Economic and Social Value Burden of Arthritis in Canada, 2025 – 2055

A Canadian Centre for Economic Analysis
And RiskAnalytica Research Study

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Contents

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Executive Summary

Purpose of the study

Arthritis is a major and growing source of health, economic, and wellbeing burden in Canada. This study estimates that burden over the 2025 to 2055 projection horizon, including effects on individuals, health systems, labour markets, households, private expenditures, disability, pain, independence, participation, and life satisfaction.

The analysis reports national and provincial results. It covers osteoarthritis, autoimmune inflammatory arthritis and major subtypes, other forms of inflammatory arthritis including gout and juvenile idiopathic arthritis (JIA), and the systemic autoimmune rheumatic disease category represented in the current results by systemic lupus erythematosus (SLE). Results are presented in real 2026 dollars.

What the report measures

The analysis measures four connected but distinct forms of burden:

- **Disease burden:** the number of people living with modelled arthritis conditions, including prevalence by disease group, age, sex, and province.
- **Economic burden:** direct health costs (including drugs, hospital care, physician services, and allied health services), productivity and caregiving impacts, and additional private disability costs.
- **Social burden:** dollar-equivalent welfare loss associated with pain, disability, reduced participation, independence, and life satisfaction.
- **Total burden:** economic burden plus social burden, shown only after the components are visible so that costs and welfare losses are not confused.

This distinction is central to the report. Arthritis burden cannot be understood through health-system spending alone: pain, disability, loss of independence, reduced participation, and lower life satisfaction can create substantial losses even when they do not appear as public expenditure or labour-market loss.

Integrated agent-based modelling approach

The analysis uses ONEMODEL, CANCEA's national-scale agent-based simulation platform, to represent how people, disease states, geography, costs, disability, and wellbeing outcomes interact over time. In practical terms, the burden estimates are built from one consistent population, disease, age, sex, geography, cost, disability, and social-value structure rather than from separate models with different assumptions or denominators.

This matters because arthritis burden is multi-dimensional. The same person may be counted in disease burden, generate direct health costs, experience productivity or caregiving impacts, incur additional private disability costs, and face pain or reduced life satisfaction. Using ONEMODEL keeps those relationships aligned while preserving the accounting boundary between economic burden and social value loss. Results remain scenario-based estimates and should be read in relation to the baseline, assumptions, input evidence, and uncertainty treatment used in the analysis.

Headline findings for Canada

The number of people in Canada living with any modelled arthritis condition is projected to increase from 6.1 million in 2025 to 10.0 million in 2055. Crude prevalence is projected to rise from 14.7% to 21.0%, an increase of 3.9 million people and 6.3 percentage points.

Over the same period, the baseline projection includes 15.5 million new Any Arthritis cases, averaging about 0.5 million new cases per year. Annual incident cases are approximately 483,000 in 2025 and 506,000 in 2055. These incidence results are consistent with the prevalence trajectory, but they describe a different measure of burden. Incidence counts new cases over time, while prevalence counts people living with arthritis in a given year. Over the 30-year horizon, many incident cases occur among people who are no longer in the 2055 population because of age-related mortality and broader population turnover, rather than arthritis-specific mortality.

Annual economic burden is projected to increase from $45.9B in 2025 to $71.3B in 2055, while annual social value loss is projected to increase from $96.5B to $151.1B. Together, these components rise from $142.4B in 2025 to $222.3B in 2055. They are reported separately because they represent different forms of loss.

Table 1: National arthritis burden summary, Canada, 2025 and 2055

Measure	2025	2055	Change
People with any modelled arthritis condition	6.1M	10.0M	+3.9M
Crude prevalence	14.7%	21.0%	+6.3 pp
Direct health cost	$14.8B	$25.3B	+$10.5B
Additional private disability costs	$5.9B	$10.7B	+$4.8B
Productivity and related indirect impacts	$25.2B	$35.3B	+$10.1B
Economic burden	$45.9B	$71.3B	+$25.4B
Social value loss	$96.5B	$151.1B	+$54.6B
Economic plus social burden	$142.4B	$222.3B	+$79.9B

Economic burden

Economic burden is projected to rise from $45.9B in 2025 to $71.3B in 2055, with a scenario range of $68.3B to $80.5B for 2055. The aggregate indirect-burden category is the largest economic driver at $35.3B in 2055, accounting for 49.5% of total economic burden. This highlights the importance of work participation, absenteeism, presenteeism, and labour-force withdrawal in the overall burden of arthritis.

Direct health costs are projected to rise from $14.8B in 2025 to $25.3B in 2055. These costs include drugs, hospitalisations, physician and allied health services, and other publicly funded health services represented in the model. Additional private disability costs are projected to rise from $5.9B to $10.7B over the same period. They include patient-paid medical and alternative care, medical aids, travel and transportation, home modifications, and paid help. Private costs are reported separately from both direct health-system costs and social value loss.

Table 2: Selected direct health-cost drivers, Canada, 2025 and 2055

Economic burden component or driver	2025 estimated value	2055 estimated value
Drugs	$5.6B	$9.8B
Hospitalisations	$3.3B	$5.7B
Health professionals	$3.1B	$5.4B

Social burden, disability, and pain

Social burden is larger than measured economic burden because it captures a different dimension of loss. It reflects the dollar-equivalent wellbeing loss associated with pain, disability, reduced participation, lower independence, and lower life satisfaction. It is not a public expenditure, a private bill, or a productivity cost. Pain, disability, participation, and independence are jointly represented in the calibrated welfare estimate rather than treated as separate additive components.

The estimate is based on an income-equivalent wellbeing approach. Pain and disability are treated as welfare-relevant states, and the method allows for partial adaptation rather than assuming people fully adjust to these losses. For that reason, social value loss is reported separately before it is combined with economic burden.

Social value loss is projected to increase from $96.5B in 2025 to $151.1B in 2055, or $15,126 per person with arthritis in 2055. The leading disease-group contributors are knee osteoarthritis (OA), other OA, hip OA, gout, rheumatoid arthritis (RA), and hand OA. RA affects fewer people than the large OA categories, but its social value loss per case is higher than that of the leading OA categories shown in the 2055 results.

Disease groups

Osteoarthritis is the largest disease family in the analysis. In 2025, Any OA included about 5.0 million people, with $25.4B in economic burden and $81.0B in social value loss. By 2055, Any OA is projected to include 8.2 million people, with $40.2B in economic burden and $127.9B in social value loss. Within OA, site matters: knee, hip, hand, and other OA differ in pain, mobility, function, private costs, and social value loss.

Any inflammatory arthritis (IA) has a smaller population than Any OA, but it remains important because treatment, disease activity, disability, productivity, and wellbeing mechanisms differ. Gout is the most common form of inflammatory arthritis in the modelled results, while RA is the most common autoimmune inflammatory arthritis subtype. Gout also shows the fastest proportional population growth among the listed disease groups and should be interpreted with attention to flare exposure.

Table 3: Selected disease-group burden results, Canada, 2025

Disease group	People with condition	Economic burden	Economic burden per case	Social value loss	Social value loss per case
Any Arthritis	6.1M	$45.9B	$7,557	$96.5B	$15,890
Any OA	5.0M	$25.4B	$5,103	$81.0B	$16,265
Any IA	0.6M	$10.7B	$17,916	$10.9B	$18,224
Knee OA	2.3M	$8.0B	$3,455	$37.4B	$16,190
Hip OA	1.0M	$6.4B	$6,672	$16.1B	$16,789
Hand OA	0.5M	$1.0B	$1,892	$8.5B	$16,485
Other OA	2.0M	$10.0B	$4,922	$33.1B	$16,212
Any SpA	0.137M	$3.6B	$26,585	$2.2B	$16,187
AS	0.079M	$2.5B	$31,461	$1.3B	$15,972
PsA	0.058M	$1.2B	$19,907	$1.0B	$16,480
SLE	0.068M	$2.1B	$30,961	$1.2B	$18,445
RA	0.5M	$7.1B	$15,271	$8.8B	$18,821
Gout	0.9M	$6.9B	$7,962	$10.0B	$11,586

Table 4: Selected disease-group burden results, Canada, 2055

Disease group	People with condition	Economic burden	Economic burden per case	Social value loss	Social value loss per case
Any Arthritis	10.0M	$71.3B	$7,135	$151.1B	$15,126
Any OA	8.2M	$40.2B	$4,886	$127.9B	$15,565
Any IA	0.9M	$14.4B	$15,991	$15.8B	$17,550
Knee OA	4.1M	$13.0B	$3,168	$63.9B	$15,527
Hip OA	1.8M	$11.1B	$6,116	$28.6B	$15,819
Hand OA	0.8M	$1.4B	$1,718	$12.8B	$15,507
Other OA	3.4M	$14.6B	$4,362	$51.8B	$15,447
Any SpA	0.166M	$4.0B	$23,829	$2.6B	$15,779
AS	0.095M	$2.7B	$28,344	$1.5B	$15,661
PsA	0.071M	$1.3B	$17,696	$1.1B	$15,939
SLE	0.074M	$2.1B	$29,033	$1.4B	$18,415
RA	0.7M	$10.5B	$14,138	$13.3B	$17,949
Gout	1.9M	$13.6B	$7,135	$21.6B	$11,346

Demographics and life-course burden

Arthritis burden rises strongly with age. In 2055, crude prevalence is projected to reach 31.0% among people aged 60 to 64 and 76.4% among people aged 100 and older. Population growth and, in particular, population ageing are major drivers of the projected increase in the number of people living with arthritis because more people move into age groups with higher prevalence. The comparatively flatter age-standardised prevalence paths presented later in the report reinforce that population structure, rather than a uniform increase in age-specific prevalence, accounts for much of the projected growth.

Age and sex also shape social value loss and prevalence. In 2055, the largest age-sex segment is the female 70-and-older group at $56.9B, followed by the male 70-and-older group at $25.3B. Adults aged 60 to 69 also carry large burdens, with social value loss projected at $14.5B for males and $24.6B for females. Any-arthritis crude prevalence is 23.1% among adults aged 50 to 64 and 51.6% among adults aged 65 and older in 2055; the corresponding 2025 values are 21.5% and 47.4%.

Table 5: Selected age- and sex- specific economic and social burden results, Canada, 2025 and 2055

Age and sex segment	2025 people with arthritis	2055 people with arthritis	2025 economic burden	2055 economic burden	2025 social value loss	2055 social value loss
Female, 50-59	0.46M	0.64M	$5.4B	$7.9B	$9.6B	$13.2B
Female, 60-69	0.92M	1.28M	$6.8B	$9.8B	$18.0B	$24.6B
Female, 70+	1.71M	3.27M	$7.3B	$14.8B	$31.7B	$56.9B
Male, 50-59	0.41M	0.67M	$5.1B	$8.6B	$4.8B	$7.9B
Male, 60-69	0.76M	1.17M	$6.4B	$10.4B	$9.6B	$14.5B
Male, 70+	1.19M	2.35M	$5.1B	$10.5B	$13.6B	$25.3B

Workforce and productivity

Workforce and indirect economic effects are most visible in the aggregate indirect-burden category, the largest economic driver in both 2025 and 2055. Arthritis-related work transitions, accommodation needs, absenteeism, presenteeism, and labour-force withdrawal are therefore central to the economic interpretation of the results. The analysis presents these effects at an aggregate level consistent with the burden framework.

The current results support interpretation of productivity burden through aggregate productivity-loss estimates. These results show that arthritis burden extends beyond health-system spending to include lost productive time and other work-related consequences.

Provincial results

Provincial burden varies with population size, age structure, prevalence, disease mix, economic burden, and social value loss. These comparisons describe how burden is distributed across Canada; they are not measures of health-system performance.

Ontario has the largest burden in both baseline and projected absolute terms. In 2025, Ontario has 2.33 million people with any arthritis, $17.8B in economic burden, and $38.2B in social value loss; by 2055, these values are projected to reach 3.96 million people, $28.3B, and $61.3B, respectively. Quebec and British Columbia also account for large absolute burdens. Newfoundland and Labrador has the highest crude prevalence in the provincial summary, at 18.1% in 2025 and 25.4% in 2055, while Alberta has a lower crude prevalence but a large absolute burden because of its population size.

Table 6: Provincial arthritis burden summary, 2025

Province	People with any arthritis	Crude prevalence	Economic burden	Social value loss
Alberta	0.62M	12.6%	$5.1B	$10.3B
British Columbia	0.86M	15.0%	$6.5B	$14.0B
Manitoba	0.20M	13.2%	$1.5B	$3.1B
New Brunswick	0.14M	16.8%	$1.0B	$2.2B
Newfoundland and Labrador	0.10M	18.1%	$0.6B	$1.5B
Nova Scotia	0.18M	16.5%	$1.3B	$2.7B
Ontario	2.33M	14.4%	$17.8B	$38.2B
Prince Edward Island	0.03M	15.3%	$0.2B	$0.4B
Quebec	1.44M	15.8%	$10.5B	$21.4B
Saskatchewan	0.17M	13.5%	$1.4B	$2.7B

Table 7: Provincial arthritis burden summary, 2055

Province	People with any arthritis	Crude prevalence	Economic burden	Social value loss
Alberta	1.28M	17.6%	$9.2B	$20.6B
British Columbia	1.54M	22.6%	$10.8B	$23.9B
Manitoba	0.32M	18.7%	$2.4B	$4.7B
New Brunswick	0.19M	22.4%	$1.3B	$2.6B
Newfoundland and Labrador	0.11M	25.4%	$0.7B	$1.4B
Nova Scotia	0.23M	22.5%	$1.6B	$3.3B
Ontario	3.96M	21.2%	$28.3B	$61.3B
Prince Edward Island	0.04M	21.4%	$0.3B	$0.6B
Quebec	2.04M	22.3%	$14.4B	$28.3B
Saskatchewan	0.28M	18.3%	$2.2B	$4.3B

Interpretation

The central finding is that arthritis burden in Canada is large, growing, and multi-dimensional. By 2055, the measured annual economic plus social burden is projected to reach $222.3B. That combined figure is useful for showing scale, but the economic burden and social value loss components remain essential for interpretation.

Economic burden reflects direct health costs, additional private disability costs, and productivity and caregiving impacts. Social value loss reflects pain, disability, daily-life and social participation, independence, and life satisfaction. Disease group, age, sex, and province all shape how this burden is experienced and understood.

Limitations and caveats

The results are limited by the modelled disease groups, burden dimensions, source data, and methods available for this study. Results are reported for Canada and the provinces. Any OA is constructed from site-specific osteoarthritis categories. Systemic autoimmune rheumatic disease (SARD), systemic lupus erythematosus (SLE), and juvenile idiopathic arthritis (JIA) should be interpreted with caution because direct evidence and parameter coverage are narrower than for the other examined arthritis categories.

Gout's high-pain burden should be interpreted with attention to flare exposure rather than as a chronic high-pain stock. Additional private disability costs apply from age 15 and older. Low and high economic values are scenario bounds, not probability intervals. Lower-limit or undercounting interpretations are included only where the available evidence supports them. Potential underestimation and methodological limitations are discussed further in the limitations and methods appendices.

Structure of the Report

The main text first defines the study purpose, scope, disease categories, burden domains, and technical boundaries. It then provides disease context, summarises the evidence base, describes the agent-based modelling approach, defines the economic, social, and total burden accounting approach, and presents national, provincial, disease-group, demographic, and distributional results. The final chapters summarise interpretation, limitations, uncertainty, and future evidence priorities.

The appendices provide supporting technical detail on model methodology, economic burden methods, additional disability-cost methods, social burden methods, total burden accounting, validation, and detailed results. This keeps the main report focused on findings and interpretation while placing detailed assumptions and methods in the supporting materials.

1 Introduction and Study Scope

1.1 Purpose of the Report

This study estimates the economic burden, social burden, and total burden of arthritis in Canada over the 2025 to 2055 project horizon. Canadian prevalence evidence shows that arthritis is a major and growing population-health condition (Badley et al., 2019). The analysis updates earlier national arthritis burden work by applying the current project scope, current evidence, and current model results to describe how arthritis affects people, health systems, labour markets, households, private expenditures, and wellbeing across Canada and its provinces.

The analysis provides a technical basis for understanding the scale, composition, distribution, and projected development of arthritis burden. Interpretation is tied to measured results, source evidence, and stated assumptions.

The central accounting concept is total burden. In this report, total burden is the combination of economic burden and social burden, subject to explicit no-double-counting rules. Economic burden and social burden are first reported separately so that readers can see what is counted, how it is measured, and where overlap is prevented.

1.2 Study Scope

Table 8: Model Scope and Reporting Parameters

Scope element	Report treatment
Project horizon	2025 to 2055 for interpretation
Geography	Canada and provinces.
Population dimensions	Age group, sex, province, and condition where the relevant output table supports those dimensions.
Disease scope	Modelled osteoarthritis categories, inflammatory arthritis categories, Systemic Autoimmune Rheumatic Disease (SARD), Systemic Lupus Erythematosus (SLE), juvenile idiopathic arthritis, gout, and constructed aggregate groups.
Burden domains	Disease burden, economic burden, social burden, total burden, and distributional results where data is available.
Monetary basis	Monetary values are reported in real 2026 terms.

The report includes four major burden domains:

- disease burden, including prevalence, incidence, affected population, and related health-state outputs;
- economic burden, including direct costs, indirect costs, and additional private disability costs where supported by the project method;
- social burden, measured as an income-equivalent welfare burden associated with pain, disability, quality of life, independence, and life satisfaction;
- total burden, defined as economic burden plus social burden with explicit accounting controls.

Monetary values are reported in real 2026 terms. Any restatement to another constant-dollar basis would involve a specified deflator and is outside the current reporting basis.

1.3 Results and Reporting Domains

The report is organised around the outputs needed to describe projected arthritis health burden, economic burden, and social value loss across Canada and the provinces. The results include affected populations and prevalence, economic burden against a no-arthritis baseline, social value loss against a no-arthritis baseline, provincial results, disease-type results, age and sex patterns, and detailed appendix tables.

Table 9: Burden Domains and Reporting Structure

Domain	Main report role	Appendix role
Disease burden	Establishes the projected number of people affected, prevalence, incidence where available, and disease-group composition.	Detailed national, provincial, age, sex, and disease-group tables.
Economic burden	Presents direct costs, indirect costs, additional private disability costs, service categories, and disease/provincial drivers.	Detailed cost framework, data sources, assumptions, and result tables.
Social burden	Presents dollar-equivalent welfare losses associated with arthritis-related pain, disability, participation, independence, and life satisfaction effects.	Social burden method, evidence base, and detailed social value outputs.
Total burden	Combines economic and social burden after the component boundaries and no-double-counting rules are stated.	Detailed accounting reconciliation.
Distributional results	Shows how burden differs by available dimensions such as age, sex, province, and disease group.	Detailed tables for supported reporting dimensions; other dimensions are addressed through the stated scope and limitations.

1.4 Disease Categories and Reporting Groups

The model represents arthritis using disease groups and reporting aggregates. The model includes site-specific osteoarthritis categories, inflammatory arthritis subtypes, systemic autoimmune rheumatic disease, juvenile idiopathic arthritis, gout, and constructed aggregates. The principal reporting groups are presented in the table below.

Table 10: Arthritis Reporting Groups and Interpretation Notes

Reporting group	Report use	Interpretation
Any Arthritis	Overall modelled arthritis burden	Constructed aggregate across modelled arthritis groups.
Any OA	Overall osteoarthritis burden	Constructed aggregate of knee, hip, hand, and other OA; carries site-mix uncertainty.
Knee OA Hip OA Hand OA Other OA	Site-specific osteoarthritis results	Disability and cost implications differ by site.
Any IA	Overall inflammatory arthritis burden	Constructed aggregate of RA, AS, and PsA.
RA	Rheumatoid arthritis results	Interpretation depends on disease activity, disability, and treatment context.
AS + PsA	Spondyloarthritis-related results	May also be summarised under Any SpA.
SARD, SLE	Systemic autoimmune rheumatic disease proxy category in available outputs	Interpretation reflects the narrower evidence base for some SARD components.
JIA	Juvenile idiopathic arthritis results	Interpretation reflects evidence and parameter limitations.
Gout	Gout burden results	High-pain burden is interpreted with attention to flare exposure.

1.5 Relationship to the 2011 Arthritis Report

The 2011 report, The Impact of Arthritis in Canada: Today and Over the Next 30 Years (Bombardier et al., 2011), established a useful technical sequence: scope and background, approach, burden results, scenario or sensitivity analysis where appropriate, conclusions, glossary, bibliography, and appendices.

The current findings come from the current project scope, data inputs, methods, literature review, and supporting appendices. The 2011 report is used as historical context rather than as a source of current estimates.

2 Arthritis in Canada: Disease Context

2.1 Arthritis as a Group of Diseases

Arthritis and related rheumatic diseases include a diverse group of conditions involving pain, swelling, stiffness, inflammation, functional limitation, and in some cases systemic disease outside the joints. The term "arthritis" therefore does not describe a single disease pathway, age group, severity profile, cost structure, or wellbeing impact. It is a practical umbrella for conditions that differ in onset, progression, treatment, disability, work impact, private costs, and social burden (Badley et al., 2019; O'Donnell et al., 2015).

This distinction matters for burden measurement. A report that treats arthritis as a single uniform group would obscure differences in prevalence, disability, pain, treatment, labour force effects, private costs, social burden, and uncertainty across disease groups. The model therefore reports both aggregate categories, such as any arthritis, any osteoarthritis (OA), any inflammatory arthritis (IA), and any spondyloarthritis (SpA), and more specific categories, such as knee OA, hip OA, rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis or axial spondyloarthritis, systemic lupus erythematosus (SLE) within the systemic autoimmune rheumatic disease (SARD) category, juvenile idiopathic arthritis (JIA), and gout.

The disease context also explains why the analysis measures more than health system expenditure. Arthritis can affect mobility, hand function, sleep, fatigue, daily activities, employment, caregiving, household routines, and life satisfaction. Some of these effects appear as direct costs or productivity losses. Others appear as private expenditures or welfare losses. The burden framework separates these mechanisms before presenting any total burden estimate.

Table 11: Disease-context map for report interpretation

Disease group	Model reporting category	Typical burden mechanism	Pain and disability mechanism	Economic and social burden relevance	Interpretation
Osteoarthritis	Any OA Knee OA Hip OA Hand OA Other OA	Site-specific degenerative joint disease affecting mobility, dexterity, pain, and function.	Knee and hip OA are closely tied to mobility limitation; hand OA affects dexterity; pain may fluctuate and become persistent.	Contributes to direct costs, joint replacement needs, productivity loss, private therapy/support costs, and social burden from pain and reduced independence.	Any OA is a constructed aggregate.
Rheumatoid arthritis	Any IA RA	Systemic autoimmune inflammatory disease with disease activity, remission, treatment, and functional consequences.	Disability is linked to disease activity, function, pain, and treatment response.	Important for medication costs, healthcare use, productivity loss, and health-related quality of life (HRQoL) and subjective wellbeing/life satisfaction (SWL) effects.	Interpretation depends on disease activity and treatment context.
Psoriatic arthritis	Any IA Any SpA PsA	Inflammatory joint disease linked with psoriasis and functional impairment.	Burden includes joint inflammation, pain, function loss, and psychosocial effects.	Functional impairment is associated with higher healthcare costs in extracted economic evidence.	Canadian cost and disability evidence is less granular than for OA and RA.

