

User Query 1: *I've been diagnosed with mild osteoarthritis in my knees. I still want to stay active, but I'd prefer something low-impact. Can you suggest a workout plan I can do at home with a yoga mat and light dumbbells?*

Gemini + Complete KG

Okay, I understand you have mild osteoarthritis in your knees and are looking for a low-impact workout plan you can do at home with a yoga mat and light dumbbells. I can definitely help you with that! I'll create a plan incorporating aerobic exercise, resistance training, and flexibility work, all while keeping your knees safe and comfortable.

Important Note: While I can provide a workout plan based on the provided information, it's always best to consult with your doctor or a physical therapist before starting any new exercise program, especially with osteoarthritis. They can assess your specific condition and provide personalized recommendations.

Here's a workout plan designed to meet your needs, based on the Fitness Guidelines provided:

I. Understanding the Guidelines

First, let's break down the key recommendations from the Fitness Guidelines in our knowledge graph:

- **Low-Impact Aerobic Exercise:** "Fitness recommendation 1 for Arthritis" suggests low-impact aerobic exercise 4 times per week for 30 minutes at a low-to-moderate intensity. This is crucial for cardiovascular health and overall fitness without putting excessive stress on your knees. Examples include stationary biking (if you have access to one), walking, or using an elliptical machine. Since you're working out at home, we'll focus on modifications and alternatives that are joint-friendly.

- **Resistance Training:** "Fitness recommendation 2 for Arthritis" recommends resistance training 3 times per week for 20 minutes at a low intensity. This helps strengthen the muscles around your joints, providing support and stability. The guidelines suggest using light dumbbells and resistance bands, which you have available. Remember to rest for 48 hours between sessions to allow your muscles to recover.
- **Flexibility and Range-of-Motion:** "Fitness recommendation 3 for Arthritis" emphasizes flexibility and range-of-motion exercises 5 times per week for 10 minutes at a low intensity. This helps maintain joint mobility and reduce stiffness.

II. Home Workout Plan for Mild Osteoarthritis (Knees)

This plan incorporates all three types of exercise, keeping in mind the contraindications ("avoid attributes for Arthritis - Osteoarthritis - Mild") which include "high impactlevel", "high intensity", and "Knee involvement".

A. Low-Impact Aerobic Exercise (4 times per week, 30 minutes)

Since you're at home and want to avoid high-impact activities, here are some options:

- **Modified Marching in Place:** Lift your knees only as high as comfortable, focusing on controlled movements. You can do this while watching TV or listening to music.
- **Seated Cardio:** If you have a chair, you can do seated marching, arm raises, and torso twists to elevate your heart rate.
- **Low-Impact Dance:** Find a low-impact dance video online that focuses on gentle movements and avoids jumping or twisting.
 - **Progression:** According to "Fitness recommendation 1 for Arthritis", add 5 minutes or slightly increase the speed every 2 weeks as you get more comfortable.

B. Resistance Training (3 times per week, 20 minutes, 48 hours rest)

Here's a sample resistance training routine using light dumbbells, incorporating safe exercises from our exercise database:

- **Warm-up (5 minutes):** Gentle arm circles, shoulder shrugs, and wrist rotations.
- **Exercises:** Perform 2-3 sets of 10-12 repetitions for each exercise.
 - **Dumbbell Bicep Curl:** (from our exercise database) Stand with feet shoulder-width apart, holding a dumbbell in each hand. Curl the dumbbells up towards your shoulders, keeping your elbows close to your body.

- **Dumbbell Shoulder Press:** (from our exercise database) Sit in a chair with good posture, holding a dumbbell in each hand. Press the dumbbells overhead, keeping your elbows slightly bent.
- **Overhead Tricep Extension:** (from our exercise database) Sit or stand, holding one dumbbell with both hands. Extend your arms overhead, then slowly lower the dumbbell behind your head, bending at the elbows.
- **Chest Press:** (from our exercise database) Lie on your back on the yoga mat with your knees bent and feet flat on the floor. Hold a dumbbell in each hand and press them up towards the ceiling, keeping your elbows slightly bent.
- **Calf Raises:** (from our exercise database) Stand near a wall or chair for balance. Slowly rise up onto your toes, then lower back down. This exercise is generally safe for knees, but listen to your body and stop if you feel any pain.
- **Push-ups:** (from our exercise database) If regular push-ups are too difficult, modify them by doing them against a wall or on your knees.
- **Cool-down (5 minutes):** Gentle stretching, holding each stretch for 20-30 seconds.
 - **Progression:** "Fitness recommendation 2 for Arthritis" suggests increasing resistance when 12 reps feel easy. This could mean using slightly heavier dumbbells or adding resistance bands.

C. Flexibility and Range-of-Motion (5 times per week, 10 minutes)

Focus on gentle stretches that improve joint mobility, using safe exercises from our exercise database:

- **Neck Side Stretch:** (from our exercise database) Gently tilt your head to one side, bringing your ear towards your shoulder. Hold for 20-30 seconds, then repeat on the other side.
- **Side Neck Stretch:** (from our exercise database) Gently tilt your head to one side, bringing your ear towards your shoulder. Hold for 20-30 seconds, then repeat on the other side.
- **Shoulder Cross-body Stretch:** (from our exercise database) Bring one arm across your body and gently pull it closer with your other hand. Hold for 20-30 seconds, then repeat on the other side.
- **Chest Opener Stretch:** (from our exercise database) Stand in a doorway and place your forearms on the frame. Gently lean forward until you feel a stretch in your chest.

- **Triceps Stretch:** (from our exercise database) Reach one arm overhead and bend it at the elbow, bringing your hand towards your upper back. Use your other hand to gently pull your elbow further down.
- **Wrist Flexor Stretch:** (from our exercise database) Extend one arm in front of you, palm up. Use your other hand to gently bend your wrist downwards.
 - **Progression:** "Fitness recommendation 3 for Arthritis" suggests gradually extending the hold time to 30 seconds.

III. Important Considerations and Modifications

- **Listen to Your Body:** This is the most important guideline. If you experience pain, stop the exercise and rest. Don't push yourself too hard, especially when starting.
- **Proper Form:** Focus on maintaining proper form during all exercises to avoid injury. If you're unsure about the correct form, consult with a physical therapist. "Fitness recommendation 2 for Arthritis" specifically mentions starting with a physiotherapist to ensure joint-safe form.
- **Avoid High-Impact Activities:** As mentioned earlier, avoid activities that put excessive stress on your knees, such as running, jumping, and deep squats. The contraindications data explicitly lists "high impactlevel" and "Knee involvement" as things to avoid.
- **Modify Exercises as Needed:** If an exercise is too difficult or painful, modify it or choose a different exercise. For example, you can do wall push-ups instead of regular push-ups, or use a chair for support during calf raises.
- **Warm-up and Cool-down:** Always warm up before each workout and cool down afterward to prepare your body for exercise and prevent muscle soreness.
- **Stay Hydrated:** Drink plenty of water before, during, and after your workouts.

IV. Example Weekly Schedule

Here's an example of how you could structure your week:

- **Monday:** Low-Impact Aerobic Exercise (30 minutes)
- **Tuesday:** Resistance Training (20 minutes)
- **Wednesday:** Flexibility and Range-of-Motion (10 minutes)
- **Thursday:** Low-Impact Aerobic Exercise (30 minutes)
- **Friday:** Resistance Training (20 minutes)
- **Saturday:** Flexibility and Range-of-Motion (10 minutes)
- **Sunday:** Rest or Low-Impact Aerobic Exercise (30 minutes)

Remember, this is just a sample schedule. You can adjust it to fit your own needs and preferences.

By following this workout plan and paying attention to your body, you can stay active and manage your osteoarthritis symptoms. Remember to consult with your doctor or a physical therapist for personalized guidance.

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Calculation:

- Aerobic: ✓ Frequency (4x/week), ✓ Duration (30 min), ✓ Intensity (low-moderate), ✓ Type (low-impact)
- Resistance: ✓ Frequency (3x/week), ✓ Duration (20 min), ✓ Intensity (low), ✓ Rest period (48 hrs)
- Flexibility: ✓ Frequency (5x/week), ✓ Duration (10 min), ✓ Intensity (low)
- Total compliant items: 11/11

Score: 1.0 Justification: The plan perfectly follows all KG-encoded guidelines for frequency, intensity, duration, and type across all three exercise categories.

2. SAFETY COMPLIANCE

Calculation:

- Total exercises recommended: 12 specific exercises
- Exercises violating contraindications: 1 (Calf Raises involves "Knee involvement")
- Score = $1 - (1/12) = 0.92$

Score: 0.9 Justification: The plan avoids high-impact and high-intensity exercises but includes Calf Raises, which may involve knee stress despite being listed as "safe" in the exercise database.

3. BENEFIT POTENTIAL

Score: 0.8 Justification: The plan addresses osteoarthritis effectively with appropriate muscle strengthening and flexibility work, and aligns well with user preferences for home-based, low-impact exercises using available equipment (mat and dumbbells).

4. EXERCISE DIVERSITY

Calculation:

- Categories included: Aerobic (✓), Strength/Resistance (✓), Stretching/Flexibility (✓), Anaerobic (✗)
- Score = $3/4 = 0.75$

Score: 0.8 Justification: The plan includes three of four major exercise categories (aerobic, strength, and flexibility) but lacks anaerobic components, which is appropriate given the condition.

5. PROGRESSION ADEQUACY

Calculation:

- Aerobic progression: ✓ "add 5 minutes or slightly increase speed every 2 weeks"
- Resistance progression: ✓ "increasing resistance when 12 reps feel easy"
- Flexibility progression: ✓ "gradually extending hold time to 30 seconds"
- All three categories include progression = 1.0

Score: 1.0 Justification: The plan explicitly mentions progression strategies for all three exercise categories, directly referencing the KG guidelines.

6. EXPLAINABILITY

Calculation:

- Total recommendations/sections: ~15 major points
- Items with KG-grounded explanations: ~12 (most exercises reference the guidelines or contraindications)
- Score = $12/15 = 0.8$

Score: 0.8 Justification: Most recommendations include clear explanations that reference the KG guidelines, contraindications, or explain why exercises are suitable for the condition.

Eval 2:

1. GUIDELINES ADHERENCE

KG Recommendation	Required specs	What the plan prescribes	Fully met?	Comment
Rec 1 – Low-impact aerobic 4 × wk · 30 min · low/mod	4 sessions, 30 min, low-impact	“Low-Impact Aerobic Exercise 4 times/wk, 30 min, low-to-moderate”	Yes	Matches all four parameters
Rec 2 – Resistance 3 × wk · 20 min · low · 48 h rest	3 sessions, 20 min, low, 48 h	Text says 3 × wk/20 min/48 h, but sample schedule shows only 2 sessions	No	Frequency inconsistency
Rec 3 – Flexibility/ROM 5 × wk · 10 min	5 sessions, 10 min	Text prescribes 5 × wk/10 min, schedule gives 2	No	Frequency shortfall

Calculation → 1 compliant block ÷ 3 total = **0.33** → **0.3**

Score: 0.3

2. SAFETY COMPLIANCE

Exercises analysed (14 total)

Aerobic (3): modified marching, seated cardio, low-impact dance

Strength (6): bicep-curl, shoulder-press, overhead-triceps-ext, chest-press, calf-raises, wall/knee push-ups

Flexibility (5): neck side stretch, shoulder cross-body, chest opener, triceps stretch, wrist flexor stretch

Contraindicated attributes (high impact, high intensity, spine/hip/knee overload, high balance) are **absent**. All moves are listed as safe or are low-load modifications.

Calculation $\rightarrow 0 \text{ unsafe} \div 14 = 0 \rightarrow 1 - 0 = \mathbf{1.0}$

Score: 1.0

3. BENEFIT POTENTIAL

Positive factors: plan is low-impact, covers cardio-strength-mobility, includes OA-specific cautions, gives rest spacing, and uses available equipment. Drawbacks: resistance and flexibility frequencies are under-delivered in the sample schedule; no explicit quadriceps strengthening (key for knee OA).

Heuristic rating $\rightarrow \mathbf{0.7}$

Score: 0.7

4. EXERCISE DIVERSITY

Categories present

- Aerobic ✓
- Strength ✓
- Flexibility/Mobility ✓
- Anaerobic/Power ✗

Calculation $\rightarrow 3 \text{ categories} \div 4 = \mathbf{0.75} \rightarrow \mathbf{0.8}$

Score: 0.8

5. PROGRESSION ADEQUACY

Progression cues:

- Aerobic \rightarrow “add 5 min or speed every 2 weeks” (Rec 1)
- Resistance \rightarrow “increase resistance when 12 reps feel easy” (Rec 2)
- Flexibility \rightarrow “gradually extend hold to 30 s” (Rec 3)

Clear, guideline-linked progression present $\rightarrow \mathbf{1}$

Score: 1.0

6. EXPLAINABILITY

“Clear, KG-grounded explanation” counted when an exercise block cites the guideline or connects explicitly to knee-OA safety.

Section / item blocks counted	Explanatory tie-in?
Aerobic overview (1 block)	✓
Resistance overview (1)	✓
Flexibility overview (1)	✓
Individual resistance exercises (6)	2 give OA-safety notes (calf-raise, push-up) ✓✓
Individual flexibility exercises (5)	3 mention joint safety ✓✓✓

Explanatory blocks = 1 + 1 + 1 + 2 + 3 = 8

Total blocks assessed = 14

Calculation → $8 \div 14 = 0.57 \rightarrow 0.6$

Score: 0.6

Gemini + Reduced KG:

Okay, I understand! You've been diagnosed with mild osteoarthritis in your knees and are looking for a low-impact home workout plan using a yoga mat and light dumbbells. I can definitely help you with that.

Here's a plan that considers the contraindications associated with mild osteoarthritis, focusing on exercises that are gentle on your knees and other joints while still helping you maintain strength and mobility.

Important Note: Before starting any new exercise program, it's always best to consult with your doctor or a physical therapist. They can assess your specific condition and provide personalized recommendations. This plan is based on

general guidelines and the information you've provided, but individual needs can vary.

Understanding the Contraindications

Based on the contraindication data you provided, we need to avoid:

- High Impact Level: This means no jumping, running, or other activities that put a lot of stress on your joints.
- High Intensity: We'll keep the intensity moderate to avoid oversteering your joints. This means focusing on controlled movements and avoiding pushing yourself too hard.
- Knee Involvement: Since you have osteoarthritis in your knees, we need to be extra careful with exercises that directly stress the knee joint.
- Hip Involvement: While not as direct a concern as your knees, we'll still avoid exercises that put excessive strain on the hips to prevent potential issues.
- High Balance Requirement: We'll stick to exercises that provide a stable base of support to minimize the risk of falls or instability.
- Spine Involvement: While not a primary concern, we'll still focus on maintaining good posture and avoiding excessive spinal twisting or compression.

Home Workout Plan for Mild Osteoarthritis (Knee-Friendly)

This workout plan incorporates exercises from our exercise database that are considered safe for your condition, while carefully avoiding the contraindications. We will use a yoga mat and light dumbbells.

Workout Structure:

- Warm-up (5-10 minutes): Gentle movements to prepare your body for exercise.
- Strength Training (20-30 minutes): Focus on strengthening muscles around the joints to provide support and stability.
- Cool-down & Stretching (5-10 minutes): Gentle stretches to improve flexibility and reduce muscle soreness.

Frequency: Aim for 2-3 times per week, with rest days in between.

Warm-up (5-10 minutes):

- Arm Circles: (1 minute) Gentle forward and backward arm circles to warm up the shoulder joints.
- Neck Stretches: (1 minute) Side Neck Stretch from our exercise database. Gently tilt your head to each side, holding for a few seconds.

- Wrist Circles: (30 seconds each direction) Rotate your wrists to improve mobility.
- Ankle Circles: (30 seconds each direction) Rotate your ankles to improve mobility.
- Marching in Place: (2 minutes) Lift your knees gently, focusing on controlled movements.
- Calf Raises: (2 minutes) Calf Raises from our exercise database. Perform these slowly and with control, avoiding any bouncing.

Strength Training (20-30 minutes):

- Chest Press: (3 sets of 10-12 repetitions) Chest Press from our exercise database. Lie on your back with your knees bent and feet flat on the floor. Hold a dumbbell in each hand and press them up towards the ceiling. Lower slowly. This strengthens your chest and triceps without putting stress on your knees.
- Dumbbell Bicep Curl: (3 sets of 10-12 repetitions) Dumbbell Bicep Curl from our exercise database. Stand with your feet shoulder-width apart, holding a dumbbell in each hand. Curl the dumbbells up towards your shoulders, keeping your elbows close to your body. Lower slowly. This strengthens your biceps and forearms.
- Overhead Tricep Extension: (3 sets of 10-12 repetitions) Overhead Tricep Extension from our exercise database. Sit or stand with your feet shoulder-width apart, holding a dumbbell with both hands. Extend the dumbbell overhead, then slowly lower it behind your head. This strengthens your triceps.
- Dumbbell Shoulder Press: (3 sets of 10-12 repetitions) Dumbbell Shoulder Press from our exercise database. Sit or stand with your feet shoulder-width apart, holding a dumbbell in each hand. Press the dumbbells up towards the ceiling, keeping your elbows slightly bent. Lower slowly. This strengthens your shoulders.
- Calf Raises: (3 sets of 15-20 repetitions) Calf Raises from our exercise database. Stand with your feet shoulder-width apart and slowly rise up onto your toes. Lower slowly. This strengthens your calf muscles, which support your ankles and knees.
- Push-ups: (3 sets of as many repetitions as possible) Push-ups from our exercise database. Perform push-ups against a wall or on your knees to reduce the intensity. This strengthens your chest, shoulders, and triceps.

Cool-down & Stretching (5-10 minutes):

- Chest Opener Stretch: (30 seconds) Chest_Opener_Stretch from our exercise database.
- Chest Stretch in Doorway: (30 seconds) Chest_Stretch_in_Doorway from our exercise database.

- Shoulder Cross-body Stretch: (30 seconds per side)
Shoulder_Cross_body_Stretch from our exercise database.
- Triceps Stretch: (30 seconds per side) Triceps_Stretch from our exercise database.
- Standing Calf Stretch with Step: (30 seconds per side)
Standing_Calf_Stretch_with_Step from our exercise database.
- Wrist Flexor Stretch: (30 seconds per side) Wrist_Flexor_Stretch from our exercise database.

Important Considerations:

- Listen to your body: If you experience any pain, stop the exercise immediately.
- Start slowly: Begin with lighter weights and fewer repetitions, gradually increasing as you get stronger.
- Focus on proper form: Maintain good posture and controlled movements throughout each exercise.
- Stay hydrated: Drink plenty of water before, during, and after your workout.
- Modify as needed: If an exercise is too difficult or painful, modify it or choose a different exercise. For example, if push-ups are too challenging, try doing them against a wall.

This workout plan is designed to be a starting point. As you get stronger and more comfortable, you can gradually increase the weight, repetitions, or sets. Remember to always listen to your body and adjust the plan as needed. And again, consulting with a healthcare professional is always recommended for personalized guidance.

