



DOSSIER · SUBSTANCE

Glucosamine and Chondroitin

Glucosamine and chondroitin sulfate are cartilage building blocks; human studies show mixed results depending on form and joint.

747

STUDIES IN
TOTAL

339

IN HUMANS

137

OF WHICH
CONTROLLED

72

IN ANIMALS

36

IN THE LAB

Figures from the IHR study database · Last updated 2026-10-15

How to Read This Dossier

ESTABLISHED

measured in humans, with a comparison group

PLAUSIBLE

supported by mechanism, animal studies or observation

HYPOTHESIS

a likely connection that still needs to be tested

Glucosamine and Chondroitin at a Glance

In knee osteoarthritis, pain and function improved more than with placebo in several controlled studies with oral glucosamine sulfate ¹⁸³⁴⁴²⁶¹¹¹⁹ and with oral chondroitin sulfate ²³³²⁴⁹. Large randomized controlled trials, however, found no confirmed advantage for glucosamine, chondroitin sulfate, and their combination for pain ⁴³⁴⁵⁴⁸.

For joint structure, reviews showed less loss of joint space with glucosamine sulfate and chondroitin sulfate ⁶⁴¹.

In osteoarthritis of the hip joint, oral glucosamine sulfate was not better than placebo for WOMAC pain and function in a two-year randomized controlled trial ⁵⁸⁵⁹.

We evaluated 302 human studies on Glucosamine and Chondroitin, including 107 randomised controlled trials and 46 meta-analyses or systematic reviews; the controlled studies include 18,153 participants in total. As of 15 October 2026.

1. What Is Glucosamine and Chondroitin? Occurrence, Origin and Forms

Glucosamine is an amino sugar and a natural building block of glycosaminoglycans, to which chondroitin sulfate also belongs. Both substances occur in the cartilage and connective tissue of humans and animals. As dietary supplements they are commonly taken for joint complaints and for osteoarthritis, either alone or as a combination.

Glucosamine and chondroitin sulfate occur naturally in joint cartilage and in other connective tissue. In use they are taken as dietary supplements, and it is exactly this intake that is examined in studies in humans.

Glucosamine is obtained from chitin, which comes from the shells of crustaceans, and chondroitin sulfate from cartilage tissue of cattle, pigs or cartilaginous fish. Studies examine mainly glucosamine sulfate, glucosamine hydrochloride and chondroitin sulfate, alone and in combination, in different preparations and over different periods of time.

Forms and Preparations Studied

- Glucosamine sulfate
- Glucosamine hydrochloride
- N-acetylglucosamine
- Chondroitin sulfate
- Combination of glucosamine and chondroitin sulfate
- Dietary supplements as tablets, capsules or powder

Not covered on this page:

- Collagen and collagen hydrolysate are substances of their own and do not belong to glucosamine and chondroitin.
- Hyaluronic acid, including injection into the joint, is a different substance.
- MSM (methylsulfonylmethane) is a dietary supplement of its own and is not part of this topic.
- Pain and anti-inflammatory drugs such as ibuprofen or paracetamol are medicines and not forms of glucosamine or chondroitin.

2. What Does Glucosamine and Chondroitin Do? Results by Area

AREA	RESULT IN CONTROLLED STUDIES	STRENGTH OF EVIDENCE	STUDIES	PARTICIPANTS
Knee Osteoarthritis	mixed	high	23 meta-analyses · 47 controlled · 60 other	8,334
Joint Pain	mixed	high	20 meta-analyses · 24 controlled · 33 other	2,993
Cartilage and Joint Structure	mixed	high	10 meta-analyses · 21 controlled · 34 other	4,309
Tolerability and Adverse Effects	mixed	low	0 meta-analyses · 5 controlled · 91 other	291
Hand Osteoarthritis	mostly improved	low	0 meta-analyses · 1 controlled · 2 other	108
Hip Osteoarthritis	mostly no difference	unclear	1 meta-analyses · 1 controlled · 3 other	222
Back Pain	mostly no difference	unclear	1 meta-analyses · 1 controlled · 3 other	45
Other investigations	mixed	high	7 meta-analyses · 22 controlled · 67 other	1,984

How to read the table: counted are human studies whose results concern the area. “High” means at least one meta-analysis and two controlled studies showing improvement, or at least three controlled studies of which three quarters show improvement, with at least 300 participants in total. “Moderate” means at least two controlled studies showing improvement, as a majority, or one meta-analysis alongside controlled studies. “Low” means one controlled study showing improvement. Where an area has no controlled study, the strength of evidence is at most “low” (result “reviews only” or “observational data only”). Everything else is “unclear”. A study counts as showing improvement when at least half of its outcomes in this area improved. Reviews of combination products do not count as meta-analyses; results that only describe side effects or shares of users do not count as an effect. The same study is counted only once.