Disease group	Model reporting category	Typical burden mechanism	Pain and disability mechanism	Economic and social burden relevance	Interpretation
Ankylosing spondylitis / axial spondyloarthritis	Any IA Any SpA AS	Axial inflammatory disease affecting spinal mobility, pain, fatigue, and work participation.	Disability relates to function and disease activity measures.	Relevant to medication costs, productivity, and social burden in working-age adults.	Subtype interpretation depends on available model and evidence granularity.
Systemic autoimmune rheumatic disease	SARD, SLE	Systemic disease burden beyond joints, represented in available outputs by SLE.	Disability may be higher at a given pain level because of systemic burden.	Relevant to healthcare use, productivity, and wellbeing impacts.	The current output category represents SLE rather than the full systemic autoimmune rheumatic disease spectrum.
Juvenile idiopathic arthritis	JIA	Childhood-onset inflammatory arthritis affecting children, families, schooling, and usual activities.	Pain and function can affect daily activities and family routines.	Evidence points to family, caregiver, direct, non-healthcare, productivity, and private-cost dimensions.	Results are read alongside the more limited evidence and parameter base for childhood-onset disease.
Gout	Gout	Crystal arthritis with acute flares and possible chronic burden if uncontrolled.	Severe short-duration flare pain can drive disability and social burden.	Relevant to acute care, medication, productivity disruption, and wellbeing effects during flares.	High-pain burden is interpreted as flare exposure where applicable.

Some conditions appear in multiple reporting categories because aggregate and disease-specific groups serve different reporting purposes. These categories are not additive and should not be summed to avoid double counting.

2.2 Osteoarthritis

Osteoarthritis is the largest modelled arthritis family in the reported analysis. It is represented through site-specific categories for knee, hip, hand, and other osteoarthritis, as well as the combined Any OA category. Site matters because mobility, dexterity, surgery, pain, disability, self-management, and private cost pathways differ by joint location (Hawker & King, 2022; King et al., 2018).

Knee and hip OA are closely tied to mobility, walking, stairs, paid work in physically demanding occupations, assistive devices, rehabilitation, and joint replacement pathways. Hand OA has different functional implications, including grip, dexterity, self-care, and household or workplace tasks requiring fine motor function. "Other OA" is a constructed residual reporting category in the model rather than a single clinically homogeneous joint-site category, and is therefore interpreted as a model/reporting limitation.

Risk-factor evidence reinforces the need for site-specific interpretation. Hip OA evidence distinguishes clinical hip OA from radiographic hip OA, and modifiable and non-modifiable risk factors do not contribute equally to each outcome. In the Rotterdam Study analysis of incident hip OA, low educational level was an important modifiable population-attributable factor for incident clinical hip OA, while being overweight was an important modifiable population-attributable factor for incident radiographic hip OA (Runhaar et al., 2023). These findings do not directly inform the Canadian burden results, but they illustrate why OA site, symptom definition, and population context matter.

Pain is a central mechanism in OA burden. Health expenditure evidence for osteoarthritis with pain shows that pain is associated with higher direct healthcare expenditures and that comorbidities and prescription medications can be major drivers of excess spending (Ikram et al., 2022). Canadian CLSA evidence identifies several distinct OA burden channels: OA is associated with social participation through activity limitations and instrumental supports (Perruccio et al., 2021; Perruccio et al., 2024), labour-force participation differs among adults with OA or OA-like joint symptoms (Badley et al., 2024), and younger adults with OA can report substantial symptom burden, including pain, fatigue, and activity limitations (Wilfong et al., 2024). Economic evidence indicates that OA may appear less costly from a narrow public payer perspective when privately paid physiotherapy, exercise, self-management, aids, and other supports are not fully captured. That is one reason the analysis separately includes additional private disability costs.

OA also affects work and participation. The economic evidence identifies work ability, early retirement, absenteeism, presenteeism, and physically demanding occupations as relevant pathways. These effects can occur in older adults who remain in the labour market and in younger or middle-aged adults with advanced symptoms or joint damage. Labour-force participation evidence for adults with OA or OA-like symptoms and work-disability evidence for OA indicate that OA burden extends beyond healthcare spending alone (Badley et al., 2024; Sharif et al., 2017).

The Any OA aggregate is useful for reporting overall osteoarthritis burden, but it is not a directly observed clinical disease category. It inherits uncertainty from the mix of knee, hip, hand, and other OA cases. The report therefore interprets Any OA alongside the site-specific OA categories whenever disability, cost, or social burden patterns may differ by site.

2.3 Inflammatory Arthritis

Inflammatory arthritis is represented through rheumatoid arthritis, ankylosing spondylitis or axial spondyloarthritis, and psoriatic arthritis, with aggregate categories for any inflammatory arthritis (Any IA) and any spondyloarthritis (Any SpA). These conditions differ from osteoarthritis in disease process, treatment pathways, disability patterns, medication costs, and potential systemic effects.

Rheumatoid arthritis is the largest autoimmune inflammatory arthritis subtype in the current reported analysis. Its burden is interpreted in relation to disease activity, functional limitation, treatment, productivity loss, and social burden. Canadian and international evidence describes substantial RA burden, including healthcare use, treatment, comorbidity, disability, and productivity effects (Barber et al., 2023; Gignac et al., 2008; Hassen et al., 2024).

Risk-factor profiles also differ across inflammatory arthritis populations and demographic groups. Smoking is one of the most consistently identified modifiable risk factors for rheumatoid arthritis. Evidence for BMI, adiposity, and metabolic factors is less uniform and appears to vary by sex, serostatus, and study design. These relationships are therefore treated as contextual risk-factor evidence rather than direct drivers of the Canadian burden estimates (Demoruelle et al., 2016; Sugiyama et al., 2010; Ljung & Rantapää-Dahlqvist, 2016; Ohno et al., 2020).

Psoriatic arthritis and ankylosing spondylitis or axial spondyloarthritis have distinct clinical and functional profiles. Psoriatic arthritis can combine joint disease, skin disease, function loss, and psychosocial burden. Axial spondyloarthritis can affect spinal mobility, pain, fatigue, and working-age participation. The inflammatory-arthritis work-disability literature identifies productivity losses and sick leave as important pathways, while Canadian axSpA evidence documents work-related, physical, psychological, diagnostic-delay, and functional-limitation burdens (Lenssinck et al., 2013; Inman et al., 2023; Rahman et al., 2024).

The aggregate Any IA is useful for reporting broad inflammatory arthritis burden, but it combines conditions with different treatment, cost, and disability profiles. Interpretation therefore needs to preserve subtype distinctions where the results support them.

Inflammatory arthritis also illustrates why treatment and disability cannot be separated from economic interpretation. Medication costs can be a large direct-cost component, while morbidity-related productivity loss remains a major indirect-cost pathway. The mix of medication, healthcare use, function, and work disability varies by disease subtype and by the availability of evidence.

2.4 SARD, JIA, and Gout

The reported analysis includes systemic lupus erythematosus (SLE) within the systemic autoimmune rheumatic disease (SARD) category, juvenile idiopathic arthritis, and gout. These categories are interpreted with care.

In the reported results, SLE is used as the reporting category for systemic autoimmune rheumatic disease burden in the available output set. It is interpreted as an SLE-based systemic autoimmune category rather than as a measured estimate for all systemic autoimmune rheumatic disease (Barber et al., 2023; Fatoye et al., 2018).

Juvenile idiopathic arthritis represents childhood-onset arthritis burden. Economic evidence for JIA indicates that burden can extend beyond direct healthcare costs to family time, caregiver activity, school and usual activity disruption, private costs, and longer-term consequences (Marshall et al., 2024). The current model includes JIA, with interpretation reflecting the smaller population, family and caregiver dimensions, and more limited evidence coverage.

Gout burden is interpreted with attention to the impact and frequency of flares. Gout can be controlled between flares for some people, while acute flares can generate short periods of severe pain and disability. Contemporary gout reviews and Canadian cost evidence identify prevalence, treatment, acute burden, and direct economic implications as important to interpretation (Dalbeth et al., 2021; Dehlin et al., 2020; Fischer et al., 2017). High pain burden should not necessarily be interpreted as continuous chronic pain, because acute flares are a key driver of gout burden.

For SARD, JIA, and gout, the common theme is that small or episodic populations can still generate meaningful burden through severity, family effects, acute flares, systemic disease, or concentrated disability. These categories remain clinically and economically relevant even when their population counts are smaller than OA or RA.

2.5 Implications for Burden Measurement

The disease context supports the structure of the report. Disease burden establishes who is affected and how that changes over time. Economic burden measures direct costs, indirect costs, and additional private disability costs. Social burden measures income-equivalent welfare losses associated with pain, disability, participation, independence, and life satisfaction. Total burden combines economic and social burden only after the component boundaries are clear.

The same context also explains why the analysis separates main disease categories rather than relying only on an overall arthritis total. Differences by disease type, age, sex, geography, pain state, disability state, and burden domain are central to interpretation.

The disease context also frames the evidence and methods chapters. Evidence is stronger for some disease groups and burden mechanisms than for others. Some cost components are visible in public payer or administrative data, while others are borne by patients, families, employers, or caregivers. Some wellbeing losses are associated with pain and disability even when they do not appear as direct expenditures. These distinctions are the reason the analysis uses an integrated burden framework rather than a single cost total.

The results that follow should therefore be interpreted as disease-specific and burden-domain-specific, even when headline totals are presented. Aggregate results are useful for scale. Disease-specific results are necessary for interpretation.

3 Evidence Base and Literature Foundation

3.1 Evidence Review Purpose

The evidence base supports the development from clinical and population evidence into reportable burden estimates. It informs disease definitions, reporting categories, parameter choices, burden-state assumptions, cost interpretation, social burden interpretation, and limitations. Arthritis evidence varies by disease type, population, geography, study design, cost perspective, and outcome measure; those differences must be defined explicitly before the results can be interpreted.

The 2025 literature review organises evidence into four analytic pillars: epidemiology and disease burden; economic burden; social value and quality of life; and risk factors and demographics. That structure is used here to explain how the evidence supports the report and where uncertainty remains. Additional methodological detail is provided in the appendices where it is directly relevant to the reported results.

3.2 Evidence Hierarchy and Main-Report Parsimony

The analysis uses different source types for different purposes. Model results provide the reported estimates. Project scope and input materials define the analytical scope. Method documentation explains how burden components are represented. Peer-reviewed literature supports disease context, parameterisation, interpretation, and uncertainty. Arthritis Society Canada contextual material is used only where it provides relevant project context.

Table 12: Evidence hierarchy and report use

Source family	Report use	Main limitation
Study scope and reporting boundaries	Study objective, geography, time horizon, disease scope, and burden domains	Scope definitions are applied consistently with the modelled output basis.
Literature review and reference list	Disease evidence, burden pathways, data hierarchy, evidence gaps, and citation authority	Individual citations are reconciled against the controlling reference list.
Disability and additional-cost methods	Burden-state method, D0/D1/D2 disability mapping, private disability costs, flare handling, and social-value parameter support	Some parameters are evidence-informed assumptions rather than direct disease-by-age-by-sex estimates.
Model results and supporting tables	Summary metrics, table structure, result definitions, and reported values	Values are checked against the model output tables before publication.
Arthritis Society Canada contextual material	Disease and lived-experience context where technically relevant	Contextual source language is separated from technical evidence and model findings.

3.3 Epidemiology and Disease Burden Evidence

Epidemiology evidence establishes the populations and disease categories to which burden estimates apply. Canadian arthritis prevalence evidence and projection work provide the broad context for rising burden and provincial variation (Badley et al., 2019). Disability evidence identifies arthritis as a major contributor to activity limitation and functional burden (Perruccio et al., 2025).

Osteoarthritis evidence is most impactful for modelling when it distinguishes joint sites, symptoms, severity, and functional consequences. Risk-factor evidence for hip OA, for example, distinguishes clinical hip OA from radiographic hip OA and shows that modifiable factors may contribute differently depending on the outcome definition (Runhaar et al., 2023). Canadian CLSA evidence identifies labour-force participation impacts among adults with OA or OA-like symptoms (Badley et al., 2024) and documents substantial OA burden among younger adults (Wilfong et al., 2024).

Inflammatory arthritis evidence includes rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis or axial spondyloarthritis, and related disease groups. RA has relatively stronger Canadian evidence on disease burden, healthcare use, comorbidity, treatment, and work effects (Barber et al., 2023; Gignac et al., 2008; Hassen et al., 2024). PsA and axSpA evidence is more heterogeneous but remains important because function, disease activity, medication use, and productivity loss can be significant. SARD, JIA, and gout require disease-specific interpretation: systemic disease can extend beyond joint symptoms, childhood-onset disease can shift burden to families and caregivers, and gout can produce severe episodic flare burden (Dalbeth et al., 2021; Dehlin et al., 2020; Marshall et al., 2024).

3.4 Economic Burden Evidence

Economic burden evidence supports direct costs, indirect costs, and additional private disability costs. Direct cost evidence includes physician services, hospitalisation, pharmaceuticals, rehabilitation, long-term care, and service categories included in the analysis. Indirect cost evidence includes work disability, absenteeism, presenteeism, labour force exit, and caregiver or family productivity where measured. Work-disability evidence is especially important because arthritis can reduce labour force participation, job stability, and workplace activity even when people remain employed (Gignac et al., 2008; Gignac et al., 2018; Jetha et al., 2015).

The economic research tables show why disease subtype and perspective matter. RA evidence identifies drug costs, comorbidity, healthcare use, and work disability as important contributors (Barber et al., 2023; Hassen et al., 2024; Widdifield et al., 2014). PsA and axSpA evidence links functional impairment to healthcare use, work burden, and diagnosis pathways (Inman et al., 2023; Rahman et al., 2024). JIA evidence shows that costs can extend beyond direct healthcare to non-healthcare costs, family time, and caregiver impacts (Currie et al., 2023; Grazziotin et al., 2021; Grazziotin et al., 2022). These evidence streams support the report's separation of direct costs, indirect costs, additional private disability costs, and social burden.

The additional private disability-cost method adds a separate cost layer for out-of-pocket and disability-related private expenditures. It draws on the project disability/additional-cost method and its supporting literature rather than treating the literature as a direct table of disease-by-age-by-sex cost values. The method translates the available evidence into a consistent parameter structure across disease group, age band, sex, duration, and severity state.

3.5 Social Burden and Quality-of-Life Evidence

Social burden evidence links arthritis pain, disability, disease activity, participation, independence, health-related quality of life, life satisfaction, and income-equivalent valuation. Chronic pain, musculoskeletal pain, and disability are associated with lower life satisfaction and wellbeing, and the evidence supports partial rather than complete adaptation to long-run disability (McNamee & Mendolia, 2014; Anke et al., 2013; Dong et al., 2020; Oswald & Powdthavee, 2008; Stockel et al., 2023). In RA, remission and low disease activity are associated with better function and quality-of-life outcomes than active disease, supporting separate interpretation of controlled and uncontrolled disease states (Nikiphorou et al., 2020; Haridoss et al., 2021; Maynard et al., 2020).

The social burden method uses life satisfaction and related wellbeing evidence to estimate income-equivalent social value loss. It does not treat social value loss as a health system cost or productivity cost. It is a separate burden measure that is combined with economic burden only when total burden accounting is explicitly presented.

The literature supports a graded and time-of-event approach rather than a single universal pain coefficient. Evidence from chronic pain, musculoskeletal pain, disability adaptation, OA participation, and RA disease activity indicates that pain severity, disability, disease activity, remission, adaptation, and residual long-run burden need to be distinguished (McNamee & Mendolia, 2014; Anke et al., 2013; Dong et al., 2020; Oswald & Powdthavee, 2008; Stockel et al., 2023; Perruccio et al., 2021; Nikiphorou et al., 2020). Where direct arthritis-specific SWL evidence is limited, HRQoL and chronic pain evidence help inform parameter estimates.

3.6 Risk Factor and Demographic Evidence

Risk factor and demographic evidence support interpretation of age, sex, obesity, smoking, comorbidity, geography, and high-impact populations. In this analysis, risk factor evidence is used primarily to drive disease burden patterns and distributional results.

Several risk factors operate differently across disease groups. For OA, obesity and joint injury are particularly relevant (Badley et al., 2017; Duong et al., 2025; Runhaar et al., 2023; Szilagyi et al., 2023; Snoeker et al., 2020; Whittaker et al., 2022). For RA, smoking is one of the more consistently identified modifiable risk factors; evidence for high BMI, adiposity, and related metabolic factors is more mixed and appears to vary by sex, serostatus, and study design (Demoruelle et al., 2016; Sugiyama et al., 2010; Ljung & Rantapää-Dahlqvist, 2016; Ohno et al., 2020). Comorbidity can affect both healthcare cost and disability pathways, and multimorbidity can increase the cost burden associated with inflammatory arthritis (Marshall et al., 2019). Demographic factors also affect reporting and interpretation because disease prevalence, work participation, and risk profiles vary by age and sex (Badley et al., 2024; Szilagyi et al., 2023).

3.7 Evidence Gaps and Conservative Use of Evidence

The evidence base is not as complete for some subtypes, cost categories, disability states, and population segments. Proxy evidence and conservative assumptions are therefore used. The report identifies these gaps rather than filling them with unsupported claims.

Administrative case definitions require validation and may vary by algorithm, data source, and disease definition (Widdifield et al., 2020). Survey and cohort data can capture broader lived experience, including people who report arthritis but do not know their specific arthritis type, but those data may not map cleanly onto disease-specific administrative categories or cost records (Badley et al., 2022).

Detailed technical assumptions and validation material are provided in the appendices. Appendix F documents additional disability-cost methods. Appendix G documents social burden methods. Appendix J documents validation and consistency checks.

4 Agent-Based Modelling and Analytical Framework

4.1 Why Agent-Based Modelling

Arthritis burden emerges from heterogeneous people moving through disease states, disability states, labour force states, geographies, cost exposures, and wellbeing consequences over time. ONEMODEL represents these elements as an interconnected system rather than as separate analytical silos. This agent-based simulation structure is consistent with individual-level chronic-disease modelling practice (Macal & North, 2010; Nianogo & Arah, 2015) and allows the analysis to maintain age, sex, disease, geography, cost, and burden-domain distinctions rather than relying on a single aggregate cost coefficient. Related evidence on work transitions and social participation supports the need for this multi-domain structure (Gignac et al., 2008).

The model outputs used in this report include population, prevalence, costs by disease-group, costs by service category, and derived economic and social burden metrics. The analysis includes these outputs by year, province, sex, age group, disease-group, and cost category where the relevant table supports those dimensions.

Incidence outputs are used as a complementary disease-burden measure. They describe the flow of new cases over the projection horizon and are interpreted alongside, rather than derived from, the prevalence outputs.

4.2 Model Output Framework

Model results are organised into standardised domains used throughout the analysis.

Table 13: Model result domains and report use

Output domain	Description
Population	Defines demographics by year, province, sex, and age group.
Disease burden	Includes disease prevalence, disease group, age, sex, and provincial results.
Economic burden	Covers direct, indirect, additional disability, service category, disease, and provincial cost results.
Disability and private costs	Includes disability states and additional private disability-cost calculations.
Social burden	Includes social value loss and income-equivalent welfare interpretation.

4.3 Integrated Representation Across Topics

The analysis uses one model results structure across disease burden, demography, labour force relationships, geography, economic burden, social burden, and time. This matters because the same population and condition structure supports multiple burden views. Disease burden, economic burden, and social burden can be linked while their accounting definitions remain separate.

Separate models for epidemiology, health costs, labour force effects, geography, and social burden can produce incompatible denominators, disease definitions, time horizons, or accounting rules. A single model output framework reduces that risk by tying outputs to the same declared dimensions and disease groups.

4.4 Population, Geography, and Time

The model reports results from 2025 to 2055. The project horizon for interpretation is 2025 to 2055, with 2025 used as the baseline year where comparisons involve it. Reporting dimensions include province, sex, age group, disease group, and cost category where relevant.

The disease group dimension includes site-specific osteoarthritis categories, inflammatory arthritis categories, SLE, JIA, gout, and aggregate categories such as Any OA, Any IA, Any SpA, and Any Arthritis. The cost category dimension supports service-category reporting.

4.5 Disease Burden Representation

Disease burden is represented primarily through prevalence outputs in the reported results. These outputs report prevalent cases, population, and prevalence rate by year, province, sex, age group, and disease group.

Incidence outputs provide the corresponding annual flow of new cases over the 2025 to 2055 projection period. Prevalence and incidence are internally consistent within the model results, but one cannot be inferred directly from the other. Incidence is a flow of new cases over time, while prevalence is a stock of people living with arthritis in a given year. Over the 30-year horizon, many incident cases occur among people who are no longer in the 2055 population because of age-related mortality and broader population turnover, rather than arthritis-specific mortality.

The disease burden chapter uses these results to present national, disease-group, age-sex, and provincial patterns. The disability and additional-cost method then translates burden states, pain states, disability states, and flare exposure into cost and social burden measures.

4.6 Economic Burden Representation

Economic burden is represented through annual cost measures by disease group, province, sex, and age group, and through service-category measures by disease group, province, and cost category. The analysis reports direct cost, indirect cost, additional disability cost, and total expected costs in real 2026 terms.

Economic burden is measured against a no-arthritis baseline. Direct costs, indirect costs, additional private disability costs, and any caregiving-related cost components remain separately traceable before economic burden is interpreted as part of total burden.

4.7 Additional Disability-Cost Representation

The additional disability-cost method uses a burden-state approach rather than a single diagnosis-level cost coefficient. Disability burden and related private costs depend on arthritis condition or subtype, age and sex, chronic symptom or disease-activity state, acute flares or sustained worsening episodes, resulting disability state, and private out-of-pocket cost associated with that disability state. This structure is consistent with severity-state and burden-of-disease approaches that distinguish symptoms, disability, and valuation rather than treating diagnosis alone as the burden measure (Salomon et al., 2015).

The method translates symptom or activity states into three disability states, defined in the table below.

Table 14: Disability states and interpretations

Disability state	Interpretation
D0	None or mild limitation
D1	Moderate limitation
D2	Severe limitation

The disability-cost calculation uses final annualised D0/D1/D2 allocations. Flare exposure is carried as an overlay in the burden model and is reflected in final annualised outputs before costs are applied. This distinction is especially important for gout, where acute flare periods can produce high short-duration burden.

4.8 Social Burden Representation

Social burden is represented through life satisfaction, wellbeing, pain, independence, participation, and income-equivalent valuation. It is reported separately from economic burden. The social-value method treats pain and disability as welfare-relevant states, with evidence supporting severity gradients, partial adaptation, and residual long-run burden (McNamee & Mendolia, 2014; Anke et al., 2013; Dong et al., 2020; Oswald & Powdthavee, 2008; Stockel et al., 2023). Rheumatoid arthritis remission and low-disease-activity evidence also supports distinguishing controlled disease from ongoing disease activity (Nikiphorou et al., 2020; Maynard et al., 2020).

Social value loss is the difference in dollar-equivalent social value between the no-arthritis baseline and the modelled case with arthritis disease. It is a welfare measure, not a conventional cost category.

4.9 Total Burden Accounting

Total burden is the combination of economic burden and social burden. The report shows the components separately before presenting the combined total. This prevents social value loss from being treated as a health system cost and prevents economic cost categories from being hidden inside a combined number.

4.10 Consistency and Validation

The model standards include declared dimensions, logical tables, measures, specified years, and non-negative measure checks. These validation rules support internal consistency across model results. The validation appendix extends these checks by documenting source alignment, result consistency, terminology, accounting separation, no-double-counting, and specified caveats. Simulation validation evidence supports explicit documentation of internal consistency, traceability, and uncertainty when model results are interpreted for decision-making (Sargent, 2015).

Validation does not remove uncertainty. It documents whether reported outputs are internally consistent, traceable to evidence sources, and interpreted within the limits of the evidence and model design.

5 Disease Burden Results

5.1 National Disease Burden

Disease burden is the population foundation for the economic, social, and total burden results that follow. Arthritis prevalence evidence in Canada supports treating disease burden as a major population-health input rather than a narrow cost denominator (Arthritis Community Research and Epidemiology Unit, 2021; Badley et al., 2019; Public Health Agency of Canada, 2020). Disability evidence reinforces the same point (Perruccio et al., 2025). The analysis shows 6.07 million people with any modelled arthritis condition in 2025 and 9.99 million in 2055. This is an increase of 3.9 million people, or 65%, over the model output window. Crude prevalence among the modelled population rises to 21.0% in 2055.