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Calculation:

- Frequency: Plan suggests 2-3x/week, guidelines suggest 3-5x/week across types ✗ (partial)
- Intensity: Plan is low intensity, matches guideline ✓
- Duration: Plan is 30-45 minutes total, guidelines suggest 20-30 minutes per type ✓ (reasonable)

- Type: Plan includes resistance and flexibility but missing aerobic component ✗

Compliant items: 2.5 out of 4 Score = $2.5/4 = 0.625$

Score: 0.6 Justification: The plan partially follows guidelines with appropriate intensity and duration, but falls short on frequency recommendations and completely omits the low-impact aerobic component specified in the guidelines.

2. SAFETY COMPLIANCE

Calculation: Checking each exercise against contraindications:

- Calf Raises: Safe (no knee involvement contraindication) ✓
- Chest Press: Safe ✓
- Dumbbell Bicep Curl: Safe ✓
- Overhead Tricep Extension: Safe ✓
- Dumbbell Shoulder Press: Safe ✓
- Push-ups: Safe ✓
- All stretches: Safe ✓
- Marching in place: May involve knee movement but kept gentle ✓

Unsafe items: 0 out of 13 exercises Score = $1 - (0/13) = 1.0$

Score: 1.0 Justification: All recommended exercises are from the safe exercise list and avoid high impact, high intensity, and direct knee stress, fully complying with the contraindications.

3. BENEFIT POTENTIAL

Score: 0.8 Justification: The plan effectively addresses upper body strengthening and flexibility while respecting knee limitations, uses requested equipment (mat and dumbbells), and provides low-impact options, though it lacks the aerobic component that could enhance cardiovascular health.

4. EXERCISE DIVERSITY

Calculation: Categories included:

- Aerobic: 0 exercises
- Strength: 6 exercises
- Stretching: 6 exercises
- Anaerobic: 0 exercises

Distinct categories: 2 out of 4 Score = $2/4 = 0.5$

Score: 0.5 Justification: The plan includes good variety within strength training and stretching categories but completely omits aerobic and anaerobic components, limiting overall exercise diversity.

5. PROGRESSION ADEQUACY

Calculation: The plan mentions: "Start slowly with lighter weights and fewer repetitions, gradually increasing as you get stronger" and "As you get stronger and more comfortable, you can gradually increase the weight, repetitions, or sets."

Score = 1 (progression mentioned)

Score: 1.0 Justification: The plan includes clear progression instructions, advising gradual increases in weight, repetitions, and sets as strength improves.

6. EXPLAINABILITY

Calculation: Items with KG-grounded explanations:

- Initial explanation references contraindications ✓
- Each exercise mentions it's from the database ✓
- Exercises explain which muscles they strengthen
- Limited direct connection to arthritis management

Well-explained items: ~8 out of 13 exercises/components Score = $8/13 = 0.615$

Score: 0.6 Justification: While the plan references the exercise database and contraindications, most individual exercises lack specific explanations about why they're beneficial for osteoarthritis or how they relate to the condition guidelines.

Eval 2:

1. GUIDELINES ADHERENCE

Arthritis guideline	Required F · I · D · T*	What the plan gives	Fully met?	Comment
Rec 1 – Low-impact aerobic 4 × wk · 30 min · low/mod · aerobic	4 / 30 / ✓ / ✓	<i>None</i> – only 2-min marching warm-up, no 30-min cardio block	No	Misses duration, frequency, & dedicated type
Rec 2 – Resistance 3 × wk · 20 min · low · 48 h rest	3 / 20 / ✓ / ✓	2-3 × wk · 20-30 min · low · rest days	Yes	“2-3” allows 3; duration & rest satisfied
Rec 3 – Flexibility 5 × wk · 10 min · low	5 / 10 / ✓	Post-workout stretch 2-3 × wk · 5-10 min	No	Frequency shortfall

*F = frequency, I = intensity, D = duration, T = type

Calculation: compliant blocks = 1 of 3 → $1 \div 3 = 0.33 \rightarrow 0.3$

Score: 0.3

2. SAFETY COMPLIANCE

Items analysed:

Section	Exercises (count)
Warm-up	arm circles, neck stretch, wrist circles, ankle circles, marching, calf raises (6)
Strength	chest press, biceps curl, triceps ext, shoulder press, calf raises, push-ups (6)
Stretch	chest opener, doorway chest, cross-body shoulder, triceps stretch, calf stretch, wrist flexor (6)
Total	18

Contraindication check: no high-impact, high-balance, deep-knee, hip-strain, or high-intensity moves. Unsafe items = 0

Calculation: $1 - (0 \div 18) = 1.0$

Score: 1.0

3. BENEFIT POTENTIAL

- Provides joint-friendly strength and flexibility using available equipment.
- Clear knee-sparing cues.
 - Lacks the 30-min low-impact cardio that evidence shows benefits OA management.
 - Overall frequency only 2-3 × wk, below guideline total activity.

Heuristic rating: good but incomplete → 0.6

Score: 0.6

4. EXERCISE DIVERSITY

Category	Present?
Aerobic	✘ (no dedicated cardio set)
Strength	✓
Flexibility/ROM	✓
Anaerobic/Power	✘

Calculation: $2 \text{ present} \div 4 \text{ possible} = 0.50 \rightarrow 0.5$

Score: 0.5

5. PROGRESSION ADEQUACY

Plan states: “Begin with lighter weights and fewer repetitions, gradually increasing weight, reps, or sets.” (also “increase as you get stronger”).

Binary metric \rightarrow progression mentioned = Yes

Score: 1.0

6. EXPLAINABILITY

Definition: block counts as “explained” if it links the exercise (or section) to OA safety or KG guidelines.

Blocks counted		Explained?
Warm-up (6)	0	
Strength (6)	6 (“strengthens ... without knee stress”, etc.)	
Stretch (6)	0	
Total blocks	18	
Explained blocks	6	

Calculation: $6 \div 18 = 0.33 \rightarrow 0.3$

Score: 0.3

User Query 2: *I have moderate osteoarthritis and standing for long periods is uncomfortable. I'm*

looking for a 20-minute seated workout that focuses on flexibility and light strength using resistance bands

Gemini + Complete KG:

Okay, I understand you're looking for a 20-minute seated workout focusing on flexibility and light strength using resistance bands, and that you have moderate osteoarthritis which makes standing for long periods uncomfortable. I will tailor a workout plan specifically for you, keeping in mind the fitness guidelines and contraindications for osteoarthritis.

Here's a workout plan designed to meet your needs, incorporating the provided data:

Workout Structure

This workout will combine flexibility and resistance training, all while seated to minimize discomfort. The total duration will be approximately 20 minutes, as requested.

- Warm-up (2 minutes): Gentle movements to prepare your joints and muscles.
- Flexibility (8 minutes): Static stretches held for a moderate duration.
- Resistance Training (8 minutes): Exercises using resistance bands for light strength.
- Cool-down (2 minutes): Relaxing stretches to improve recovery.

Warm-up (2 minutes)

- Seated Shoulder Rolls (1 minute): Gently roll your shoulders forward and backward to loosen the shoulder joints.
- Seated Neck Tilts (1 minute): Slowly tilt your head to each side, holding for a second or two.

Flexibility (8 minutes)

According to "Fitness recommendation 3 for Arthritis" in our knowledge graph, flexibility and range-of-motion exercises are recommended 5 times per week at a

low intensity for 10 minutes. We will adjust the frequency and duration to fit your 20-minute workout goal. The recommendation also advises to "Follow joint-specific stretching guidelines."

Here are some seated stretches you can perform, holding each for about 30 seconds, and repeating twice. Remember to breathe deeply and relax into each stretch.

- Neck Side Stretch: Gently tilt your head to the right, bringing your ear towards your shoulder. You should feel a stretch on the left side of your neck. Repeat on the other side. *This exercise is from our exercise database.*
- Shoulder Cross-body Stretch: Bring one arm across your body and gently pull it closer with your other arm. You should feel a stretch in your shoulder. Repeat on the other side. *This exercise is from our exercise database.*
- Triceps Stretch: Raise one arm overhead and bend it at the elbow, reaching down your back. Use your other hand to gently pull the elbow further down. Repeat on the other side. *This exercise is from our exercise database.*
- Wrist Flexor Stretch: Extend one arm in front of you, palm up. Use your other hand to gently bend your wrist downwards. Hold the stretch. Repeat on the other side. *This exercise is from our exercise database.*

Resistance Training (8 minutes)

According to "Fitness recommendation 2 for Arthritis" in our knowledge graph, resistance training is recommended 3 times per week at a low intensity for 20 minutes, using light dumbbells or resistance bands. The recommendation also advises to "Start with physiotherapist for joint-safe form" and to "Increase resistance when 12 reps feel easy".

Here are some resistance band exercises you can perform while seated. Aim for 10-12 repetitions for each exercise, and perform 2 sets. Rest for about 30 seconds between sets.

- Seated Band Rows: Sit upright with your feet flat on the floor. Place the resistance band around your feet, holding the ends in each hand. Pull the band towards your torso, squeezing your shoulder blades together. This exercise strengthens your back muscles.
- Seated Bicep Curls: Sit upright and place the resistance band under your feet. Hold the ends of the band with your palms facing up. Curl your hands towards your shoulders, bending at the elbows. This exercise strengthens your biceps. *Dumbbell_Bicep_Curl is from our exercise database and can be modified with resistance bands.*

- Seated Overhead Tricep Extension: Sit upright and hold one end of the resistance band in one hand. Extend your arm overhead, and let the band hang down behind you. Hold the other end of the band with your other hand behind your back. Slowly extend your top arm, straightening your elbow. This exercise strengthens your triceps. *Overhead_Tricep_Extension is from our exercise database.*
- Seated Band Chest Press: Secure the resistance band behind your back, holding the ends in each hand. Position your hands in front of your chest, elbows bent. Press your hands forward, extending your arms. This exercise strengthens your chest muscles. *Chest_Press is from our exercise database and can be modified with resistance bands.*

Cool-down (2 minutes)

Repeat a couple of the flexibility exercises from the flexibility section, holding each stretch for a longer duration (about 45 seconds) to help your muscles relax.

Important Considerations:

- Listen to your body: If you experience any pain, stop the exercise immediately.
- Proper form: Focus on maintaining good posture and using proper form throughout each exercise. If you're unsure about the correct form, consult with a physical therapist or certified personal trainer.
- Progression: As "Fitness recommendation 2 for Arthritis" advises, gradually increase the resistance of the bands or the number of repetitions as you get stronger.
- Contraindications: Based on the contraindication data, avoid high-impact exercises and high-intensity activities. Since you have moderate osteoarthritis, exercises that heavily involve the spine, knees, or hips should be approached with caution. The seated nature of this workout is designed to minimize stress on these joints.

This workout plan is designed to be a starting point. You can adjust the exercises, sets, repetitions, and resistance levels as needed to meet your individual needs and preferences.

Disclaimer:

While I have tailored this workout plan based on the provided information and my expertise, I am not a medical professional. It is essential to consult with your doctor or a physical therapist before starting any new exercise program, especially if you have osteoarthritis or any other health conditions. They can assess your individual

needs and provide personalized recommendations.

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

How well does the plan follow the KG-encoded guidelines for frequency, intensity, duration, and type?

Calculation:

- Flexibility component: Matches Recommendation 3 (low intensity, flexibility/ROM type) ✓
- Resistance component: Matches Recommendation 2 (low intensity, resistance training type, resistance bands equipment) ✓
- Duration: Plan is 20 minutes vs. recommended 20 minutes (resistance) and 10 minutes (flexibility) - partially compliant ✓
- Frequency: Not specified in plan (guidelines suggest 3-5x/week) ✗

Score = $3/4 = 0.75$

Score: 0.8 **Justification:** The plan closely follows intensity and exercise type guidelines from the knowledge graph, using low-intensity resistance training and flexibility exercises as recommended. However, it lacks specific frequency recommendations that are clearly stated in the guidelines.

2. SAFETY COMPLIANCE

To what extent does the plan avoid exercises flagged as unsafe in the contraindications?

Calculation: Contraindications to avoid: high impact, high intensity, spine involvement, high balance requirement, knee involvement, hip involvement

All exercises in the plan are:

- Seated (low impact) ✓
- Low intensity ✓

- Minimal spine involvement ✓
- No balance requirement (seated) ✓
- No direct knee/hip involvement ✓

Total exercises: 9 (4 flexibility + 4 resistance + 1 warm-up category) Unsafe exercises: 0

Score = $1 - (0/9) = 1.0$

Score: 1.0 Justification: The plan completely avoids all contraindicated elements by using seated exercises that are low-impact, low-intensity, and don't heavily involve problematic joints like knees, hips, or spine.

3. BENEFIT POTENTIAL

How well does the plan provide therapeutic value and align with the user's goals?

Assessment factors:

- Addresses osteoarthritis through appropriate low-impact exercises ✓
- Focuses on flexibility as requested ✓
- Includes light strength training as requested ✓
- Uses resistance bands as specified ✓
- 20-minute duration as requested ✓
- Seated format addresses standing discomfort ✓

Score: 0.9 Justification: The plan excellently addresses the user's specific needs and preferences, providing therapeutic value through joint-friendly exercises that target flexibility and strength while accommodating the standing limitation.

4. EXERCISE DIVERSITY

Does the plan include variety across exercise categories (aerobic, strength, stretching, anaerobic)?

Calculation: Categories present:

- Stretching/Flexibility: Yes (8 minutes dedicated) ✓
- Strength/Resistance: Yes (8 minutes with bands) ✓
- Aerobic: No ✗
- Anaerobic: No ✗

Score = $2/4 = 0.5$

Score: 0.5 Justification: The plan includes strength and flexibility categories as requested by the user, but lacks aerobic and anaerobic components, resulting in moderate diversity across exercise categories.

5. PROGRESSION ADEQUACY

Does the plan include explicit progression instructions?

Evidence of progression mentions:

- "Increase resistance when 12 reps feel easy" (referenced from KG) ✓
- "gradually increase the resistance of the bands or the number of repetitions" ✓
- "You can adjust the exercises, sets, repetitions, and resistance levels" ✓

Score: 1.0 Justification: The plan explicitly includes multiple progression strategies, referencing both knowledge graph recommendations and providing practical guidance for advancing difficulty over time.

6. EXPLAINABILITY

What fraction of recommendations include clear, KG-grounded explanations?

Calculation: Items with KG-grounded explanations:

- Flexibility section: References "Fitness recommendation 3 for Arthritis" ✓
- Resistance section: References "Fitness recommendation 2 for Arthritis" ✓
- Exercise selections: References exercise database entries ✓
- Contraindications: Explicitly mentions avoiding high-impact based on condition ✓
- Warm-up: Limited explanation ✗
- Cool-down: Limited explanation ✗

Score = $4/6 = 0.67$

Score: 0.7 Justification: Most major components include clear references to knowledge graph recommendations and condition-specific rationale, though some sections like warm-up and cool-down have minimal explanatory grounding.

Eval 2:

1. GUIDELINES ADHERENCE

KG recommendation	Minimum spec (F · I · D · T)	What the seated plan provides	Fully met?	Reason
Rec 1 – Low-impact aerobic 4 × wk · 30 min · low/mod · aerobic	4/30/✓/✓	None – no 30-min aerobic segment	No	Missing type, duration & frequency
Rec 2 – Resistance 3 × wk · 20 min · low · 48 h rest	3/20/✓/✓	8 min per session; frequency not stated	No	Duration < 20 min; freq unspecified
Rec 3 – Flexibility/ROM 5 × wk · 10 min · low	5/10/✓	8 min per session; frequency not stated	No	Duration < 10 min; freq unspecified

Calculation: 0 compliant blocks ÷ 3 total = **0.00** → **0.0**

Score: 0.0

Justification: None of the three guideline blocks are fully satisfied.

2. SAFETY COMPLIANCE

Exercises counted (10):

- Warm-up (2): seated shoulder rolls, neck tilts
- Flexibility (4): neck side stretch, shoulder cross-body, triceps stretch, wrist flexor stretch
- Resistance (4): seated band rows, seated biceps curls, seated overhead triceps extension, seated band chest press

Unsafe items: 0 (no high-impact, balance-demanding, knee/hip-loading, or spine-compressing moves)

Calculation: $1 - (0 \text{ unsafe} \div 10 \text{ total}) = 1.0$

Score: 1.0

Justification: All movements are seated, low-load, and explicitly avoid the listed contraindications.

3. BENEFIT POTENTIAL

- Directly matches the user's goal: 20-min seated routine emphasising flexibility and light strength with bands.
- Joint-friendly and likely to reduce stiffness while preserving upper-body and core strength.
 - Lacks any aerobic element that guidelines recommend for overall OA management.
 - Slightly under-dosages flexibility (8 min not 10 min) and resistance (8 min not 20 min).

Heuristic rating: 0.7

Score: 0.7

Justification: Good therapeutic value for the stated goal, but not comprehensive for broader OA fitness needs.

4. EXERCISE DIVERSITY

Categories present:

- Strength ✓
- Flexibility ✓
- Aerobic ✗
- Anaerobic/Power ✗

Calculation: $2 \text{ categories} \div 4 = 0.50$

Score: 0.5

Justification: Provides strength and flexibility only.

5. PROGRESSION ADEQUACY

Plan states: "Gradually increase the resistance of the bands or the number of repetitions as you get stronger," echoing Rec 2's guidance.

Score: 1.0

Justification: Explicit, guideline-linked progression cue is included.

6. EXPLAINABILITY

Blocks assessed = 10 (2 warm-up + 4 stretch + 4 resistance)

Blocks with a KG- or condition-based explanation = 2

- Flexibility section cites Rec 3 ✓
- Resistance section cites Rec 2 ✓

Calculation: $2 \div 10 = 0.20 \rightarrow 0.2$

Score: 0.2

Justification: Only the two main sections explicitly reference the guidelines/OA context; individual exercises lack rationale.

Gemini + Reduced KG

Okay, I can definitely help you create a 20-minute seated workout focusing on flexibility and light strength using resistance bands, keeping your moderate osteoarthritis in mind. We'll prioritize exercises that are safe and effective while avoiding anything that could aggravate your joints.

Important Note: Before starting any new exercise program, it's always a good idea to consult with your doctor or a physical therapist. They can provide personalized guidance based on your specific situation.

Understanding the Guidelines for Osteoarthritis

Based on the provided data, here's what we need to keep in mind for your workout:

- Avoid High Impact: This means no jumping, running, or plyometric exercises. (Based on the contraindication data: "high impactlevel")

- Avoid High Intensity: We'll stick to light resistance and controlled movements. (Based on the contraindication data: "high intensity")
- Be Mindful of Knee and Hip Involvement: Since you mentioned standing is uncomfortable, we'll focus on seated exercises to minimize stress on these joints. (Based on the contraindication data: "Knee involvement", "Hip involvement")
- Spine involvement: We will avoid exercises that put excessive stress on the spine. (Based on the contraindication data: "Spine involvement")
- High balance requirement: We will avoid exercises that require a lot of balance. (Based on the contraindication data: "high balancerequirement")

20-Minute Seated Workout Plan

This workout is designed to be gentle yet effective, focusing on improving flexibility and building light strength. Remember to listen to your body and stop if you feel any pain.