3. What the Studies Show in Detail

Glucosamine and Chondroitin and Knee Osteoarthritis: Human Studies

In osteoarthritis of the knee joint, several controlled studies found improvements in pain and function with oral glucosamine sulfate ¹⁸³⁴⁴²⁶¹¹¹⁹. Controlled studies also showed improvements in pain and function for chondroitin sulfate ²³³²⁴⁹. For the structure of the joint, reviews found less loss of joint space with glucosamine sulfate and chondroitin sulfate ⁶⁴¹. Large randomized controlled trials, however, found no confirmed advantage over placebo for pain with glucosamine, chondroitin sulfate, and their combination ⁴³⁴⁵⁴⁸. With the combination of chondroitin sulfate and glucosamine sulfate, pain even decreased less than with placebo in one study ⁶⁶. Intramuscularly injected glucosamine sulfate lowered the Lequesne index more than placebo ⁶⁸. A meta-analysis found less pain than with placebo for mixtures of glucosamine with omega-3, with ibuprofen, or with chondroitin sulfate and methylsulfonylmethane ³. A mixture of glucosamine HCl, chondroitin sulfate, and manganese ascorbate relieved knee complaints more than placebo in a small study ¹⁰⁹. It remains open whether a specific preparation, dose, or treatment duration works reliably and which patient groups benefit from it.

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
² Yang et al. 2021	meta-analysis · 11,890 participants	Glucosamine, chondroitin (preparation form not reported); at least 12 months follow-up; vs. Placebo and other DMOAD clas
⁶ Lee et al. 2010	meta-analysis · 1,502 participants	Glucosamine sulfate and chondroitin sulfate; daily, dose not reported; 1 to 3 years; vs. placebo/controls
⁷ Wang et al. 2022	meta-analysis · 764 participants	Chondroitin combined with glucosamine; vs. Routine treatment or chondroitin or glucosamine alone
⁹ Čeh et al. 2023	meta-analysis · 297 participants	Glucosamine alone or glucosamine plus chondroitin, form not stated; vs. Add-on to exercise program versus exercise alone
¹¹ McAlindon et al. 2000	meta-analysis · 15 participants	Glucosamine or chondroitin preparations; at least 4 weeks; vs. Placebo, double-blind randomized; manufacturer-funded
¹³ Chen et al. 2026	meta-analysis	Glucosamine/chondroitin combination (CS+GH); vs. Celecoxib, probiotics, metformin, krill oil, placebo/control
¹⁵ Baden et al. 2025	systematic review	glucosamine and/or chondroitin; mostly 1500 mg glucosamine plus 1200 mg chondroitin daily; vs. placebo or celecoxib
¹⁷ Rabade et al. 2024	meta-analysis	Oral glucosamine sulfate, chondroitin sulfate, GS+CS combination; vs. Placebo-controlled

Further studies in this area: ^{18 23 26 27 29 30 31 32 34 36 37 39 40 41 42 43 44 45 46 47 49 53 54 56 57 60 61 63 64 65 66 67 68 70 71 73 74 75 76 77 79 80 82 83 84 85 87 88 89 90 91 94 96 98 99 101 106 107 115 116 118 119 121 122 125 128 129 130 142 144 147 148 150 154 155 156 158 164 165 166 167 168 169 170 179 180 182 185 186 189 191 205 206 214 219 220 221 223 225 227 228 229 230 233 234 235 236 237 238 241 243 244 245 247 251 252 253 254 255 256 258 259}

Glucosamine and Chondroitin and Joint Pain: Human Studies

Meta-analyses found small to moderate relief compared with placebo in osteoarthritis pain with oral glucosamine sulfate ²⁸⁴¹ and with chondroitin ³². A network meta-analysis, however, saw no clinically relevant difference from placebo for glucosamine, chondroitin, and their combination ⁴. The combination was better than placebo in a large study only for moderate to severe baseline pain ⁴³; crystalline glucosamine sulfate did not differ from placebo in another study ⁶⁰. The evidence is considered high because numerous randomized trials and several meta-analyses are available; however, the results depend strongly on the preparation tested, since glucosamine sulfate, glucosamine hydrochloride, and chondroitin sulfate cannot be exchanged for one another. Mostly oral preparations were investigated, sometimes as a single substance, sometimes as a combination; manufacturer-supported studies showed larger effects than independent ones ⁴²⁸. It remains open which preparation and which patient group are most likely to benefit and how the findings behave with longer use.

