara et al. (3)	GNRI <103 vs 103 to <109	Retear	3.88	1.14 to 13.16
Shitara et al. (3)	GNRI <103 vs ≥109	Retear	5.62	1.58 to 20.00
Liu et al. (2)	Habitual meat intake	Rapid recovery	1.84	1.22 to 2.76
Liu et al. (2)	Habitual fruit intake	Rapid recovery	2.33	1.26 to 5.67
Liu et al. (2)	Habitual wheat-flour foods	Rapid recovery	1.62	1.20 to 2.25
Liu et al. (2)	Steamed flour products	Rapid recovery	3.86	1.79 to 8.35
Liu et al. (2)	Soup-mixed flour foods	Rapid recovery	4.69	2.02 to 10.87

CI, confidence interval; GNRI, Geriatric Nutritional Risk Index; OR, odds ratio.

Methodological quality was rated moderate for the Chen and Liu studies and moderate to good for the Shitara study. Principal limitations were retrospective design and residual confounding, small samples, food-frequency exposure assessment, restriction of the GNRI cohort to older adults, and the need to validate the reported GNRI threshold. Formal small-study-effect assessment was not performed because only one study contributed to each distinct exposure-outcome association.

Table 3. Quality assessment of included studies

Study	Selection	Comparability	Outcome	Overall quality
Chen et al. (1)	Good	Moderate	Good	Moderate
Liu et al. (2)	Moderate	Moderate	Moderate	Moderate
Shitara et al. (3)	Good	Good	Good	Moderate to good

DISCUSSION

This review identified only three quantitative clinical studies, comprising 287 patients, that directly evaluated nutrition-related exposures in relation to healing or early recovery after rotator cuff repair. The studies addressed different constructs: serum vitamin D deficiency, GNRI-based nutritional risk in older adults, and habitual dietary intake. Each reported at least one positive association, but the exposures, populations, outcome definitions, follow-up, and analytical models were too heterogeneous for a single clinically meaningful pooled estimate. The evidence therefore supports a possible relationship between nutritional status and postoperative outcome, not a unified causal effect of “nutrition” as one intervention.

The vitamin D study reported a retear rate of 26.67% in deficient patients and 9.09% in those with sufficient status, corresponding to an odds ratio of 3.64 with a confidence interval from 1.07 to 12.41 (1). Higher early pain was also reported at one and three months, whereas longer-term function did not differ. Vitamin D has plausible roles in muscle function, immune regulation, collagen organization, inflammatory signalling, and bone–tendon integration. Experimental work has shown impaired tendon-to-bone healing under vitamin D deficiency, and economic modelling has suggested that correction may be inexpensive relative to revision surgery (8,9). However, observational clinical findings are not uniform: Ryu et al. did not identify a relationship between low vitamin D and retear, indicating that threshold selection, background prevalence, tear characteristics, supplementation, and case mix may modify the association (4).

The GNRI findings broaden the hypothesis from a single micronutrient to general nutritional reserve. In the cohort of patients aged 65 years or older, the two-year retear rate was 20.3%, and lower GNRI was independently associated with retear (3). The reported odds increased across contrasts involving GNRI below 103, but confidence intervals were wide, reflecting limited events and sample size. GNRI combines serum albumin and the relation between actual and ideal body weight; it may capture vulnerability that is not apparent from clinical appearance alone. At the same time, albumin and body weight can be influenced by inflammation, hydration, comorbidity, and body composition. The proposed threshold should therefore be validated externally before it is used to determine surgical eligibility or a specific nutritional intervention.

The dietary cohort introduced a different outcome—rapid rather than slow functional recovery—and found positive associations with habitual consumption of meat, fruit, wheat-flour foods, steamed flour products, and soup-mixed flour foods (2). These results are clinically interesting because they move

beyond isolated supplementation toward whole-diet patterns. They are also especially vulnerable to residual confounding. Food-frequency reporting is affected by recall and cultural context, and patients with greater dietary variety may differ in income, total energy and protein intake, comorbidity, rehabilitation adherence, family support, or health behaviour. Multiple estimates from the same cohort are correlated and should not be treated as independent confirmations. The larger odds ratios for specific flour preparations should therefore be considered exploratory rather than prescriptive.

Other metabolic and nutritional factors remain relevant to the broader biological framework. Hyperlipidaemia, diabetes, obesity, and impaired bone quality may adversely affect microvascular supply, chronic inflammation, oxidative stress, tendon matrix turnover, and fixation at the bone–tendon interface (5,6,11,12,15,16). Clinical and preclinical studies have also examined vitamin C, collagen-based products, amino-acid formulations, glutamine, and antioxidant strategies (7,10,13,14). These lines of evidence support continued investigation but cannot be combined with the three included cohorts as though they represent the same exposure, dose, treatment window, or outcome.

The practical implication is risk assessment rather than routine supplementation. Measurement of vitamin D, albumin, body weight, recent weight change, dietary intake, glycaemic status, lipids, and relevant comorbidities may help identify modifiable concerns before repair, particularly in older or medically vulnerable patients. Correction of established deficiency and provision of appropriate dietary care are consistent with general perioperative practice, but this review does not establish that supplementation beyond standard care prevents retear or accelerates recovery. Any intervention should account for safety, interactions, baseline status, and the possibility that a biomarker is a proxy for broader health rather than the direct cause of impaired healing.

The review is limited by the small number of eligible studies, modest sample sizes, observational designs, residual confounding, heterogeneous exposures and outcomes, and reliance on single measurements or food-frequency assessment. Two studies were retrospective, and the prospective dietary cohort remained non-randomized. The search and study-flow descriptions in the source manuscript were internally inconsistent, and a fully reproducible multi-database search with reconciled deduplication counts is needed. Formal assessment of publication bias was inappropriate for one study per distinct association. Because several odds ratios arose from the same cohorts, conventional pooling would create false precision. Future prospective multicentre cohorts should use standardized exposure definitions, serial biomarker measurement, validated dietary assessment, imaging-defined healing, validated function, and complete confounder adjustment. Randomized trials should evaluate targeted correction of documented deficiencies and report adherence, safety, retear, pain, strength, return to activity, and patient-reported recovery.

CONCLUSION

Vitamin D deficiency, lower GNRI, and selected dietary patterns were associated with retear or early recovery after rotator cuff repair in three observational cohorts. The direction of these findings supports further evaluation of preoperative nutritional risk, but the small, heterogeneous, and confounded evidence base does not establish causality or justify a universal supplement or diet protocol. Clinical care may reasonably identify and correct established deficiencies while well-designed prospective cohorts and randomized trials determine whether targeted nutritional optimization improves structural healing and patient-centred recovery.

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