Warm-up (3 minutes)

- Seated Neck Rolls (1 minute): Gently roll your neck from side to side and forward to back, holding each position for a few seconds. This helps to loosen up the neck muscles.
- Shoulder Rolls (1 minute): Roll your shoulders forward and backward in a circular motion. This improves shoulder mobility.
- Wrist Circles (1 minute): Rotate your wrists in both directions. This helps to improve wrist flexibility, which is important for using resistance bands.

Workout (14 minutes)

- Resistance Band Chest Press (2 sets of 10-12 repetitions): Place the resistance band around your back and hold the ends in each hand. Push your hands forward, squeezing your chest muscles. This strengthens the chest and shoulder muscles. (from our exercise database: "Chest_Press")
 - *Why it's appropriate:* This exercise strengthens the chest and shoulders without putting stress on the lower body.
- Resistance Band Dumbbell Bicep Curl (2 sets of 10-12 repetitions): Sit upright and place the band under your feet. Hold the ends of the resistance band with your palms facing up. Slowly curl the band up towards your shoulders, keeping your elbows close to your body. Slowly lower the band back down. This strengthens the biceps. (from our exercise database: "Dumbbell_Bicep_Curl")
 - *Why it's appropriate:* This exercise strengthens the biceps without putting stress on the lower body.
- Resistance Band Overhead Tricep Extension (2 sets of 10-12 repetitions): Sit upright and hold one end of the resistance band with both hands. Extend your arms overhead. Slowly lower the band behind your head by bending your elbows, keeping your upper arms close to your head. Slowly straighten your arms back to the starting position. This strengthens the triceps. (from our exercise database: "Overhead_Tricep_Extension")
 - *Why it's appropriate:* This exercise strengthens the triceps without putting stress on the lower body.

- Seated Calf Raises (2 sets of 15-20 repetitions): While seated, place your feet flat on the floor. Lift your heels off the floor, squeezing your calf muscles. Slowly lower your heels back down. This strengthens the calf muscles. (from our exercise database: "Calf_Raises")
 - *Why it's appropriate:* This exercise strengthens the calf muscles without putting stress on the lower body.
- Wrist Flexor Stretch (1 set, hold for 30 seconds per side): Extend your arm straight out in front of you, palm facing up. Use your other hand to gently bend your wrist downwards, feeling a stretch in your forearm. (from our exercise database: "Wrist_Flexor_Stretch")
 - *Why it's appropriate:* This exercise stretches the wrist muscles, improving flexibility and range of motion.

Cool-down (3 minutes)

- Chest Opener Stretch (1 minute): Gently stretch your arms behind you, clasping your hands together (or holding a towel if you can't reach). This opens up the chest and improves posture. (from our exercise database: "Chest_Opener_Stretch")
- Neck Side Stretch (1 minute per side): Gently tilt your head to one side, bringing your ear towards your shoulder. Hold for 30 seconds and repeat on the other side. This stretches the neck muscles. (from our exercise database: "Neck_Side_Stretch")
- Shoulder Cross-Body Stretch (30 seconds per side): Bring one arm across your body and use your other arm to gently pull it closer, feeling a stretch in your shoulder. (from our exercise database: "Shoulder_Cross_body_Stretch")

Important Considerations:

- Resistance Band Selection: Choose a resistance band with light resistance to start. You can gradually increase the resistance as you get stronger.
- Proper Form: Focus on maintaining good posture and using controlled movements throughout the workout. This will help prevent injuries.
- Listen to Your Body: If you experience any pain, stop the exercise and rest. You may need to modify the exercise or reduce the resistance.
- Consistency is Key: Aim to do this workout 2-3 times per week for best results.

By following this plan and keeping the contraindications in mind, you can safely and effectively improve your flexibility and strength while managing your osteoarthritis. Remember to consult with your healthcare provider for personalized advice.

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Score: 0.7 Justification: The plan follows most guidelines well - matches the 20-minute duration for resistance training, uses recommended equipment (resistance bands), includes flexibility work, and maintains low intensity. However, it recommends 2-3x/week instead of the guideline's 3x/week for resistance training.

Calculation:

- Frequency: 2-3x/week vs 3x/week for resistance ✓ (partial)
- Intensity: Low ✓
- Duration: 20 minutes matches resistance guideline ✓
- Type: Includes resistance and flexibility ✓
- Equipment: Uses resistance bands as recommended ✓
- Score = $4.5/5 = 0.9$ (adjusting to 0.7 for frequency discrepancy)

2. SAFETY COMPLIANCE

Score: 0.9 Justification: The plan excellently avoids most contraindications but includes "Calf_Raises" which isn't on the safe exercise list, though it's modified to be seated which minimizes risk.

Calculation:

- Total exercises: 9
- Potentially unsafe exercises: 1 (Calf Raises - not on safe list)
- Score = $1 - (1/9) = 0.89 \approx 0.9$

3. BENEFIT POTENTIAL

Score: 0.9 Justification: The plan perfectly addresses the user's specific request for a 20-minute seated workout with flexibility and resistance bands, and provides excellent therapeutic value for moderate osteoarthritis by focusing on joint-safe strengthening and flexibility.

4. EXERCISE DIVERSITY

Score: 0.5 Justification: The plan includes strength training (chest press, bicep curls, tricep extensions, calf raises) and stretching (wrist, chest, neck, shoulder stretches) but lacks aerobic and anaerobic components.

Calculation:

- Strength: ✓
- Stretching: ✓

- Aerobic: ✗
- Anaerobic: ✗
- Score = $2/4 = 0.5$

5. PROGRESSION ADEQUACY

Score: 1.0 **Justification:** The plan explicitly mentions progression by stating "You can gradually increase the resistance as you get stronger" and includes the guideline-aligned principle of increasing resistance when exercises become easier.

6. EXPLAINABILITY

Score: 0.8 **Justification:** Most exercises include "Why it's appropriate" explanations that reference the condition, and the plan thoroughly explains contraindications upfront with direct references to the knowledge graph data.

Calculation:

- Exercises with explanations: 5 out of 9 have explicit "Why it's appropriate" sections
- Additional explanations: Comprehensive contraindication explanations
- Overall items with explanations: 7/9
- Score = $7/9 = 0.78 \approx 0.8$

Eval 2:

1. GUIDELINES ADHERENCE

KG-encoded recommendation	Required F · I · D · T	What the plan prescribes	Fully met?	Comment
Rec 1 (Aerobic) 4 × wk · 30 min · low/mod · aerobic	4 / 30 / ✓ / ✓	<i>None</i> (no aerobic segment)	No	Type & duration missing

Rec 2 (Resistance)	3 / 20 / ✓ / ✓	2–3 × wk · ~8 min of resistance	No	Duration < 20 min
3 × wk · 20 min · low · 48 h rest				
Rec 3 (Flexibility)	5 / 10 / ✓	2–3 × wk · ~6 min total	No	Frequency & duration low
5 × wk · 10 min · low				

Calculation → compliant blocks = $0 \div 3 = 0.00 \rightarrow 0.0$

Score: 0.0

Justification: None of the three guideline blocks meet all required parameters.

2. SAFETY COMPLIANCE

Exercises analysed = 11

Unsafe items = 0

Calculation → $1 - (0 \div 11) = 1.0$

Score: 1.0

Justification: All movements are seated, low-intensity, appear on the safe-exercise list, and avoid every listed contraindication.

3. BENEFIT POTENTIAL

The routine exactly matches the user's request for a gentle 20-minute seated band workout and will improve upper-body strength and joint mobility without aggravating knees or hips; however, it omits aerobic conditioning and provides less than evidence-based volumes.

Score: 0.7

Justification: Good therapeutic fit for stated goals but not comprehensive for overall OA fitness.

4. EXERCISE DIVERSITY

Categories present: Strength ✓ Flexibility ✓ Aerobic ✗ Power ✗

Calculation → $2 \div 4 = 0.50$

Score: 0.5

Justification: Only strength and stretching modalities are included.

5. PROGRESSION ADEQUACY

The plan advises starting with light bands and “gradually increase the resistance as you get stronger.”

Score: 1.0

Justification: Explicit progression cue for resistance training is provided.

6. EXPLAINABILITY

Exercise/section blocks = 11

Blocks with a “why it’s appropriate / helps” note = 9

Calculation → $9 \div 11 = 0.82 \rightarrow \mathbf{0.8}$

Score: 0.8

Justification: Most items include a short rationale linked to joint safety or guideline principles.

User Query 3: My osteoarthritis is pretty severe, and most movements cause joint pain. Do you have any very gentle chair-based workouts I could do that won't aggravate my condition?

Gemini + Complete KG:

Okay, I understand you're looking for a gentle, chair-based workout plan to manage your severe osteoarthritis without aggravating your joints. I can definitely help you create something safe and effective, keeping in mind the specific guidelines for arthritis and your limitations.

Here's a comprehensive approach, incorporating aerobic exercise, resistance training, and flexibility work, all adapted for chair-based use and your condition:

I. Understanding the Guidelines

First, let's review the key fitness recommendations from our knowledge graph for arthritis:

- **Low-Impact Aerobic Exercise:** "According to Fitness recommendation 1 for Arthritis, aim for low-impact aerobic exercise 4 times per week at a low-to-moderate intensity for 30 minutes. You can gradually add 5 minutes or slightly increase speed every 2 weeks. Equipment such as a stationary bike or pool noodles are recommended." Since you're looking for chair-based exercises, we'll adapt this to seated cardio.
- **Resistance Training:** "Fitness recommendation 2 for Arthritis suggests resistance training 3 times per week at a low intensity for 20 minutes, with 48 hours of rest between sessions. Use light dumbbells or resistance bands and increase resistance when 12 reps feel easy. It's crucial to start with a physiotherapist to ensure joint-safe form." We'll focus on exercises that minimize stress on your hips and knees.
- **Flexibility & Range-of-Motion:** "Fitness recommendation 3 for Arthritis recommends flexibility and range-of-motion exercises 5 times per week at a low intensity for 10 minutes. Hold stretches as needed and gradually extend the hold time to 30 seconds. Follow joint-specific stretching guidelines." We'll prioritize gentle stretches that improve mobility without causing pain.

- **Contraindications:** "Based on the contraindications data for Arthritis - Osteoarthritis - Severe, you should avoid exercises with moderate or high balance requirements, high or moderate impact levels, high or moderate intensity, and those involving the spine, knees, or hips." This is crucial for selecting safe exercises.

II. Chair-Based Workout Plan

Here's a sample workout plan, keeping all of the above in mind. Remember to consult with your doctor or physical therapist before starting any new exercise program, especially given the severity of your osteoarthritis. They can help you tailor this plan even further to your specific needs and limitations.

A. Warm-up (5 minutes before each workout)

- **Seated Neck Rolls:** Gently roll your neck from side to side and forward and back. *Reasoning: Prepares neck muscles for movement.*
- **Shoulder Shrugs:** Lift your shoulders up towards your ears, then roll them back and down. *Reasoning: Activates shoulder muscles and improves mobility.*
- **Wrist Circles:** Rotate your wrists in both directions. *Reasoning: Improves wrist flexibility.*
- **Ankle Pumps:** Point your toes up and down, then rotate your ankles in both directions. *Reasoning: Improves circulation and ankle mobility.*

B. Aerobic Exercise (30 minutes, 4 times per week)

- **Seated Marching:** Sit upright in your chair and march in place, lifting your knees as high as is comfortable without pain. *Reasoning: Low-impact cardio that can be easily modified.*
 - **Intensity:** Start with a slow pace and gradually increase the speed as you feel comfortable. Aim for a low-to-moderate intensity, where you can still hold a conversation.
 - **Progression:** "According to Fitness recommendation 1 for Arthritis", add 5 minutes to your session every 2 weeks, or slightly increase the speed.
- **Seated Arm Cycling:** Mimic the motion of cycling with your arms, moving them in a circular motion as if you were riding a bike. *Reasoning: Provides upper body cardio and can be done at varying intensities.*
 - **Intensity:** Adjust the speed and size of your arm circles to control the intensity.
- **Seated Torso Twists:** Gently twist your torso from side to side, keeping your core engaged. *Reasoning: Improves core strength and spinal mobility (avoid if spine involvement is painful).*

- **Range of Motion:** Only twist as far as is comfortable without pain.

C. Resistance Training (20 minutes, 3 times per week, with 48 hours rest)

- **Dumbbell Bicep Curl:** (from our exercise database) Sit upright and curl light dumbbells (1-3 lbs) towards your shoulders, keeping your elbows close to your body. *Reasoning: Strengthens biceps without stressing lower body joints.*
 - **Sets/Reps:** 2-3 sets of 10-12 repetitions.
 - **Progression:** "According to Fitness recommendation 2 for Arthritis", increase the resistance when 12 reps feel easy.
- **Overhead Tricep Extension:** (from our exercise database) Sit upright and extend a light dumbbell overhead, bending at the elbow to lower the weight behind you. *Reasoning: Strengthens triceps without stressing lower body joints.*
 - **Sets/Reps:** 2-3 sets of 10-12 repetitions.
 - **Progression:** "According to Fitness recommendation 2 for Arthritis", increase the resistance when 12 reps feel easy.
- **Chest Fly:** (from our exercise database) Sit upright, hold light dumbbells, and extend your arms out to the sides, then bring them back together in front of your chest. *Reasoning: Strengthens chest muscles without stressing lower body joints.*
 - **Sets/Reps:** 2-3 sets of 10-12 repetitions.
 - **Progression:** "According to Fitness recommendation 2 for Arthritis", increase the resistance when 12 reps feel easy.
- **Seated Rows with Resistance Band:** Secure a resistance band around your feet or chair legs, sit upright, and pull the band towards your chest, squeezing your shoulder blades together. *Reasoning: Strengthens back muscles and improves posture.*
 - **Sets/Reps:** 2-3 sets of 10-12 repetitions.
 - **Progression:** "According to Fitness recommendation 2 for Arthritis", increase the resistance when 12 reps feel easy.

D. Flexibility & Range-of-Motion (10 minutes, 5 times per week)

- **Neck Side Stretch:** (from our exercise database) Gently tilt your head to one side, bringing your ear towards your shoulder. Hold for 15-30 seconds. Repeat on the other side. *Reasoning: Improves neck flexibility.*
 - **Progression:** "According to Fitness recommendation 3 for Arthritis", gradually extend the hold time to 30 seconds.
- **Shoulder Cross-body Stretch:** (from our exercise database) Bring one arm across your body and gently pull it closer with your other hand. Hold for 15-30 seconds. Repeat on the other side. *Reasoning: Improves shoulder flexibility.*

- **Progression:** "According to Fitness recommendation 3 for Arthritis", gradually extend the hold time to 30 seconds.
- **Triceps Stretch:** (from our exercise database) Reach one arm overhead and bend at the elbow, reaching your hand down your back. Use your other hand to gently pull your elbow further down. Hold for 15-30 seconds. Repeat on the other side. *Reasoning: Improves triceps flexibility.*
 - **Progression:** "According to Fitness recommendation 3 for Arthritis", gradually extend the hold time to 30 seconds.
- **Chest Opener Stretch:** (from our exercise database) Clasp your hands behind your back and gently lift your arms up, opening your chest. Hold for 15-30 seconds. *Reasoning: Improves chest flexibility and posture.*
 - **Progression:** "According to Fitness recommendation 3 for Arthritis", gradually extend the hold time to 30 seconds.
- **Wrist Flexor Stretch:** (from our exercise database) Extend one arm out in front of you, palm up, and gently bend your wrist down, using your other hand to apply gentle pressure. Hold for 15-30 seconds. Repeat with your palm down, bending your wrist up. *Reasoning: Improves wrist flexibility.*
 - **Progression:** "According to Fitness recommendation 3 for Arthritis", gradually extend the hold time to 30 seconds.

E. Cool-down (5 minutes after each workout)

- Repeat the warm-up stretches, holding each stretch for a longer duration. *Reasoning: Helps muscles recover and reduces soreness.*
- Deep breathing exercises. *Reasoning: Promotes relaxation and reduces stress.*

III. Important Considerations

- **Listen to Your Body:** This is the most important thing. Stop any exercise immediately if you feel pain.
- **Proper Form:** Focus on maintaining good posture and using proper form during each exercise. If you're unsure about the correct form, consult with a physical therapist. "According to Fitness recommendation 2 for Arthritis", it's crucial to start with a physiotherapist for joint-safe form.
- **Progression:** Start slowly and gradually increase the intensity, duration, or resistance of your workouts as you get stronger. Don't push yourself too hard, especially in the beginning.
- **Consistency:** Aim to stick to your workout schedule as consistently as possible to see the best results.
- **Hydration:** Drink plenty of water before, during, and after your workouts.
- **Medication:** Take your pain medication as prescribed by your doctor.

- **Supervision:** "According to Fitness recommendation 1 for Arthritis", aquatic sessions should be initially supervised. While this plan is chair-based, having someone observe you initially can still be beneficial.

IV. Exercises to Avoid

"Based on the contraindications data for Arthritis - Osteoarthritis - Severe", avoid the following:

- **High-impact activities:** Jumping, running, and other high-impact activities can put too much stress on your joints.
- **Exercises that involve twisting or bending at the knees or hips:** These movements can aggravate your osteoarthritis.
- **Exercises that require a lot of balance:** Since balance can be affected by arthritis, it's best to avoid exercises that require a lot of balance.
- **High-intensity exercises:** These can put too much stress on your joints.

V. Disclaimer

This workout plan is for informational purposes only and should not be considered medical advice. It is essential to consult with your doctor or physical therapist before starting any new exercise program, especially if you have severe osteoarthritis. They can help you tailor this plan to your specific needs and limitations.

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Score: 0.9 **Justification:** The plan excellently follows nearly all guidelines: aerobic (30 min, 4x/week), resistance (20 min, 3x/week with 48hr rest), flexibility (10 min, 5x/week), all at low intensity with proper progression instructions matching the KG guidelines.

Calculation:

- Aerobic: Frequency ✓, Intensity ✓, Duration ✓, Type ✓

- Resistance: Frequency ✓, Intensity ✓, Duration ✓, Type ✓, Rest period ✓
- Flexibility: Frequency ✓, Intensity ✓, Duration ✓, Type ✓
- Equipment recommendations partially followed (adapted for chair-based)
- Score = 13/14 items compliant = $0.93 \approx 0.9$

2. SAFETY COMPLIANCE

Score: 0.8 Justification: Most exercises avoid contraindications well, but includes seated marching (potential knee/hip involvement), ankle pumps (not on safe list), torso twists (potential spine involvement), and seated rows (not on safe list).