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
¹ Zeng et al. 2015	meta-analysis · 16,427 participants	Glucosamine, chondroitin, combination, celecoxib, placebo; vs. Placebo; celecoxib as active comparator

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
⁴ Wandel et al. 2010	meta-analysis · 3,803 participants	Glucosamine, chondroitin, or their combination; vs. Placebo or head-to-head comparison of preparations
⁵ Towheed et al. 2005	systematic review · 2,570 participants	Glucosamine, Rotta and non-Rotta preparations; up to 3 years in two RCTs; vs. placebo and NSAID
⁷ Wang et al. 2022	meta-analysis · 764 participants	Chondroitin combined with glucosamine; vs. Routine treatment or chondroitin or glucosamine alone
⁹ Čeh et al. 2023	meta-analysis · 297 participants	Glucosamine alone or glucosamine plus chondroitin, form not stated; vs. Add-on to exercise program versus exercise al
¹¹ McAlindon et al. 2000	meta-analysis · 15 participants	Glucosamine or chondroitin preparations; at least 4 weeks; vs. Placebo, double-blind randomized; manufacturer-fundec
¹⁵ Baden et al. 2025	systematic review	glucosamine and/or chondroitin; mostly 1500 mg glucosamine plus 1200 mg chondroitin daily; vs. placebo or celecoxib
¹⁷ Rabade et al. 2024	meta-analysis	Oral glucosamine sulfate, chondroitin sulfate, GS+CS combination; vs. Placebo-controlled

Further studies in this area: [22](#) [25](#) [26](#) [27](#) [28](#) [29](#) [30](#) [32](#) [35](#) [39](#) [41](#) [42](#) [48](#) [56](#) [60](#) [66](#) [67](#) [69](#) [72](#) [73](#) [74](#) [75](#) [80](#) [82](#) [89](#) [90](#) [92](#) [94](#) [96](#) [97](#) [98](#) [110](#) [115](#) [121](#) [123](#) [126](#) [129](#) [142](#) [145](#) [146](#) [148](#) [150](#) [157](#) [158](#) [162](#) [163](#) [164](#) [167](#) [170](#) [171](#) [172](#) [205](#) [206](#) [208](#) [209](#) [211](#) [216](#) [218](#) [222](#) [227](#) [231](#) [238](#) [240](#) [246](#) [248](#) [249](#) [250](#) [257](#) [260](#)

Glucosamine and Chondroitin, Cartilage and Joint Structure: Human Studies

In knee osteoarthritis, joint space narrowed less with oral glucosamine sulfate than with placebo in two randomized controlled trials over three years ⁶¹¹²². A review found this also for chondroitin ³², while a meta-analysis for glucosamine sulfate found only a small effect ²⁸. For the combination of glucosamine and chondroitin sulfate, the picture is inconsistent: one randomized controlled trial found less joint space narrowing after two years than with placebo ⁴⁸, two meta-analyses found no difference ⁴¹⁷. On MRI, the knee lost less cartilage volume with chondroitin sulfate than with placebo ⁹²; with glucosamine, two controlled studies found no structural advantage on MRI ⁵²⁶². The robustness is considered high because many randomized trials and several meta-analyses are available; however, the results depend strongly on the form tested, and glucosamine sulfate, glucosamine hydrochloride, and chondroitin sulfate are not interchangeable. It remains open which patients and which osteoarthritis stages actually benefit structurally from which preparation.

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
¹ Zeng et al. 2015	meta-analysis · 16,427 participants	Glucosamine, chondroitin, combination, celecoxib, placebo; vs. Placebo; celecoxib as active comparator
⁴ Wandel et al. 2010	meta-analysis · 3,803 participants	Glucosamine, chondroitin, or their combination; vs. Placebo or head-to-head comparison of preparations
⁵ Towheed et al. 2005	systematic review · 2,570 participants	Glucosamine, Rotta and non-Rotta preparations; up to 3 years in two RCTs; vs. placebo and NSAID
¹⁷ Rabade et al. 2024	meta-analysis	Oral glucosamine sulfate, chondroitin sulfate, GS+CS combination; vs. Placebo-controlled
²⁵ Liu et al. 2018	systematic review	Oral dietary supplements, including glucosamine and chondroitin; Short term, medium term and long term; vs. Placebo
²⁸ Knapik et al. 2018	meta-analysis	Oral glucosamine sulfate; various dosages, including 1500 mg once daily; vs. Placebo
³² Singh et al. 2015	systematic review	oral chondroitin; from 1 month to 3 years; vs. placebo, NSAIDs/analgesics/opioids, glucosamine or other herbal medicatic