Table 15: Disease summary, Canada, 2025 and 2055

Disease group	People 2025	People 2055	Growth	Growth %	Prevalence 2055
Any Arthritis	6.07M	9.99M	+3.92M	+65%	21.0%
Any OA	4.98M	8.22M	+3.24M	+65%	17.3%
Any IA	0.60M	0.90M	+0.30M	+50%	1.9%
Any SpA	0.14M	0.17M	+0.03M	+21%	0.3%
Knee OA	2.31M	4.11M	+1.80M	+78%	8.7%
Hip OA	0.96M	1.81M	+0.85M	+88%	3.8%
Hand OA	0.52M	0.83M	+0.31M	+60%	1.7%
Other OA	2.04M	3.35M	+1.31M	+64%	7.1%
RA	0.47M	0.74M	+0.27M	+59%	1.6%
AS	0.08M	0.10M	+0.02M	+21%	0.2%
PsA	0.06M	0.07M	+0.01M	+22%	0.1%
SLE	0.068M	0.074M	+0.006M	+10%	0.2%
JIA (under 15)	6,457	7,891	+1,434	+22%	0.1%
Gout	0.86M	1.91M	+1.05M	+121%	4.0%

The Any rows in Table 15 are union counts, not sums of the disease rows beneath them. This is particularly important for aggregate categories because a person can contribute to more than one disease-specific line while being counted once in an aggregate union measure.

Incidence adds a flow measure to the prevalence results. From 2025 to 2055, the baseline projection includes 15.5 million new Any Arthritis cases, or about 0.5M new cases per year on average. Any OA accounts for most new arthritis cases over the period, with 13.1M new cases, while RA accounts for about 1.0M. Annual incidence rates vary from year to year, so the 2051 to 2055 average is used alongside the endpoint value when interpreting the long-run rate.

Table 16: Baseline incidence summary, Canada, 2025 to 2055

Disease group	Incident cases, 2025	Incident cases, 2055	Total new cases, 2025-2055	Annual average	ASIR, 2051-2055 avg.
Any Arthritis	483,000	506,000	15.5M	0.5M	0.9%
Any OA	389,000	445,000	13.1M	0.4M	0.9%
RA	25,000	36,000	1.0M	0.03M	0.1%

The cumulative incidence results reinforce the prevalence findings without replacing them. Prevalence shows the number of people living with arthritis in a given year; incidence shows the sustained flow of new cases that contributes to the future affected population. Over the 30-year horizon, many incident cases occur among people who are no longer in the 2055 population because of age-related mortality and broader population turnover, rather than arthritis-specific mortality. This is why cumulative new cases can exceed the point-in-time prevalence count.

The RA row is a national all-age model projection based on the baseline prevalence output and calibration factors, and may differ from CCDSS point estimates because of definition, scope, and calibration differences. JIA is reported using under-15 prevalence only. The adjusted baseline is 6,457 children in 2025 and 7,891 children in 2055, with incidence suppressed because annual counts are small.

Figure 1: Projected population with any modelled arthritis condition by sex, Canada, 2025 to 2055

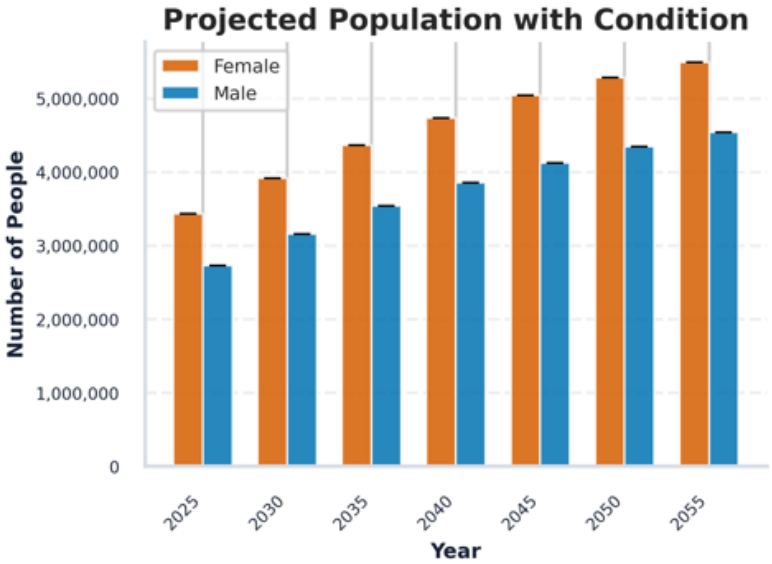


Figure 1illustrates the projected growth in the number of people living with any modelled arthritis condition by sex over the project horizon. It complements Table 15 by showing that the national increase is not only a terminal-year result, but a persistent upward trajectory across the projection period.

Figure 2: Absolute growth in any modelled arthritis condition by age group and sex, Canada, 2025 to 2055

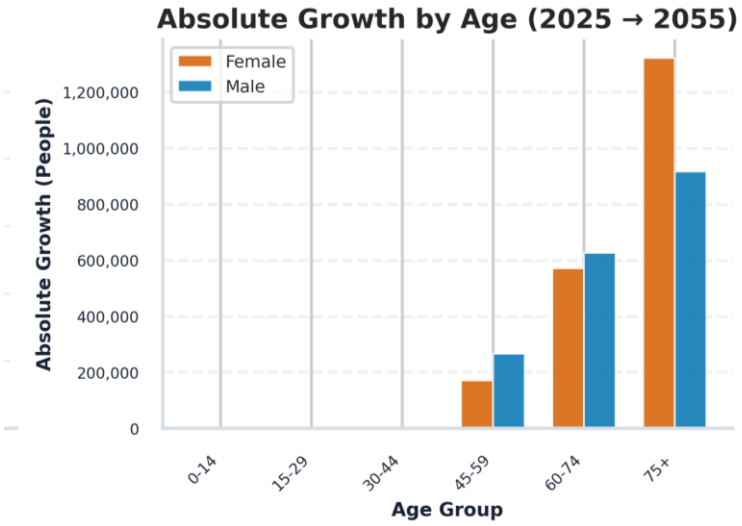


Figure 2 shows that most absolute growth in Any Arthritis is concentrated in older age groups, especially ages 60 to 74 and 75 and older. It provides visual support for the report's life-course interpretation: the rise in arthritis burden reflects both prevalence and population ageing, which later affects social burden, private disability costs, and labour-force interpretation.

Figure 3: Crude and age-standardised prevalence of any modelled arthritis condition by sex, Canada, 2025 to 2055

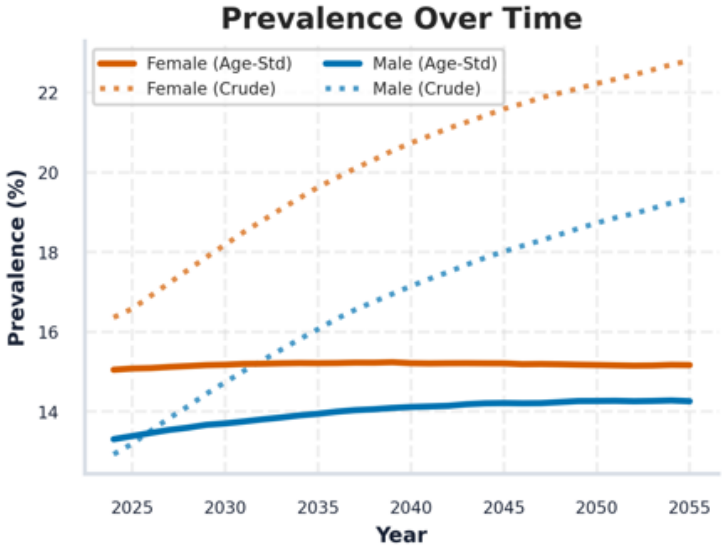


Figure 3 separates crude prevalence from age-standardised prevalence, which is essential for interpreting projected growth. The widening crude lines show the effect of population ageing, while the comparatively flatter age-standardised lines indicate that changes in population structure are a major part of the projected burden increase.

5.2 Burden by Disease Group and Subtype

The largest modelled category is Any OA, which grows from 4.98 million people in 2025 to 8.22 million people in 2055. This aggregate combines knee, hip, hand, and other osteoarthritis sites. These sites differ in functional impact, disability, pain, surgery, work, and cost pathways, so the aggregate is interpreted alongside site-specific OA results (Hawker & King, 2022; Marshall et al., 2015; Widdifield et al., 2020).

Figure 4: Projected population with any modelled osteoarthritis by sex, Canada, 2025 to 2055

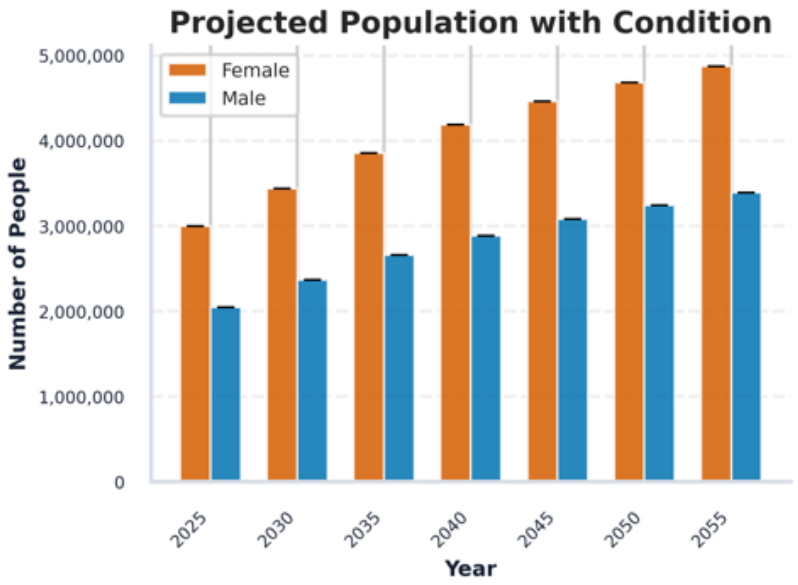


Figure 4 shows the growth in the modelled osteoarthritis population, which is the largest disease family in the report. It supports the chapter's emphasis that OA drives much of the overall arthritis disease burden and therefore anchors several downstream economic and social-burden findings.

Figure 5: Absolute growth in any modelled osteoarthritis by age group and sex, Canada, 2025 to 2055

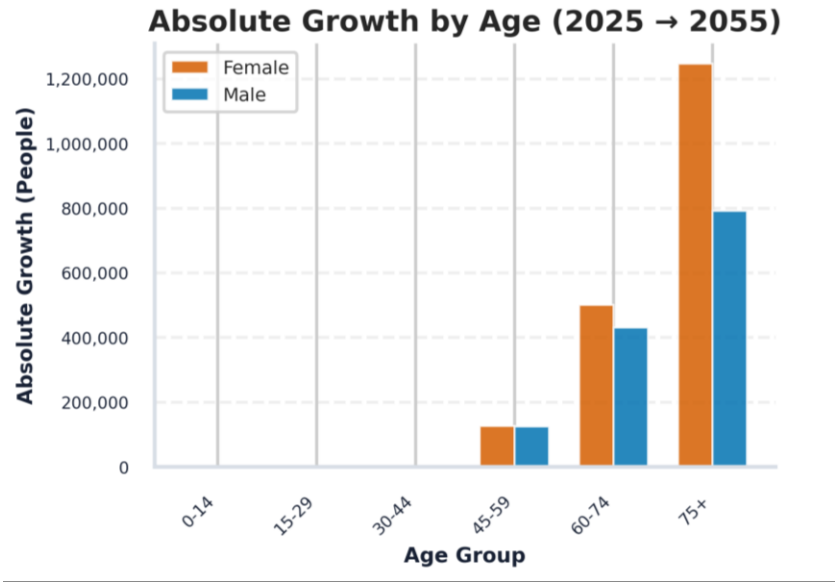


Figure 5 shows that OA growth is concentrated in older ages, particularly among adults aged 60 to 74 and 75 and older. That age pattern is relevant because OA disability, mobility limitation, surgery pathways, and private support needs are strongly age-structured.

Figure 6: Crude and age-standardised prevalence of any modelled osteoarthritis by sex, Canada, 2025 to 2055

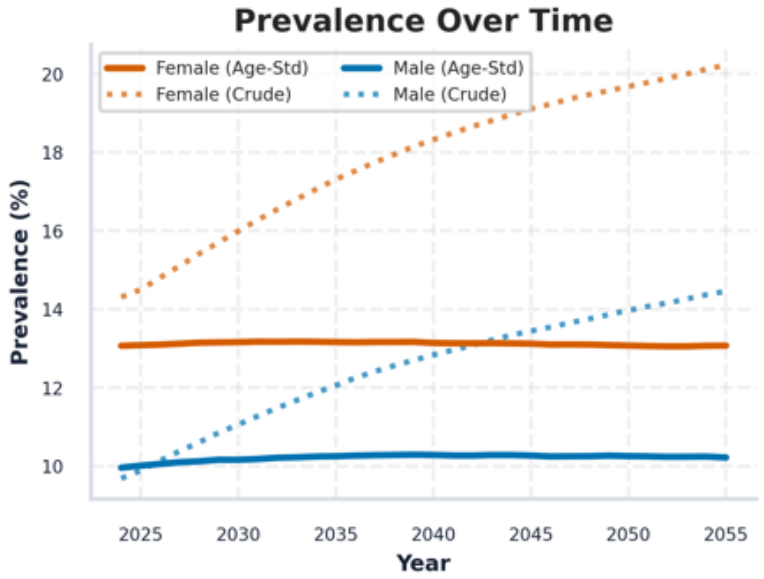


Figure 6 distinguishes the projected crude increase in OA prevalence from the more stable age-standardised trend. It explains why OA burden rises substantially in total population terms even when age-standardised prevalence is comparatively less volatile.

Among site-specific osteoarthritis categories, knee OA has the largest affected population in 2055, followed by other OA, hip OA, and hand OA. Inflammatory arthritis is smaller in population count than osteoarthritis but remains important because of its disability, treatment, productivity, and wellbeing consequences. RA accounts for the largest population within the autoimmune inflammatory arthritis grouping, consistent with Canadian administrative and burden evidence (Hassen et al., 2024; Marshall et al., 2020; Widdifield et al., 2014).

Gout has the highest proportional growth among the listed disease groups, increasing from 0.86 million people in 2025 to 1.91 million people in 2055. Interpretation of gout burden distinguishes chronic gout burden from flare exposure, especially where high-pain burden is reported (Dalbeth et al., 2021; Dehlin et al., 2020; Rai et al., 2017).

SARD and JIA results are included in the model outputs and are interpreted with disease-specific caution. SARD is represented in the current output as SLE; it is not a complete measured burden for every systemic autoimmune rheumatic disease. JIA estimates are small in population terms and are interpreted alongside the evidence limitations and family-burden considerations described in the disease-context and methods chapters (Barber et al., 2023; Currie et al., 2023; Fatoye et al., 2018; Grazziotin et al., 2021).

Table 17: Interpretation of selected disease burden categories

Disease category	Result pattern	Interpretation
Any Arthritis	9.99M people in 2055; 21.0% crude prevalence	Overall scale of modelled arthritis burden.
Any OA	Largest disease family; 8.22M people in 2055	Aggregate is read with site-specific OA categories.
Knee OA	Largest site-specific OA category; 4.11M people in 2055	Major mobility and disability relevance.
Any IA	0.90M people in 2055	Smaller population than OA but important for treatment, disability, and productivity pathways.
RA	Largest autoimmune IA subtype; 0.74M people in 2055	Principal inflammatory arthritis contributor in modelled IA results.
Gout	Largest proportional growth; 1.91M people in 2055	Interpreted with attention to flare exposure.
SLE and JIA (under 15)	Smaller population categories	SLE is interpreted in light of evidence and parameter limitations. JIA is reported as under-15 prevalence only.

5.3 Burden by Age and Sex

Age and sex patterns are central because arthritis burden is not evenly distributed across the life course. These patterns also shape labour force impacts, private disability costs, and social burden. Canadian population evidence supports distinct life-course mechanisms: arthritis affects daily activities across age groups (O'Donnell et al., 2015), OA is associated with social participation (Perruccio et al., 2021), and OA or OA-like symptoms are associated with labour-force participation among adults aged 45 to 74 (Badley et al., 2024). Detailed age and sex tables are provided in Appendix M.

In this report, age and sex patterns are used to interpret how disease burden connects to labour force exposure, private disability costs, and social burden. Age and sex differences are interpreted as distributional patterns unless a specific cited source supports a causal explanation.

5.4 Provincial Burden

Provincial results show where burden differs geographically. Provincial comparisons are interpreted in relation to population size, age structure, disease mix, and modelled rates. Canadian spatial and utilisation evidence supports this interpretation because arthritis prevalence, comorbidity, and access patterns vary geographically (Liu et al., 2020; Liu et al., 2022; Marshall et al., 2019). Detailed provincial disease burden tables are provided in Appendix L, while the main text focuses on national patterns and high-level geographic variation. This framing supports geographic interpretation without treating provincial differences as direct measures of health-system performance.

5.5 Labour Force Affected Population

The affected working-age population links disease burden to productivity, labour force participation, workplace accommodation, income, private costs, and social burden. Arthritis-related work transitions, accommodation needs, and productivity loss are well documented in the arthritis work-disability literature (Berkovic et al., 2021; Gignac et al., 2008; Gignac et al., 2018; Sharif et al., 2016; Sharif et al., 2017). Working-age results are therefore interpreted as a bridge between disease burden and the later economic and distributional chapters.

5.6 Disease Burden Interpretation

Disease burden interpretation is the starting point for the burden accounting that follows. Arthritis burden grows materially over the projection window, with osteoarthritis accounting for the largest affected population and gout showing the largest proportional growth among the listed categories. These disease burden patterns help explain why the report separately examines economic burden, social burden, total burden, and distributional effects.

The disease burden results do not by themselves establish the cause of every cost or wellbeing impact. Those relationships are addressed through the economic, disability-cost, and social burden methods in later chapters.

6 Economic Burden Results

6.1 Economic Burden

Economic burden is one component of the total burden of arthritis. It captures monetary costs and losses measured against a no-arthritis baseline. The 2055 economic burden for all modelled arthritis conditions is $71.3B in real 2026 terms, with a scenario range of $68.3B to $80.5B. This range reflects the additional-cost lower and upper totals used for lower-to-upper range; it is not a probability interval.

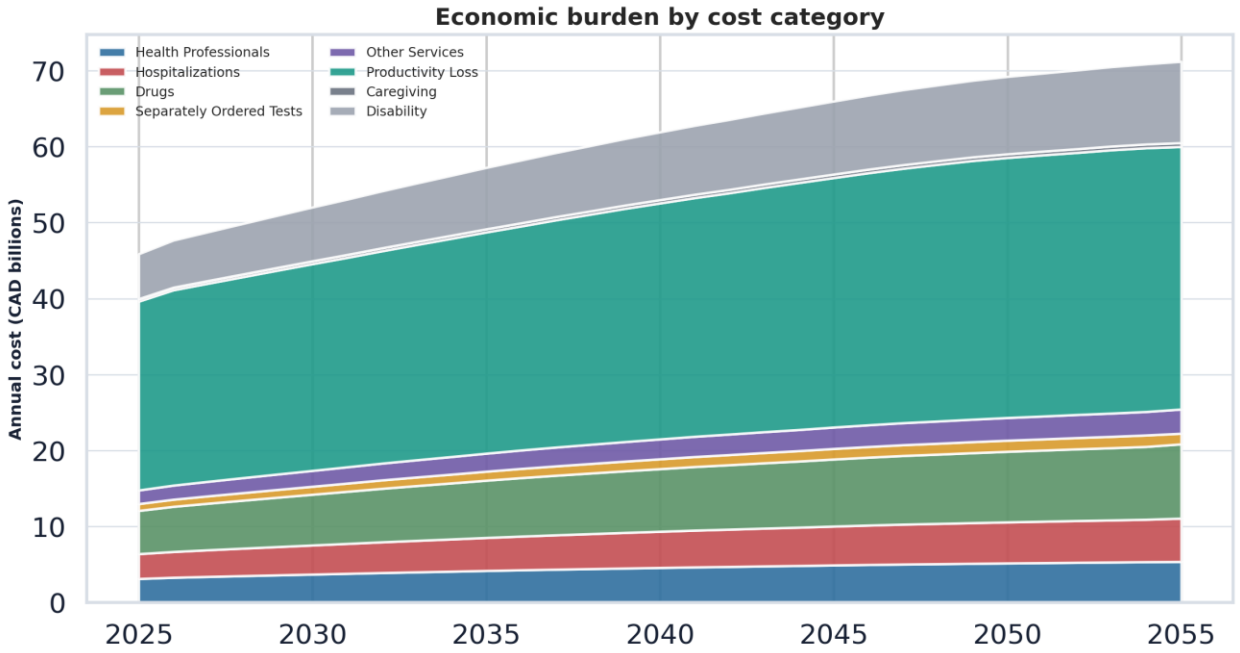
The largest 2055 service-category driver is productivity loss, followed by additional disability costs, drugs, hospitalisations, health professional costs, and other services. Arthritis work-disability literature supports the importance of productivity and labour force pathways in interpreting these results (Berkovic et al., 2021; Gignac et al., 2008; Lenssinck et al., 2013; Sharif et al., 2017). Workplace accommodation evidence reinforces the relevance of labour force context (Gignac et al., 2018). These components are reported separately so that economic burden is not confused with social burden or total burden.

Table 18: Economic burden drivers, Canada, 2055

Driver	2025 Value	2055 value	2055 range	Share of 2055 economic burden	Growth since 2025
All modelled disease groups	$45.9B	$71.3B	$68.3B-$80.5B	100.0%	+$25.4B
Productivity and related indirect impacts	$25B	$35.3B	$33.1B-$39.1B	49.5%	+$10.1B
Disability (additional private disability cost)	$5.9B	$10.7B	$10.3B-$12.1B	15.0%	+$4.8B
Drugs	$5.6B	$9.8B	$9.4B-$11.1B	13.7%	+$4.2B
Hospitalisations	$3.3B	$5.7B	$5.5B-$6.4B	8.0%	+$2.4B
Health professionals	$3.1B	$5.4B	$5.1B-$6.1B	7.5%	+$2.3B
Other services	$1.8B	$3.2B	$3.1B-$3.6B	4.5%	+$1.4B

Figure 7 shows the composition of economic burden over time and makes clear that productivity loss is the dominant cost category in the modelled 2055 burden. It also shows why the report separates direct health system costs, productivity and caregiving impacts, and additional private disability costs before interpreting economic burden as part of total burden.

Figure 7: Economic burden by cost category, Canada, 2025 to 2055



The aggregate indirect-burden category leads the economic components because arthritis affects working-age participation across multiple disease groups, including osteoarthritis, rheumatoid arthritis, and other inflammatory subtypes (Inman et al., 2023; Martikainen et al., 2016; Sharif et al., 2016). The dominance of productivity loss does not imply that direct health system costs are small in absolute terms; the combined direct-cost layers (drugs, hospitalisations, health professional services, and other services) account for a material share of the economic burden total. The relative ranking of the categories is interpreted alongside the disease-group composition in Table 19 and the labour-force evidence in Chapter 10, Section 10.3.