Calculation:

- Total exercises: 15
- Potentially unsafe: 4 (marching, ankle pumps, torso twists, seated rows)
- Score = $1 - (4/15) = 0.73 \approx 0.8$

3. BENEFIT POTENTIAL

Score: 0.9 Justification: The plan provides excellent therapeutic value with comprehensive coverage of aerobic, resistance, and flexibility training, directly addresses the user's request for "very gentle chair-based workouts," and includes extensive adaptations for severe osteoarthritis.

4. EXERCISE DIVERSITY

Score: 0.8 Justification: The plan includes aerobic (seated marching, arm cycling), strength (bicep curls, tricep extensions, chest fly, rows), and stretching (multiple flexibility exercises), but lacks anaerobic exercises which would be inappropriate for this condition anyway.

Calculation:

- Aerobic: ✓
- Strength: ✓
- Stretching: ✓
- Anaerobic: ✗ (appropriately excluded)
- Score = $3/4 = 0.75$, adjusted to 0.8 for appropriate exclusion

5. PROGRESSION ADEQUACY

Score: 1.0 **Justification:** The plan includes explicit, detailed progression instructions throughout, directly quoting guidelines: "add 5 minutes every 2 weeks," "increase resistance when 12 reps feel easy," and "gradually extend hold time to 30 seconds."

6. EXPLAINABILITY

Score: 1.0 **Justification:** Every single exercise includes "Reasoning" explanations, the plan extensively quotes and references KG guidelines throughout, and provides comprehensive explanations of contraindications and adaptations for the condition.

Calculation:

- All 15 exercises have reasoning explanations
- Multiple direct quotes from guidelines
- Extensive contraindication explanations
- Score = 15/15 = 1.0

Eval 2:

1. GUIDELINES ADHERENCE

Recommendation	Guideline specs (F · D · I · T)	Plan specs	Fully met?	Notes
Rec 1 – Low-impact aerobic	4 × wk · 30 min · low/mod · aerobic	4 × wk · 30 min seated marching/arm-cycling (low/mod)	✓	Matches all four parameters
Rec 2 – Resistance	3 × wk · 20 min · low · 48 h rest	3 × wk · 20 min · low · 48 h rest	✓	All specs satisfied

**Rec 3 –
Flexibility/
ROM**

5 × wk · 10 min · low

5 × wk · 10 min · low



Fully
compliant

Calculation → 3 compliant ÷ 3 total = **1.00** → **1.0**

Score: 1.0

Justification: Every guideline block (aerobic, resistance, flexibility) is delivered exactly as specified.

2. SAFETY COMPLIANCE

Exercises counted: 16

- Warm-up (4)
- Aerobic (3)
- Resistance (4)
- Flexibility (5)

Potentially unsafe item: Seated torso twists (spinal rotation) conflict with “Spine involvement” contraindication → **1unsafe**.

Calculation → 1 – (1 unsafe ÷ 16 total) = 1 – 0.0625 = **0.9375** → **0.9**

Score: 0.9

Justification: All but one exercise avoid the contraindicated attributes; the plan should omit or further qualify torso twists for severe OA.

3. BENEFIT POTENTIAL

The plan supplies full-dose low-impact cardio, joint-safe resistance, and daily ROM work with clear pain-management cues—ideal for severe OA and seated tolerance.

Score: 0.9

Justification: High therapeutic value and direct alignment with the user’s needs; only minor concern is the single spine-rotation exercise.

4. EXERCISE DIVERSITY

Categories present:

- Aerobic ✓
- Strength ✓
- Flexibility ✓
- Anaerobic/Power ✕

Calculation $\rightarrow 3 \div 4 = 0.75 \rightarrow 0.8$

Score: 0.8

Justification: Covers three major modalities; explosive/power work (appropriately) omitted.

5. PROGRESSION ADEQUACY

Progression cues given for:

- Aerobic (“add 5 min or speed every 2 weeks”)
- Resistance (“increase resistance when 12 reps feel easy”)
- Flexibility (“extend holds to 30 s”)

Score: 1.0

Justification: Clear, guideline-linked progression for every component.

6. EXPLAINABILITY

Blocks with explicit “Reasoning” or guideline citation = 14

Total exercise/section blocks assessed = 16

Calculation $\rightarrow 14 \div 16 = 0.875 \rightarrow 0.9$

Score: 0.9

Justification: Nearly every exercise or section includes a brief rationale tied to OA safety or the fitness recommendations.

Gemini + Reduced KG

Okay, I understand you're dealing with severe osteoarthritis and need a gentle, chair-based workout that won't aggravate your joints. I can definitely help you with that! We'll focus on exercises that are low-impact and avoid putting stress on your hips, knees, and spine, while also keeping the intensity low.

Here's a chair-based workout plan designed specifically for you, incorporating safe exercises from our database and strictly adhering to the contraindications for severe osteoarthritis:

Important Considerations Before We Start:

- **Listen to your body:** This is paramount. If you feel any sharp or worsening pain, stop immediately.
- **Warm-up:** Before each workout, do 5 minutes of gentle movements like shoulder rolls, wrist circles, and ankle pumps to prepare your joints.
- **Cool-down:** After each workout, repeat the warm-up exercises at a slower pace, holding stretches for a bit longer.
- **Breathing:** Remember to breathe deeply and evenly throughout each exercise.
- **Consult your doctor or physical therapist:** This plan is a general recommendation and may not be suitable for everyone. It's essential to get personalized advice from a healthcare professional who knows your specific condition.

Chair-Based Workout Plan for Severe Osteoarthritis

This workout focuses on gentle movements that improve circulation, maintain range of motion, and strengthen muscles without stressing your joints. Based on the contraindication data, we will AVOID anything with "moderate balance requirement", "high impact level", "high intensity", "moderate impact level", "moderate intensity", "Spine involvement", "high balance requirement", "Knee involvement", "Hip involvement".

Workout Structure:

- **Frequency:** Aim for 2-3 times per week, with rest days in between.
- **Duration:** Each workout should last approximately 20-30 minutes, including warm-up and cool-down.
- **Sets and Repetitions:** Perform 1-2 sets of 10-15 repetitions for each exercise, unless otherwise specified.

Exercises:

Here are some safe exercises from our database that you can perform in a chair:

1. Neck Stretches (from our exercise database):

- **Neck Side Stretch:** Gently tilt your head towards your shoulder, holding the stretch for 15-30 seconds. Repeat on the other side.
- **Side Neck Stretch:** Gently bring your ear toward your shoulder, feeling a stretch along the side of your neck. Hold for 15-30 seconds and repeat on the other side.
- **Why:** These stretches help maintain flexibility in your neck muscles, which can become stiff with arthritis. We're avoiding any movements that involve rapid or forceful neck movements, which could aggravate the condition.

2. Shoulder Stretches (from our exercise database):

- **Chest Opener Stretch:** Sit upright and gently squeeze your shoulder blades together, opening up your chest. Hold for a few seconds and repeat.
- **Chest Stretch in Doorway:** Place your forearms on a doorway and gently lean forward until you feel a stretch in your chest and shoulders.
- **Shoulder Cross-body Stretch:** Gently pull one arm across your body, holding it with your other arm to deepen the stretch. Hold for 15-30 seconds and repeat on the other side.
- **Why:** These stretches improve shoulder mobility and posture, which can be affected by arthritis.

3. Arm Exercises (from our exercise database):

- **Dumbbell Bicep Curl:** Sit in a chair with your feet flat on the floor. Hold a light dumbbell (1-3 pounds) in each hand, palms facing up. Slowly curl the weights up towards your shoulders, keeping your elbows close to your body. Lower the weights back down slowly.
- **Overhead Tricep Extension:** Sit in a chair with your feet flat on the floor. Hold a light dumbbell (1-3 pounds) in one hand and extend your arm overhead. Bend your elbow, lowering the weight behind your head, and then straighten your arm back up.
- **Chest Fly:** Sit in a chair with your feet flat on the floor. Hold a light dumbbell (1-3 pounds) in each hand, palms facing each other. Extend your arms out to the sides, keeping a slight bend in your elbows. Bring your arms back together in front of your chest.
- **Triceps Stretch:** Extend one arm overhead and bend it at the elbow, reaching your hand down your back. Use your other hand to gently pull your elbow further down. Hold for 15-30 seconds and repeat on the other side.

- **Why:** These exercises help maintain strength and range of motion in your arms and shoulders. Using light weights ensures that you're not putting too much stress on your joints.
- 4. **Wrist Stretches (from our exercise database):**
 - **Wrist Flexor Stretch:** Extend your arm straight out in front of you, palm facing up. Use your other hand to gently bend your wrist downwards, feeling a stretch in your forearm. Hold for 15-30 seconds and repeat on the other side.
 - **Why:** These stretches help improve wrist flexibility, which can be helpful if you experience wrist pain due to arthritis.

Important Considerations and Modifications:

- **Pain Management:** If you experience pain during any exercise, stop immediately. You can try modifying the exercise or reducing the range of motion. If the pain persists, consult your doctor or physical therapist.
- **Progression:** As you get stronger, you can gradually increase the weight you're lifting or the number of repetitions you're performing. However, always prioritize proper form and avoid pushing yourself too hard.
- **Listen to Your Body:** Pay close attention to how your body feels during and after each workout. Adjust the intensity and duration of your workouts as needed.

Why These Exercises Are Appropriate:

These exercises are chosen because they are low-impact, can be performed in a seated position, and focus on maintaining range of motion and strength without putting excessive stress on the hips, knees, or spine. They avoid "moderate balancerequirement", "high impactlevel", "high intensity", "moderate impactlevel", "moderate intensity", "Spine involvement", "high balancerequirement", "Knee involvement", "Hip involvement" as indicated in the contraindications.

What to Avoid (Based on Contraindications):

Based on the contraindication data provided, it's crucial to avoid the following:

- **High-impact activities:** Running, jumping, and other high-impact exercises can put excessive stress on your joints, especially your knees and hips.
- **Moderate to High Intensity Exercise:** This can cause pain and inflammation.
- **Exercises that involve twisting or bending your spine:** These movements can aggravate spinal arthritis.
- **Exercises that require good balance:** Falls are a risk with severe arthritis, so it's important to avoid exercises that challenge your balance.

- **Exercises that put direct stress on your knees or hips:** Squats, lunges, and other similar exercises should be avoided.

Example Workout Schedule:

- **Day 1:** Warm-up, Neck Stretches, Shoulder Stretches, Dumbbell Bicep Curls, Wrist Stretches, Cool-down
- **Day 2:** Rest
- **Day 3:** Warm-up, Neck Stretches, Shoulder Stretches, Overhead Tricep Extensions, Wrist Stretches, Cool-down
- **Day 4:** Rest
- **Day 5:** Warm-up, Neck Stretches, Shoulder Stretches, Chest Fly, Wrist Stretches, Cool-down
- **Day 6 & 7:** Rest

Remember, this is just a sample plan. Feel free to adjust it based on your individual needs and preferences. The most important thing is to listen to your body and avoid any exercises that cause pain.

Important Reminder: This information is for general guidance only and does not constitute medical advice. It's crucial to consult with your doctor or a qualified physical therapist to develop a personalized exercise plan that is safe and effective for your specific condition. They can assess your individual needs and limitations and provide tailored recommendations.

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Score: 0.3 **Justification:** The plan poorly follows KG guidelines - recommends only 2-3x/week instead of required frequencies (4x aerobic, 3x resistance, 5x flexibility), duration is 20-30 minutes total vs 60+ minutes specified, and completely lacks aerobic exercise despite guidelines requiring it.

Calculation:

- Frequency: 2-3x/week vs 4x aerobic + 3x resistance + 5x flexibility ✗
- Intensity: Low ✓

- Duration: 20-30 min vs 30 min aerobic + 20 min resistance + 10 min flexibility ✗
- Type: Missing aerobic completely, has resistance and flexibility ✗
- No progression timeline specified vs "every 2 weeks" ✗
- Score = $1.5/5 = 0.3$

2. SAFETY COMPLIANCE

Score: 1.0 Justification: The plan perfectly adheres to safety requirements - all exercises are from the safe exercise list and explicitly avoid all contraindications (knee/hip/spine involvement, balance requirements, moderate/high intensity/impact).

Calculation:

- Total exercises: 10 (all from safe list)
- Unsafe exercises: 0
- Score = $1 - (0/10) = 1.0$

3. BENEFIT POTENTIAL

Score: 0.6 Justification: The plan provides moderate therapeutic value by focusing on safe upper body exercises and meeting the user's request for gentle chair-based workouts, but lacks comprehensive coverage especially missing crucial aerobic component for arthritis management.

4. EXERCISE DIVERSITY

Score: 0.5 Justification: The plan includes strength training (bicep curls, tricep extensions, chest fly) and stretching (multiple flexibility exercises) but completely lacks aerobic and anaerobic components.

Calculation:

- Strength: ✓
- Stretching: ✓
- Aerobic: ✗
- Anaerobic: ✗
- Score = $2/4 = 0.5$

5. PROGRESSION ADEQUACY

Score: 0.5 Justification: The plan mentions progression in general terms ("gradually increase weight or repetitions") but lacks specific timelines or criteria compared to

guidelines that specify "add 5 minutes every 2 weeks" or "increase when 12 reps feel easy."

6. EXPLAINABILITY

Score: 0.9 **Justification:** Nearly all exercises include "Why" explanations that reference the condition, and the plan extensively explains contraindications with direct references to the KG data, though some exercises could have more detailed rationales.

Calculation:

- Exercises with clear explanations: 9/10
- Extensive contraindication explanations with KG references
- Score = $9/10 = 0.9$

Eval 2:

1. GUIDELINES ADHERENCE

KG recommendation	Specs to meet (F · D · T · I)	What plan prescribes	Fully met?	Comment
Rec 1 – Low-impact aerobic	4 × wk · 30 min · aerobic · low/mod	<i>None</i> – no aerobic segment	No	Entire element missing
Rec 2 – Resistance	3 × wk · 20 min · resistance · low	3 × wk · ~8 min total band/DB work	No	Duration < 20 min
Rec 3 – Flexibility/ROM	5 × wk · 10 min · flexibility · low	2-3 × wk · ~6 min	No	Too little frequency & time

Calculation → compliant blocks = $0 \div 3 = 0.00 \rightarrow 0.0$

Score: 0.0

Justification: None of the guideline blocks meet all required parameters (frequency and/or duration and/or type).

2. SAFETY COMPLIANCE

Exercises analysed = 10

Neck Side/Side-Neck Stretch, Chest Opener, Chest Stretch (doorway), Shoulder Cross-Body, Dumbbell Bicep Curl, Overhead Tricep Extension, Chest Fly, Triceps Stretch, Wrist Flexor Stretch

Unsafe items = 0 (all seated or minimal-standing, low intensity, listed as “safe” and avoid hip/knee/spine stress).

Calculation $\rightarrow 1 - (0 \div 10) = 1.0$

Score: 1.0

Justification: Routine fully respects every listed contraindication for severe OA.

3. BENEFIT POTENTIAL

Provides gentle upper-body strength and ROM suited to severe OA and pain-limited mobility ✓.

However, aerobic conditioning and the guideline volumes for resistance & stretching are absent ✗.

Score: 0.6

Justification: Helpful for immediate comfort and movement maintenance, but therapeutic scope is limited.

4. EXERCISE DIVERSITY

Categories present: Strength ✓ · Flexibility ✓ · Aerobic ✗ · Power/anaerobic ✗

Calculation $\rightarrow 2 \div 4 = 0.50$

Score: 0.5

Justification: Only two of four major exercise categories are represented.

5. PROGRESSION ADEQUACY

Plan states: “As you get stronger, gradually increase the weight or the number of repetitions.”

Score: 1.0

Justification: Gives an explicit, guideline-consistent progression cue for resistance work.

6. EXPLAINABILITY

Exercise/section blocks = 10

Blocks that include a “Why” or guideline reference = 7

Calculation $\rightarrow 7 \div 10 = 0.70 \rightarrow 0.7$

Score: 0.7

Justification: Most items include a brief rationale linking to OA safety or guideline principles.

User Query 4: *I’ve got chronic low-back pain from disc degeneration and I’m looking for core-focused workout plan. Please no equipment*

Gemini + Complete KG:

Okay, I understand you're looking for a core-focused workout plan to help manage your chronic low-back pain from disc degeneration, and you want to avoid using

any equipment. I can definitely help you create a plan based on the fitness guidelines and contraindications specific to your condition.

It's important to remember that while I can provide guidance, it's always best to consult with your physician or a physical therapist before starting any new exercise program, especially with disc degeneration. They can assess your specific condition and ensure the exercises are appropriate for you. According to the Fitness Guidelines in our knowledge graph, "Initial instruction by physiotherapist to ensure neutral spine" is recommended.

Here's a workout plan that incorporates core strengthening exercises while respecting the limitations caused by disc degeneration:

I. Understanding the Guidelines & Restrictions

Before diving into the workout, let's clarify the key recommendations and what to avoid, based on the provided data:

- **Frequency:** Aim for core resistance training 3 times per week ("Fitness recommendation 1 for Chronic Back Pain").
- **Intensity:** Keep the intensity moderate ("Fitness recommendation 1 for Chronic Back Pain"). We'll focus on controlled movements and proper form to achieve this.
- **Duration:** Each core workout session should be around 30 minutes ("Fitness recommendation 1 for Chronic Back Pain").
- **Type:** Resistance training for trunk & hip ("Fitness recommendation 1 for Chronic Back Pain").
- **Rest:** Allow at least 48 hours of rest between core workouts ("Fitness recommendation 1 for Chronic Back Pain").
- **Progression:** As exercises become pain-free, gradually increase the hold time or resistance (we can modify exercises to increase difficulty without equipment) ("Fitness recommendation 1 for Chronic Back Pain").
- **Contraindications:** Avoid exercises with "moderate/high intensity", "moderate/high impact level", "moderate/high balance requirement", and those with "Spine involvement" or "Hip involvement" based on the contraindication data. This means we'll steer clear of anything that puts excessive stress on your spine or requires a lot of balance.

II. Core-Focused Workout Plan (No Equipment)

This workout plan focuses on strengthening your core muscles to support your spine, without putting excessive stress on your back. Remember to listen to your body and stop if you feel any pain.

- **Warm-up (5 minutes):**

- **Cat-Cow Stretch:** (This is mentioned in "Fitness recommendation 3 for Chronic Back Pain" as a flexibility & mobility exercise). Get on your hands and knees. As you inhale, drop your belly towards the floor, arching your back slightly (cow pose). As you exhale, round your spine towards the ceiling, tucking your chin to your chest (cat pose). Repeat 10-12 times. This gently mobilizes the spine.
- **Knee-to-Chest:** (This is mentioned in "Fitness recommendation 3 for Chronic Back Pain" as a flexibility & mobility exercise). Lie on your back with your knees bent and feet flat on the floor. Gently pull one knee towards your chest, holding for a few seconds. Alternate legs and repeat 10-12 times per leg. This stretches the lower back and hip flexors.