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
33 Gallagher et al. 2015	systematic review	oral glucosamine; chondroitin sulfate; trials of at least 12 months; vs. placebo

Further studies in this area: [39](#) [42](#) [44](#) [47](#) [48](#) [50](#) [52](#) [56](#) [59](#) [60](#) [61](#) [62](#) [72](#) [74](#) [75](#) [79](#) [89](#) [90](#) [92](#) [93](#) [94](#) [117](#) [122](#) [123](#) [147](#) [153](#) [162](#) [163](#) [171](#) [176](#) [192](#) [194](#) [202](#) [203](#) [204](#) [205](#) [208](#) [209](#) [211](#) [213](#) [216](#) [226](#) [227](#) [228](#) [229](#) [238](#) [240](#) [243](#) [245](#) [246](#) [247](#) [248](#) [249](#) [250](#) [253](#) [254](#) [259](#)

Glucosamine and Chondroitin, Tolerability and Adverse Effects: Human Studies

For the tolerability of glucosamine and chondroitin sulfate, the controlled studies show a largely unremarkable picture. In several randomized controlled studies, the tolerability of glucosamine sulfate did not differ from placebo [576119122](#). According to a review, serious adverse events occurred less frequently with chondroitin than with placebo [32](#). Individual studies reported fewer adverse events with glucosamine sulfate compared to ibuprofen [6497](#). A randomized controlled study also found fewer drug-related study discontinuations with glucosamine sulfate than with ibuprofen [65](#). In a small study on temporomandibular joint osteoarthritis, more participants reported gastrointestinal complaints with glucosamine sulfate than with placebo [100](#). Overall, the evidence is low, the studies are mostly small, short, and examine different preparations, so the transferability to all forms is limited.

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
1 Zeng et al. 2015	meta-analysis · 16,427 participants	Glucosamine, chondroitin, combination, celecoxib, placebo; vs. Placebo; celecoxib as active comparator
2 Yang et al. 2021	meta-analysis · 11,890 participants	Glucosamine, chondroitin (preparation form not reported); at least 12 months follow-up; vs. Placebo and other DMOAD cl:
5 Towheed et al. 2005	systematic review · 2,570 participants	Glucosamine, Rotta and non-Rotta preparations; up to 3 years in two RCTs; vs. placebo and NSAID
7 Wang et al. 2022	meta-analysis · 764 participants	Chondroitin combined with glucosamine; vs. Routine treatment or chondroitin or glucosamine alone
12 Calzada-Gonzales et al. 2026	systematic review · 7 participants	Oral glucosamine (unspecified preparation); 3 to 12 months; vs. Placebo or active control
15 Baden et al. 2025	systematic review	glucosamine and/or chondroitin; mostly 1500 mg glucosamine plus 1200 mg chondroitin daily; vs. placebo or celecoxib
17 Rabade et al. 2024	meta-analysis	Oral glucosamine sulfate, chondroitin sulfate, GS+CS combination; vs. Placebo-controlled
18 Vo et al. 2023	systematic review	oral glucosamine, stated as glucosamine sulfate; glucosamine sulfate 1500 mg/day; long-term treatment, duration not sta

Further studies in this area: [25](#) [27](#) [28](#) [29](#) [31](#) [32](#) [34](#) [41](#) [42](#) [44](#) [45](#) [46](#) [47](#) [48](#) [49](#) [57](#) [60](#) [61](#) [63](#) [64](#) [65](#) [66](#) [71](#) [75](#) [76](#) [77](#) [78](#) [82](#) [84](#) [89](#) [91](#) [93](#) [97](#) [98](#) [99](#) [100](#) [101](#) [103](#) [105](#) [106](#) [112](#) [113](#) [114](#) [115](#) [117](#) [118](#) [119](#) [120](#) [122](#) [127](#) [128](#) [148](#) [149](#) [150](#) [151](#) [153](#) [154](#) [157](#) [158](#) [159](#) [160](#) [161](#) [167](#) [170](#) [171](#) [172](#) [177](#) [196](#) [198](#) [205](#) [207](#) [208](#) [213](#) [215](#) [217](#) [218](#) [225](#) [227](#) [234](#) [244](#) [245](#) [246](#) [247](#) [248](#) [251](#) [252](#) [254](#) [260](#)

Glucosamine and Chondroitin and Hand Osteoarthritis: Human Studies

In hand osteoarthritis, hand pain and hand function improved more in two retrospective observational studies when glucosamine sulfate was added to usual therapy than with usual therapy alone [78160](#). The evidence is low because placebo-controlled studies are still pending and all participants also had knee osteoarthritis. It remains open whether the findings apply to other preparations such as glucosamine hydrochloride or chondroitin sulfate alone.