6.2 Direct Cost Burden

Direct costs include health system expenditures attributable to arthritis. Canadian studies of musculoskeletal and arthritis-specific healthcare utilisation identify material cost contributions from physician services, hospital care, pharmaceuticals, rehabilitation, and related services (Barber et al., 2023; Marshall et al., 2015; Power et al., 2022). In the selected national burden trajectory, direct health costs rise from $14.8B in 2025 to $25.3B in 2055. These values are reported separately from additional private disability costs and from productivity and caregiving impacts. This separation allows the direct health-system component to be read alongside, but not confused with, the broader economic and welfare burden.

Publicly funded allied health services represented in the model are included in direct health costs. Patient-paid private allied health and alternative-care expenditures are included in additional private disability costs where they are not already represented in the public health-system cost layer.

6.3 Indirect Cost Burden

Indirect costs capture labour force and related productivity effects, including work impairment, absenteeism, presenteeism, and labour force withdrawal where these are represented in the model. The national trajectory reports an aggregate indirect-burden category. The baseline standard outputs include a separate caregiving service-category input, but it is not de-overlapped to the Any-Arthritis union and is not used in this report as a separate caregiving-impact estimate.

6.4 Additional Private Disability Costs

Additional private disability costs capture private out-of-pocket disability-related costs not otherwise represented in conventional direct or indirect costs. The method uses D0, D1, and D2 disability states and applies private disability-cost parameters by age, sex, disease group, and scenario value. The central estimate is included in standard economic burden totals, while low and high values are retained for lower-to-upper range.

These values are not conventional health system costs and are distinct from social burden. They represent an additional private cost layer linked to disability-state allocation. The disability-cost method is supported by literature on patient-borne and non-health-service costs, including out-of-pocket medical spending, alternative care, medical aids, travel, transportation, home modifications, and paid help. OA and gout sources support out-of-pocket and patient-borne cost pathways (Kotlarz et al., 2009; Nathan et al., 2021), while the scleroderma evidence is used only as systemic rheumatic disease context for patient-borne access costs (Trenaman et al., 2023). Private disability-cost estimates were calculated for ages 15 and older only, leaving pediatric private disability costs outside the current parameter scope.

6.5 Economic Burden by Disease Group

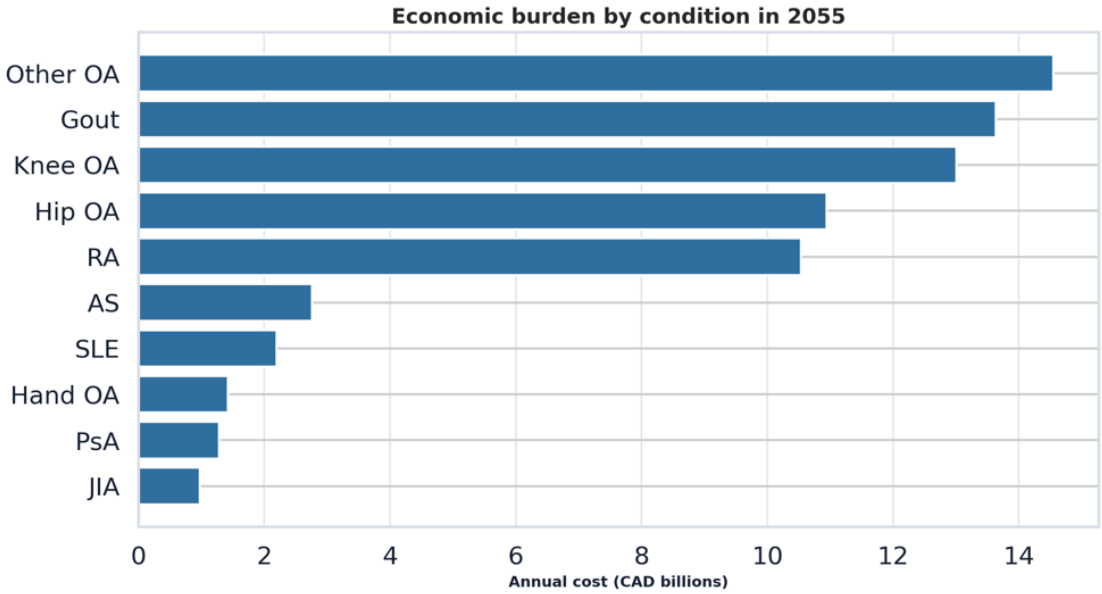
Disease-group comparisons show that economic burden does not follow prevalence alone. In 2055, the largest disease-type economic burden drivers are Other OA, gout, knee OA, hip OA, and RA. The high economic contribution of gout relative to its population share is interpreted with attention to flare exposure, cost categories, and disease-specific assumptions (Dalbeth et al., 2021; Fischer et al., 2017).

Table 19: Top disease group drivers of economic burden, Canada, 2055

Disease group	2055 value	2055 range	Share of 2055 economic burden	Growth since 2025	2025 Value
Other OA	$14.6B	$13.9B-$16.4B	20.4%	+$4.6B (+46%)	$10.0B
Gout	$13.6B	$13.1B-$15.4B	19.1%	+$6.7B (+97%)	$6.9B
Knee OA	$13.0B	$12.5B-$14.7B	18.2%	+$5.0B (+63%)	$8.0B
Hip OA	$11.1B	$10.5B-$12.4B	15.4%	+$4.7B (+73%)	$6.4B
RA	$10.5B	$10.1B-$11.9B	14.8%	+$3.4B (+48%)	$7.1B

Figure 8 shows that economic burden does not follow prevalence alone: Other OA, gout, knee OA, hip OA, and RA are the largest disease-type economic contributors in 2055. JIA is not presented as a separate disease-level economic or total-burden result because the additional private disability-cost framework begins at age 15; presenting a full burden estimate for pediatric JIA on the same basis would therefore be incomplete. The figure supports disease-specific interpretation, especially the finding that gout contributes a large economic share relative to its population size.

Figure 8: Economic burden by arthritis condition, Canada, 2055



6.6 Provincial Economic Burden

Provincial economic burden results are reported in the detailed provincial appendix and interpreted in relation to population size, age structure, disease mix, and cost composition. Provincial totals are useful for understanding geographic burden, but they are not measures of provincial system performance without additional evidence (Liu et al., 2022; Power et al., 2022). The estimates therefore support comparison of where burden is concentrated, not conclusions about the relative effectiveness of provincial health systems.

6.7 Economic Burden Interpretation

The economic burden results show the monetary consequences of arthritis through health system costs, productivity and labour-related losses, and additional private disability costs. They do not capture the full burden of arthritis. Social burden is reported separately because pain, disability, reduced independence, participation loss, and life satisfaction effects are not fully represented in economic cost categories. This structure allows economic burden to remain a monetary cost measure while social burden captures income-equivalent welfare loss.

7 Social Burden Results

This chapter reports the social burden of arthritis in Canada. Social burden is the dollar-equivalent welfare loss associated with arthritis, measured against a modelled no-arthritis baseline. It is reported as a distinct burden domain because it captures losses in well-being, life satisfaction, independence, participation, pain, disability, and disease activity that are not fully represented in direct health care costs, productivity losses, or private disability costs.

The results should be read as an income-equivalent welfare measure rather than as a budgetary cost. The dollar unit makes the results comparable with economic burden outputs, but it does not imply that the social burden is a cash expenditure, a fiscal liability, or an amount that could be eliminated by spending the same number of dollars. The social burden is combined with economic burden only where the report explicitly applies the total-burden accounting rules described in Appendix H.

The methodology is bottom-up. ONEMODEL, CANCEA's integrated simulation framework, compares modelled person well-being paths under an arthritis scenario with otherwise-aligned paths under a no-arthritis counterfactual. Those differences are converted to income-equivalent values using the valuation approach summarised in Appendix G, then aggregated across people and time.

7.1 National Social Burden

In 2055, the national social value loss for any arthritis is estimated to be $151.1B, equivalent to $15,126 per person with arthritis. This burden is substantially larger than the measured economic burden because arthritis affects everyday welfare through pain, functional limitation, fatigue, reduced independence, lower daily-life participation, and lower life satisfaction, not only through spending and labour-market effects.

The magnitude of the estimate is consistent with the interpretation of arthritis as a chronic welfare burden. Pain and disability are not treated as simple clinical descriptors; they are welfare-relevant states that can persist, vary in severity, and affect the way people evaluate their lives. The underlying evidence supports wellbeing losses associated with chronic pain, musculoskeletal pain, and disability, and supports partial, heterogeneous adaptation rather than an assumption that people fully adapt to long-run pain or limitation (McNamee & Mendolia, 2014; Anke et al., 2013; Dong et al., 2020; Oswald & Powdthavee, 2008; Stockel et al., 2023).

Canadian osteoarthritis evidence also supports a broad welfare interpretation. Canadian OA evidence links activity limitations and instrumental supports with social participation (Perruccio et al., 2024). Broader OA symptom-burden evidence links pain with depression, sleep disturbance, and functional impairment (Cavallo et al., 2025; Hawker et al., 2011). The social burden estimate therefore provides a complementary view of disease impact: it measures the welfare consequences that remain even when no additional bill is paid and no measured hour of paid work is lost.

7.2 Social Burden by Disease Group

Disease-group results show whether social burden ranks arthritis conditions differently than economic burden. This is important because social burden is shaped by prevalence, pain and disability severity, social participation, baseline wellbeing, and disease-specific factors such as inflammatory disease activity or remission. OA participation evidence supports the role of activity limitations and instrumental supports (Perruccio et al., 2021; Perruccio et al., 2024), while wellbeing/adaptation and disease-activity evidence support the valuation and remission components (McNamee & Mendolia, 2014; Nikiphorou et al., 2020; Oswald & Powdthavee, 2008). Smaller modelled categories, including AS, PsA, SLE, and Any SpA, are included in the full disease-group results where table space permits; JIA is kept subject to the separate pediatric-scope reconciliation noted in the limitations.

Table 20: Disease group drivers of social burden, Canada, 2055

Disease group	2055 social value loss	Social value loss per case (2055)	Growth since 2025	2025 social value loss	Social value loss per case (2025)
Knee OA	$63.9B	$15,527	+26.5B	$37.4B	$16,190
Other OA	$51.8B	$15,447	+18.7B	$33.1B	$16,212
Hip OA	$28.6B	$15,819	+12.5B	$16.1B	$16,789
Gout	$21.6B	$11,346	+11.6B	$10.0B	$11,586
RA	$13.3B	$17,949	+4.5B	$8.8B	$18,821
Hand OA	$12.8B	$15,493	+4.3B	$8.5B	$16,485

The table shows the leading social burden drivers. Smaller modelled categories are still included in the analysis: Any SpA contributes $2.6B in social value loss in 2055, AS contributes $1.5B, SLE contributes $1.4B, and PsA contributes $1.1B.

The leading disease contributors are osteoarthritis categories, particularly knee OA, other OA, and hip OA. Their aggregate burden reflects both the size of the affected population and the welfare consequences of pain and functional limitation. Gout also appears among the largest social burden drivers, reflecting both population size and the welfare impact of painful disease episodes. RA has a smaller population than the aggregate OA categories, but it has the highest social value loss per prevalent case in the table, consistent with evidence that remission and low disease activity are associated with better function and quality-of-life outcomes than active disease in RA (Nikiphorou et al., 2020; Haridoss et al., 2021; Maynard et al., 2020).

Per-case results should be interpreted alongside aggregate burden. The OA categories generate the largest national social value losses because they are highly prevalent, while RA illustrates how a smaller disease group can still carry a high welfare burden per case. This distinction is useful for policy interpretation: aggregate burden identifies where the largest total welfare losses occur, while per-case

burden helps identify disease groups and severity profiles where the individual welfare impact is especially high.

The Any Arthritis per-case result is not a simple average of the disease-specific rows. Any Arthritis is a unique-person union measure: a person with more than one modelled arthritis condition is counted once, and overlapping pain, disability, and wellbeing effects are reconciled rather than added. The aggregate also includes a broad mix of disease types and severity levels, including people with relatively mild or well-controlled disease. Individual conditions with higher average pain, disability, or disease activity can therefore have a higher social value loss per case than the Any Arthritis aggregate.

7.3 Social Burden by Age and Sex

Age and sex patterns are important because social burden is not determined by prevalence alone. It also depends on life stage, work and family roles, caregiving responsibilities, social participation, disability, pain experience, baseline life satisfaction, household circumstances, and the person-specific income-equivalent valuation step. Canadian evidence supports separate life-course pathways: arthritis affects daily activities across age groups (O'Donnell et al., 2015), OA is associated with social participation (Perruccio et al., 2021), OA or OA-like symptoms are associated with labour-force participation among adults aged 45 to 74 (Badley et al., 2024), and people with arthritis may continue to participate in informal caregiving roles (Wilfong et al., 2021). These sources support the relevance of age, work, participation, and caregiving dimensions; the report's age-sex social-value estimates come from the model.

In 2055, the largest age-sex social value loss segments in the presentation are the female 70-and-older group, the male 70-and-older group, the female 60-to-69 group, and the male 60-to-69 group. These segments combine high prevalence with substantial modelled welfare effects. The results should not be read simply as an age ranking; they reflect the interaction of population size, disease mix, pain and disability allocation, life-satisfaction differences, and valuation assumptions.

The age-sex pattern also reinforces why social burden is a distinct analytic domain. Older adults may experience arthritis through loss of independence, mobility, and social participation, while working-age adults may experience added effects through work capacity, household roles, caregiving, and participation. The income-equivalent framework captures these effects as welfare losses rather than forcing all impacts into employment or health-expenditure categories. Detailed age-sex tables are provided in Appendix M.

7.4 Provincial Social Burden

Provincial social burden results are interpreted separately from provincial economic burden. A province can have a different rank by economic burden, social burden, or total burden depending on population size, age structure, disease mix, severity patterns, income distributions, and the relative size of welfare impacts. This interpretation is consistent with Canadian evidence that arthritis prevalence, comorbidity, and care access vary geographically (Liu et al., 2020; Liu et al., 2022; Marshall et al., 2019).

Economic burden per person is comparatively stable across provinces because many health-cost, productivity, and private disability-cost parameters are applied consistently across Canada, with provincial differences arising through population structure, wages, disease mix, and utilisation. Social value loss is more sensitive to provincial differences in age and sex composition, disease severity, pain and disability, baseline wellbeing, participation, and income. The income-equivalent valuation can therefore produce greater provincial variation than conventional economic cost measures.

The provincial estimates are therefore best read as geographic welfare-burden results, not as rankings of provincial health-system performance. Differences across provinces may reflect demographic composition, prevalence, disease mix, and modelled welfare pathways as much as differences in services or policy. Detailed provincial social burden outputs are provided in Appendix L. The main report uses provincial results to interpret broad geographic variation rather than to rank provincial health systems.

7.5 Calibration Inputs from Canadian Wellbeing Evidence

The social burden parameters used in the report are informed by Canadian Community Health Survey well-being evidence from the 2019-2020 cycle and by the project's pain and life-satisfaction method. The Canadian well-being evidence is descriptive: it summarises how reported life satisfaction varies with age, sex, household income, province, pain experience, and the presence of musculoskeletal conditions, using survey weights and bootstrap weights. These descriptive relationships are used to support calibration; they are not treated as direct causal estimates of arthritis-attributable welfare loss.

The final parameterisation combines Canadian well-being patterns with peer-reviewed evidence on pain severity, disability gradients, disease activity, remission or disease control, and adaptation. Because published life-satisfaction evidence is less granular than the model structure by arthritis subtype, severity, disability state, age, sex, and disease activity, the method uses adjacent evidence from health-related quality of life, pain, disability, and disease-activity studies. The bridging assumptions are documented in Appendix G.

The reported social value loss is therefore conditional on four elements: the welfare parameter set, the modelled allocation of pain and disability, the disease-activity and remission pathways, and the assumption that adaptation is partial rather than complete. Sensitivity to alternative welfare parameters is addressed in Appendix I. The underlying CCHS calibration table is reproduced in Appendix M, Section M.4.

7.6 Social Burden Interpretation and Accounting Safeguards

Social burden is an income-equivalent welfare measure. It broadens burden measurement beyond direct costs, indirect costs, and additional private disability costs. Appendix G summarises the social burden valuation approach. Social burden remains separate until total burden accounting is explicitly presented because the same arthritis experience can affect both economic outcomes and well-being outcomes. For example, pain can reduce life satisfaction, restrict participation, increase health care use, and reduce work capacity. The report therefore keeps social value and economic burden separate until overlap and accounting boundaries are made explicit.

The main interpretation is that arthritis burden cannot be understood from economic costs alone. Pain, disability, loss of independence, reduced participation, and lower life satisfaction can be large even where they do not appear as direct spending or productivity loss. The social burden results make these non-market welfare losses visible in a comparable dollar unit while preserving the distinction between welfare loss and financial cost. Taken together, the social burden estimates show that arthritis imposes a large welfare loss on Canadians over and above measurable economic costs.

8 Total Burden Results

8.1 Total Burden Accounting

Total burden is calculated as economic burden plus social burden. The economic and social components are shown separately before the combined total is shown. This separation is necessary because the economic component measures monetary costs and losses, while the social component measures CAD-equivalent welfare loss.

Economic burden includes direct health costs, additional private disability costs and productivity and caregiving impacts. Social burden is the dollar-equivalent welfare loss associated with arthritis relative to the no-arthritis baseline. Social burden is not a conventional cost or budgetary expenditure. The social-value method and disability-cost method also treat these quantities as conceptually separate; social value loss is reported separately from direct costs, indirect costs, caregiving costs, and additional disability costs before any combined burden value is presented. The social-value approach is supported by evidence linking chronic pain, musculoskeletal pain, and disability to lower wellbeing and incomplete adaptation (McNamee & Mendolia, 2014; Anke et al., 2013; Dong et al., 2020; Oswald & Powdthavee, 2008; Stockel et al., 2023). This evidence supports keeping welfare burden analytically distinct from direct monetary cost categories. The disability-cost layer is supported by the project method and by patient-borne cost evidence summarised in the disability methodology.

8.2 National Total Burden

The selected-year national trajectory shows both components and the combined total. In 2055, the analysis reports $71.3B in economic burden and $151.1B in social value loss, for an economic plus social burden total of $222.3B. These values are in real 2026 terms.

Table 21: National burden trajectory by component, Canada, selected years

Year	Direct health costs	Private disability costs	Indirect impacts	Economic burden	Economic lower	Economic upper	Social value loss	Total burden (Econ + SV)
2025	$14.8B	$5.9B	$25.2B	$45.9B	$44.1B	$51.5B	$96.5B	$142.4B
2030	$17.4B	$7.1B	$27.6B	$52.1B	$50.0B	$58.6B	$110.0B	$162.1B
2040	$21.5B	$8.9B	$31.5B	$62.0B	$59.4B	$69.9B	$130.0B	$192.0B
2055	$25.3B	$10.7B	$35.3B	$71.3B	$68.3B	$80.5B	$151.1B	$222.3B

Economic lower and upper values are scenario bounds.

8.3 Total Burden by Disease Group

Disease-group total burden shows how interpretation changes when welfare burden is examined alongside economic burden. Component transparency remains necessary: a disease group may have a high social burden because of pain and disability even when its measured economic burden is lower than another disease group.

Table 22: Burden by arthritis type, Canada, 2025

Disease group	People with condition	Economic burden	Economic burden per case	Social value loss	Social value loss per case
Any Arthritis	6.1M	$45.9B	$7,557	$96.5B	$15,890
Any OA	5.0M	$25.4B	$5,103	$81.0B	$16,265
Any IA	0.6M	$10.7B	$17,916	$10.9B	$18,224
Knee OA	2.3M	$8.0B	$3,455	$37.4B	$16,190
Hip OA	1.0M	$6.4B	$6,672	$16.1B	$16,789
Hand OA	0.5M	$1.0B	$1,892	$8.5B	$16,485
Other OA	2.0M	$10.0B	$4,922	$33.1B	$16,212
Any SpA	0.137M	$3.6B	$26,585	$2.2B	$16,187
AS	0.079M	$2.5B	$31,461	$1.3B	$15,972
PsA	0.058M	$1.2B	$19,907	$1.0B	$16,480
SLE	0.068M	$2.1B	$30,961	$1.2B	$18,445
RA	0.5M	$7.1B	$15,271	$8.8B	$18,821
Gout	0.9M	$6.9B	$7,962	$10.0B	$11,586

Table 23: Burden by arthritis type, Canada, 2055

Disease group	People with condition	Economic burden	Economic burden per case	Social value loss	Social value loss per case
Any Arthritis	10.0M	$71.3B	$7,135	$151.1B	$15,126
Any OA	8.2M	$40.2B	$4,886	$127.9B	$15,565
Any IA	0.9M	$14.4B	$15,991	$15.8B	$17,550
Knee OA	4.1M	$13.0B	$3,168	$63.9B	$15,527
Hip OA	1.8M	$11.1B	$6,116	$28.6B	$15,819
Hand OA	0.8M	$1.4B	$1,718	$12.8B	$15,507
Other OA	3.4M	$14.6B	$4,362	$51.8B	$15,447
Any SpA	0.166M	$4.0B	$23,829	$2.6B	$15,779
AS	0.095M	$2.7B	$28,344	$1.5B	$15,661
PsA	0.071M	$1.3B	$17,696	$1.1B	$15,939
SLE	0.074M	$2.1B	$29,033	$1.4B	$18,415
RA	0.7M	$10.5B	$14,138	$13.3B	$17,949
Gout	1.9M	$13.6B	$7,135	$21.6B	$11,346

Condition rows are disease group-specific views rather than simple additive components across comorbid people. JIA is not shown separately because it uses an under-15 prevalence adjustment and is not included in the adult disability-cost framework.

8.4 Provincial Total Burden

Provincial total burden is reported as a combined measure with separate economic and social components. Differences across provinces are interpreted in relation to population size, age structure, disease mix, and reporting definitions. Detailed provincial economic and social burden values are provided in Appendix L. The provincial totals support geographic burden interpretation, while the component values remain necessary for understanding whether differences are driven primarily by economic costs or welfare losses.

8.5 Total Burden Interpretation

Total burden provides a broader burden measure, but it does not remove the need to examine components separately. The combined value shows the scale of measured burden when economic and welfare impacts are considered together. It does not imply that social burden is a public expenditure, nor does it imply that every component can be interpreted through the same institutional or programme mechanism. The total is therefore most useful as a scale measure when read with the economic and social components visible.

9 Distributional Results

9.1 Available Distributional Dimensions

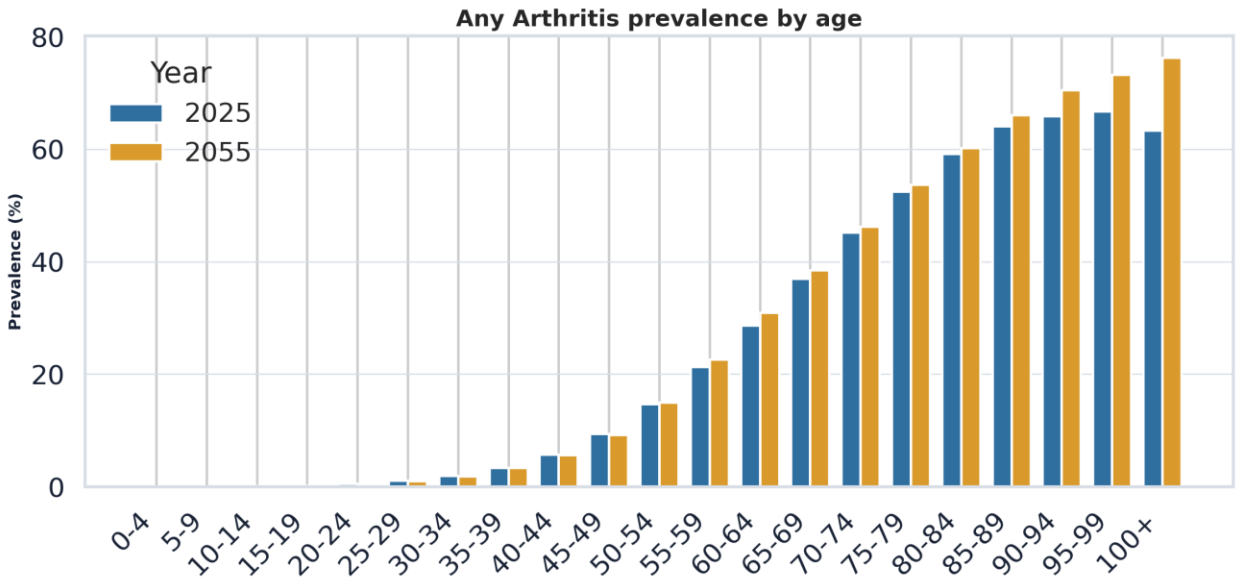
The current model results support distributional reporting by year, province, sex, age group, disease group, and cost category, with additional derived metrics by year, province, and disease group. Appendix companion tables provide selected age profiles, sex-specific prevalence and burden measures, social value by age-sex segment, and provincial outcomes. These dimensions describe where burden is concentrated within the reported results.