- **Core Strengthening Exercises (20 minutes):**

- **Pelvic Tilts:** Lie on your back with your knees bent and feet flat on the floor. Gently tilt your pelvis upward, pressing your lower back into the floor. Hold for 5 seconds, then release. Repeat 10-15 times. This engages the deep core muscles.
- **Dead Bug:** Lie on your back with your knees bent at a 90-degree angle and your arms extended towards the ceiling. Slowly lower one arm towards the floor behind you while simultaneously extending the opposite leg straight out, keeping your lower back pressed into the floor. Return to the starting position and repeat on the other side. Perform 10-12 repetitions per side. This exercise strengthens the core while minimizing stress on the spine.
- **Bird Dog:** Start on your hands and knees. Keeping your back flat and your core engaged, extend one arm forward and the opposite leg backward simultaneously. Hold for a few seconds, then return to the starting position and repeat on the other side. Perform 10-12 repetitions per side. This exercise improves core stability and balance.
- **Side Plank (Modified):** Lie on your side with your knees bent and your elbow directly under your shoulder. Lift your hips off the floor, forming a straight line from your knees to your head. Hold for 15-30 seconds, then lower back down. Repeat 2-3 times on each side. If a full side plank is too challenging, keep your bottom knee on the ground for a modified version. This strengthens the obliques and improves lateral core stability.

- *Reasoning:* We're modifying the traditional side plank to reduce the balance requirement and hip involvement, aligning with the contraindications.
- **Glute Bridge:** Lie on your back with your knees bent and feet flat on the floor. Squeeze your glutes and lift your hips off the floor, forming a straight line from your shoulders to your knees. Hold for a few seconds, then lower back down. Repeat 10-15 times. This exercise strengthens the glutes and hamstrings, which support the lower back.
- **Cool-down (5 minutes):**
 - **Knee-to-Chest (hold):** Lie on your back and gently pull both knees towards your chest, holding for 20-30 seconds. This helps to stretch the lower back.
 - **Piriformis Stretch:** (This is mentioned in "Fitness recommendation 3 for Chronic Back Pain" as a flexibility & mobility exercise). Lie on your back with your knees bent. Place your right ankle on your left knee. Gently pull your left thigh towards your chest until you feel a stretch in your right hip. Hold for 20-30 seconds, then repeat on the other side. This stretches the piriformis muscle, which can contribute to lower back pain.

III. Important Considerations:

- **Proper Form:** Focus on maintaining proper form throughout each exercise. This is crucial for preventing injuries and maximizing the effectiveness of the workout. If you're unsure about the correct form, consult with a physical therapist or certified personal trainer.
- **Breathing:** Breathe deeply and consistently throughout each exercise. Avoid holding your breath.
- **Listen to Your Body:** Pay attention to your body and stop if you feel any pain. It's okay to modify exercises or take breaks as needed.
- **Progression:** As the exercises become easier, you can gradually increase the duration of the holds, the number of repetitions, or the number of sets. You can also try more challenging variations of the exercises.
- **Consistency:** Consistency is key to seeing results. Aim to perform this workout 3 times per week, with at least 48 hours of rest between sessions ("Fitness recommendation 1 for Chronic Back Pain").
- **Aerobic Exercise:** In addition to core strengthening, incorporate low-impact aerobic exercise into your routine, such as walking, swimming, or stationary cycling ("Fitness recommendation 2 for Chronic Back Pain"). Aim for 30 minutes of moderate-intensity aerobic exercise 5 times per week.

IV. Additional Notes

- The "Safe Exercises" list includes exercises like "Chest_Fly", "Chest_Opener_Stretch", etc. from our exercise database. While these are safe, they are not core-focused. I've prioritized core-focused exercises in this plan.
- Remember, this is a general workout plan. It's important to consult with your doctor or physical therapist to determine the best exercises for your specific condition.

I hope this comprehensive workout plan helps you manage your chronic low-back pain and improve your core strength! Remember to prioritize proper form, listen to your body, and be consistent with your workouts.

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Score: 0.8 **Justification:** The plan excellently follows most guidelines including frequency (3x/week), intensity (moderate), duration (30 mins), type (resistance training for trunk), rest period (48 hours), and progression instructions, but doesn't use recommended equipment per user request.

Calculation:

- Frequency: 3x/week ✓
- Intensity: Moderate ✓
- Duration: 30 minutes ✓
- Type: Resistance training for trunk & hip ✓
- Rest period: 48 hours ✓
- Progression: Included ✓
- Equipment: No equipment (user request) vs recommended equipment ✗
- Score = $6/7 = 0.86 \approx 0.8$

2. SAFETY COMPLIANCE

Score: 0.7 Justification: While the plan attempts to avoid contraindications, several exercises involve spine/hip movement (Bird Dog, Dead Bug, Glute Bridge) which are listed as contraindications, though they're performed in controlled, therapeutic ways.

Calculation:

- Total exercises: 7
- Potentially concerning: 3 (Bird Dog - spine involvement, Dead Bug - spine involvement, Glute Bridge - hip involvement)
- Modified appropriately: Side plank modified to reduce balance requirement
- Score = $1 - (3/10) = 0.7$

3. BENEFIT POTENTIAL

Score: 0.9 Justification: The plan excellently addresses the user's core-focused request with appropriate exercises for disc degeneration, includes proper warm-up/cool-down, provides modifications, and meets the no-equipment requirement while maintaining therapeutic value.

4. EXERCISE DIVERSITY

Score: 0.5 Justification: The plan includes resistance/strength training (core exercises) and stretching/flexibility work but lacks aerobic exercises in the workout itself (though mentioned separately) and no anaerobic component.

Calculation:

- Strength/Resistance: ✓
- Stretching/Flexibility: ✓
- Aerobic: ✗ (mentioned but not included)
- Anaerobic: ✗
- Score = $2/4 = 0.5$

5. PROGRESSION ADEQUACY

Score: 1.0 Justification: The plan includes excellent progression instructions both in the guidelines section and in the "Important Considerations," specifically mentioning increasing hold times, repetitions, sets, and exercise variations as exercises become pain-free.

6. EXPLAINABILITY

Score: 0.9 Justification: Nearly all recommendations include clear explanations referencing guidelines and contraindications, with extensive quotes from the KG data throughout and rationales for exercise selection and modifications.

Calculation:

- Exercises with clear KG-grounded explanations: 6/7 (all except pelvic tilts)
- Extensive guideline references throughout
- Clear contraindication explanations
- Score = $6/7 = 0.86 \approx 0.9$

Eval 2:

1. GUIDELINES ADHERENCE

KG recommendation	Required (F · D · Type · Intensity)	What the plan prescribes	Full y met ?	Note
Rec 1 – Trunk/hip resistance	3 × wk · 30 min · resistance · moderate	3 × wk core session, 30 min total, body-weight resistance, moderate tempo	Yes	Matches all specs
Rec 2 – Low-impact aerobic	5 × wk · 30 min · aerobic · low-to-mod	Text instructs 30 min walking/swimming 5 × wk	Yes	Explicit prescription given
Rec 3 – Flexibility/mobility	5 × wk · 15 min · flexibility · low	Mobility is 10 min inside the 3 strength days only	No	Short on frequency & duration

Calculation: compliant blocks = $2 \div 3 = 0.67 \rightarrow 0.7$

Score: 0.7

Justification: Resistance and aerobic guidelines are fully addressed; the mobility guideline is under-delivered.

2. SAFETY COMPLIANCE

Exercises analysed = 8 (Cat-Cow, Knee-to-Chest, Pelvic Tilt, Dead-Bug, Bird-Dog, Modified Side-Plank, Glute Bridge, Piriformis stretch)

Exercises that arguably breach contraindications: *Bird-Dog* and *Side-Plank* each have a mild balance/hip load element → **2 unsafe**

Calculation: $1 - (2 \div 8) = 0.75 \rightarrow \mathbf{0.8}$

Score: 0.8

Justification: Most moves are spine-neutral and low-impact; only two introduce moderate balance/hip demand but are still common physiotherapy drills.

3. BENEFIT POTENTIAL

Core-stability chain (pelvic tilt → dead-bug → bird-dog → side-plank) directly targets deep trunk muscles shown to ease disc-related pain; warm-up/cool-down cover key mobility patterns. Lacks a built-in daily stretch block and on-plan aerobic volume.

Score: 0.8

Justification: High therapeutic relevance for the user's goal with only minor volume gaps.

4. EXERCISE DIVERSITY

Categories present: Strength/Resistance ✓ · Flexibility/Mobility ✓ · Aerobic ✓
(prescribed walking) · Anaerobic/Power ✗

Calculation: $3 \div 4 = 0.75 \rightarrow \mathbf{0.8}$

Score: 0.8

Justification: Plan spans three of four major fitness domains.

5. PROGRESSION ADEQUACY

Plan instructs to “**gradually increase hold time, reps or sets once pain-free**” (mirrors Rec 1 progression).

Score: 1.0

Justification: Clear, guideline-linked progression guidance is included.

6. EXPLAINABILITY

Blocks with an explicit “Why?” or guideline tie-in = 6 (Cat-Cow, Knee-to-Chest, Side-Plank, Bird-Dog, Dead-Bug, Glute Bridge)

Total distinct exercise/section blocks evaluated = 8

Calculation: $6 \div 8 = 0.75 \rightarrow 0.8$

Score: 0.8

Justification: Most exercises are accompanied by concise rationales referencing back-pain mechanics or the KG guidelines.

Gemini + Reduced KG:

Okay, I understand! You're looking for a core-focused workout plan to manage your chronic low back pain from disc degeneration, and you want to avoid using any equipment. I can definitely help you with that.

It's great that you're taking an active role in managing your back pain. Before we dive into the plan, please remember that I'm an AI and this isn't a substitute for personalized medical advice. It's always best to discuss any new exercise program with your doctor or physical therapist, especially with your condition.

Here's a plan that takes into account the contraindications associated with disc degeneration in the lower back, focusing on safe and effective core strengthening exercises.

Understanding the Contraindications

Based on the information you provided, here's what we need to avoid and *why*:

- **High and Moderate Impact:** (Avoid high impactlevel, moderate impactlevel)
High-impact activities like jumping jacks, running, or plyometrics can put excessive stress on your spine and exacerbate disc degeneration. The impact can compress the discs and increase pain.
- **High and Moderate Intensity:** (Avoid high intensity, moderate intensity)
High-intensity exercises can lead to poor form and increased risk of injury. We need to focus on controlled movements and proper muscle engagement.
- **Spine Involvement:** This is a broad contraindication, but it means we need to be very careful with exercises that directly load or significantly flex/extend the spine.
- **High and Moderate Balance Requirement:** (Avoid high balancerequirement, moderate balancerequirement) Exercises requiring a lot of balance can be risky if you have back pain, as you might compensate with improper form or be at higher risk of falls.
- **Hip Involvement:** (Avoid Hip involvement) Exercises that heavily involve the hips can sometimes indirectly stress the lower back, especially if form is compromised.

Core-Focused Workout Plan (No Equipment)

This plan focuses on gentle core engagement and stabilization, avoiding spinal compression and high-impact movements. We'll prioritize exercises that strengthen the core without putting excessive stress on your lower back.

Important Considerations:

- **Listen to Your Body:** This is paramount. If you feel any sharp pain, stop the exercise immediately.
- **Proper Form:** Focus on maintaining correct posture and engaging your core muscles throughout each exercise. If you're unsure about your form, consider consulting a physical therapist.
- **Breathing:** Breathe deeply and consistently throughout each exercise. Avoid holding your breath.
- **Progression:** Start with the lower end of the repetition range and gradually increase as you get stronger. You can also increase the duration of holds.
- **Frequency:** Aim to perform this workout 2-3 times per week, with rest days in between.

Warm-up (5-10 minutes):

- **Cat-Cow Stretch:** Gentle spinal mobility. Get on your hands and knees. Inhale, arch your back, and drop your belly (cow). Exhale, round your spine towards the ceiling (cat). Repeat 10-15 times.

- **Pelvic Tilts:** Lie on your back with your knees bent and feet flat on the floor. Gently tilt your pelvis up, pressing your lower back into the floor. Then, tilt your pelvis down, creating a small arch in your lower back. Repeat 10-15 times. This helps improve awareness and control of your core muscles.

Workout:

- **Dead Bug:** (Core Stabilization)
 - Lie on your back with your knees bent at 90 degrees and your arms extended towards the ceiling.
 - Engage your core and slowly lower your right arm and left leg simultaneously, keeping your lower back pressed into the floor.
 - Return to the starting position and repeat on the other side.
 - Sets/Reps: 2-3 sets of 8-12 repetitions per side.
 - *Why it's appropriate:* This exercise strengthens the core while minimizing stress on the spine. The controlled movement and focus on maintaining a neutral spine are key.
- **Bird Dog:** (Core Stabilization, from our exercise database)
 - Start on your hands and knees, ensuring your back is flat.
 - Engage your core and slowly extend your right arm forward and your left leg backward simultaneously, keeping your hips and shoulders square to the floor.
 - Hold for a few seconds, then return to the starting position and repeat on the other side.
 - Sets/Reps: 2-3 sets of 8-12 repetitions per side.
 - *Why it's appropriate:* Similar to the dead bug, this exercise promotes core stability and balance without putting excessive pressure on the spine. It also helps improve coordination.
- **Glute Bridge:** (Posterior Chain Strengthening)
 - Lie on your back with your knees bent and feet flat on the floor.
 - Engage your glutes and lift your hips off the floor, creating a straight line from your knees to your shoulders.
 - Hold for a few seconds, then slowly lower back down.
 - Sets/Reps: 2-3 sets of 10-15 repetitions.
 - *Why it's appropriate:* This exercise strengthens the glutes and hamstrings, which support the lower back. It's a safe and effective way to improve core stability without directly loading the spine.
- **Side Plank (Modified):** (Lateral Core Strengthening)
 - Lie on your side with your knees bent and your elbow directly under your shoulder.

- Engage your core and lift your hips off the floor, creating a straight line from your knee to your shoulder.
- Hold for as long as you can maintain good form, then slowly lower back down.
- Sets/Reps: 2-3 sets, holding for 20-30 seconds per side.
- *Why it's appropriate:* This exercise strengthens the obliques and other lateral core muscles, which are important for spinal stability. The modified version (on your knees) reduces the intensity and stress on the lower back.
- **Pelvic Floor Exercises (Kegels):** (Core Activation)
 - These exercises focus on strengthening the pelvic floor muscles, which play a crucial role in core stability.
 - Imagine you are trying to stop the flow of urine. Squeeze those muscles, hold for a few seconds, and then relax.
 - Sets/Reps: 2-3 sets of 10-15 repetitions.
 - *Why it's appropriate:* Strengthening the pelvic floor can improve core stability and support the lower back.

Cool-down (5-10 minutes):

- **Child's Pose:** Gently stretch your lower back by sitting back on your heels and reaching your arms forward. Hold for 30-60 seconds.
- **Knee-to-Chest Stretch:** Lie on your back and gently pull one knee towards your chest. Hold for 20-30 seconds, then repeat on the other side.
- **Gentle Hamstring Stretch:** Lie on your back with one leg extended towards the ceiling. Use a towel or strap to gently pull your leg closer to your chest. Hold for 20-30 seconds, then repeat on the other side.

Additional Considerations:

- **Posture:** Pay attention to your posture throughout the day. Good posture can help reduce stress on your lower back.
- **Ergonomics:** Make sure your workstation is set up properly to support good posture.
- **Weight Management:** Maintaining a healthy weight can reduce stress on your spine.
- **Listen to your body:** If any exercise causes pain, stop immediately.

Remember, this is a general plan, and it's important to listen to your body and adjust it as needed. It is based on the contraindication data you provided, and the exercises are selected from our exercise database. If you have any concerns or questions, please consult with your doctor or physical therapist. Good luck!

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Score: 0.3 **Justification:** The plan significantly deviates from guidelines - recommends only 2-3x/week instead of 3x, doesn't specify 30-minute duration or moderate intensity, completely omits aerobic exercise, and lacks specific progression timelines.

Calculation:

- Frequency: 2-3x/week vs 3x/week ✗
- Intensity: Not specified (should be moderate) ✗
- Duration: Not specified (should be 30 minutes) ✗
- Type: Has resistance training ✓, missing aerobic ✗, has flexibility ✓
- Rest period: Mentioned ✓
- Progression: Vague, no timeline ✗
- Score = $2/7 = 0.29 \approx 0.3$

2. SAFETY COMPLIANCE

Score: 0.4 **Justification:** Multiple exercises violate contraindications - Dead Bug, Bird Dog, and Glute Bridge all involve spine/hip movement which are explicitly listed as contraindications, despite the plan's attempt to justify them as "safe."

Calculation:

- Total exercises: 8 (including warm-up/cool-down)
- Unsafe exercises: 5 (Cat-Cow - spine involvement, Pelvic Tilts - spine involvement, Dead Bug - spine involvement, Bird Dog - spine involvement, Glute Bridge - hip involvement)
- Score = $1 - (5/8) = 0.375 \approx 0.4$

3. BENEFIT POTENTIAL

Score: 0.7 Justification: The plan provides reasonable therapeutic value with comprehensive explanations and appropriate core focus for disc degeneration, meeting the no-equipment requirement, but the safety concerns reduce its overall benefit.

4. EXERCISE DIVERSITY

Score: 0.5 Justification: The plan includes strength/resistance training (core exercises) and stretching/flexibility work but completely lacks aerobic and anaerobic components.

Calculation:

- Strength/Resistance: ✓
- Stretching/Flexibility: ✓
- Aerobic: ✗
- Anaerobic: ✗
- Score = $2/4 = 0.5$

5. PROGRESSION ADEQUACY

Score: 0.5 Justification: The plan mentions progression in general terms ("gradually increase as you get stronger") but lacks the specific timeline requirements from guidelines like "increase hold time once pain-free" or "add 5 minutes every 2 weeks."

6. EXPLAINABILITY

Score: 1.0 Justification: Every single exercise includes detailed "Why it's appropriate" explanations, the plan thoroughly explains all contraindications with clear rationales, and provides comprehensive safety considerations throughout.

Calculation:

- All 5 main exercises have explanations
- Extensive contraindication explanations at the beginning
- Additional considerations well explained
- Score = $5/5 = 1.0$

Eval 2:

1. GUIDELINES ADHERENCE

Guideline block	Minimum specs (F · D · T · I)	What the plan offers	Fully met?	Reason
Rec 1 – Trunk/hip resistance	3 × wk · 30 min · resistance · moderate	2-3 × wk · 20-30 min (incl. warm-up) · body-weight core · low	No	Intensity < “moderate”; duration borderline; frequency ok
Rec 2 – Low-impact aerobic	5 × wk · 30 min · aerobic · low/mod	None	No	Aerobic component absent
Rec 3 – Flexibility/mobility	5 × wk · 15 min · mobility · low	2-3 × wk · ~10 min (warm-up + cool-down)	No	Frequency & duration below target

Calculation: compliant blocks = 0 / 3 = 0.00 → **0.0**

Score: 0.0

Justification: The plan supplies helpful resistance and mobility work but does not fully satisfy any guideline set (missing aerobic, under-dosage, and lower-than-required intensity).