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
78 Tenti et al. 2020	controlled · 108 participants	crystalline glucosamine sulfate plus conventional therapy; 1500 mg once daily; 6 months; vs. conventional therapy alone
160 Tenti et al. 2022	case-control study · 123 participants	prescription-grade crystalline glucosamine sulfate (pCGS); 1500 mg/day; 6 months; vs. usual therapy plus pCGS vs. usua

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
¹⁶² Scarpellini et al. 2008	cohort study · 104 participants	Glucosamine + chondroitin sulfate (GC) or plus type II collagen (GCC); 1 year; vs. GC alone vs GCC (no placebo control), I

Glucosamine and Chondroitin and Hip Osteoarthritis: Human Studies

In hip osteoarthritis, oral glucosamine sulfate was not better than placebo for WOMAC pain and function in a two-year randomized controlled study ⁵⁸⁵⁹. A review on glucosamine and chondroitin also saw no clinically relevant benefit in knee and hip osteoarthritis ³⁶. The evidence is considered unclear because the controlled investigations are limited to a single preparation. It remains open whether other forms such as glucosamine hydrochloride or chondroitin sulfate perform differently in the hip joint.

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
³⁶ Lopes et al. 2013	systematic review	Glucosamine and chondroitin; vs. Placebo or control groups in the included studies
⁵⁹ Rozendaal et al. 2008	randomised controlled · 222 participants	Oral glucosamine sulfate or placebo; 1500 mg once daily; 2 years; vs. Glucosamine sulfate versus placebo
¹⁴⁸ Lila et al. 2023	cohort study · 1,102 participants	Oral capsules glucosamine hydrochloride 500 mg + chondroitin sulfate 400 mg; 3 capsules daily for 3 weeks, then 2
²⁰⁶ Deal et al. 1999	review · 227 participants	Glucosamine, chondroitin sulfate, sometimes combined; collagen hydrolysate mentioned; Glucosamine 1500 mg/day,
²¹² Nicholas et al. 2023	review	Glucosamine (form not specified); vs. Society recommendations versus other non-operative options

Glucosamine and Chondroitin and Back Pain: Human Studies

For chronic back pain, a systematic review found no difference in function with oral glucosamine and conflicting results for pain ⁸. In a subanalysis of a randomized controlled trial, Modic changes of the vertebral bodies and bright zones in the annulus fibrosus on MRI did not change differently with oral glucosamine sulfate than with placebo ¹⁰². A small placebo-controlled trial with a mixture of glucosamine HCl, chondroitin sulfate and manganese ascorbate could neither show nor rule out a benefit for degeneration of the lumbar spine ¹⁰⁹. In a non-randomized trial, pain decreased most markedly when injected chondroitin sulfate was added to standard therapy, followed by a mixture with glucosamine sulfate and type II collagen ¹²⁴. The strength of evidence is unclear because only a small placebo-controlled trial with glucosamine alone is available ¹⁰²; the forms and combinations tested differ greatly.

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
⁸ Sodha et al. 2013	systematic review · 309 participants	Oral glucosamine, preparation form not stated; vs. Placebo or control (three RCTs, n=309)
³⁸ Stuber et al. 2011	systematic review	Glucosamine, chondroitin sulfate and methylsulfonylmethane; vs. Placebo or no intervention
¹⁰² Wilkens et al. 2012	randomised controlled · 45 participants	oral glucosamine sulfate; 6-month intake, 6-18 months follow-up; vs. glucosamine (n=19) vs. placebo (n=26)
¹⁶¹ Shavlovskaya et al. 2025	cohort study · 120 participants	Chondroguard TRIO (CS+GS+UC-II), Artra/Teraflex (CS+GG), Dona (GS); September 2024 to May 2025; vs. Chond
¹⁷⁶ Samushila et al. 2006	case series · 6 participants	glucosamine sulfate and chondroitin sulfate; long-term use; vs. no control group

Glucosamine and Chondroitin: Further Outcomes in Studies

For temporomandibular joint complaints, the mouth opened wider with the combination of glucosamine and chondroitin sulfate than with tramadol in a small randomized trial ¹¹⁰. For temporomandibular joint osteoarthritis, glucosamine sulfate was not better than placebo ¹⁰⁰ and relieved pain similarly to or more than ibuprofen ⁹⁷¹⁰³. For the combination of glucosamine and chondroitin sulfate, a randomized controlled trial showed no difference in the need for rescue medication ⁶⁶. One randomized controlled trial with glucosamine sulfate reported an increase in intraocular pressure ⁸⁶, while another found no difference ¹⁰⁴. Overall, the evidence is high, but the results differ markedly by the form tested, dose and comparison group; most studies tested glucosamine sulfate or the combination with chondroitin sulfate.