9.2 Age and Sex Distribution

Distributional analysis begins with age and sex because these dimensions are present in the core model outputs and shape disease burden, labour force exposure, private disability costs, and social burden. Canadian survey evidence shows that arthritis affects daily life across age groups (O'Donnell et al., 2015). Osteoarthritis evidence also links disease burden to social participation, supporting attention to life-course and participation patterns (Perruccio et al., 2021).

Figure 9 shows the steep age gradient in Any Arthritis prevalence and visually explains why life-course interpretation is central to the report. The figure also clarifies that older adults carry much higher crude prevalence, so national burden growth cannot be interpreted without reference to population ageing and age-specific prevalence.

Figure 9: Any Arthritis crude prevalence by age group, Canada, 2025 and 2055



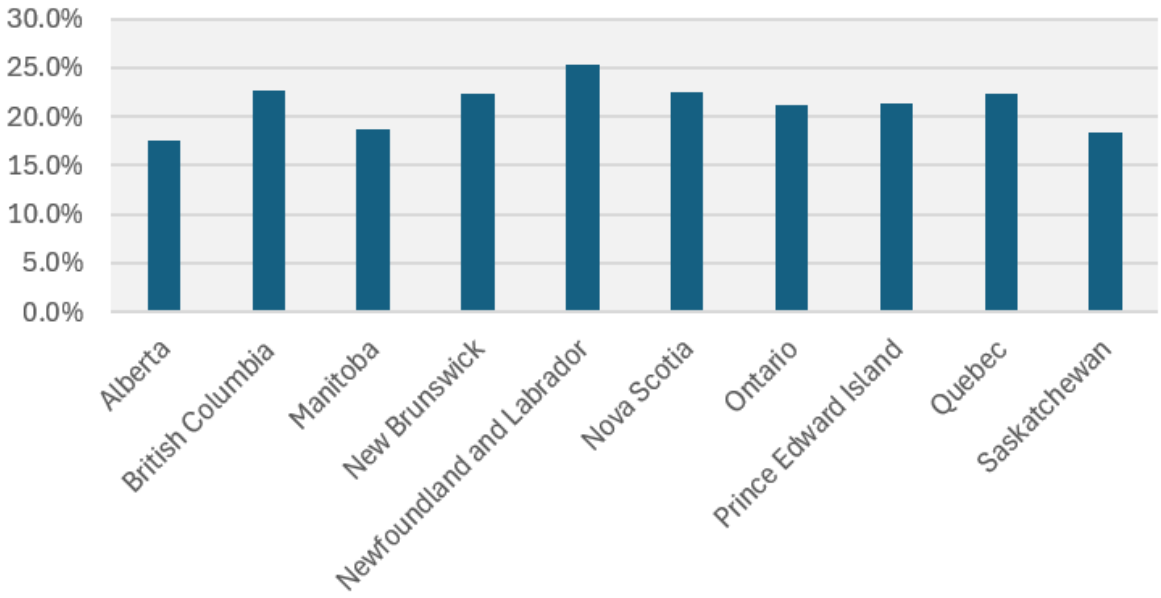
Detailed age-sex tables including economic burden and social value outputs are provided in Appendix M. The largest social value segments in 2055 are among adults aged 70 and older and adults aged 60 to 69, reflecting the combination of population size, arthritis prevalence, and age-sex social value allocation.

9.3 Provincial and Regional Patterns

Provincial patterns connect geography to measured burden. Provincial differences are interpreted with care because total burden reflects population size, age structure, disease mix, and modelled rates.

A matching 2025 provincial prevalence view can be produced from the baseline outputs. The 2025 table shows the same broad pattern as the 2055 chart, with Newfoundland and Labrador highest on crude prevalence (18.1%) and Ontario largest in absolute burden.

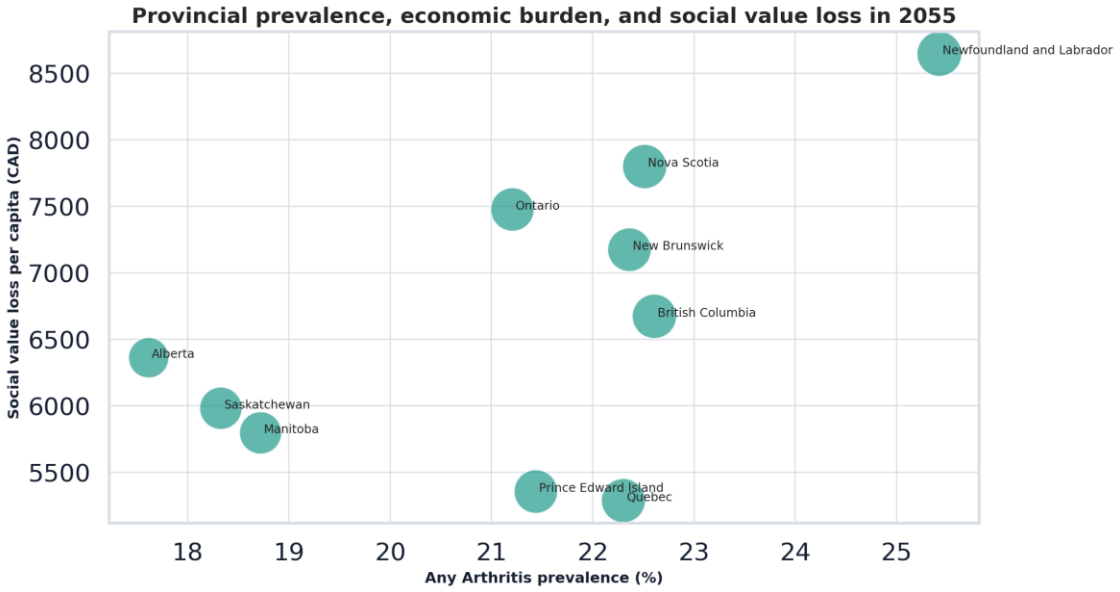
Figure 10: Provincial Any Arthritis crude prevalence, 2055



The project outputs include people with Any Arthritis, population, crude prevalence, age-standardised prevalence, economic burden, social value loss, and per-person measures. They are used to show geographic burden patterns, not to rank health systems.

Figure 11 shows that provincial patterns differ depending on whether the reader focuses on prevalence, social value loss per capita, or economic burden per capita. It supports the report's caution that provincial comparisons are useful for describing geographic burden, but they are not direct measures of provincial health-system performance.

Figure 11: Provincial Any Arthritis prevalence and social value loss per capita, with bubble size reflecting economic burden per capita, Canada, 2055



There is a clear positive relationship between arthritis prevalence and social value loss per capita; Provinces with higher arthritis prevalence generally experience greater social value loss on a per capita basis. However, some provinces deviate from the trend, suggesting differences in demographics, healthcare systems, labor participation, age structure, or productivity impacts.

10 Interpretation of Findings

10.1 Interpreting the Measured Burden

This chapter interprets the measured burden results presented in the preceding chapters and explains their broader significance. Taken together, the findings show that arthritis is not only a health system issue but also a labour force, household, and social welfare issue. The results therefore need to be read across disease burden, direct costs, productivity losses, private disability-related costs, social burden, and distributional variation, while keeping the limits of the available evidence in view.

Table 24: Interpretation matrix

Finding domain	Observed finding	Interpretation	Source base	Limitation
Disease burden	Modelled arthritis prevalence increases materially by 2055.	Growth in affected population is the foundation for later economic, social, and total burden increases.	Chapters 5 and 9; model outputs	Disease-specific interpretation remains necessary because aggregate categories mask heterogeneity.
Health system and direct costs	Direct health costs rise over the projection period.	Health service use, pharmaceuticals, hospitalisations, professional services, rehabilitation, and related service categories remain important cost domains.	Chapters 6 and 8; model outputs	The model reports burden, not programme capacity or access performance.
Labour force and productivity	The aggregate indirect-burden category is the largest 2055 economic driver.	Work participation, absenteeism, presenteeism, and labour force withdrawal are central to economic interpretation.	Chapter 6; Gignac et al. (2008)	The report focuses on aggregate labour-market effects.
Additional private disability costs	Additional disability costs form a distinct economic burden layer.	Out-of-pocket disability-related expenses materially broaden the economic burden beyond public health system costs.	Chapter 6; disability-cost method	Under-15 private disability costs are outside the current parameter scope.

Finding domain	Observed finding	Interpretation	Source base	Limitation
Social burden	Social value loss is substantially larger than measured economic burden.	Pain, disability, participation, independence, and life satisfaction effects are central to the overall burden picture.	Chapter 7; McNamee & Mendolia (2014); Anke et al. (2013); Dong et al. (2020); Oswald & Powdthavee (2008); Stockel et al. (2023)	Social burden is a welfare measure, not a budgetary cost.
Total burden	Economic and social burden combine to show a broader burden measure.	Total burden is useful for scale when read with component transparency.	Chapter 8	Components are not interchangeable and are not collapsed for interpretation.
Distributional results	Burden varies by age, sex, province, disease group, and cost category.	Interpretation attends to population structure, disease mix, and denominator choice.	Chapter 9	Socioeconomic and household cuts depend on verified outputs before they are reported as results.
Evidence gaps	Evidence is uneven across disease groups and burden domains.	Further evidence development is most valuable where uncertainty affects interpretation: rare/bundled diseases, private costs, caregiver impacts, social burden, and underdiagnosed disease.	Chapter 3 and Chapter 11	Lower-limit interpretation is limited to source-supported material.

10.2 Health System Interpretation

The disease burden and direct cost results indicate that arthritis affects the health system through several service categories, including medications, hospital care, physician and allied health services, and other forms of treatment and support. Rehabilitation, surgery, medication use, and pain management are therefore important parts of the burden picture, even when their effects are not fully visible within a single cost category. This interpretation follows from the measured cost categories and the disease context; it is not a programme-capacity assessment or a ranking of health-system performance.

10.3 Workplace and Labour Force Interpretation

Workplace and labour force effects are central to the economic burden of arthritis (Gignac et al., 2008; Gignac et al., 2018). Indirect burden reflects not only missed work but also reduced effectiveness while working and earlier withdrawal from the labour force. The analysis therefore interprets productivity burden at the aggregate level supported by the current results.

10.4 Research, Innovation, and Data Interpretation

Priorities for future research and data development follow from the main areas of uncertainty in the analysis. These include rare or bundled disease categories, private disability-related costs, caregiver and household impacts, social burden parameters, underdiagnosed or untreated disease, and distributional breakdowns that are not yet available in the confirmed results. Stronger evidence in these areas would improve the accuracy, completeness, and interpretability of future burden estimates. These priorities are presented as evidence-development considerations, not as programme recommendations.

11 Risk-Removal Scenarios

The analysis uses counterfactual risk-removal scenarios to examine the modelled arthritis burden associated with obesity or high BMI, physical inactivity, and smoking-related risks. Separate scenarios remove each risk relationship in turn, while an all-risk removal scenario neutralises the three sets of excess-risk effects together. Results in this chapter are limited to Any Arthritis, Any OA, and rheumatoid arthritis (RA).

The scenarios provide a prevention-oriented view of the burden associated with the modelled risk relationships. They are not estimates of specific interventions or assumptions that the risks can be eliminated in practice. Individual scenarios isolate each modelled risk category, while the all-risk scenario reflects their combined treatment within ONEMODEL and should not be interpreted as the arithmetic sum of the individual scenarios. The accompanying dataset contains the baseline results; the scenario results are reported in this chapter.

11.1 Disease burden

The updated risk-removal results extend to 2055 and report the reduction in prevalent cases relative to the baseline projection. Results are limited to Any Arthritis, Any OA, and rheumatoid arthritis (RA). Percentages below use the corresponding 2055 baseline populations reported elsewhere in this report: 9.99 million people with Any Arthritis, 8.22 million with Any OA, and 0.74 million with RA.

Table 25: Risk-removal scenario reductions in prevalent cases, Canada, 2055

Scenario	Any Arthritis	Any OA	RA
Smoking-related risk removed	8,092 (0.1%)	8,092 (0.1%)	1,636 (0.2%)
Obesity/high-BMI-related risk removed	786,753 (7.9%)	567,866 (6.9%)	10,112 (1.4%)
Physical-inactivity-related risk removed	156,437 (1.6%)	156,437 (1.9%)	0 (0.0%)

Obesity or high BMI is the largest modelled risk pathway for Any Arthritis and Any OA. Removing this risk is associated with approximately 786,800 fewer Any Arthritis cases and 567,900 fewer Any OA cases in 2055, equivalent to reductions of 7.9% and 6.9% from their respective baselines. The corresponding RA reduction is smaller at approximately 10,100 cases, or 1.4%.

Removing physical-inactivity-related risk is associated with approximately 156,400 fewer Any Arthritis cases and the same number of fewer Any OA cases. Because Any OA has a smaller baseline population, this represents a somewhat larger proportional reduction for Any OA (1.9%) than for Any Arthritis (1.6%). No reduction in prevalent RA cases is reported for this scenario.

Removing smoking-related risk produces the smallest change in overall case counts, with approximately 8,100 fewer Any Arthritis and Any OA cases. Its proportional effect is more visible for RA, where approximately 1,600 fewer cases represent a 0.2% reduction from baseline.

The all-risk removal scenario is available over the full projection horizon. By 2055, it has 8.2 million people living with any modelled arthritis condition, compared with 10.0 million in the baseline projection. The difference is 1.8 million fewer people living with arthritis.

Table 26: All-risk removal scenario disease burden summary, Canada, 2055

Measure	Baseline, 2055	All-risk removal scenario, 2055	Difference
People living with any modelled arthritis condition	10.0M	8.2M	-1.8M
Any Arthritis prevalence	21.0%	17.2%	-3.8 pp
Any OA prevalence	17.3%	14.5%	-2.8 pp
RA prevalence	1.6%	1.5%	-0.1 pp

In 2055, Any Arthritis prevalence is 3.8 percentage points lower than baseline and Any OA prevalence is 2.8 percentage points lower. RA prevalence is 0.1 percentage points lower. Population ageing remains present in both the baseline and risk-removal scenarios, so the comparison isolates the effect of the modelled risk relationships rather than removing the demographic pressures that continue to increase arthritis burden over time.

11.2 Economic and social burden

The lower disease burden in the all-risk removal scenario is associated with lower economic burden and lower social value loss. In 2055, annual economic burden is $59.7B under the all-risk removal scenario, compared with $71.3B in the baseline projection. Annual social value loss is $132.0B under the all-risk removal scenario, compared with $151.1B in the baseline projection.

Table 27: All-risk removal scenario burden summary, Canada, 2055

Measure	Baseline, 2055	All-risk removal scenario, 2055	Difference
Economic burden	$71.3B	$59.7B	-$11.5B
Social value loss	$151.1B	$132.0B	-$19.1B
Economic plus social burden	$222.3B	$191.7B	-$30.6B

The annual economic burden difference is $11.5B in 2055. This reflects lower projected burden across the economic components associated with arthritis, including health costs, productivity and caregiving impacts, and additional private disability costs.

The annual social value loss difference is $19.1B in 2055. This reflects fewer people experiencing arthritis-related welfare losses associated with pain, disability, reduced daily-life participation, reduced independence, and lower life satisfaction. The social value difference is larger than the economic burden difference in dollar-equivalent terms, consistent with the report's broader finding that arthritis burden extends beyond direct spending and labour-market effects.

11.3 Risk-reduction opportunity

The results indicate that the largest individual modelled opportunity is associated with obesity or high BMI and is concentrated in Any Arthritis and Any OA. Physical inactivity produces a smaller osteoarthritis-focused effect, while smoking produces a smaller aggregate effect but a relatively greater effect for RA. The all-risk removal scenario shows the combined full-horizon effect across the modelled risk relationships.

These scenarios provide a prevention-oriented view of the burden associated with the modelled risk relationships. They are counterfactual tests rather than estimates of a specific intervention or an assumption that the risks can be eliminated in practice.

12 Technical Limitations, Uncertainty, and Lower-Limit Interpretation

12.1 Scope Limitations

The analysis focuses on the modelled arthritis conditions and the reported dimensions of province, age, sex, economic burden, social burden, and total burden over the project horizon. It does not represent every rheumatic disease, every possible care pathway, or every social, household, and community consequence of arthritis. The results should therefore be interpreted within these defined analytical boundaries.

Table 28: Main limitations and interpretation

Limitation domain	Description	Interpretation
Scope	Results are limited to modelled disease groups and output dimensions.	Findings are read within the defined disease, geography, time, and burden domains.
Data capture	Administrative and clinical data can miss undiagnosed, untreated, self-managed, or infrequently treated disease.	Disease burden may be conservative where people are not captured by health system or survey data.
Evidence coverage	Evidence is stronger for OA and RA than for some smaller, bundled, or pediatric categories.	SARD, JIA, and some aggregate categories should be interpreted with additional caution because direct evidence is less complete.
Additional private disability costs	Private cost parameters apply from age 15 onward and rely on D0/D1/D2 crosswalks and representative allocations.	Pediatric private disability costs and some heterogeneous private expenses may be understated.
Social burden	Social value parameters are evidence-informed and partly rely on bridged HRQoL/SWL evidence.	Social burden is a modelled welfare measure, not a directly observed expenditure.
Accounting	Economic and social burden are related but distinct.	Component boundaries remain visible before total burden is interpreted.
Distributional outputs	Current outputs support age, sex, province, disease group, and cost category.	Distributional results are reported by age, sex, province, disease group, and cost category, with detailed tables for the confirmed reporting dimensions used throughout the report.

12.2 Data and Evidence Limitations

Administrative data can be strong for treated cases and service use, but can miss undiagnosed, untreated, self-managed, or infrequently treated burden. Canadian evidence on people who report arthritis without knowing the specific type illustrates the difficulty of translating broad population experience into precise disease categories (Badley et al., 2022). Administrative algorithm validation evidence also shows why case definitions and observation windows matter for disease-burden estimation (Widdifield et al., 2020).

The evidence base is stronger for some disease groups than others, and this affects how confidently outputs can be interpreted across disease groups. OA and RA have broader literature coverage than several smaller or bundled categories. SARD and JIA estimates should therefore be read with more caution because direct evidence and parameter coverage are less complete than for major adult arthritis categories. The "Any OA" aggregate also carries site-mix uncertainty because disability and cost pathways differ across knee, hip, hand, and other OA. Patient-borne and private cost evidence varies by disease and setting as well, which limits direct transferability into a complete Canadian parameter table; the scleroderma evidence is treated as systemic rheumatic disease context rather than as an arthritis-wide parameter source (Trenaman et al., 2023).

12.3 Modelling and Parameter Limitations

Model limitations include structural assumptions, evidence crosswalks, aggregation choices, event-time approximation, constructed disease aggregates, proxy evidence, and uncertainty around rare or bundled disease groups. These features are necessary to generate comparable outputs across diseases and population groups, but they also mean that some estimates reflect modelled parameterisation rather than direct observation.

The additional disability-cost method uses structured burden-state and D0/D1/D2 mappings, but those mappings are evidence-informed parameterisations rather than direct observations for every disease, age, sex, and severity combination. For gout, high-pain burden is interpreted as flare exposure rather than as a chronic high-pain stock, consistent with clinical evidence on gout flare burden (Dalbeth et al., 2021; Dehlin et al., 2020). For under-15 ages, private disability costs are outside the current parameter scope unless separately supplied. Low and high additional-cost values should be interpreted as scenario bounds rather than probability intervals.

12.4 Accounting and No-Double-Counting Limitations

No-double-counting controls reduce overlap risk through transparent boundaries. Direct costs, indirect costs, additional private disability costs, caregiving-related impacts, and social burden are conceptually related but not interchangeable. The report therefore shows economic and social components separately before presenting total burden. This distinction is important because pain and disability can affect both economic outcomes and wellbeing outcomes; the report treats those pathways separately rather than using wellbeing evidence as a direct monetary cost input.

Social burden is a welfare or income-equivalent impact. It is not a conventional economic cost or budgetary expenditure.

12.5 Lower-Limit and Undercounting Considerations

Potential reasons for understatement include underdiagnosis, untreated populations, incomplete private costs, incomplete caregiver or household impacts, limited attribution of pain and disability to arthritis in general data sources, and evidence gaps. Published Canadian evidence on arthritis-type knowledge and administrative algorithm performance supports treating measurement and classification gaps as limitations rather than numeric adjustments in the absence of a method (Badley et al., 2022; Widdifield et al., 2020).

These considerations are presented as limitations and uncertainty factors. They do not modify the reported model results. Taken together, these limitations do not negate the usefulness of the results, but they do define how the results should be read. The estimates remain decision-useful as structured, conservative measures of burden within the modelled scope, while some dimensions of arthritis burden are likely understated because of data, evidence, and parameter constraints.

13 Conclusions and Future Research Priorities

13.1 Overview

The analysis estimates that arthritis burden in Canada is large, growing, and multi-dimensional. By 2055, almost 10 million people are projected to have any modelled arthritis condition, with $71.3B in annual economic burden and $151.1B in annual social value loss. The combined economic plus social burden is reported as $222.3B in 2055, with economic and social components kept visible.

Osteoarthritis accounts for the largest affected population. Gout shows substantial proportional growth. RA remains the largest autoimmune inflammatory arthritis subtype in the available outputs. SLE and JIA are included, but their interpretation is more sensitive to evidence and parameter limitations.

The economic burden results show the monetary consequences of arthritis through direct costs, productivity and labour-related losses, and additional private disability costs. The social burden results show welfare losses associated with pain, disability, participation, independence, and life satisfaction. The total burden framework brings those domains together while preserving component boundaries.

Within the economic burden, the aggregate indirect-burden category is dominant, accounting for $35.3B (49.5%) of the total economic burden. Private disability costs ($10.7B, 15.0%) and drugs ($9.8B, 13.7%) follow as the next largest components. Gout shows the steepest proportional economic growth among disease types, rising 97% from 2025 to 2055 and reaching $13.6B in annual burden — the second-largest condition-level contributor.

Social value loss is concentrated among older Canadians and is unequally distributed by sex. In 2055, the female 70-and-older group accounts for $56.9B in social value loss, and the male 70-and-older group accounts for $25.3B. Working-age adults aged 60 to 69 contribute a further $14.5B (males) and $24.6B (females), with higher per-person welfare loss reflecting participation and independence impacts during peak employment years. By disease group, knee OA ($63.9B) and other OA ($51.8B) generate the largest shares of social value loss. These figures are not additive across people with multiple conditions and are read alongside, not added to, economic burden.

13.2 Implications

The results support two key interpretation points.

1. First, arthritis burden extends beyond health system expenditure. Productivity loss, private disability costs, and social value loss are central to the measured burden.
2. Second, distributional results matter. Age, sex, province, disease group, and cost category change the interpretation of burden.