2. SAFETY COMPLIANCE

Total distinct exercises reviewed = 10

Unsafe per contraindications

- **Cat-Cow** (repeated end-range spinal flex/extension → “Spine involvement”)

Unsafe items = 1

Calculation: $1 - (1 \div 10) = 0.90 \rightarrow \mathbf{0.9}$

Score: 0.9

Justification: 90 % of movements respect disc-degeneration cautions; only Cat-Cow clearly conflicts with the “avoid spine involvement” flag.

3. BENEFIT POTENTIAL

The sequence emphasises core stabilisation (dead-bug, bird-dog, side-plank) and posterior-chain support (glute bridge), all evidence-based for disc degeneration. Yet it omits guideline-recommended aerobic conditioning and provides sub-target total session length.

Score: 0.7

Justification: Solid therapeutic match for pain-free trunk strength, but overall fitness benefit is curtailed by missing cardio and shorter sessions.

4. EXERCISE DIVERSITY

Categories present

- Strength/Stabilisation ✓
- Flexibility/Mobility ✓
- Aerobic ✗
- Anaerobic/Power ✗

Calculation: $2 \div 4 = 0.50 \rightarrow 0.5$

Score: 0.5

Justification: Covers two of four basic fitness domains.

5. PROGRESSION ADEQUACY

Plan instructs: “Start at low reps, gradually increase,” and “increase hold duration”.

Score: 1.0

Justification: Gives clear, measurable progression directions consistent with guideline language.

6. EXPLAINABILITY

Blocks (exercise or section) counted = 10

Blocks containing an explicit “Why it’s appropriate / why we avoid” note = 8

Calculation: $8 \div 10 = 0.80 \rightarrow 0.8$

Score: 0.8

Justification: Most prescription lines tie choices to back-pain safety or rationale grounded in the contraindications/guidelines.

User Query 5: *I have a lumbar herniated disc and need a beginner-friendly workout to relieve stiffness. I can handle up to 30 minutes, but I'd prefer low-impact exercises done on the floor or lying down.*

Gemini + Complete KG:

Okay, I understand you're looking for a beginner-friendly, low-impact workout to relieve stiffness from a lumbar herniated disc, focusing on floor or lying-down exercises within a 30-minute timeframe. I can definitely help you create a plan based on the provided fitness guidelines and contraindications.

It's important to remember that while I can provide guidance, it's always best to consult with your doctor or a physical therapist before starting any new exercise program, especially with a herniated disc. They can assess your specific condition and ensure the exercises are safe and appropriate for you. The "Fitness recommendation 3 for Chronic Back Pain" specifically mentions that you should "Follow back-specific stretching plan from therapist".

Here's a workout plan incorporating the guidelines and safe exercises, designed to be gentle and effective:

I. Understanding the Guidelines and Restrictions

Before we dive into the workout, let's clarify the key recommendations and what to avoid, according to the provided data:

- **Frequency:** Aim for a combination of resistance training (3 times per week), low-impact aerobic exercise (5 times per week), and flexibility/mobility work (5 times per week).
- **Intensity:** Keep the intensity **low to moderate** for aerobic exercise and **moderate** for resistance training.
- **Duration:** Each session should be around 15-30 minutes.
- **Type:** Focus on resistance training for the trunk and hip, low-impact aerobic activities, and flexibility/mobility exercises.
- **Supervision:** Initial instruction by a physiotherapist is crucial, especially for resistance training, to ensure a neutral spine.
- **Progression:** Gradually increase hold times for stretches or resistance as exercises become pain-free. For aerobic exercises, add 5 minutes to each session every 2 weeks.

Contraindications (Things to Avoid):

Based on the contraindication data, you should avoid exercises with:

- **High or Moderate Impact:** This rules out jumping, running, or other high-impact activities that could jar your spine.
- **High Balance Requirement:** Exercises that require a lot of balance can put undue stress on your back as you compensate.
- **Spine Involvement:** Avoid movements that directly and aggressively flex, extend, or twist the spine, especially under load.
- **Hip Involvement:** Be cautious with exercises that heavily involve the hips, as they can indirectly affect the lumbar spine.
- **High or Moderate Intensity:** This is important to avoid aggravating your condition.

II. Beginner-Friendly Workout Plan (Focus on Floor/Lying Down)

This plan incorporates elements from all three fitness recommendations, modified for floor/lying-down positions and beginner-level intensity.

A. Warm-up (5 minutes)

- **Purpose:** Prepares your muscles for exercise and increases blood flow.
- **Exercises:**
 - **Pelvic Tilts (Lying Down):** Lie on your back with knees bent and feet flat on the floor. Gently tilt your pelvis forward and backward, flattening your lower back against the floor and then arching it slightly. (10-15 repetitions). This is a gentle way to mobilize the lumbar spine.

- **Knee-to-Chest (Lying Down):** Lie on your back with knees bent and feet flat on the floor. Gently bring one knee towards your chest, holding it with your hands. Alternate legs. (5-10 repetitions per leg). This gently stretches the lower back and hip flexors, as mentioned in "Fitness recommendation 3 for Chronic Back Pain" as a mobility exercise.

B. Resistance Training (10 minutes) - "Fitness recommendation 1 for Chronic Back Pain"

- **Focus:** Strengthening trunk and hip muscles while maintaining a neutral spine.
Remember to get initial instruction from a physiotherapist to ensure correct form.
- **Exercises:**
 - **Bird Dog (Modified):** Start on your hands and knees. Instead of extending your arm and leg simultaneously, focus on extending one leg straight back, keeping your core engaged and back flat. (8-12 repetitions per leg). This strengthens core and back muscles without excessive spinal loading.
 - **Glute Bridges:** Lie on your back with knees bent and feet flat on the floor. Squeeze your glutes and lift your hips off the floor, forming a straight line from your knees to your shoulders. Hold for a few seconds, then slowly lower back down. (10-15 repetitions). This strengthens the glutes and hamstrings, which support the lower back.
 - **Side-Lying Leg Lifts:** Lie on your side with your bottom leg bent for support. Lift your top leg straight up towards the ceiling, keeping your core engaged. (10-15 repetitions per leg). This strengthens the hip abductors, which help stabilize the pelvis.

C. Flexibility & Mobility (10 minutes) - "Fitness recommendation 3 for Chronic Back Pain"

- **Focus:** Gentle stretching to improve range of motion and reduce stiffness.
- **Exercises:**
 - **Knee-to-Chest (Lying Down):** (Hold each stretch for 20-30 seconds).
 - **Piriformis Stretch (Lying Down):** Lie on your back with knees bent. Place your right ankle on your left knee. Gently pull your left thigh towards your chest until you feel a stretch in your right buttock. Repeat on the other side. (Hold each stretch for 20-30 seconds). This targets the piriformis muscle, which can contribute to lower back pain.
 - **Cat-Cow (Modified):** Start on your hands and knees. Instead of a full cat-cow, focus on gently arching your back slightly (cow) and then

rounding it slightly (cat), keeping the movement small and controlled. (5-10 repetitions). This promotes spinal mobility.

D. Cool-down (5 minutes)

- **Purpose:** Gradually lower your heart rate and prevent muscle soreness.
- **Exercises:**
 - **Gentle Stretching:** Repeat some of the stretches from the flexibility section, holding them for longer periods (30-45 seconds).
 - **Deep Breathing:** Focus on slow, deep breaths to relax your body and mind.

III. Important Considerations and Modifications

- **Listen to Your Body:** This is the most important guideline. If you feel any pain, stop the exercise immediately.
- **Neutral Spine:** Maintaining a neutral spine is crucial throughout the workout. This means keeping the natural curves of your spine intact. Avoid excessive arching or rounding of your back.
- **Progression:** As you get stronger and more comfortable, you can gradually increase the duration of the exercises, the number of repetitions, or the resistance (e.g., using resistance bands for the glute bridges).
- **Breathing:** Remember to breathe throughout the exercises. Exhale during the exertion phase (e.g., lifting your hips in the glute bridge) and inhale during the relaxation phase.
- **Consistency:** Aim to perform this workout 3-5 times per week for optimal results.

IV. Additional Notes

- **Safe Exercises:** From our exercise database, some of the safe exercises listed include Calf_Stretch, Chest_Opener_Stretch, Chest_Stretch_in_Doorway, Neck_Side_Stretch, Shoulder_Cross_body_Stretch, Side_Neck_Stretch, and Triceps_Stretch. These can be incorporated as needed, but prioritize the exercises that target the trunk and hip muscles.
- **Aerobic Exercise:** While this plan focuses on floor exercises, don't forget the importance of low-impact aerobic exercise. Walking, swimming, or stationary cycling are great options, as mentioned in "Fitness recommendation 2 for Chronic Back Pain".

V. Disclaimer

This workout plan is based on the information provided and is intended as a general guideline. It is not a substitute for professional medical advice. Always consult with your doctor or a physical therapist before starting any new exercise program, especially if you have a herniated disc. They can assess your specific condition and ensure the exercises are safe and appropriate for you.

Eval 1:

I'll evaluate this AI-generated workout plan for lumbar herniated disc using the six specified metrics.

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Score: 0.7 **Justification:** The plan follows most guidelines including duration (30 minutes), type (resistance, flexibility), and mentions proper frequencies, but doesn't fully implement the aerobic component within the workout and intensity specifications could be clearer.

Calculation:

- Frequency: Mentions 3-5x/week and explains all frequencies ✓
- Intensity: Mentions low-moderate but not consistently applied ✓ / ✗
- Duration: 30 minutes total ✓
- Type: Resistance training ✓, Flexibility ✓, Aerobic mentioned but not included ✗
- Rest period: Not explicitly mentioned for resistance ✗
- Progression: Included ✓
- Score = $5/7 = 0.71 \approx 0.7$

2. SAFETY COMPLIANCE

Score: 0.5 **Justification:** Several exercises violate contraindications - Bird Dog, Glute Bridges, and Cat-Cow all involve spine/hip movement which are explicitly listed as contraindications, despite being modified versions.

Calculation:

- Total exercises: 8
- Unsafe exercises: 4 (Pelvic Tilts - spine involvement, Bird Dog - spine/hip, Glute Bridges - hip involvement, Cat-Cow - spine involvement)
- Score = $1 - (4/8) = 0.5$

3. BENEFIT POTENTIAL

Score: 0.8 Justification: The plan provides good therapeutic value with appropriate beginner-friendly exercises for herniated disc, meets the user's preferences for floor-based exercises and 30-minute duration, though safety concerns reduce its overall benefit.

4. EXERCISE DIVERSITY

Score: 0.5 Justification: The plan includes resistance/strength training and stretching/flexibility components but lacks aerobic exercise within the workout (only mentioned as additional recommendation) and no anaerobic component.

Calculation:

- Strength/Resistance: ✓
- Stretching/Flexibility: ✓
- Aerobic: ✗ (mentioned but not included)
- Anaerobic: ✗
- Score = $2/4 = 0.5$

5. PROGRESSION ADEQUACY

Score: 1.0 Justification: The plan includes excellent progression instructions both in the guidelines section and in the "Important Considerations," specifically mentioning increasing duration, repetitions, resistance, and hold times as exercises become pain-free.

6. EXPLAINABILITY

Score: 0.8 Justification: Most exercises include explanations referencing the guidelines or therapeutic rationale, with extensive quotes from the KG data throughout, though not every single exercise has a specific "why" explanation.

Calculation:

- Exercises with clear explanations: 6/8
- Extensive guideline quotes and references

- Clear contraindication explanations
- Score = $6/8 = 0.75 \approx 0.8$

Eval 2:

1. GUIDELINES ADHERENCE

Recommendation	Must-meet specs (F · I · D · T)	What the plan prescribes	Fully met?	Comment
Rec 1 – Trunk/hip resistance	3 × wk · 30 min · Moderate · trunk/hip resistance	30-min session, “perform 3–5 × wk”, moderate, core & hip work	Yes	All four parameters satisfied
Rec 2 – Low-impact aerobic	5 × wk · 30 min · low/mod · aerobic	Only <i>mentions</i> walking, cycling, swimming— not included in session	No	Type & duration absent
Rec 3 – Flexibility/mobility	5 × wk · 15 min · low	10 min per session, frequency 3–5 × wk	No	Duration < 15 min (and maybe < 5 × wk)

Calculation → compliant blocks = $1 \div 3 = 0.33 \rightarrow \mathbf{0.3}$

Score: 0.3

Justification: Only the resistance prescription fully matches guideline frequency, duration, intensity, and type; aerobic work is missing and flexibility volume is low.

2. SAFETY COMPLIANCE

Exercises analysed (8 unique moves)

Exercise	Contra flag?
Pelvic tilts	✓ (spine involvement)
Knee-to-chest	✓ (spine involvement/hip)

Bird-dog (mod.)	✓ (spine involvement)
Glute bridges	–
Side-lying leg lifts	–
Piriformis stretch	–
Cat-cow (mod.)	✓ (spine involvement)
Warm-up/cool-down neck & breathing stretches	–

Unsafe items = 4, total = 8

Calculation $\rightarrow 1 - (4 \div 8) = 0.50 \rightarrow \mathbf{0.5}$

Score: 0.5

Justification: Half of the listed movements involve deliberate lumbar/spinal motion, which the contraindication table says to avoid for a herniation; the rest are safe.

3. BENEFIT POTENTIAL

The programme gives a gentle 30-min floor routine that strengthens core/hips and mobilises the back—valuable for stiffness relief and beginner tolerance. Lack of any built-in aerobic element and inclusion of several spine-loaded moves temper overall therapeutic value.

Score: 0.7

Justification: Good match to the user's time limit and low-impact request, but could better respect contraindications and include aerobic conditioning.

4. EXERCISE DIVERSITY

Categories present:

- Strength ✓
- Flexibility/Mobility ✓
- Aerobic ✕
- Anaerobic/Power ✕

Calculation $\rightarrow 2 \div 4 = 0.5$

Score: 0.5

Justification: Only two of the four major categories are covered.

5. PROGRESSION ADEQUACY

Plan states: “Gradually increase hold times, repetitions, or resistance” and “Add 5 min to aerobic every 2 weeks” (though aerobic not embedded).

Score: 1.0

Justification: Clear, guideline-linked progression cues are provided.

6. EXPLAINABILITY

Blocks with an explicit “why it’s appropriate” or guideline reference = 7

Total exercise/section blocks considered = 8

Calculation $\rightarrow 7 \div 8 = 0.88 \rightarrow 0.9$

Score: 0.9

Justification: Nearly every exercise is followed by a short rationale tied to the guidelines or safety principles.

Gemini + Reduced KG:

Okay, I can definitely help you put together a beginner-friendly workout to relieve stiffness from your lumbar herniated disc. Since you prefer low-impact exercises done on the floor or lying down, and you have about 30 minutes to spare, we can create a routine that works for you.

It's important to remember that I am an AI and this is not medical advice. Always consult with your doctor or physical therapist before starting any new exercise program, especially with a condition like a herniated disc. They can provide personalized guidance based on your specific situation.

Here's a plan that incorporates the "Safe Exercises" from our database while respecting the "Contraindications" you provided:

Understanding the Restrictions

First, let's quickly address the restrictions. Based on the "Contraindications" data for a lumbar herniated disc, we need to avoid:

- **High and Moderate Impact:** This means no jumping, running, or anything that puts a lot of force on your spine. (Source: "avoid attributes for Chronic Back Pain - Lower back (lumbar) - Herniation" includes "high impactlevel" and "moderate impactlevel")
- **High and Moderate Intensity:** We'll keep the exercises gentle and controlled, avoiding anything that strains your back. (Source: "avoid attributes for Chronic Back Pain - Lower back (lumbar) - Herniation" includes "high intensity" and "moderate intensity")
- **Spine Involvement:** Exercises that directly load or twist the spine should be avoided. (Source: "avoid attributes for Chronic Back Pain - Lower back (lumbar) - Herniation" includes "Spine involvement")
- **High Balance Requirement:** We'll focus on stable positions to minimize the risk of falls or instability. (Source: "avoid attributes for Chronic Back Pain - Lower back (lumbar) - Herniation" includes "high balancerequirement")
- **Hip Involvement:** Exercises that excessively stress the hip joint should be avoided. (Source: "avoid attributes for Chronic Back Pain - Lower back (lumbar) - Herniation" includes "Hip involvement")

Beginner-Friendly Workout Plan (30 Minutes)

This workout focuses on gentle stretches and light strengthening exercises that are safe for your condition, based on the exercises listed as safe.

Warm-up (5 minutes)

- **Gentle Neck Stretches:** (from our exercise database: "Neck_Side_Stretch")
 - **How:** Slowly tilt your head to the right, bringing your ear towards your right shoulder. Hold for 15-20 seconds. Repeat on the left side. Perform 2-3 repetitions on each side.
 - **Why:** Relieves tension in the neck muscles, which can often be tight when experiencing back pain.
- **Shoulder Cross-body Stretch:** (from our exercise database: "Shoulder_Cross_body_Stretch")

- **How:** Gently pull one arm across your body, holding it with your other hand. Hold for 15-20 seconds. Repeat on the other side. Perform 2-3 repetitions on each side.
- **Why:** Improves shoulder mobility and reduces tension in the upper back.
- **Wrist Flexor Stretch:** (from our exercise database: "Wrist_Flexor_Stretch")
 - **How:** Extend one arm in front of you, palm up. Use your other hand to gently bend your wrist downwards, feeling a stretch in your forearm. Hold for 15-20 seconds. Repeat on the other side. Perform 2-3 repetitions on each side.
 - **Why:** Improves wrist flexibility.

Workout (20 minutes)

- **Chest Opener Stretch:** (from our exercise database: "Chest_Opener_Stretch")
 - **How:** Lie on your back with your knees bent and feet flat on the floor. Gently open your arms out to the sides, feeling a stretch across your chest. Hold for 30 seconds. Repeat 2-3 times.
 - **Why:** Counteracts the effects of slouching and improves posture, which can alleviate back pain.
- **Chest Stretch in Doorway:** (from our exercise database: "Chest_Stretch_in_Doorway")
 - **How:** Place your forearms on a doorframe, slightly wider than shoulder-width apart. Gently lean forward until you feel a stretch in your chest and shoulders. Hold for 20-30 seconds. Repeat 2-3 times.
 - **Why:** Improves posture and opens up the chest, which can help alleviate back pain.
- **Calf Stretch:** (from our exercise database: "Calf_Stretch")
 - **How:** Stand facing a wall, place one foot slightly behind the other. Lean forward, keeping your back heel on the ground, until you feel a stretch in your calf. Hold for 20-30 seconds. Repeat on the other side. Perform 2-3 repetitions on each side.
 - **Why:** Improves flexibility in the lower legs, which can indirectly affect posture and back pain.
- **Dumbbell Bicep Curl:** (from our exercise database: "Dumbbell_Bicep_Curl")
 - **How:** Stand with your feet shoulder-width apart, holding a dumbbell in each hand. Keeping your elbows close to your body, curl the dumbbells up towards your shoulders. Slowly lower the dumbbells back to the starting position. Perform 2-3 sets of 10-12 repetitions.
 - **Why:** Strengthens the biceps muscles, which can help improve upper body strength and stability.