STUDY	DESIGN · PARTICIPANTS	PREPARATION · DOSE · DURATION · COMPARISON
¹⁰ Lapaeva et al. 2023	systematic review · 186 participants	Dietary supplements: glucosamine, leucine, creatine, vitamins E and C, whey protein; vs. Placebo group or no supplement
¹¹ McAlindon et al. 2000	meta-analysis · 15 participants	Glucosamine or chondroitin preparations; at least 4 weeks; vs. Placebo, double-blind randomized; manufacturer-funded
¹² Calzada-Gonzales et al. 2026	systematic review · 7 participants	Oral glucosamine (unspecified preparation); 3 to 12 months; vs. Placebo or active control
¹³ Chen et al. 2026	meta-analysis	Glucosamine/chondroitin combination (CS+GH); vs. Celecoxib, probiotics, metformin, krill oil, placebo/control
¹⁹ Derwich et al. 2023	systematic review	oral glucosamine; longer administration, e.g. 3 months
²⁰ Vo et al. 2023	systematic review	Glucosamine with or without other formulations; vs. Glucosamine (pCGS) vs. other glucosamine formulations or conventio
²¹ Khan et al. 2022	systematic review	Glucosamine and chondroitin sulfate combined
²⁴ Shmagel et al. 2019	systematic review	Oral glucosamine sulfate or chondroitin sulfate supplements; vs. Varied designs, supplementation protocols and microbior

Further studies in this area: ⁴⁶ ⁵¹ ⁵⁶ ⁶⁶ ⁶⁷ ⁶⁹ ⁷³ ⁷⁵ ⁷⁸ ⁸¹ ⁸⁵ ⁸⁶ ⁸⁷ ⁸⁹ ⁹⁵ ⁹⁶ ⁹⁷ ⁹⁹ ¹⁰⁰ ¹⁰³ ¹⁰⁴ ¹⁰⁵ ¹⁰⁶ ¹⁰⁸ ¹¹⁰ ¹¹¹ ¹¹⁴ ¹²⁰ ¹²⁵ ¹²⁶ ¹³¹ ¹³² ¹³³ ¹³⁴ ¹³⁵ ¹³⁶ ¹³⁷ ¹³⁸ ¹³⁹ ¹⁴⁰ ¹⁴¹ ¹⁴² ¹⁴³ ¹⁴⁶ ¹⁴⁸ ¹⁵⁰ ¹⁵² ¹⁵³ ¹⁵⁷ ¹⁶³ ¹⁶⁴ ¹⁶⁵ ¹⁷⁰ ¹⁷¹ ¹⁷² ¹⁷³ ¹⁷⁴ ¹⁷⁵ ¹⁷⁸ ¹⁸¹ ¹⁸³ ¹⁸⁴ ¹⁸⁷ ¹⁸⁸ ¹⁹⁰ ¹⁹³ ¹⁹⁴ ¹⁹⁵ ¹⁹⁷ ¹⁹⁹ ²⁰⁰ ²⁰¹ ²⁰⁶ ²¹⁰ ²¹¹ ²¹⁴ ²¹⁷ ²²³ ²²⁴ ²²⁹ ²³¹ ²³² ²³⁸ ²³⁹ ²⁴² ²⁴⁶ ²⁴⁷ ²⁴⁸

4. How Is Glucosamine and Chondroitin Dosed? Preparation, Dose and Duration in Studies

The studies mainly used oral preparations in tablet, capsule, or powder form, alone or as a combination. Glucosamine sulfate ⁵⁷, glucosamine hydrochloride ⁶⁷, chondroitin sulfate ⁴⁹, and N-acetylglucosamine ⁹³ were tested, mostly for oral use; glucosamine sulfate was also injected intramuscularly in one study ⁶⁸. The combination of glucosamine and chondroitin sulfate was compared with placebo or celecoxib in several large randomized controlled trials ⁴³⁴⁵⁴⁷⁴⁸.