13.3 Provincial and Regional Patterns

Provincial results indicate that burden is not distributed evenly across Canada. In 2055, Newfoundland and Labrador carries the highest crude prevalence (25.4%) and the highest social value loss per capita ($3,424), reflecting its older population structure. Ontario accounts for the largest absolute number of people affected (3.96 million) and the largest share of national economic burden. Atlantic provinces consistently show higher prevalence and per-capita social value loss than the national average, while Alberta and Saskatchewan show lower per-capita burdens, partly reflecting younger age structures after age-standardization. These patterns show why province-specific results can provide a more accurate view of geographic burden than national averages alone.

13.4 Research and Data Priorities

Research priorities focus on the evidence gaps that most affect interpretation. Canadian arthritis prevalence evidence shows why stronger disease-specific and distributional data remain important (Badley et al., 2019). Priority areas include:

1. stronger Canadian evidence for smaller or bundled disease categories, including SLE and JIA;
2. better disease-by-age-by-sex evidence for private disability costs;
3. clearer evidence on caregiver, family, household, and out-of-pocket impacts;
4. stronger social burden parameters, especially by pain severity, disability state, age, sex, and disease group;
5. validation of distributional outputs and expansion of evidence-supported socioeconomic and household detail;
6. continued investigation of underdiagnosis, untreated disease, and incomplete data capture where material supports lower-limit interpretation.

13.5 Conclusions

By 2055, arthritis is projected to affect nearly 10 million Canadians, with $71.3B in annual economic burden and $151.1B in social value loss. The burden extends beyond health system costs into productivity, independence, and quality of life, and is unevenly distributed across disease types, age groups, sexes, and provinces. The findings provide a structured view of where arthritis burden is concentrated and which components drive the total, while preserving the distinction between monetary costs and income-equivalent welfare loss.

Appendix A Glossary

Additional private disability costs: Private out-of-pocket and disability-related costs associated with arthritis-related limitations, reported separately from health-care spending and productivity losses. In this report, they are treated as a distinct economic burden layer rather than as social burden.

Age-standardised prevalence: A prevalence measure adjusted to a common reference age structure so populations with different age distributions can be compared more fairly. It differs from crude prevalence, which is not age-adjusted.

Agent-based modelling: A simulation approach that represents individual agents with attributes, states, and transition rules that can vary across people and over time. It is useful when population heterogeneity, geography, disease states, and accounting outputs must be represented in one system.

Ankylosing spondylitis: A form of axial spondyloarthritis that primarily affects the spine and sacroiliac joints and may lead to inflammatory back pain and structural spinal change. It is included in the broader spondyloarthritis family.

Any Arthritis: The report's aggregate category for all arthritis conditions included in the model outputs. It is a reporting group, not a separate clinical diagnosis.

Any IA: The report's aggregate category for modelled autoimmune inflammatory arthritis conditions. It groups clinically distinct inflammatory diseases for reporting purposes.

Any OA: The report's aggregate category for modelled osteoarthritis conditions. It combines site-specific osteoarthritis groups such as knee, hip, hand, and other osteoarthritis.

Arthritis: A broad term for conditions involving joint inflammation, pain, stiffness, or joint damage. It includes distinct diseases such as osteoarthritis, rheumatoid arthritis, gout, and spondyloarthritis rather than one single condition.

Baseline: The comparator year, population, or counterfactual state against which changes are measured. In this report, baseline language should specify whether it refers to a reporting year, a no-arthritis comparator, or another model state.

Burden accounting: The structured assignment of disease impacts to mutually exclusive burden categories so that costs, social value losses, and totals are not mixed or double-counted. It supports transparent interpretation of what is included in each reported total.

Calibration: The process of adjusting or selecting model parameters so outputs align with external evidence or target quantities. Calibration is distinct from validation, which assesses whether model behaviour is credible for its intended use.

Caregiving impacts: The time, productivity, and out-of-pocket effects experienced by unpaid caregivers because of another person's arthritis-related needs. These impacts should be assigned consistently to avoid double-counting with productivity or social burden measures.

Cohort: A group of people who share a defining characteristic and are followed or analysed over time. Cohorts may be defined by age, disease status, geography, exposure, or model entry year.

Comorbidity: The presence of one or more additional diseases or health conditions in a person who has the condition of interest. Comorbidity can affect disease burden, costs, quality of life, and interpretation of attribution.

Constant dollars: Dollar values adjusted to a common price year so amounts from different years can be compared without inflation effects. The price year must be stated because constant-dollar estimates depend on the deflator and base year used.

Cost category: A grouping used to organise cost components, such as direct health-care costs, indirect productivity costs, or private disability costs. Cost categories should be mutually clear enough to support interpretation and avoid double-counting.

Counterfactual: A hypothetical comparison state describing what would have happened in the absence of a disease, exposure, intervention, or scenario. Counterfactuals are central to causal interpretation because observed outcomes are compared with an unobserved alternative.

Crude prevalence: The proportion of a population that has a condition at a specified time, without adjustment for age or other population structure. It reflects both disease occurrence and the demographic composition of the population.

D0, D1, D2: The report's disability-state labels for none or mild limitation, moderate limitation, and severe limitation. They are model states used to organise disability-related costs and burden, not universal clinical categories.

Direct costs: Health-care resource costs attributable to arthritis, such as drugs, hospital care, physician services, or other health services where included. They are distinct from productivity losses, private disability costs, and social value losses.

Disability state: A model or measurement category describing a person's level of functional limitation or disability. Disability states are used to connect arthritis-related limitations with costs, quality of life, or social burden.

Discounting: The practice of expressing future costs or benefits in present-value terms, reflecting time preference or opportunity cost. Reports should state whether discounting was applied and at what rate.

Disease activity: The current level of inflammatory or symptomatic disease process, often reflected in symptoms, clinical measures, or disease-specific indices. It is not the same as permanent damage or long-term disability, although they can be related.

Disease burden: The population impact of a disease, including measures such as how many people are affected and the consequences for health, functioning, costs, and wellbeing. The exact components depend on the study scope and must be stated.

Disease group: A reporting category that groups related conditions for analysis, such as osteoarthritis or inflammatory arthritis. Disease groups can be useful for reporting but may combine clinically distinct diseases.

Disease severity: The extent or seriousness of disease manifestations, which may include symptoms, functional limitation, inflammation, damage, or need for treatment. Severity should be interpreted according to the measure or model state being used.

Economic burden: The monetary burden attributable to arthritis, including health-care costs and other economic costs defined in the report scope. It should be reported separately from social burden before any total burden calculation.

Flare: A period of acute worsening of symptoms in a disease that can otherwise vary over time. In gout, flares are episodic attacks of pain and inflammation rather than a continuous high-pain state.

Flare exposure: The portion of time or burden associated with experiencing disease flares. It is used to represent episodic burden, particularly where high pain occurs during acute flare periods.

Gout: An inflammatory arthritis caused by monosodium urate crystal deposition, often presenting as recurrent acute flares. It can also involve chronic joint damage or tophi in some people.

Gout flare exposure: The portion of gout-related burden associated with acute flare periods. It should not be interpreted as a chronic high-pain stock unless the source or model state explicitly supports that interpretation.

Hand osteoarthritis: Osteoarthritis affecting joints of the hand, often associated with pain, stiffness, reduced grip, and functional limitation. It is reported separately when the model distinguishes osteoarthritis by joint site.

Health-care spending: Expenditures on health-care goods and services, such as hospital care, health professionals, drugs, and related services. In a burden study, only the portion attributable to arthritis should be counted as direct cost.

High-pain state: A model or reporting state indicating a high level of pain burden. For episodic conditions such as gout, high pain should be interpreted with attention to flare exposure rather than assumed to be continuous.

Hip osteoarthritis: Osteoarthritis affecting the hip joint, commonly associated with pain, stiffness, mobility limitation, and possible need for joint replacement. It is one of the site-specific osteoarthritis groups used in the report.

Incidence: The occurrence of new cases of a condition in a population over a specified period. It differs from prevalence, which counts existing cases at or during a point or period of time.

Income-equivalent: A monetary expression of a non-market welfare change, usually asking what income change would have an equivalent effect on wellbeing or life satisfaction. It does not mean that the person actually receives or loses that income.

Income-equivalent valuation: A valuation method that expresses a non-monetary wellbeing loss as the income change that would produce an equivalent welfare effect. In this report, it supports reporting social value loss in CAD-equivalent terms while keeping it distinct from economic costs.

Indirect costs: Costs from lost productivity, labour force effects, unpaid work, or related economic activity rather than direct health-care spending. The exact scope must be stated because indirect-cost methods differ across studies.

Inflammatory arthritis: A group of arthritis conditions driven primarily by immune-mediated inflammation rather than mechanical joint degeneration alone. Examples include rheumatoid arthritis, psoriatic arthritis, spondyloarthritis, and juvenile idiopathic arthritis.

Joint replacement: Surgical replacement of a damaged joint with an artificial implant, most commonly discussed for hip or knee osteoarthritis. It is typically considered when pain and functional limitation remain severe despite non-surgical treatment.

Juvenile idiopathic arthritis: A group of chronic arthritis beginning before age 16 with no other identified cause. It includes several subtypes and can affect joints, function, growth, and quality of life.

Knee osteoarthritis: Osteoarthritis affecting the knee joint, commonly associated with pain, stiffness, mobility limitation, and potential need for knee replacement. It is one of the major site-specific osteoarthritis groups in the report.

Labour force: The population that is employed or actively seeking work, depending on the statistical definition used. Arthritis can affect labour force participation through disability, absenteeism, presenteeism, or early exit from work.

Life satisfaction: A person's overall cognitive evaluation of their life as a whole. It is commonly used in wellbeing valuation because it can be related statistically to health states, income, and other life circumstances.

Microsimulation: A simulation approach that models individual units and their transitions over time, often under specified probabilities or rules. In this project, the method should be described as agent-based modelling unless microsimulation is being discussed as an external or limiting-case comparator.

Mobility limitation: Difficulty moving around, such as walking, climbing stairs, or carrying out physical activities. In arthritis, mobility limitation is a key pathway linking joint disease to disability, costs, and reduced quality of life.

Model reporting group: A condition or aggregate label used to organise model outputs. It may not be identical to a full clinical taxonomy and should be interpreted according to the report's model definitions.

Modelled population: The set of people or agents represented in the model for a given year, geography, age group, sex, or disease state. It is the denominator for model-based estimates unless another denominator is specified.

No-double-counting rule: An accounting rule requiring each burden component to be counted once and only once in totals. It is especially important when economic costs and social value losses are reported together.

ONEMODEL: The integrated CANCEA modelling platform used in this report to organise population, disease, economic, and social burden outputs within a single consistent analytical framework.

Osteoarthritis: A joint disease involving structural changes, pain, and functional limitation, often described as the most common form of arthritis. It can affect different joint sites, including knee, hip, hand, and spine or other joints.

Other osteoarthritis: The report's model category for osteoarthritis sites not separately reported as knee, hip, or hand osteoarthritis. It is a reporting group and should not be treated as one clinical disease.

Out-of-pocket costs: Costs paid directly by individuals or households rather than by public or private insurers. In arthritis burden accounting, relevant out-of-pocket costs may include disability-related expenditures if they are attributable to arthritis.

Parameter: A numerical input or assumption used in a model, such as a rate, probability, cost, or valuation coefficient. Parameter values should be traceable to model outputs, evidence, calibration, or scenario assumptions.

Prevalence: The proportion or number of people in a population who have a condition at a specified point or over a specified period. Prevalence includes existing cases, not only newly diagnosed cases.

Price year: The year whose prices are used when reporting monetary values. Stating the price year is necessary because dollar estimates can change when values are adjusted for inflation.

Private disability costs: Disability-related costs borne privately by individuals or households, rather than by the health system or employers. In this report, they are kept distinct from direct health-care costs and productivity losses.

Productivity loss: Economic loss from reduced paid or unpaid work because of illness, disability, caregiving, or premature withdrawal from work. It is usually treated as an indirect cost, with results depending on the method used.

Projection horizon: The period over which model results are projected and reported. It should be stated explicitly because results depend on the start year, end year, and reporting intervals.

Psoriatic arthritis: An inflammatory arthritis associated with psoriasis that can affect peripheral joints, the spine, entheses, skin, and nails. It is part of the broader spondyloarthritis family but is often reported as a distinct condition.

Quality of life: A broad concept describing how health and life circumstances affect physical, mental, and social wellbeing. Health-related quality of life focuses on the aspects of quality of life most directly affected by health status.

Remission: A state in which disease activity is absent or sufficiently low under a specified definition. Remission depends on the disease and measurement criteria being used.

Reporting interval: The standard time step at which model outputs are recorded or summarised. Events within an interval may be aggregated before appearing in reported population, cost, or burden tables.

Rheumatoid arthritis: A chronic autoimmune inflammatory arthritis that commonly affects synovial joints and can cause pain, swelling, disability, and systemic effects. It is clinically distinct from osteoarthritis and gout.

Risk factor: A characteristic, exposure, or condition associated with a higher or lower probability of an outcome. A risk factor is not automatically a proven cause unless the evidence supports a causal interpretation.

S4CI: The report's single-modelling consistency framework for coherence, calibration, conservation and closure, and causal traceability. It is a project-specific quality-assurance label grounded in general modelling principles.

Scenario analysis: An analysis that examines how results change under alternative plausible assumptions or future conditions. Scenario results should not be interpreted as probabilities unless a probability framework is specified.

Scenario bounds: Low and high values used to show how results vary under alternative assumptions. They are not confidence intervals or probability intervals unless the source explicitly defines them that way.

Sensitivity analysis: A method for testing how model results change when assumptions, parameters, or structures are varied. It helps identify which inputs or assumptions materially influence the results.

Severity: The degree of seriousness or intensity of disease, symptoms, disability, or burden. The term should be tied to a specific measure, such as pain level, disability state, disease activity, or cost burden.

Simulation: A model-based representation of processes over time used to estimate outcomes under specified assumptions. Simulations can be deterministic or stochastic and should be interpreted according to their structure and inputs.

Social burden: The non-market welfare or wellbeing burden associated with arthritis, such as pain, disability, reduced independence, and reduced life satisfaction. It is reported separately from economic burden before any total burden calculation.

Social value: A monetary-equivalent expression of changes in a person's satisfaction with life in response to an event or series of events, in this case arthritis. In this analysis, social value language remains distinct from health-care spending or productivity costs. Aggregate social value loss is the sum of individual welfare losses after each change in satisfaction with life is translated into monetary-equivalent terms. A larger social value loss indicates a larger aggregate reduction in satisfaction-with-life terms.

Social value loss: A term used for a negative social value as defined above.

Spondyloarthritis: A family of inflammatory arthritis conditions that can affect the spine, peripheral joints, entheses, skin, bowel, or eyes. It includes ankylosing spondylitis and psoriatic arthritis among other forms.

Symptom state: A model or clinical category describing the current symptom level experienced by a person. It may change over time and should not be assumed to represent permanent disability.

Systemic autoimmune rheumatic disease: An umbrella term for autoimmune rheumatic diseases that can affect multiple organs or body systems as well as joints. Examples include systemic lupus erythematosus and related connective tissue diseases.

Systemic Lupus Erythematosus: A chronic autoimmune inflammatory disease in which the immune system attacks healthy tissues and organs. SLE can affect joints, skin, kidneys, blood vessels, and other body systems, and disease activity may fluctuate over time with periods of flare and remission.

Total burden: The combined burden measure formed from economic burden plus social burden under explicit no-double-counting rules. It should be interpreted as an accounting total, not as a single observed market transaction.

Transfer payment: A payment that redistributes income from one party to another without directly measuring new resource use. In cost-of-illness accounting, transfer payments should be distinguished from real resource costs.

Transition: A movement from one model state to another, such as from no disease to disease, from one disability state to another, or from one year to the next. Transition rules determine how simulated populations evolve over time.

Validation: The process of assessing whether a model is credible and fit for its intended purpose by checking structure, inputs, outputs, and behaviour against evidence or expectations. Validation does not prove a model is true; it assesses whether it is sufficiently reliable for the stated use.

Welfare burden: The loss in wellbeing or welfare associated with disease beyond direct spending and productivity effects. In this report, welfare burden is represented through income-equivalent social value loss.

Appendix B Abbreviations

Abbreviation	Meaning
ABM	Agent-based modelling
ACREU	Arthritis Community Research and Epidemiology Unit
AS	Ankylosing spondylitis
ASC	Arthritis Society Canada
axSpA	Axial spondyloarthritis
BMI	Body mass index
BRM	Biologic response modifier
CAD	Canadian dollar(s)
CANCEA	Canadian Centre for Economic Analysis
CCHS	Canadian Community Health Survey
CLSA	Canadian Longitudinal Study on Aging
CSD	Canadian Survey on Disability
D0, D1, D2	Disability states (no/mild, moderate, severe)
DAS28	Disease Activity Score 28 (RA)
DTC	Disability Tax Credit
DMARD	Disease-modifying anti-rheumatic drug
EQ-5D	EuroQol five-dimension health utility instrument
HAQ	Health Assessment Questionnaire
HRQoL	Health-related quality of life
IA	Inflammatory arthritis
ICES	Institute for Clinical Evaluative Sciences

Abbreviation	Meaning
JIA	Juvenile idiopathic arthritis
OA	Osteoarthritis
OARSI	Osteoarthritis Research Society International
p.p.	percentage points
PsA	Psoriatic arthritis
QA	Quality assurance
RA	Rheumatoid arthritis
SARD	Systemic autoimmune rheumatic disease(s)
SF-6D, SF-36	Short-Form health surveys
SLE	Systemic lupus erythematosus
SOW	Statement of Work
SpA	Spondyloarthritis
SV	Social value
SWL	Satisfaction with life
WOMAC	Western Ontario and McMaster Universities OA Index

Appendix C ONEMODEL Agent-Based Modelling Methodology

This appendix describes the ONEMODEL analytical foundation used for the arthritis burden analysis. ONEMODEL uses an agent-based simulation structure to represent people, attributes, relationships, histories, events, evidence, validation, and scenarios. For this project, it assigns disease and disability states, applies cost and welfare parameterisation, and aggregates results through a common reporting framework. The purpose of this appendix is to explain the model structure behind the full arthritis analysis, not only the social value component.

The central modelling principle is bottom-up consistency. Disease burden, direct and indirect economic burden, additional private disability costs, social burden, and total burden accounting are generated from the same underlying population, time horizon, geography, disease-state definitions, and output contract. This allows results across chapters and appendices to be interpreted as different views of one coherent modelled system rather than as separate estimates stitched together after the fact.

C.1 Role in the Arthritis Project

ONEMODEL is CANCEA's integrated socio-economic modelling platform for complex population problems where outcomes vary across people, places, disease states, and time. For this arthritis project, it provides the analytical infrastructure for population projection, condition-specific prevalence and incidence, disease and disability state assignment, cost attribution, welfare loss estimation, and aggregation to reportable burden metrics.

The project uses ONEMODEL because arthritis burden is not a single event or a single average cost. It is a dynamic, multi-condition system involving osteoarthritis by site, inflammatory arthritis, gout and other condition groupings, each interacting with age, sex, geography, disability, pain, labour-market participation, service use, private costs, and wellbeing. ONEMODEL is designed to preserve those distinctions until the reporting stage, so that aggregate outputs traced back to structured person-period states and assumptions.

The model therefore plays three roles in the project:

- a population engine that maintains demographic and geographic consistency over the projection horizon;
- a disease-state engine that organises condition-specific prevalence, incidence, disease activity, flare exposure, and disability assumptions; and
- a burden-accounting engine that applies direct, indirect, private disability, social value, and total-burden rules without treating these domains as interchangeable.

This architecture is important for interpretation. A disease group that appears large in the social burden chapter, for example, is not being valued in isolation from the rest of the model. Its social value loss is linked to the same prevalence, age-sex structure, geography, and disease-state allocation used in the economic and epidemiological outputs.

C.2 System Representation

ONEMODEL represents people as heterogeneous agents embedded in a structured population. Each agent carries demographic, geographic, epidemiological, clinical, economic, and welfare attributes relevant to the arthritis analysis.

The study analyze year, province, sex, age group, condition, cost category, and derived burden metrics, but those outputs are generated from person-level states before aggregation. This supports traceability from headline results back to modelled population segments, disease states, disability states, and burden domains.

The principal attribute families are:

- Demographic attributes: age band, sex, province, and population membership over time.
- Epidemiological attributes: condition group, prevalence status, incidence status, and membership in aggregate disease categories.
- Clinical and functional attributes: disease activity or symptom state, flare exposure, and disability state in the D0/D1/D2 framework.
- Economic attributes: direct cost, indirect cost, additional private disability cost exposure, and service-category attribution.
- Welfare attributes: pain, disability, participation, life-satisfaction and income-equivalent parameters used for the social value calculation.

Because these attributes are carried together, outputs can be reconciled across domains. For example, the same simulated population structure supports disease prevalence tables, economic cost tables, disability-cost outputs, and social value loss estimates.

C.3 Time, Geography, and Reporting Contract

The analysis outputs from 2025 to 2055. The project interpretation horizon is 2025 to 2055. Results are organised by province, sex, age group, condition, and cost category. The national geography is Canada excluding territories unless otherwise specified.

The reporting contract is organised around declared dimensions and tables rather than ad hoc tabular outputs. The main dimensions are year, province, sex, age group, condition, and cost category. The main logical tables include population, prevalence, incidence, costs by condition, costs by service category, social value loss, additional private disability costs, and derived total-burden metrics.

This standardised results structure reduces the risk that one chapter uses one population denominator, another chapter uses a different geography, and a third chapter uses an inconsistent disease grouping. Province-level results are used for geographic interpretation, while national results are used for headline reporting.

C.4 Disease and Disability State Architecture

The arthritis analysis includes multiple disease states and aggregate disease groups. ONEMODEL treats these as structured model states rather than as independent labels. Site-specific osteoarthritis categories, rheumatoid arthritis, gout, juvenile idiopathic arthritis where relevant, and aggregate groups such as any osteoarthritis are organised so that condition-specific and aggregate outputs remain interpretable.

Disease burden is represented through condition-specific prevalence and incidence outputs. The model distinguishes prevalent cases from incident cases by the results, and it applies admissibility rules so that states are clinically and demographically coherent. For example, a modelled person cannot become incident for a childhood-onset condition at an inadmissible adult age, and aggregate categories such as any osteoarthritis are constructed from site-specific OA states rather than treated as independent transition targets.

The disability and additional-cost method adds burden-state interpretation using chronic states, flare exposure, and D0/D1/D2 disability states. The D0/D1/D2 allocation is used for private disability-cost calculations and prevents the same person from contributing to multiple mutually exclusive disability states within a reporting period.

Model layer	Purpose in the arthritis analysis	Examples of reconciliation safeguards
Condition state	Identifies disease group, prevalence, incidence, and aggregate membership.	Aggregate categories are derived from component states rather than treated as independent disease targets.
Disease activity or symptom state	Captures severity-relevant clinical variation where evidence supports it.	Severity assumptions are tied to condition-specific parameter sources and sensitivity ranges.
Flare exposure	Represents episodic burden, particularly for painful episodic conditions.	Flare exposure is applied as an exposure state rather than double-counted as a separate prevalent disease.
Disability state	Supports additional private disability-cost calculations and burden-state interpretation.	D0/D1/D2 states are mutually exclusive within a reporting period.
Aggregate reporting group	Supports report-friendly summaries such as any arthritis or any osteoarthritis.	Aggregate values are reconciled to underlying disease states and population denominators.

C.5 Burden Domains

ONEMODEL supports multiple burden domains within the same project framework:

- disease burden, including prevalence and incidence;
- direct economic burden;
- indirect economic burden;
- additional private disability costs;
- social value loss; and
- total burden accounting.