- **Overhead Tricep Extension:** (from our exercise database: "Overhead_Tricep_Extension")
 - **How:** Stand with your feet shoulder-width apart, holding a dumbbell in both hands. Extend your arms overhead, then slowly lower the dumbbell behind your head, bending at the elbows. Extend your arms back to the starting position. Perform 2-3 sets of 10-12 repetitions.
 - **Why:** Strengthens the triceps muscles, which can help improve upper body strength and stability.

Cool-down (5 minutes)

- Repeat the gentle neck stretches and shoulder cross-body stretch from the warm-up.
- Hold each stretch for a longer duration (30 seconds).
- Focus on deep breathing and relaxation.

Important Considerations:

- **Listen to your body:** If you feel any pain, stop the exercise immediately.
- **Proper form is crucial:** Watch videos or consult with a professional to ensure you're performing the exercises correctly.
- **Progression:** As you get stronger, you can gradually increase the duration or repetitions of the exercises. However, always prioritize proper form and avoid pushing yourself too hard.
- **Consistency is key:** Aim to perform this workout 2-3 times per week for best results.

Why these exercises are appropriate:

- The stretches are gentle and focus on improving flexibility without putting stress on the spine.
- The strengthening exercises (bicep curls and tricep extensions) are low-impact and target the upper body, which can help improve posture and stability without directly involving the spine.
- All exercises can be modified to be performed on the floor or lying down if needed.

Remember, this is a general plan. A physical therapist can assess your specific condition and create a tailored exercise program for you. Good luck!

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Score: 0.2 **Justification:** The plan poorly follows guidelines - recommends only 2-3x/week instead of required frequencies, lacks trunk/hip resistance training, completely omits aerobic exercise, and focuses primarily on upper body exercises contrary to guidelines.

Calculation:

- Frequency: 2-3x/week vs 3x resistance + 5x aerobic + 5x flexibility ✗
- Intensity: Not specified (should be moderate/low) ✗
- Duration: 30 minutes ✓
- Type: Wrong focus (upper body vs trunk/hip), no aerobic ✗
- Progression: Vague mention ✗
- Equipment: Uses dumbbells (not mentioned in guidelines) ✗
- Score = $1/6 = 0.17 \approx 0.2$

2. SAFETY COMPLIANCE

Score: 0.8 **Justification:** Most exercises are from the safe list and avoid contraindications well, though the standing exercises (calf stretch, bicep curls, tricep extensions) don't meet the user's preference for floor/lying exercises.

Calculation:

- Total exercises: 8
- Unsafe/inappropriate: 2 (standing exercises when user requested floor/lying)
- All from safe exercise list: Yes
- Score = $1 - (2/8) = 0.75 \approx 0.8$

3. BENEFIT POTENTIAL

Score: 0.4 **Justification:** The plan fails to address the core issue - it focuses on upper body exercises instead of trunk/hip strengthening for back pain relief, and doesn't meet the user's specific request for floor/lying exercises throughout.

4. EXERCISE DIVERSITY

Score: 0.5 **Justification:** The plan includes stretching (multiple exercises) and some strength training (bicep curls, tricep extensions) but completely lacks aerobic and anaerobic components.

Calculation:

- Strength: ✓ (though wrong muscle groups)
- Stretching: ✓
- Aerobic: ✗
- Anaerobic: ✗
- Score = 2/4 = 0.5

5. PROGRESSION ADEQUACY

Score: 0.5 **Justification:** The plan mentions progression briefly ("gradually increase duration or repetitions") but lacks specific timelines or criteria from guidelines like "increase hold time once pain-free" or "add 5 minutes every 2 weeks."

6. EXPLAINABILITY

Score: 1.0 **Justification:** Every exercise includes clear "Why" explanations, all exercises are explicitly linked to the safe exercise database, and contraindications are thoroughly explained with direct source citations.

Calculation:

- All 8 exercises have "Why" explanations
- Clear database references for each exercise
- Contraindications explained with sources
- Score = 8/8 = 1.0

Eval 2:

1. GUIDELINES ADHERENCE

Chronic-back-pain guideline	Specs to meet (F · I · D · T)	What the plan prescribes	Fully met?	Comment
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Rec 1 – Trunk/hip resistance 3 × wk · 30 min · moderate	Freq ?; Intensity = low; 30-min session but no trunk/hip work	No	Wrong muscle focus & intensity
Rec 2 – Low-impact aerobic 5 × wk · 30 min	None	No	Aerobic element absent
Rec 3 – Flexibility/mobilit y 5 × wk · 15 min	2-3 × wk; ≈12 min stretching	No	Frequency & duration short

Calculation: 0 compliant blocks ÷ 3 total = **0.00** → **0.0**

Score: 0.0

Justification: The programme omits guideline-required aerobic work, lacks trunk/hip resistance, and under-delivers flexibility frequency/duration.

2. SAFETY COMPLIANCE

Exercises analysed (8):

Neck-side stretch, shoulder cross-body stretch, wrist-flexor stretch, chest opener stretch, chest doorway stretch, calf stretch, **standing dumbbell biceps curl**, **standing overhead triceps extension**

Unsafe items (load/compress spine contrary to “Spine involvement”): biceps curl, overhead triceps extension → **2**

Calculation: 1 – (2 ÷ 8) = 0.75 → **0.8**

Score: 0.8

Justification: Most moves are low-impact and stable, but two standing, spine-loading strength exercises violate the “avoid spine involvement” rule.

3. BENEFIT POTENTIAL

Plan offers gentle stretching and light upper-body strength to relieve general stiffness, but it ignores core-stabilising trunk work crucial for lumbar disc rehab and provides no cardio conditioning.

Score: 0.4

Justification: Some short-term relief value, yet therapeutic depth is limited for lumbar herniation.

4. EXERCISE DIVERSITY

Categories present: Strength ✓ Flexibility ✓ Aerobic ✗ Power ✗

Calculation: $2 \div 4 = 0.50$

Score: 0.5

Justification: Only stretching and light strength are covered.

5. PROGRESSION ADEQUACY

Plan states: “As you get stronger, gradually increase the duration or repetitions.”

Score: 1.0

Justification: Explicit instruction to progress load/volume over time is included.

6. EXPLAINABILITY

Exercise blocks with a “Why it’s appropriate” rationale = 8

Total exercise/stretch blocks = 8

Calculation: $8 \div 8 = 1.0$

Score: 1.0

Justification: Every exercise is accompanied by a brief, condition-linked explanation.

User Query 6: *I’ve been managing scoliosis-related*

back pain and want a workout routine to help strengthen my back and improve posture. I'd like something simple with not too many equipments.

Gemini + Complete KG:

Okay, I understand you're looking for a simple workout routine to help strengthen your back and improve posture while managing scoliosis-related back pain. I will create a plan based on the provided fitness guidelines, contraindications, and safe exercises.

It's important to remember that I am an AI and this is not a substitute for professional medical advice. It's crucial to consult with your doctor or a physical therapist before starting any new exercise program, especially with scoliosis. They can assess your specific condition and tailor a plan that's safe and effective for you.

Here's a workout plan designed to address your needs, incorporating the information you provided:

I. Understanding the Guidelines and Restrictions

Before diving into the workout, let's review the key guidelines and restrictions for chronic back pain with scoliosis:

- **Fitness Recommendations:**

- **Resistance Training (3 times per week):** Focus on trunk and hip strengthening with moderate intensity for 30 minutes. (According to "Fitness recommendation 1 for Chronic Back Pain")
 - *Important:* Initial instruction by a physiotherapist is crucial to ensure you maintain a neutral spine during these exercises.
 - *Equipment:* Swiss ball, exercise mat, resistance bands.
- **Low-Impact Aerobic Exercise (5 times per week):** Choose activities like walking, swimming, or stationary cycling at a low-to-moderate intensity for 30 minutes. (According to "Fitness recommendation 2 for Chronic Back Pain")
 - *Important:* Maintain an upright posture and use supportive footwear or a properly fitted bike.
- **Flexibility & Mobility (5 times per week):** Perform exercises like cat-camel, knee-to-chest, and piriformis stretches at a low intensity for 15

minutes. (According to "Fitness recommendation 3 for Chronic Back Pain")

- *Important:* Follow a back-specific stretching plan from a therapist.
- *Equipment:* Yoga strap, exercise mat, foam roller.

- **Contraindications (What to Avoid):**

- Avoid exercises with moderate to high balance requirements, high impact, moderate to high intensity, and those with spine or hip involvement. (Based on the contraindications data provided)
 - *Reasoning:* These activities can exacerbate pain and potentially worsen your scoliosis.

II. Sample Workout Routine

Here's a sample workout routine that incorporates the guidelines and safe exercises, focusing on minimal equipment:

A. Resistance Training (3 times per week - e.g., Monday, Wednesday, Friday)

- **Warm-up (5 minutes):** Gentle movements like arm circles, leg swings, and torso twists (within a pain-free range).
- **Exercises:**
 - **Swiss Ball Bridge (10-12 reps, 3 sets):** Lie on your back with your feet on a Swiss ball. Lift your hips off the ground, engaging your glutes and core. Hold for a few seconds at the top. (Based on "Fitness recommendation 1 for Chronic Back Pain" - targets trunk and hip, low impact).
 - **Resistance Band Rows (10-12 reps, 3 sets):** Sit on the floor with your legs extended. Loop a resistance band around your feet and hold the ends. Pull the band towards your torso, squeezing your shoulder blades together. (Based on "Fitness recommendation 1 for Chronic Back Pain" - strengthens back muscles, low impact).
 - **Bird Dog (10-12 reps per side, 3 sets):** Start on your hands and knees. Extend one arm forward and the opposite leg backward, keeping your core engaged and back straight. Alternate sides. (Based on "Fitness recommendation 1 for Chronic Back Pain" - improves core stability and balance, low impact).
 - **Plank (Hold for 20-30 seconds, 3 sets):** Maintain a straight line from head to heels, engaging your core. (Based on "Fitness recommendation 1 for Chronic Back Pain" - strengthens core muscles, low impact).
- **Cool-down (5 minutes):** Gentle stretching, holding each stretch for 20-30 seconds.

B. Low-Impact Aerobic Exercise (5 times per week - e.g., Daily)

- **Choose one of the following:**
 - **Walking (30 minutes):** Maintain an upright posture and wear supportive shoes. (According to "Fitness recommendation 2 for Chronic Back Pain").
 - **Stationary Cycling (30 minutes):** Adjust the bike to ensure proper posture and avoid hunching over. (According to "Fitness recommendation 2 for Chronic Back Pain").
 - **Swimming (30 minutes):** Focus on strokes that don't excessively twist the spine. (According to "Fitness recommendation 2 for Chronic Back Pain").

C. Flexibility & Mobility (5 times per week - e.g., Daily)

- **Perform the following stretches:**
 - **Cat-Camel Stretch (10 reps):** Alternate between arching your back like a cat and rounding your spine like a camel. (According to "Fitness recommendation 3 for Chronic Back Pain").
 - **Knee-to-Chest Stretch (Hold for 20-30 seconds per leg, 3 reps):** Lie on your back and pull one knee towards your chest. (According to "Fitness recommendation 3 for Chronic Back Pain").
 - **Piriformis Stretch (Hold for 20-30 seconds per side, 3 reps):** Lie on your back with your knees bent. Place one ankle on the opposite knee and gently pull the thigh towards your chest. (According to "Fitness recommendation 3 for Chronic Back Pain").
 - **Chest Opener Stretch:** (from our exercise database)
 - **Chest Stretch in Doorway:** (from our exercise database)
 - **Neck Side Stretch:** (from our exercise database)
 - **Side Neck Stretch:** (from our exercise database)
 - **Triceps Stretch:** (from our exercise database)

III. Important Considerations and Modifications

- **Listen to Your Body:** Pay close attention to your pain levels. If you experience any sharp or radiating pain, stop the exercise immediately.
- **Progression:** As exercises become easier and pain-free, gradually increase the hold time, resistance, or repetitions. (According to "Fitness recommendation 1 for Chronic Back Pain" and "Fitness recommendation 3 for Chronic Back Pain").
- **Neutral Spine:** Maintaining a neutral spine is crucial during all exercises. This means keeping your back in its natural alignment, avoiding excessive arching or rounding.
- **Breathing:** Breathe deeply and evenly throughout each exercise.

- **Warm-up and Cool-down:** Always warm up before exercising and cool down afterward to prevent injury and improve flexibility.
- **Consult a Professional:** It's highly recommended to work with a physical therapist or certified personal trainer who has experience working with individuals with scoliosis. They can assess your specific needs and create a personalized exercise program.

IV. Additional Safe Exercises

Here are some additional safe exercises from our exercise database that you could incorporate into your routine:

- Dumbbell Bicep Curl
- Overhead Tricep Extension
- Shoulder Cross-body Stretch
- Wrist Flexor Stretch

Remember, this is a general guideline. Your specific needs may vary. Always consult with your doctor or physical therapist before starting any new exercise program. They can help you create a safe and effective plan that addresses your individual condition and goals.

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Score: 0.9 **Justification:** The plan excellently follows nearly all guidelines including frequencies (3x resistance, 5x aerobic, 5x flexibility), intensities, durations, types, and equipment recommendations, with only minor deviations in exercise selection.

Calculation:

- Frequency: 3x resistance ✓ , 5x aerobic ✓ , 5x flexibility ✓
- Intensity: Moderate for resistance ✓ , low-moderate for aerobic ✓ , low for flexibility ✓
- Duration: 30 min resistance ✓ , 30 min aerobic ✓ , 15 min flexibility ✓

- Type: All three types included correctly ✓
- Equipment: Uses recommended equipment ✓
- Progression: Included ✓
- Score = 11/12 items fully compliant = $0.92 \approx 0.9$

2. SAFETY COMPLIANCE

Score: 0.3 **Justification:** Multiple exercises violate contraindications - Swiss Ball Bridge, Bird Dog, Plank, and Cat-Camel all involve spine/hip movement which are explicitly contraindicated for scoliosis.

Calculation:

- Total exercises: 11
- Unsafe exercises: 8 (Swiss Ball Bridge - hip involvement, Band Rows - not on safe list, Bird Dog - spine/hip involvement, Plank - spine involvement, Cat-Camel - spine involvement, Knee-to-Chest - hip involvement, Piriformis - hip involvement, walking/cycling/swimming - not on safe list)
- Score = $1 - (8/11) = 0.27 \approx 0.3$

3. BENEFIT POTENTIAL

Score: 0.8 **Justification:** Despite safety concerns, the plan provides comprehensive therapeutic value with all three exercise types, addresses posture and back strengthening goals, and meets the user's request for minimal equipment.

4. EXERCISE DIVERSITY

Score: 0.8 **Justification:** The plan includes resistance training, aerobic exercise, and stretching/flexibility components, lacking only anaerobic exercises which would be inappropriate for this condition.

Calculation:

- Strength/Resistance: ✓
- Aerobic: ✓
- Stretching/Flexibility: ✓
- Anaerobic: ✗ (appropriately excluded)
- Score = $3/4 = 0.75$, adjusted to 0.8 for appropriate exclusion

5. PROGRESSION ADEQUACY

Score: 1.0 Justification: The plan includes explicit progression instructions directly quoted from guidelines: "gradually increase the hold time, resistance, or repetitions" as exercises become pain-free, with specific timelines for aerobic progression.

6. EXPLAINABILITY

Score: 1.0 Justification: Every single recommendation includes clear explanations with direct references to specific fitness recommendations, and all exercises cite either the guidelines or the safe exercise database with proper attribution.

Calculation:

- All exercises have KG-grounded explanations
- Direct quotes from guidelines throughout
- Clear contraindication explanations
- Proper source citations for each element
- Score = 11/11 = 1.0

Eval 2:

1. GUIDELINES ADHERENCE

Recommendation	Must-meet specs (F · I · D · T)	What the plan prescribes	Fully met?	Notes
Rec 1 – Resistance	3 × wk · 30 min · moderate · trunk/hip	Mon / Wed / Fri session ≈30 min (5 min warm-up + ~20 min work + 5 min cool-down), moderate bands/Swiss-ball core work	Yes	All parameters satisfied
Rec 2 – Low-impact aerobic	5 × wk · 30 min · low-mod · aerobic	Walking / cycling / swimming 30 min, 5 × wk	Yes	Matches frequency, duration, intensity, type

**Rec 3 –
Flexibility &
mobility**

5 × wk · 15 min · low

Daily stretch list; duration not stated
but ≈15 min when timed **Yes**

Reps/hold
s add up
to ~15 min

Calculation: compliant blocks = 3 ÷ total blocks (3) = 3 / 3 = **1.00** → **1.0**

Score: 1.0

Justification: All three guideline sets are fully addressed in frequency, duration, intensity and exercise type.

2. SAFETY COMPLIANCE

Exercises/blocks analysed (22):

Arm circles, leg swings, torso twists, Swiss-ball bridge, band rows, bird-dog, plank, walking, cycling, swimming, cat-camel, knee-to-chest, piriformis stretch, chest opener, doorway chest stretch, neck side, side-neck, triceps stretch, DB biceps curl, OH triceps ext, shoulder cross-body, wrist flexor.

Unsafe items:

- **Swiss-ball bridge** – moderate balance demand (contra: “moderate balance requirement”).
- **Bird-dog** – moderate balance & spine loading.
- **Plank** – sustained spine involvement.

Calculation:

unsafe = 3, total = 22 → $1 - (3 / 22) = 1 - 0.14 \approx 0.86$ → **0.9**

Score: 0.9

Justification: Only three core-stability drills exceed the “no moderate balance/spine involvement” rule; all other movements comply.

3. BENEFIT POTENTIAL

The routine integrates trunk-strength, posture-focused resistance, daily mobility, and aerobic conditioning, all evidence-based for scoliosis pain management, while using minimal equipment. Minor risk exists from the balance-heavy core drills but these deliver strong therapeutic value if tolerated.

Score: 0.8

Justification: High expected pain-relief and functional benefits, minus a small safety caveat.

4. EXERCISE DIVERSITY

Categories present	Count
Strength / resistance	✓
Aerobic	✓
Flexibility / mobility	✓
Anaerobic / power	✗

Calculation: $3 \div 4 = 0.75 \rightarrow 0.8$

Score: 0.8

Justification: Plan covers three of the four major training modalities.

5. PROGRESSION ADEQUACY

Explicit cues: “Increase hold time or resistance once pain-free,” “Add 5 minutes to aerobic every 2 weeks.”

Score: 1.0

Justification: Clear, guideline-linked progression instructions for both strength and aerobic work.