PREPARATION OR FORM	DOSE	DURATION	STUDY
glucosamine, chondroitin sulfate, combination, celecoxib, or placebo	1500 mg glucosamine daily, 1200 mg chondroitin sulfate daily, 200 mg celecoxib daily	24 weeks	⁴³
Glucosamine, chondroitin sulphate, combination, celecoxib or placebo	Glucosamine 500 mg three times daily, CS 400 mg three times daily, celecoxib 200 mg daily	24 months	⁴⁵
Chondroitin sulfate plus glucosamine hydrochloride	400 mg CS plus 500 mg GH three times daily	6 months	⁴⁷
glucosamine sulfate, chondroitin sulfate or combination capsules	glucosamine sulfate 1500 mg, chondroitin sulfate 800 mg, combination, once daily	2-year follow-up	⁴⁸
Pharmaceutical-grade chondroitin sulfate (CS)	800 mg/day	6 months (182 days)	⁴⁹

PREPARATION OR FORM	DOSE	DURATION	STUDY
Glucosamine, chondroitin sulfate, combination, celecoxib, or placebo	Glucosamine 500 mg 3 times daily, CS 400 mg 3 times daily, celecoxib 200 mg daily	24 months	50
oral crystalline glucosamine sulfate vs placebo	—	2.5-year intervention, 6.5-year follow-up	51
glucosamine sulphate, double-blind, placebo-controlled	—	2.5 years	52
oral crystalline glucosamine sulfate vs. placebo	1500 mg once daily	2.5 years	53
oral glucosamine sulfate, double-blind, placebo-controlled	—	2.5 years	54
glucosamine sulfate versus placebo	—	3 years	55
Chondroitin sulphate	1 g/day	24 weeks	56
Oral glucosamine sulfate versus placebo	500 mg three times daily	4 weeks	57
Oral glucosamine sulphate 1500 mg	1500 mg once daily	2 years	58
Oral glucosamine sulfate or placebo	1500 mg once daily	2 years	59

5. Is Glucosamine and Chondroitin Safe? Side Effects in Studies

In randomized controlled trials, glucosamine sulfate was similarly well tolerated as placebo ⁵⁷¹¹⁹¹²² and caused fewer adverse events than ibuprofen ⁶⁴⁶⁵⁹⁷. Gastrointestinal complaints were reported by more participants taking glucosamine sulfate than placebo in a small study on temporomandibular joint osteoarthritis ¹⁰⁰. One study found an increase in intraocular pressure with glucosamine, especially in older adults ⁸⁶, while another did not ¹⁰⁴.

STUDY	REPORTED SIDE EFFECTS
¹ Zeng et al. 2015	No difference in three major adverse effects; celecoxib more GI adverse effects vs placebo
² Yang et al. 2021	both had favourable safety profiles
³ Sumsuzzman et al. 2024	glucosamine plus omega-3 most favorable for adverse events
⁵ Towheed et al. 2005	glucosamine as safe as placebo (RR 0.97)
⁷ Wang et al. 2022	No significant difference in adverse reactions
¹² Calzada-Gonzales et al. 2026	Adverse and serious adverse events very uncertain
¹³ Chen et al. 2026	Safety rankings: probiotics and metformin most favorable
¹⁴ Park et al. 2025	Safety profile: risk ratios did not differ significantly between treatment and control groups
¹⁵ Baden et al. 2025	mostly minimal or no adverse effects
¹⁶ Migliore et al. 2025	combination could minimize systemic adverse effects
¹⁷ Rabade et al. 2024	CS and GS well tolerated, good safety profile
¹⁸ Vo et al. 2023	no serious drug interactions or significant adverse events reported

6. What Remains Open: Limits of the Evidence

- It remains open whether a specific preparation, dose, or treatment duration works reliably and which patient groups benefit from it.
- The results depend strongly on the form tested, since glucosamine sulfate, glucosamine hydrochloride, and chondroitin sulfate are not interchangeable.
- Many studies are small, short, and investigate different preparations, which limits generalizability.
- In hip osteoarthritis, controlled investigations are limited to a single preparation.
- N-acetylglucosamine has so far only been tested in healthy people with cartilage markers ⁹³¹¹⁷; studies in osteoarthritis are still pending.

7. Bottom Line: What Is Established About Glucosamine and Chondroitin

Glucosamine and chondroitin sulfate are natural building blocks of glycosaminoglycans and are taken as dietary supplements for joint complaints and osteoarthritis. Human studies show a mixed picture: in knee osteoarthritis and joint pain, several controlled studies found improvements in pain and function with oral glucosamine sulfate and chondroitin sulfate, while others saw no difference from placebo. For joint structure, there are indications of less loss of joint space, but here too the results are not uniform. In hip osteoarthritis, glucosamine sulfate was not better than placebo in a large study. Tolerability was mostly unremarkable, but the evidence for side effects is low. The form tested is decisive: glucosamine sulfate, glucosamine hydrochloride, and chondroitin sulfate are distinct preparations and are not interchangeable.