These domains are connected through the same output framework but are not interchangeable. Economic and social burden are reported separately before total burden is interpreted. Direct and indirect economic costs represent monetary resource and productivity effects. Additional private disability costs represent extra private costs associated with disability states. Social value loss represents CAD-equivalent welfare loss relative to a no-arthritis baseline. Total burden accounting is a reconciliation exercise that combines eligible domains only after boundaries and double-counting risks have been addressed.

The integrated representation allows the report to compare disease burden, economic burden, social burden, and total burden against the same underlying population and geography. This is essential because rankings differ across burden domains: a condition may have high prevalence but lower per-case welfare loss, or a smaller population but higher per-case burden because of disease activity, disability, pain, or participation effects.

C.6 Economic, Private Disability, and Social Value Outputs

Economic outputs include direct cost, indirect cost, additional private disability cost, and total expected economic cost. Cost categories provide composition detail, allowing results to be interpreted by service type or cost pathway.

Private disability costs are calculated through the disability-state framework. They are distinct from direct health-care spending and from indirect productivity losses. Their role is to capture additional private costs associated with living with arthritis-related disability, using the D0/D1/D2 burden-state interpretation described in the disability-cost method.

Social value outputs report CAD-equivalent welfare loss separately from economic burden. The social value calculation uses the same modelled disease, pain, disability, age, sex, geography, and income-related context as the rest of the project. It compares a disease scenario with a no-arthritis baseline and translates modelled welfare or life-satisfaction differences into income-equivalent values. The detailed social value method is documented in Appendix G, while this appendix emphasises that the social value output is produced from the same ONEMODEL population and disease-state architecture as the other burden domains.

Maintaining this separation protects interpretation. A dollar-equivalent social value loss is not a health-care bill, a household expenditure, or a productivity loss. It is reported in monetary units for comparability, but it remains a welfare measure until combined under the explicit total-burden accounting rules.

C.7 Counterfactual and No-Arthritis Baseline Logic

The model's burden results are interpreted against explicit comparison states. For economic and disease burden outputs, the relevant comparison depends on the reported metric: prevalence, incidence, expected cost, or incremental burden. For social value loss, the comparison is the modelled no-arthritis baseline for the same person-period context.

This counterfactual structure is central to ONEMODEL. Results are not obtained by applying a single average multiplier to a headline population count. Instead, disease states, disability states, costs, and welfare impacts are linked to the modelled population structure and then aggregated after person-period differences have been assigned.

Where the evidence base is incomplete for a condition, state, transition, or valuation input, the project method records the assumption category, parameter source, evidence rating, and scenario range so that the assumption is revisited under future evidence review. The model therefore distinguishes between data-driven estimates, evidence-informed parameterisation, and scenario assumptions.

C.8 Admissibility, Closure, and Double-Counting Controls

ONEMODEL applies admissibility and closure controls to keep the arthritis analysis internally coherent. Admissibility rules constrain transitions between disease, incidence, age, and disability states. Closure rules ensure that output tables reconcile to the declared population, geography, time horizon, and disease grouping. Double-counting controls ensure that economic, private disability, social value, and total burden domains are not combined mechanically without checking overlap.

Minimum controls used in interpretation include:

- Population consistency: output counts reconcile to the declared population and geography for the reporting period.
- State consistency: agents cannot occupy mutually exclusive disease or disability states in the same period unless the model explicitly permits comorbidity or overlap.
- Aggregate consistency: aggregate groups are reconciled to underlying condition states and are not interpreted as independent disease targets.
- Burden-domain consistency: costs, private disability costs, social value loss, and total burden are interpreted under distinct accounting rules.
- Time consistency: annual outputs, projection horizon, and interpretation period are aligned across population, disease, cost, and burden tables.
- Traceability: headline outputs is traced to population segments, disease states, parameter choices, and burden-domain rules.

These controls are especially important for a multi-state arthritis project. Without them, aggregate arthritis results could inadvertently count the same person twice, mix incompatible geographies, apply disease-state assumptions outside their admissible range, or combine welfare and cost measures without an explicit accounting boundary. These controls are formalised as the S4CI framework; see Appendix D for operational detail.

C.9 Validation, Sensitivity, and Reproducibility

Validation in ONEMODEL is not a single statistical test. It is a set of checks that determine whether the model is adequate for the decision purpose. For this arthritis project, validation occurs through structural review, calibration review, output reconciliation, sensitivity analysis, and documentation of assumptions.

The minimum validation disciplines are:

- Structural validation: the model represents the relevant population, disease states, disability states, cost domains, welfare domains, time horizon, and geography.
- Calibration validation: epidemiological, cost, disability, and welfare parameters are tied to empirical evidence, administrative data, peer-reviewed literature, or transparent assumptions.
- Output validation: selected outputs are checked against external benchmarks or independently estimated quantities.
- Sensitivity analysis: key assumptions are varied, including prevalence and incidence inputs, disability-state allocation, flare or severity assumptions, valuation parameters, discounting conventions, and burden-domain inclusion rules.
- Reproducibility: outputs are reported through method appendices so that another analyst can trace how results move from population and disease states to burden-domain tables.

The model is therefore best understood as a transparent simulation system with documented structure and assumptions, not as a black-box forecast. Its strength lies in maintaining one consistent analytical frame across many disease states and burden domains while allowing parameter uncertainty and alternative assumptions to be tested. Validation results and benchmark comparisons are documented in Appendix J.

C.10 Relationship to Other Appendices

This appendix provides the overall ONEMODEL modelling methodology. Appendix G documents the social value methodology. Appendix H documents total burden accounting. Appendix I documents sensitivity analysis. Appendices L and M provide detailed provincial and detailed age, sex, and distributional results. Together, these appendices separate model architecture, parameterisation, accounting rules, and output detail while keeping them linked to the same ONEMODEL analytical foundation.

Appendix C is the project-level modelling appendix. It explains why the arthritis analysis reports disease burden, economic burden, additional private disability costs, social value loss, and total burden within a common structure, while still respecting the different meanings and accounting rules of each burden domain.

Appendix D S4CI: Model Integrity, Consistency, and Invariants

This appendix explains how the modelling integrity requirements used in this report support internally consistent estimates of arthritis-related burden across population, geography, disease states, disability, economic costs, additional private disability costs, social value, and total burden.

The key point is practical. The four C's used here are well known:

1. coherence,
2. calibration,
3. conservation and closure, and
4. causal traceability

They are not intended to be novel modelling concepts. They are plain-language versions of requirements that any valid complex-system model should satisfy before its outputs are used for interpretation or decision support. The contribution in this project is that ONEMODEL is built to enforce these requirements through one integrated representation, rather than leaving them to be reconciled after separate models have already produced results.

S4CI is used in this appendix as a plain-language model-integrity lens. It highlights common risks in complex modelling, including incompatible definitions, duplicated quantities, omitted flows, unclear boundaries, effects that are not linked to modelled mechanisms, and conclusions that depend on arbitrary aggregation choices. This appendix translates those risks into the arthritis project context and focuses on what the reader needs to know to interpret the report outputs.

D.1 Why model integrity matters in this project

The arthritis analysis combines several types of evidence and output: population projections, disease prevalence and incidence, multiple arthritis conditions, disability states, direct health-system costs, indirect costs, additional private disability costs, social burden, provincial results, and total burden accounting. These components cannot simply be estimated in isolation and added together at the end. If they are built on different population bases, age groups, geographies, disease definitions, time steps, or accounting boundaries, the final totals can become internally inconsistent even when each individual component looks reasonable on its own.

This is the many-model problem. It occurs when separate models or tabular outputs are treated as though they describe one system, even though their definitions and boundaries were never made common. In a burden study, this can lead to avoidable errors, such as:

- provincial populations that do not reconcile to the national population;
- disease categories that overlap in one table but are treated as mutually exclusive in another;
- a person counted in more than one disability state at the same reporting time;
- cost components that do not sum to the stated economic burden total;
- social and economic losses being combined before double-counting rules are applied; or
- scenario results that reflect joining assumptions rather than genuine modelled changes.

The four C's are used as a safeguard against these problems. They are a checklist for whether the model is internally eligible to support the claims being made from it.

D.2 ONEMODEL as the integrated modelling foundation

ONEMODEL addresses the many-model problem by representing the arthritis analysis in one integrated agent-based modelling structure. People are represented as heterogeneous agents with demographic, geographic, disease, disability, economic, and welfare-related attributes. The same underlying population and geography are used to produce disease burden, economic burden, additional private disability costs, social burden, and total burden outputs.

This does not mean every result is the same type of result. Disease burden, economic burden, disability costs, social burden, and total burden remain distinct domains. The advantage is that they are generated from a common modelled structure with shared definitions, admissible transitions, common reporting dimensions, and explicit accounting rules. This makes the outputs comparable and reconcilable without forcing unlike concepts to become interchangeable.

For this arthritis project, ONEMODEL organizes results by the declared reporting dimensions, including year, province, sex, age group, condition, and cost or burden category. Disease states and aggregate groups are governed by model rules rather than being assembled ad hoc in separate tables. For example, site-specific osteoarthritis categories and aggregate osteoarthritis categories are handled consistently, and mutually exclusive disability states are not allowed to overlap within a reporting period.

In plain language, ONEMODEL is used so that the report is not stitching together disconnected estimates. It is applying different burden calculations to the same modelled system.

D.3 The four C's in plain language

The four C's summarize the minimum modelling disciplines applied here. They are deliberately expressed in accessible terms because their purpose is quality assurance, not technical novelty.

Requirement	Plain-language meaning	How it applies in the arthritis project
Coherence	The pieces of the model describe the same system using compatible definitions.	Population, geography, age, sex, disease states, disability states, cost categories, social burden, and total burden are interpreted within one shared reporting structure.
Calibration	The model is anchored to the best available evidence and source-supported inputs.	Disease, cost, disability, and wellbeing parameters are tied to project evidence, literature, administrative data, or documented assumptions. Calibration supports plausibility; it does not remove all uncertainty.
Conservation and closure	Quantities that should add up are made to add up, and model boundaries are explicit.	People, disease states, disability states, cost components, and burden components reconcile within the defined population, geography, time horizon, and accounting rules.
Causal traceability	Outputs can be traced back to assumptions, transitions, or modelled pathways.	Changes in burden results are linked to modelled population, disease, disability, cost, and welfare pathways rather than to unexplained adjustments between separate models.

The four C's are the practical version used for readers and quality assurance. They translate broader systems-modelling expectations - one accountable structure, consistent definitions, causal pathways, balanced ledgers, stable classifications, clear boundaries, and whole-system reconciliation - into checks that can be applied directly to the arthritis analysis.

D.4 What ONEMODEL enforces by design

A common modelling weakness is to state consistency rules in documentation but enforce them only through manual review. ONEMODEL reduces this risk by embedding key consistency rules in the model structure and output contract. This means that many integrity checks are not optional presentation choices; they are part of how the model is organized.

The main design features are:

- Single population frame. Modelled people are assigned to the relevant demographic and geographic cells, and results are aggregated from those cells rather than being independently constructed at each reporting level.
- Typed attributes. Age, sex, province, condition, disease state, disability state, cost category, and burden domain have defined meanings. This prevents a category from changing meaning across chapters or appendices.
- Admissible disease and disability states. Agents can only occupy states and make transitions that are allowed by the disease and disability logic used for the project. Mutually exclusive states cannot both apply to the same person in the same period.
- Shared reporting dimensions. Population, prevalence, incidence, costs, disability costs, social value, and derived burden metrics are reported through common dimensions so that national, provincial, age-sex, and disease-group outputs can be reconciled.
- Separate burden ledgers. Economic burden, additional private disability costs, social burden, and total burden are connected through the same system but are not treated as the same concept. They remain separate until the report applies explicit total burden accounting rules.
- Traceable aggregation. Headline results are built from lower-level modelled cells and pathways. This supports review of which populations, diseases, cost categories, or burden domains drive a result.

D.5 Invariants used for quality assurance

Invariants are rules the model is designed to satisfy. They are useful because they make model integrity visible to readers. An invariant does not mean the model is perfect or that every input is known with certainty. It means that a result must pass specific internal consistency checks before it is treated as a valid output of the integrated system.

Invariant	Reader-facing statement	Operational check
Population consistency	Every modelled person belongs to the appropriate demographic cells at each reporting time.	Population totals across age-sex cells reconcile to the modelled total for the relevant geography and year.
Geography consistency	People are assigned to one geography at a reporting time, and geographic totals are interpreted within the same population frame.	Provincial results reconcile to the national reporting frame, subject to the geography scope defined for the project.
Disease-state admissibility	Disease states and aggregate disease groups are applied according to model rules, not informal table joins.	Condition-specific and aggregate outputs are checked so mutually exclusive states are not double-counted and aggregate groups are constructed consistently.
Disability-state exclusivity	A person cannot occupy more than one mutually exclusive disability state in the same reporting period.	D0/D1/D2 or other applicable disability-state distributions sum correctly within the relevant population cell.
Accounting closure	Economic cost components reconcile to the reported economic burden total	Direct, indirect, and additional private disability cost components are checked against the relevant headline economic burden tables.
Social/economic separation	A welfare loss is not automatically treated as a budgetary or productivity cost.	Social burden remains separate from economic burden until total burden accounting applies explicit reconciliation and no-double-counting rules.
Causal traceability	A result should be explainable from the modelled population, disease, disability, cost, and welfare pathways.	Changes in outputs are traced to assumptions, parameter changes, disease-state logic, disability allocation, cost inputs, or social value parameters.
Time and reporting consistency	Results are compared over a common project horizon and reporting interval.	Year-specific outputs are produced under the same reporting contract so growth, provincial, age-sex, and disease-group comparisons use consistent timing.

D.6 What S4CI does and does not claim

S4CI should be interpreted as a modelling-integrity lens. It helps identify whether a model is internally disciplined enough to support decision-relevant interpretation. It does not claim that the four C's are new, nor does it claim that passing these checks proves every empirical parameter is correct.

S4CI means:

- the analysis is expected to use one accountable model structure rather than a patchwork of incompatible modules;
- definitions, units, categories, and time periods must remain consistent across outputs;
- stocks, flows, people, costs, and burden components should not appear, disappear, or duplicate without an explicit rule;
- outputs should be traceable to modelled mechanisms, assumptions, or accounting rules; and
- remaining uncertainty should be handled through documented assumptions, validation, and sensitivity analysis rather than hidden reconciliation.

S4CI does not mean:

- the model is free of uncertainty;
- every parameter has a single uncontested empirical value;
- calibration alone proves causality;
- complexity is valuable for its own sake; or
- integrated modelling removes the need for transparent reporting and sensitivity analysis.

The appendix therefore uses S4CI as a disciplined way to explain why the ONEMODEL outputs are interpreted together. The four C's are the starting point for a valid modelling approach, and ONEMODEL is the project implementation that enforces them through structure, definitions, transitions, ledgers, and reconciliation checks.

D.7 Reporting implications

The four C's and the ONEMODEL invariants imply several report conventions:

- national and provincial results are interpreted within the same modelled population and geography structure;
- age, sex, disease, disability, and burden categories are not redefined across chapters;
- disease-specific outputs and aggregate categories are kept conceptually distinct;
- direct costs, indirect costs, additional private disability costs, and social burden are reported as separate domains before total burden is presented;
- economic and social burden are not added together until the total burden accounting rules have addressed overlap and double-counting;
- scenario bounds and sensitivity cases are interpreted as assumption-based ranges unless explicitly described as probability intervals;
- validation, reconciliation, and sensitivity checks are documented in the relevant technical appendices rather than hidden in the main results; and
- headline values should be read as outputs of one integrated modelled system, conditional on the evidence base, assumptions, and reporting scope specified for the project.

D.8 Summary interpretation

For this arthritis report, the main implication is straightforward: a burden model should not only be calibrated to evidence; it should also be internally eligible to represent the system being analysed. A model can appear reasonable at the component level while still being unsuitable for combined reporting if its populations, disease states, cost categories, geographies, time steps, or accounting boundaries do not form one coherent system.

ONEMODEL operationalizes that principle for this project. It provides the single-system structure through which arthritis disease states, disability states, economic costs, social value, geography, and reporting dimensions are kept aligned. The four C's are presented as basic modelling disciplines that ONEMODEL is designed to make routine, auditable, and enforceable.

Appendix E Economic Burden Framework

Economic burden includes direct health system costs, indirect productivity and labour force costs, and additional private disability costs where defined. Economic burden is distinct from social burden. Economic burden becomes one component of total burden.

The economic framework analyses costs by detailed categories including disability-costs. Components are kept separate before any total burden calculation.

E.1 Economic Components

Component	Notes
Direct health costs	Direct health costs line in Total Burden trajectory
Indirect costs (productivity and related indirect impacts)	Productivity and caregiving impacts line
Productivity and related indirect impacts	Productivity and related indirect impact category
Additional private disability costs	Additional private disability costs line in trajectory; Disability service category
Service-category breakdown (Drugs, Hospitalisations, Health Professionals, Other Services)	Sub-components of direct health costs

E.2 Layer-by-Layer Mapping

The economic burden total in Chapter 6 is the sum of three conceptually distinct layers, each of which carries its own measurement basis and source authority.

The direct health cost layer captures health-system expenditures attributable to arthritis. Service-category components, including drugs, hospitalisations, physician and allied health services, and other services, are presented in the Economic Scorecard and in the direct-cost results table in Chapter 6.

The indirect cost layer captures productivity and labour force effects. The analysis reports a combined productivity and caregiving impacts line in the trajectory.

The additional private disability cost layer captures private out-of-pocket disability-related costs that are not represented in conventional direct or indirect costs. The values are produced through the D0/D1/D2 disability-state framework documented in Appendix F and applied by age, sex, condition, and scenario. The central value enters the headline economic burden total; the low and high values are scenario bounds, not statistical confidence intervals.

The three layers are kept separately traceable in every chapter table so that overlap between economic and social burden can be reasoned about at the layer level rather than only at the aggregate. The no-double-counting reconciliation in Appendix H references each layer explicitly.

E.3 Monetary Basis

All economic burden values reported here and in Chapter 6 use real 2026 terms. Restatement to a different constant-dollar basis would involve a specified deflator. The basis is restated in the source line of every monetary table to reduce the risk of reader miscalibration when individual tables are read out of sequence.

Appendix F Additional Disability-Cost Method

This appendix documents the method and evidence base used to parameterise the additional private disability-cost layer reported in Chapter 6. Low and high values shown as scenario bounds in Chapter 6, Section 6.1 are produced by the parameter assumptions described below; they are not statistical confidence intervals.

F.1 Purpose and scope

This appendix describes the method and data sources used to estimate arthritis-related disability burden and additional private disability costs in this project. It focuses on the conceptual approach, evidence base, transformations, assumptions, and interpretation of results.

The method estimates the additional private disability-cost layer separately from direct health costs, productivity losses, and social value loss.

F.2 Overview of the approach

The project estimates arthritis-related disability and additional costs using a burden-state approach rather than a single diagnosis-level cost coefficient. The model assumes that disability burden and related private costs depend on:

1. arthritis condition or subtype;
2. age and sex;
3. chronic symptom, disease-activity, or remission state;
4. acute flares or sustained worsening episodes;
5. resulting disability state; and
6. private out-of-pocket cost associated with that disability state.

The approach separates chronic disease burden, acute flare burden, disability, and private disability costs. This is necessary because arthritis-related burden can arise through different mechanisms: persistent functional limitation, pain, activity restriction, sleep interference, recurrent assistance needs, travel and access costs, home or activity adaptations, and short-duration flare episodes. These mechanisms are related, but they are not identical.

The additional disability-cost component is added as a separate cost layer to conventional economic burden estimates. It is distinct from direct health care costs, productivity loss, caregiving costs, and social value loss. The central private disability-cost estimate is included in standard economic burden totals, while low and high estimates are retained for scenario ranges.

F.3 Data sources and evidence base

The method draws on five categories of evidence and project input.

F.3.1 Literature-derived burden parameters

The clinical and burden literature provides the empirical basis for arthritis burden states, severity distributions, trajectory classes, flare assumptions, disability crosswalks, and satisfaction-with-life calibration anchors. The literature provides empirical anchors and priors for a structured parameter framework rather than a complete table of Canadian disability costs by subtype, age, sex, duration, and severity.

Key literature-derived inputs include:

- osteoarthritis severity shares based on WOMAC severity categories;
- osteoarthritis trajectory classes for symptomatic knee OA and hip/knee OA;
- rheumatoid arthritis disease-activity and remission states;
- rheumatoid arthritis EQ-5D utility anchors by disease activity;
- flare and remission-duration evidence for inflammatory arthritis;
- gout flare frequency and duration assumptions;
- disability crosswalk assumptions linking symptom/activity states to D0, D1, and D2 disability states; and
- satisfaction-with-life evidence used to calibrate welfare burden separately from economic cost.

F.3.2 Project arthritis prognosis parameter atlas

The literature-derived burden parameters were consolidated into a project arthritis prognosis parameter atlas. The atlas provides condition-, age-, sex-, and event-time parameters used to allocate people into chronic states, pain states, disability states, flare exposure, disability weights, and satisfaction-with-life deltas.

The parameter atlas standardises evidence across clinical and population instruments, including WOMAC, DAS28, HAQ, EQ-5D, SF-36, DALY/YLD disability weights, pain measures, and satisfaction-with-life instruments. It is used as the structured source for the burden-state allocation step.

F.3.3 Prevalence and case-count inputs

The burden-state model can be applied to either:

- a case-count input, where the number of people with a condition by age group and sex is supplied directly; or
- a prevalence input, where population and prevalence are combined to derive condition cases.

For a prevalence input:

condition_cases = population x condition_prevalence

For a case-count input, the supplied case count is used directly. In either case, the model first establishes the number of people in each arthritis condition, age, and sex stratum, and then applies the condition-specific burden-state shares.

The method is conditional on having arthritis. Incidence, mortality, ageing, disease onset, and prevalence changes are supplied by the broader epidemiological or economic model where they are used for a particular analysis.

F.3.4 Private disability-cost parameterisation

Private disability-cost parameters are annual private out-of-pocket disability cost values by broad age group, sex, and disability severity state. They are produced by the project's private cost parameterisation analysis and used as an upstream input to the arthritis disability-cost allocation method.

The private disability-cost parameterisation is supported by Canadian and international arthritis and rheumatic-disease cost literature showing that patient-borne and non-health-service costs are material. Relevant cost categories in this literature include out-of-pocket medical spending, alternative care, physiotherapy, chiropractic and massage therapy, over-the-counter drugs, medical aids and devices,

paid help, formal caregiver costs, travel and accommodation, transportation, home modifications, community services, and other nonmedical costs incurred to access or manage care.

The arthritis disability-cost method does not re-estimate these private cost values. It applies the supplied low, central, and high annual private out-of-pocket disability-cost values to the modelled arthritis-attributable disability-state allocations.

F.3.5 Literature supporting private and patient-borne cost framing

The private-cost parameterisation is supported by the following literature categories:

- **Canadian OA cost literature:** Sharif et al. estimate direct OA costs in Canada using POHEM-OA and explicitly include out-of-pocket and alternative-care categories, including physiotherapy, chiropractic, massage therapy, over-the-counter drugs, medical aids, formal caregiver costs, transportation, community costs, and home remodelling.
- **Inflammatory arthritis cost literature:** Cooper et al. estimate health-service and non-health-service costs in early inflammatory polyarthritis and show that non-health-service costs borne by individuals, family and friends, and employers can dominate total costs.
- **Canadian systemic autoimmune disease cost literature:** Trenaman et al. estimate patient-borne costs among people in Canada with scleroderma, including medical costs, travel and accommodation, and other nonmedical costs, and show that these costs can be substantial and geographically unequal.
- **Gout-specific out-of-pocket cost literature:** Nathan et al. estimate direct and indirect out-of-pocket costs borne by people with gout and identify cost-related treatment barriers.
- **General OA out-of-pocket cost literature:** Kotlarz et al. estimate insurer and patient out-of-pocket costs associated with OA and show substantial patient-borne expenditures.