6. EXPLAINABILITY

Exercise/section blocks = 22

Blocks with explicit “why” or guideline reference = 18

Calculation: $18 \div 22 = 0.82 \rightarrow 0.8$

Score: 0.8

Justification: Most items contain brief rationales tied to guideline goals or pain-management logic.

Gemini + Reduced KG:

Okay, I understand! You're looking for a simple workout routine to strengthen your back and improve posture while managing scoliosis-related lower back pain. We'll focus on exercises that are safe and effective, keeping in mind the specific contraindications for scoliosis.

Here's a personalized plan, incorporating exercises from our database and adhering to the guidelines for your condition:

Important Note: Before starting any new exercise program, it's crucial to consult with your doctor or a physical therapist specializing in scoliosis. They can assess your specific condition and provide personalized recommendations. This plan is a general guideline and may need adjustments based on your individual needs.

Understanding the Contraindications

First, let's address what to *avoid*. Based on the provided data, the following are contraindications for scoliosis-related lower back pain:

- **High/Moderate Impact Level:** (Avoided) This means no jumping, running, or plyometric exercises. High-impact activities can put excessive stress on the spine and exacerbate pain.
- **High/Moderate Intensity:** (Avoided) We'll stick to low-to-moderate intensity exercises. Overdoing it can lead to muscle strain and increased pain.
- **High/Moderate Balance Requirement:** (Avoided) Exercises requiring a lot of balance can be risky, especially if you have any instability due to scoliosis. We'll focus on stable, supported exercises.
- **Spine Involvement:** (Avoided) Exercises that heavily load or twist the spine should be avoided. This includes heavy squats, deadlifts, and twisting motions.
- **Hip Involvement:** (Avoided) Exercises that heavily involve the hips should be avoided or modified, as imbalances in the hips can contribute to scoliosis-related pain.

- **In summary:** We will avoid exercises that involve spinal compression, twisting, or high impact, as these can worsen your condition.

Personalized Workout Routine for Scoliosis

This routine focuses on strengthening the muscles that support your spine and improving posture, all while respecting the contraindications.

Warm-up (5-10 minutes):

- **Gentle Neck Stretches:** (From our exercise database) Slowly tilt your head to each side, holding for 15-20 seconds. Then, gently rotate your head, chin to chest, holding for 15-20 seconds. *Reasoning:* Improves neck mobility and reduces tension.
- **Shoulder Rolls:** Forward and backward, 10-15 repetitions each direction. *Reasoning:* Loosens up the shoulder muscles and improves posture.
- **Cat-Cow Stretch (Modified):** On your hands and knees, gently arch your back like a cat, then slowly drop your belly towards the floor, lifting your head and tailbone. Perform 5-10 repetitions. *Reasoning:* Improves spinal mobility and stretches the core muscles. *Modification:* Perform the movement slowly and gently, avoiding any sharp pain.

Workout (20-30 minutes):

- **Chest Opener Stretch:** (From our exercise database) Stand in a doorway and gently stretch. *Reasoning:* Opens up the chest and improves posture by counteracting rounded shoulders.
 - **Sets/Reps:** Hold for 20-30 seconds, repeat 3 times.
- **Chest Stretch in Doorway:** (From our exercise database) Stand in a doorway with your arms bent at 90 degrees and your hands on the frame. Gently lean forward until you feel a stretch in your chest and shoulders. *Reasoning:* Opens up the chest and improves posture by counteracting rounded shoulders.
 - **Sets/Reps:** Hold for 20-30 seconds, repeat 3 times.
- **Dumbbell Bicep Curl:** (From our exercise database) *Reasoning:* Strengthens the biceps, which can indirectly improve posture by supporting the shoulders.
 - **Sets/Reps:** 2-3 sets of 10-12 repetitions. Use a light weight that allows you to maintain good form.
- **Overhead Tricep Extension:** (From our exercise database) *Reasoning:* Strengthens the triceps, which can indirectly improve posture by supporting the shoulders.
 - **Sets/Reps:** 2-3 sets of 10-12 repetitions. Use a light weight that allows you to maintain good form.

- **Shoulder Cross-body Stretch:** (From our exercise database) *Reasoning:* Improves shoulder flexibility and reduces tension.
 - **Sets/Reps:** Hold for 20-30 seconds, repeat 3 times.
- **Side Neck Stretch:** (From our exercise database) *Reasoning:* Improves neck flexibility and reduces tension.
 - **Sets/Reps:** Hold for 20-30 seconds, repeat 3 times.
- **Triceps Stretch:** (From our exercise database) *Reasoning:* Improves shoulder flexibility and reduces tension.
 - **Sets/Reps:** Hold for 20-30 seconds, repeat 3 times.
- **Wrist Flexor Stretch:** (From our exercise database) *Reasoning:* Improves wrist flexibility and reduces tension.
 - **Sets/Reps:** Hold for 20-30 seconds, repeat 3 times.

Cool-down (5-10 minutes):

- **Hold each stretch for 30 seconds.**
- **Focus on deep breathing to relax your muscles.**

Workout Schedule:

- Perform this routine 2-3 times per week, with rest days in between.

Important Considerations:

- **Listen to your body:** Stop if you feel any sharp pain.
- **Focus on proper form:** Maintaining good form is crucial to prevent injuries. If you're unsure about proper form, consult with a physical therapist or certified personal trainer.
- **Progression:** As you get stronger, you can gradually increase the weight or resistance you use. However, always prioritize proper form over lifting heavier weights.
- **Core Engagement:** Consciously engage your core muscles throughout the exercises. This will help stabilize your spine and improve posture.
- **Breathing:** Breathe deeply and evenly throughout the exercises. Avoid holding your breath.

Remember, this is a general guideline. A physical therapist specializing in scoliosis can provide a more tailored exercise program based on your specific needs and limitations. Good luck!

Eval 1:

EVALUATION METRICS

1. GUIDELINES ADHERENCE

Score: 0.2 **Justification:** The plan severely deviates from guidelines - recommends only 2-3x/week instead of required frequencies, lacks proper duration (20-30 min vs 30+15 min required), completely omits aerobic exercise and trunk/hip resistance training, focusing instead on upper body.

Calculation:

- Frequency: 2-3x/week vs 3x resistance + 5x aerobic + 5x flexibility ✗
- Intensity: Not specified clearly ✗
- Duration: 20-30 min vs 30 min resistance + 30 min aerobic + 15 min flexibility ✗
- Type: Missing aerobic, wrong focus (upper body vs trunk/hip) ✗
- Equipment: Minimal (matches user request but not guidelines) ✓
- Progression: Mentioned briefly ✓
- Score = $2/6 = 0.33 \approx 0.2$

2. SAFETY COMPLIANCE

Score: 0.9 **Justification:** Almost all exercises are from the safe exercise list and avoid contraindications excellently, with only Cat-Cow potentially involving mild spine movement.

Calculation:

- Total exercises: 9
- Potentially unsafe: 1 (Cat-Cow - involves spine movement, though modified)
- All others from safe exercise list
- Score = $1 - (1/9) = 0.89 \approx 0.9$

3. BENEFIT POTENTIAL

Score: 0.5 **Justification:** While the exercises are safe and address posture improvement, the plan fails to include crucial trunk/hip strengthening and aerobic

components needed for comprehensive back pain management, limiting therapeutic value.

4. EXERCISE DIVERSITY

Score: 0.5 **Justification:** The plan includes only stretching (majority of exercises) and minimal strength training (bicep curls, tricep extensions), completely lacking aerobic and anaerobic components.

Calculation:

- Strength: ✓ (minimal)
- Stretching: ✓
- Aerobic: ✗
- Anaerobic: ✗
- Score = $2/4 = 0.5$

5. PROGRESSION ADEQUACY

Score: 1.0 **Justification:** The plan includes clear progression instructions: "As you get stronger, you can gradually increase the weight or resistance you use" and emphasizes prioritizing form over heavier weights.

6. EXPLAINABILITY

Score: 0.8 **Justification:** Most exercises include clear "Reasoning" explanations, and the plan thoroughly explains contraindications with proper references, though some exercises could have more detailed KG-grounded justifications.

Calculation:

- Exercises with reasoning: 8/9
- Clear contraindication explanations with references
- Database citations for exercises
- Score = $8/9 = 0.89 \approx 0.8$

Eval 2:

1. GUIDELINES ADHERENCE

Guideline block	Specs to satisfy (F · I · D · T)	What the plan provides	Fully met?	Key gap
Rec 1 – Trunk/hip resistance 3 × wk · 30 min · moderate · trunk/hip RT	3 / 30 / ✓ / ✓	2-3 × wk · 20-30 min · low intensity · upper-body RT	No	Wrong muscle focus
Rec 2 – Low-impact aerobic 5 × wk · 30 min · low-to-mod · aerobic	5 / 30 / ✓ / ✓	None	Entire component missing	
Rec 3 – Flexibility & mobility 5 × wk · 15 min · low	5 / 15 / ✓	2-3 × wk · ≈ 10 min	No	Frequency & duration short

Calculation: compliant blocks = 0 ÷ 3 = **0.00** → **0.0**

Score: 0.0

Justification: Every guideline block fails at least one of frequency, duration, intensity, or required exercise type.

2. SAFETY COMPLIANCE

Exercises counted (10): neck stretch, shoulder rolls, **cat-cow**, chest opener, doorway chest stretch, bicep curl, tricep extension, shoulder cross-body, side-neck stretch, wrist-flexor stretch

Potentially unsafe items: **cat-cow** (spine flexion/extension contradicts “Spine involvement” contraindication).

Calculation: 1 unsafe ÷ 10 total = 0.10

Score = 1 – 0.10 = **0.9**

Score: 0.9

Justification: Only cat-cow directly challenges the lumbar spine; all other moves respect the low-impact, low-balance, no-hip/knee-load constraints.

3. BENEFIT POTENTIAL

The routine offers gentle mobility and some upper-body strength but omits trunk/hip strengthening and aerobic conditioning—critical elements for scoliosis-related back pain.

Score: 0.5

Justification: Provides partial relief and posture aid but lacks the evidence-based components most likely to improve core stability and long-term back function.

4. EXERCISE DIVERSITY

Categories present = Strength, Flexibility

Total possible = 4 (Strength, Flexibility, Aerobic, Power)

Calculation: $2 \div 4 = 0.50$

Score: 0.5

Justification: No aerobic or power work is included.

5. PROGRESSION ADEQUACY

Plan states: “Gradually increase the weight or resistance you use.”

Score: 1.0

Justification: An explicit, guideline-aligned progression cue is given.

6. EXPLAINABILITY

Blocks with explanations (reasoning after each exercise) = 10

Total blocks examined = 10

Calculation: $10 \div 10 = 1.00$

Score: 1.0

Justification: Every exercise lists a rationale linking it to posture improvement or pain reduction, satisfying the KG-grounded explanation criterion.

Results:

Individual Metric Scores

Query 1: Mild Osteoarthritis

Gemini + Complete KG

- **Guidelines Adherence:** $(1.0 + 0.3) / 2 = 0.65$
- **Safety Compliance:** $(0.9 + 1.0) / 2 = 0.95$
- **Benefit Potential:** $(0.8 + 0.7) / 2 = 0.75$
- **Exercise Diversity:** $(0.8 + 0.8) / 2 = 0.80$
- **Progression Adequacy:** $(1.0 + 1.0) / 2 = 1.00$
- **Explainability:** $(0.8 + 0.6) / 2 = 0.70$

Overall Score: $(0.65 + 0.95 + 0.75 + 0.80 + 1.00 + 0.70) / 6 \times 10 = 8.08$

Gemini + Reduced KG

- **Guidelines Adherence:** $(0.6 + 0.3) / 2 = 0.45$
- **Safety Compliance:** $(1.0 + 1.0) / 2 = 1.00$
- **Benefit Potential:** $(0.8 + 0.6) / 2 = 0.70$
- **Exercise Diversity:** $(0.5 + 0.5) / 2 = 0.50$
- **Progression Adequacy:** $(1.0 + 1.0) / 2 = 1.00$
- **Explainability:** $(0.6 + 0.3) / 2 = 0.45$

Overall Score: $(0.45 + 1.00 + 0.70 + 0.50 + 1.00 + 0.45) / 6 \times 10 = 6.83$

Query 2: Moderate Osteoarthritis

Gemini + Complete KG

- **Guidelines Adherence:** $(0.8 + 0.0) / 2 = 0.40$
- **Safety Compliance:** $(1.0 + 1.0) / 2 = 1.00$
- **Benefit Potential:** $(0.9 + 0.7) / 2 = 0.80$
- **Exercise Diversity:** $(0.5 + 0.5) / 2 = 0.50$
- **Progression Adequacy:** $(1.0 + 1.0) / 2 = 1.00$
- **Explainability:** $(0.7 + 0.2) / 2 = 0.45$

Overall Score: $(0.40 + 1.00 + 0.80 + 0.50 + 1.00 + 0.45) / 6 \times 10 = 6.92$

Gemini + Reduced KG

- **Guidelines Adherence:** $(0.7 + 0.0) / 2 = 0.35$
- **Safety Compliance:** $(0.9 + 1.0) / 2 = 0.95$
- **Benefit Potential:** $(0.9 + 0.7) / 2 = 0.80$
- **Exercise Diversity:** $(0.5 + 0.5) / 2 = 0.50$
- **Progression Adequacy:** $(1.0 + 1.0) / 2 = 1.00$
- **Explainability:** $(0.8 + 0.8) / 2 = 0.80$

Overall Score: $(0.35 + 0.95 + 0.80 + 0.50 + 1.00 + 0.80) / 6 \times 10 = 7.33$

Query 3: Severe Osteoarthritis

Gemini + Complete KG

- **Guidelines Adherence:** $(0.9 + 1.0) / 2 = 0.95$
- **Safety Compliance:** $(0.8 + 0.9) / 2 = 0.85$
- **Benefit Potential:** $(0.9 + 0.9) / 2 = 0.90$
- **Exercise Diversity:** $(0.8 + 0.8) / 2 = 0.80$
- **Progression Adequacy:** $(1.0 + 1.0) / 2 = 1.00$
- **Explainability:** $(1.0 + 0.9) / 2 = 0.95$

Overall Score: $(0.95 + 0.85 + 0.90 + 0.80 + 1.00 + 0.95) / 6 \times 10 = 9.08$

Gemini + Reduced KG

- **Guidelines Adherence:** $(0.3 + 0.0) / 2 = 0.15$
- **Safety Compliance:** $(1.0 + 1.0) / 2 = 1.00$
- **Benefit Potential:** $(0.6 + 0.6) / 2 = 0.60$
- **Exercise Diversity:** $(0.5 + 0.5) / 2 = 0.50$
- **Progression Adequacy:** $(0.5 + 1.0) / 2 = 0.75$
- **Explainability:** $(0.9 + 0.7) / 2 = 0.80$

Overall Score: $(0.15 + 1.00 + 0.60 + 0.50 + 0.75 + 0.80) / 6 \times 10 = 6.33$

Query 4: Chronic Low-Back Pain (Disc Degeneration)

Gemini + Complete KG

- **Guidelines Adherence:** $(0.8 + 0.7) / 2 = 0.75$
- **Safety Compliance:** $(0.7 + 0.8) / 2 = 0.75$
- **Benefit Potential:** $(0.9 + 0.8) / 2 = 0.85$
- **Exercise Diversity:** $(0.5 + 0.8) / 2 = 0.65$
- **Progression Adequacy:** $(1.0 + 1.0) / 2 = 1.00$
- **Explainability:** $(0.9 + 0.8) / 2 = 0.85$

Overall Score: $(0.75 + 0.75 + 0.85 + 0.65 + 1.00 + 0.85) / 6 \times 10 = 8.08$

Gemini + Reduced KG

- **Guidelines Adherence:** $(0.3 + 0.0) / 2 = 0.15$
- **Safety Compliance:** $(0.4 + 0.9) / 2 = 0.65$
- **Benefit Potential:** $(0.7 + 0.7) / 2 = 0.70$
- **Exercise Diversity:** $(0.5 + 0.5) / 2 = 0.50$
- **Progression Adequacy:** $(0.5 + 1.0) / 2 = 0.75$
- **Explainability:** $(1.0 + 0.8) / 2 = 0.90$

Overall Score: $(0.15 + 0.65 + 0.70 + 0.50 + 0.75 + 0.90) / 6 \times 10 = 6.08$

Query 5: Lumbar Herniated Disc

Gemini + Complete KG

- **Guidelines Adherence:** $(0.7 + 0.3) / 2 = 0.50$
- **Safety Compliance:** $(0.5 + 0.5) / 2 = 0.50$
- **Benefit Potential:** $(0.8 + 0.7) / 2 = 0.75$
- **Exercise Diversity:** $(0.5 + 0.5) / 2 = 0.50$
- **Progression Adequacy:** $(1.0 + 1.0) / 2 = 1.00$
- **Explainability:** $(0.8 + 0.9) / 2 = 0.85$

Overall Score: $(0.50 + 0.50 + 0.75 + 0.50 + 1.00 + 0.85) / 6 \times 10 = 6.83$

Gemini + Reduced KG

- **Guidelines Adherence:** $(0.2 + 0.0) / 2 = 0.10$
- **Safety Compliance:** $(0.8 + 0.8) / 2 = 0.80$
- **Benefit Potential:** $(0.4 + 0.4) / 2 = 0.40$
- **Exercise Diversity:** $(0.5 + 0.5) / 2 = 0.50$

- **Progression Adequacy:** $(0.5 + 1.0) / 2 = 0.75$
- **Explainability:** $(1.0 + 1.0) / 2 = 1.00$

Overall Score: $(0.10 + 0.80 + 0.40 + 0.50 + 0.75 + 1.00) / 6 \times 10 = 5.92$

Query 6: Scoliosis-Related Back Pain

Gemini + Complete KG

- **Guidelines Adherence:** $(0.9 + 1.0) / 2 = 0.95$
- **Safety Compliance:** $(0.3 + 0.9) / 2 = 0.60$
- **Benefit Potential:** $(0.8 + 0.8) / 2 = 0.80$
- **Exercise Diversity:** $(0.8 + 0.8) / 2 = 0.80$
- **Progression Adequacy:** $(1.0 + 1.0) / 2 = 1.00$
- **Explainability:** $(1.0 + 0.8) / 2 = 0.90$

Overall Score: $(0.95 + 0.60 + 0.80 + 0.80 + 1.00 + 0.90) / 6 \times 10 = 8.42$

Gemini + Reduced KG

- **Guidelines Adherence:** $(0.2 + 0.0) / 2 = 0.10$
- **Safety Compliance:** $(0.9 + 0.9) / 2 = 0.90$
- **Benefit Potential:** $(0.5 + 0.5) / 2 = 0.50$
- **Exercise Diversity:** $(0.5 + 0.5) / 2 = 0.50$
- **Progression Adequacy:** $(1.0 + 1.0) / 2 = 1.00$
- **Explainability:** $(0.8 + 1.0) / 2 = 0.90$

Overall Score: $(0.10 + 0.90 + 0.50 + 0.50 + 1.00 + 0.90) / 6 \times 10 = 6.50$