Frequently Asked Questions

How well has Glucosamine and Chondroitin been studied in humans?

We evaluated 302 human studies on Glucosamine and Chondroitin, including 107 randomised controlled trials and 46 meta-analyses or systematic reviews; the controlled studies include 18,153 participants in total. As of 15 October 2026.

Does Glucosamine and Chondroitin help with knee Osteoarthritis? What the studies show

We evaluated 23 meta-analyses or systematic reviews, 47 controlled studies and 60 further studies; the controlled studies include 8,334 participants in total. Result of the controlled studies: mixed. Strength of evidence under our published rules: high. Sources: ²⁶⁷⁹

Does Glucosamine and Chondroitin help with joint Pain? What the studies show

We evaluated 20 meta-analyses or systematic reviews, 24 controlled studies and 33 further studies; the controlled studies include 2,993 participants in total. Result of the controlled studies: mixed. Strength of evidence under our published rules: high. Sources: ¹⁴⁵⁷

Does Glucosamine and Chondroitin help with cartilage and Joint Structure? What the studies show

We evaluated 10 meta-analyses or systematic reviews, 21 controlled studies and 34 further studies; the controlled studies include 4,309 participants in total. Result of the controlled studies: mixed. Strength of evidence under our published rules: high. Sources: ¹⁴⁵¹⁷

Does Glucosamine and Chondroitin help with tolerability and Adverse Effects? What the studies show

We evaluated 5 controlled studies and 91 further studies; the controlled studies include 291 participants in total. Result of the controlled studies: mixed. Strength of evidence under our published rules: low. Sources: ¹²⁵⁷

Does Glucosamine and Chondroitin help with hand Osteoarthritis? What the studies show

We evaluated one controlled study and 2 further studies; the controlled studies include 108 participants in total. Result of the controlled studies: mostly improved. Strength of evidence under our published rules: low. Sources: ⁷⁸¹⁶⁰¹⁶²

Does Glucosamine and Chondroitin help with hip Osteoarthritis? What the studies show

We evaluated one meta-analysis or systematic review, one controlled study and 3 further studies; the controlled studies include 222 participants in total. Result of the controlled studies: mostly no difference. Strength of evidence under our published rules: unclear. Sources: ³⁶⁵⁹¹⁴⁸²⁰⁶

What is the difference between glucosamine sulfate and glucosamine hydrochloride?

Glucosamine sulfate and glucosamine hydrochloride are different salts of the amino sugar glucosamine. In studies, they showed different results, and they are not interchangeable. Most positive findings in knee osteoarthritis relate to glucosamine sulfate ¹⁸³⁴⁴²⁶¹¹¹⁹, while glucosamine hydrochloride alone ⁶⁷ or with chondroitin sulfate ⁸⁵ did not perform better than placebo.

Does the combination of glucosamine and chondroitin sulfate help better than the individual substances?

The study situation is mixed. In large randomized controlled trials, the combination was overall not better than placebo for pain ⁴³⁴⁵⁴⁸, and in another even weaker ⁶⁶. A meta-analysis, however, found the combination more effective than usual treatment ⁷. Results from combination arms cannot be attributed to the individual substance alone.

Which side effects are known?

Individual studies reported fewer adverse events with glucosamine sulfate compared with ibuprofen ⁶⁴⁹⁷. Gastrointestinal complaints were reported by more participants taking glucosamine sulfate than placebo in a small study on temporomandibular joint osteoarthritis ¹⁰⁰. One study found an increase in intraocular pressure with glucosamine, especially in older adults ⁸⁶, while another did not ¹⁰⁴.

Does glucosamine or chondroitin work in osteoarthritis of the hip joint?

In osteoarthritis of the hip joint, oral glucosamine sulfate was not better than placebo for WOMAC pain and function in a two-year randomized controlled trial ⁵⁸⁵⁹. A review on glucosamine and chondroitin also saw no clinically relevant benefit in knee and hip osteoarthritis ³⁶. The evidence is considered unclear because the controlled investigations are limited to a single preparation.

Can glucosamine or chondroitin protect cartilage?

In knee osteoarthritis, joint space narrowed less with oral glucosamine sulfate than with placebo in two randomized controlled trials over three years ⁶¹¹²². A review found this also for chondroitin ³², while a meta-analysis for glucosamine sulfate found only a small effect ²⁸. For the combination of glucosamine and chondroitin sulfate, the picture is inconsistent: one randomized controlled trial found less joint space narrowing after two years than with placebo ⁴⁸, two meta-analyses found no difference ⁴¹⁷. The results depend strongly on the form tested.

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