These studies support the inclusion of a private disability-cost layer, but the model does not use them as direct disease-by-age-by-sex lookup tables. The project's private cost parameterisation analysis translates the available evidence into standardised annual low, central, and high cost values by cost-age group, sex, and disability severity state.

F.4 Condition grouping and disease mapping

The project represents the following arthritis condition groups:

- juvenile idiopathic arthritis (JIA);
- systemic autoimmune rheumatic diseases (SARD);
- psoriatic arthritis (PsA);
- ankylosing spondylitis / axial spondyloarthritis (AS / axSpA);
- rheumatoid arthritis (RA);
- gout; and
- osteoarthritis (OA).

Osteoarthritis is represented both by site-specific OA states and by an Any OA aggregate. The Any OA aggregate is a constructed modelling category rather than a directly observed literature condition. It is based on component OA categories, including knee, hip, hand, and other OA. Because the disability crosswalk is best supported for knee and hip OA, the Any OA aggregate inherits additional uncertainty from its hand-OA and other-OA components. This assumption is reported because OA site mix can materially affect disability and cost estimates.

The systemic autoimmune rheumatic disease category is also a bundled category. It represents systemic autoimmune rheumatic diseases such as systemic lupus erythematosus, systemic sclerosis/scleroderma, primary Sjogren syndrome, and polymyositis/dermatomyositis. Because the evidence base is not equally strong for all diseases within the bundle, SARD estimates are interpreted as structured scenario estimates rather than disease-specific measured estimates.

F.5 Event-time burden-state method

F.5.1 Chronic burden state

Each condition is assigned a chronic burden state structure appropriate to its disease family.

For osteoarthritis, the chronic state represents persistent symptom or pain burden. For knee OA, the state structure distinguishes no-pain phenotype, mild activity pain, rest plus activity pain, and severe persistent pain. For inflammatory arthritis, the chronic state more often represents disease activity or remission status. For gout, the chronic state distinguishes controlled intercritical gout from uncontrolled or chronic-burden gout, with acute flare exposure handled separately.

F.5.2 Acute flare or worsening overlay

The model includes acute flare or worsening overlays where clinically relevant. This is particularly important for gout, rheumatoid arthritis, and osteoarthritis pain volatility.

The flare overlay is not always a mutually exclusive chronic state. It can represent additional time spent in high burden during a year. For gout, high pain is interpreted primarily as acute flare exposure rather than as a chronic high-pain stock. For osteoarthritis, flare or volatility captures the fact that pain can fluctuate at sub-annual intervals even when structural disease burden changes slowly.

F.5.3 Disability state

The model translates symptom or activity states into disability states. The disability categories are:

Disability state	Interpretation
D0	none or mild limitation
D1	moderate limitation
D2	severe limitation

The base crosswalk used as a calibration prior is:

Symptom or activity state	D0	D1	D2
Remission, inactive disease, or minimal pain	85%	13%	2%
Low activity or mild pain	60%	30%	10%
Moderate activity, rest pain, or moderate pain	30%	45%	25%
High activity, severe persistent pain, or chronic uncontrolled burden	10%	35%	55%
Acute flare days	5%	20%	75%

These shares are expert-calibrated priors anchored to the cited evidence; they are not directly fitted percentages. The D0/D1/D2 definitions are informed by burden-of-disease severity frameworks, including DALY/YLD-style disability weights and severity-state approaches. OA anchoring comes from WOMAC severity and trajectory evidence; RA anchoring comes from disease-activity, remission, function, and EQ-5D evidence; flare-day anchoring comes from osteoarthritis pain-fluctuation evidence and gout flare-duration evidence. The prior is then adjusted by disease context.

Disease-specific interpretation adjustments include:

- **OA:** the crosswalk is most directly applicable to knee and hip OA. Hand and other OA are more uncertain and may require lighter or site-specific disability assumptions.
- **RA:** disability is linked to both disease activity and function. HAQ and pain evidence support treating disability as more than a simple activity-state label.
- **PsA:** disability depends on both inflammatory activity and functional limitation, with HAQ and DAPSA-type measures relevant to the burden mapping.
- **AS / axSpA:** disability is linked to functional measures such as BASFI and disease activity measures such as BASDAI or ASDAS.
- **SARD:** systemic disease burden can generate higher disability at a given nominal pain level, so SARD is treated with a more cautious disability interpretation.
- **Gout:** disability is generally low between flares when gout is controlled, but flare days can carry severe short-duration disability.

F.5.4 From chronic and flare states to annualised disability shares

The final D0/D1/D2 disability shares used for cost calculations are annualised, mutually exclusive disability-state allocations. They sum to 100% within each condition, sex, age, and event-time stratum.

Acute flare exposure is not added as a fourth disability state. Instead, flare information is carried as an overlay in the burden model and is reflected in the annualised pain, flare, and disability outputs before costs are applied. The disability-cost step uses the final D0/D1/D2 disability shares. Flare exposure is reported separately for interpretation and is not summed with the three disability states.

For example, in a gout stratum, the model can report both D0/D1/D2 disability-state shares and an annual flare exposure measure. The D0/D1/D2 shares are used for disability-cost allocation. The flare measure indicates the extent to which the annual burden is driven by short, high-severity flare periods, but it is not added on top of D0/D1/D2 case counts as if it were an additional stock of people.

F.6 Converting burden states to disability costs

F.6.1 State allocation

For each condition, sex, age group, and time horizon, the model estimates the share of cases in each disability state. If the input is a case count, the number of people in a disability state is:

disability_state_cases = total_cases_in_stratum x disability_state_share

If the input is population and prevalence, cases are first calculated as:

condition_cases = population x condition_prevalence

and then allocated to states using the same disability-state shares.

F.6.2 Time-weighted annual allocation

The event-time parameter atlas uses selected horizons rather than annual rows for every year. To create a representative 2025 annual disability-cost estimate, the model first interpolates disability-state shares, then applies costs to the resulting average case counts. Cost contributions are not interpolated directly.

The representative allocation is calculated using trapezoidal time-weighted averaging over years 0, 1, 2, 5, and 10. For an interval from year t0 to year t1, the average value of a disability-state share is:

average_share_over_interval = (share_at_t0 + share_at_t1) / 2

The interval contribution is:

interval_person_years = average_share_over_interval x cases x interval_length

For example, if the D2 share is 10% at year 0 and 20% at year 1, the average D2 share over the year 0-1 interval is 15%. In a stratum with 1,000 cases, that interval contributes 150 D2 person-years before disability costs are applied.

This approach avoids relying only on baseline or year-10 values and better represents the time path of disability burden. It still assumes linear change between the selected horizons.

F.6.3 Cost-age aggregation

Private disability-cost parameters are defined for broad age groups, but applied by individual age:

- 15 to 24 years;
- 25 to 44 years;
- 45 to 64 years; and
- 65 years and over.

Modelled 5-year age groups are aggregated into these broad cost-age groups before applying private disability-cost parameters. Under-15 ages are excluded from the private disability-cost calculation because the private cost parameterisation begins at age 15.

For JIA, only cases aged 15 and over receive a private disability-cost estimate. Pediatric JIA cases under age 15 may be represented in disability-burden outputs, but they are not assigned a private disability cost in this component.

F.6.4 Aggregate disability cost by state

For each condition, sex, broad age group, estimate bound, and disability state, aggregate disability cost is calculated as:

aggregate_disability_cost_state = disability_state_cases x annual_cost_per_case_state

The total disability cost for the condition, sex, age group, and bound is then:

total_disability_cost_bound = sum(aggregate_disability_cost_state across D0, D1, and D2)

F.6.5 Average disability cost per case

The model converts aggregate disability costs into an average disability cost per case by condition, sex, and broad age group. The average is calculated as:

average_disability_cost_per_case_bound = total_disability_cost_bound / total_cases

This produces low, central, and high average disability cost per case values. These values are the direct input to the final economic burden additional-cost calculation.

F.6.6 Geography and year handling

The disability-cost allocation is applied to condition, sex, age, province, and year case strata in the economic burden outputs. The private disability-cost values are national cost parameters. Province- and year-specific variation enters through the number of people in each condition, sex, age, province, and year stratum unless a separate province- or year-specific cost adjustment is supplied by the broader economic model.

The private disability-cost parameter table is used as the representative 2025 private-cost input. The arthritis disability-cost allocation step does not independently apply a separate inflation or deflator adjustment. Any inflation or restatement of source cost values occurs upstream in the private cost parameterisation analysis.

F.7 Applying additional disability costs to economic burden outputs

The economic burden model starts with conventional direct and indirect cost estimates. The additional disability-cost component is added as a separate cost layer.

For each mapped condition, sex, age group, province, and year, the model applies the average disability cost per case:

disability_cost_bound = average_disability_cost_per_case_bound x people_in_condition_stratum

The model carries three disability-cost values:

- Disability Cost (Lower);
- Disability Cost (Central); and
- Disability Cost (Upper).

Where model results retain the label Expected, the value is interpreted as the central scenario value.

The central value is included in standard economic burden totals:

total_cost_central = direct_cost + indirect_cost + additional_disability_cost_central

The lower and upper values are not added to the central total. They are used to form scenario ranges around total economic burden.

F.8 Comorbidity handling

A key assumption is that disability costs are not counted repeatedly for the same person solely because that person has multiple arthritis conditions. For person-level burden summary rows, the model uses a maximum-cost rule rather than summing additional disability costs across all conditions present.

For a person stratum with more than one arthritis condition, the central additional disability cost per case is:

disability_central_per_case = max(central_disability_cost_per_case across present arthritis conditions)

The same logic is applied to lower and upper bounds:

disability_lower_per_case = max(lower_disability_cost_per_case across present arthritis conditions)

disability_upper_per_case = max(upper_disability_cost_per_case across present arthritis conditions)

The resulting total costs are:

total_cost_lower = base_total_without_disability + disability_lower_per_case x people

total_cost_central = base_total_without_disability + disability_central_per_case x people

total_cost_upper = base_total_without_disability + disability_upper_per_case x people

This is a reporting-level comorbidity adjustment. It is conservative against double counting. Where multiple arthritis conditions independently generate distinct disability-related expenses, the rule may understate true joint burden. A future sensitivity analysis could compare the maximum rule with a partial-additive rule.

F.9 Satisfaction-with-life and social value outputs

The arthritis parameter atlas also includes satisfaction-with-life deltas and social-value-oriented burden parameters. These are conceptually separate from the additional disability-cost calculation.

Satisfaction-with-life values describe welfare or social value loss relative to a comparator, not private disability costs. They are informed by direct satisfaction-with-life evidence and by bridged evidence where direct disease-specific life-satisfaction data are limited.

These outputs are reported separately from economic burden. They are not added to direct costs, indirect costs, caregiving costs, or the additional disability-cost component unless a specific combined-burden accounting framework is explicitly defined.

F.10 Key modelling assumptions

F.10.1 Arthritis burden is dynamic

The model assumes that arthritis burden changes over event time. Diagnosis, symptom onset, chronic burden, flares, remission, functional decline, and treatment response are distinct events. A single static diagnosis decrement is not considered adequate.

F.10.2 Pain and disability are related but not identical

Pain states and disability states are modelled separately. Pain can fluctuate quickly, while disability may reflect longer-lived functional limitation. This is especially important for osteoarthritis and gout.

F.10.3 Disability costs are additional to conventional economic costs

The additional disability-cost component captures private out-of-pocket disability costs that are not otherwise represented in conventional direct and indirect economic cost categories. It is not a replacement for direct health care costs, productivity loss, or caregiving costs.

F.10.4 Low and high estimates are scenario bounds

The low and high disability-cost estimates are treated as scenario bounds. They are not statistical confidence intervals. The arthritis model uses the low, central, and high values supplied by the private cost parameterisation analysis and carries them through to scenario ranges.

F.10.5 Any OA is a constructed aggregate

Any OA is not a directly observed literature condition in the parameter atlas. It is a constructed aggregate based on component OA site categories. Its results are interpreted as scenario estimates and may be sensitive to the assumed site mix. Because the disability crosswalk is stronger for knee and hip OA than for hand or other OA, the Any OA aggregate carries additional uncertainty from those less directly supported components.

F.10.6 SARD and JIA are more uncertain

SARD is a bundled systemic autoimmune category, and adult JIA estimates rely partly on provisional or borrowed structure. These estimates are interpreted more cautiously than knee OA, RA, axSpA/AS, and gout, where the evidence base is stronger.

F.10.7 Gout high pain represents flare exposure

As noted in Section 5.2, gout high pain represents acute flare exposure and is not aggregated as if it were a chronic high-pain stock.

F.10.8 Social value loss is separate from economic disability cost

Satisfaction-with-life and social value outputs are conceptually distinct from economic cost outputs. They are not added to economic burden unless a specific combined-burden framework is explicitly defined.

F.11 Interpretation of outputs

The additional disability-cost estimate is interpreted as an annual private out-of-pocket economic add-on associated with arthritis-related disability burden. It is not a measure of total arthritis burden by itself. It is read alongside conventional direct and indirect cost categories and, where relevant, separately reported social value or satisfaction-with-life measures.

Central results answer the question:

- Given the modelled distribution of arthritis-related disability states, what is the central additional annual private disability cost for this condition, sex, age group, geography, and year?

Lower and upper results answer the related scenario question:

- How would the total burden change under lower or higher private disability-cost assumptions?

Because the method applies state-based disability costs to modelled case allocations, results depend on both the private cost parameters and the assumed distribution of cases across disability states.

F.12 Limitations

The main limitations are methodological and evidentiary rather than computational.

1. Evidence coverage: Canada-specific arthritis private disability-cost evidence is less complete by subtype, age, sex, duration, and severity.
2. Private cost parameterisation is upstream of this method: The arthritis allocation method uses private disability-cost parameters produced by the project's private cost parameterisation analysis. This report documents how those parameters are applied to arthritis-attributable disability states.
3. Use of crosswalks: Several model components require crosswalks between clinical states, pain states, disability states, utility values, and satisfaction-with-life anchors. The D0/D1/D2 percentages are calibrated priors, not directly fitted Canadian disability-state percentages.
4. Composite conditions: Any OA, SARD, and some inflammatory arthritis groupings involve aggregation or proxy assumptions. The Any OA estimate is particularly sensitive to OA site-mix assumptions and to the weaker evidence base for hand and other OA compared with knee and hip OA.
5. Event-time approximation: Where only selected horizons are available, time-weighted interpolation is used rather than annual observed data. Trapezoidal averaging assumes linear change between horizons and may misrepresent non-linear trajectories such as post-diagnosis treatment response in RA.
6. Private cost scope: Private disability-cost parameters apply from age 15 onward. Pediatric JIA cases under 15 are not assigned a private disability cost in this component, which understates the additional disability cost attributable to JIA if pediatric disability-related private costs are material.
7. Comorbidity adjustment: The maximum-cost rule avoids duplicate disability-cost counting but may understate cost if multiple conditions independently create distinct disability-related expenses.
8. Scenario bounds: Low and high estimates represent modelled low/high cost scenarios, not statistical uncertainty intervals.
9. Geography and year handling: The disability-cost allocation step applies national private cost parameters to condition, sex, age, province, and year case strata. Province- and year-specific variation enters through those case strata unless a separate adjustment is supplied by the broader economic model.

Appendix G Social Value Methodology

This appendix summarises the social value approach used in this report. Social burden is based on life satisfaction (subjective well-being), well-being, pain, disability, participation, adaptation, and income-equivalent valuation concepts. It is reported separately from direct and indirect economic burden.

The purpose of the appendix is to give readers enough methodological context to interpret the social value results without reproducing the full technical paper. The key point is that the social value estimate is built from person-level scenario-minus-counterfactual welfare paths, then translated into dollar-equivalent terms and aggregated only at the end.

G.1 CANCEA's Social Value Approach

CANCEA frames social value as a welfare concept that complements, rather than replaces, conventional economic output and cost measures. In this report, social burden is the dollar-equivalent welfare loss associated with arthritis. It is not a public payer cost, a private out-of-pocket expense, or a productivity loss.

Operationally, the estimate is generated in ONEMODEL as a counterfactual simulation. For each simulated person, the model compares two otherwise-identical life-course scenarios:

1. A with-arthritis scenario, in which the person experiences the pain, disability, participation limits, disease activity, treatment response, and adaptation pathways assigned in the model.
2. A no-arthritis counterfactual, in which the same person is modelled without arthritis, while keeping other relevant circumstances aligned to the baseline simulation logic.

The social burden is the individual-level difference between those two modelled welfare paths. Where the report uses life satisfaction, the object being compared is the difference between life satisfaction in the no-arthritis counterfactual and life satisfaction in the with-arthritis scenario. This difference is then converted into an income-equivalent dollar value and aggregated across people and time.

The method is deliberately bottom-up. It does not start with an aggregate social-value multiplier, an average burden per case, or a single value per life-satisfaction point applied to everyone. It first preserves the person, the disease state, the time path, the welfare channel, and the relevant circumstances, and only then applies valuation and aggregation.

G.2 Core Methodological Principles

The detailed methodology paper sets out a broader social value framework. The following principles are the elements most relevant to this arthritis application:

- The person is the primary welfare carrier. Household, labour-market, health-system, and community conditions matter because they shape person-level welfare paths, but the welfare estimate is built at the person-period level.
- Social value is counterfactual. A disease state or outcome is not valued on its own; the estimate compares the modelled arthritis scenario with a no-arthritis baseline for the same person.
- Welfare paths come before money. Pain, disability, disease activity, participation limits, and life-satisfaction changes are represented before they are translated into monetary equivalents.
- Monetisation is local and person-specific. The dollar-equivalent value of a welfare change can depend on income, age, sex, household status, and other calibration characteristics, rather than a single universal conversion factor.
- Discounting, when applicable, is applied to monetary equivalents, not to raw welfare paths. The model preserves annual or event-time welfare changes first, converts them to monetary equivalents, and then applies the report's discounting convention where present values are required.
- Aggregation comes last. Population totals are sums of individual-level results after person-period welfare changes have been valued, discounted, and checked for overlap with other burden components.
- System integrity matters. Scenario and counterfactual paths must be generated consistently, with aligned populations, time steps, disease states, and accounting rules, so that the result is not created by reconciling disconnected outputs after the fact.

These principles are particularly important in arthritis because the same diagnosis imply very different welfare consequences depending on pain severity, disability, disease subtype, disease activity, income, household context, age, employment status, and duration since onset.

G.3 What Is Being Valued

In this report, the valued outcome is the welfare loss associated with arthritis-related changes in well-being. The main measured welfare output is life satisfaction, used as the life-evaluation component of subjective well-being. Pain, disability, participation limits, and disease activity are treated as drivers of the life-satisfaction path rather than as separate budgetary costs.

The method also recognises that life satisfaction is a reported scalar measure, not a physical unit. A one-point difference in life satisfaction should not be interpreted as mechanically identical for every person in every context. For that reason, the appendix treats life satisfaction as an evaluative output that is useful for welfare measurement, while making the valuation step explicit.

The income-equivalent conversion asks: what change in income would be equivalent, in well-being terms, to the modelled change in life satisfaction for a person with these circumstances? This is why the same life-satisfaction change produce different dollar-equivalent values for different people.

The valuation function is non-linear. The calibration uses an approximately log-linear relationship between life satisfaction and household income, implying diminishing marginal well-being gains from higher income. Other characteristics captured in the calibration, such as age, sex, and household status, may also affect the conversion. As a result, social value is not calculated by multiplying all life-satisfaction changes by one fixed dollar amount.

G.4 Calculation Sequence

The appendix uses the following calculation sequence. It is the report-level version of the more general bottom-up method in the methodology paper:

1. Define the arthritis scenario and the no-arthritis counterfactual.
2. Generate modelled person-period states in ONEMODEL, including pain, disability, disease activity, participation, household context, and other relevant circumstances.
3. Estimate each person's welfare or life-satisfaction path under both scenarios.
4. Calculate the person-period welfare difference between the counterfactual and arthritis scenario.
5. Apply evidence-informed assumptions about pain severity, disability gradients, disease activity, remission, duration, and adaptation.
6. Convert person-period welfare differences into income-equivalent dollar values using the relevant person-specific valuation function.
7. Discount monetary equivalents where present-value reporting is required.
8. Aggregate across people and time, while reporting social burden separately from direct costs, indirect costs, and other economic burden components.

This ordering is important. It protects against two common errors: converting heterogeneous welfare paths into an average too early and double counting the same welfare impact through both life satisfaction and another monetised channel.

G.5 Evidence Base

The supporting evidence indicates that:

- Subjective well-being and life satisfaction are accepted inputs for "beyond GDP" policy assessment when measurement limits and comparability assumptions are made explicit.
- Well-being valuation and equivalent-income methods provide an established way to express non-market welfare changes in monetary terms, provided the income-well-being relationship and valuation assumptions are transparent.
- Chronic pain, disability, and arthritis disease activity are associated with materially lower life satisfaction or health-related quality of life; greater severity generally implies larger welfare losses.
- Adaptation occur but is incomplete and heterogeneous. The model therefore does not assume that long-run social burden automatically decays to zero.
- Remission or disease control improve health-related quality of life, especially in inflammatory arthritis, but remission does not necessarily imply that all disease-related welfare impacts disappear.
- Distribution matters. Positive and negative effects, disease subtypes, severity groups, income groups, age groups, and other modelled segments should be interpretable before totals are used for decision support.
- Social value must be reconciled with direct and indirect costs to avoid double counting, because a welfare loss overlap conceptually with underlying health, participation, or income effects.

G.6 Evidence Table

Source family	Evidence contribution	Use in this project
CANCEA social value methodology	Defines social value as a bottom-up welfare estimate built from scenario-minus-counterfactual person-period paths, with valuation and aggregation performed only after individual paths are preserved.	Provides the conceptual basis for treating arthritis social burden as welfare loss rather than as a budgetary cost add-on.
OECD and broader well-being measurement guidance	Supports "beyond GDP" assessment and recognises subjective well-being, including life evaluation, affect, and meaning, as relevant for policy analysis.	Justifies life satisfaction as the primary welfare metric while requiring transparency about what it captures and what it does not.
Subjective well-being and measurement literature	Shows that life-satisfaction scales are useful but require care around cardinality, interpersonal comparability, response scales, and measurement invariance.	Supports explicit valuation assumptions instead of treating raw life-satisfaction points as universal welfare units.
Well-being valuation and equivalent-income literature	Provides a method for translating life-satisfaction changes into monetary equivalents using an income-well-being relationship.	Supports the income-equivalent conversion and the use of a non-linear, person-specific valuation function.
Chronic pain, disability, and arthritis severity literature	Shows that pain, functional limitation, and disease activity are associated with lower life satisfaction or health-related quality of life, with larger impacts at greater severity.	Supports graded welfare-burden assumptions by pain, disability, and disease-activity state.
Remission, treatment response, and disease-control evidence	Shows that improved disease control can improve quality of life but does not necessarily eliminate all impacts.	Supports disease-activity and remission gradients rather than a binary disease/no-arthritis assumption.
Adaptation and event-time well-being evidence	Shows that people may adapt to some adverse states, but adaptation varies by event, person, and duration and may be incomplete.	Supports partial adaptation assumptions and sensitivity testing around long-run residual burden.
Agent-based modelling literature	Emphasises coherent populations, time steps, state transitions, causal mechanisms, and accounting closure in complex simulations.	Supports use of ONEMODEL as a coherent scenario/counterfactual platform and the need for internal consistency checks before aggregation.

G.7 Calibration Inputs and Interpretation

The social burden parameters are informed by Canadian Community Health Survey 2019-2020 well-being evidence summarised in Appendix M and by the project's pain and life-satisfaction method. These inputs describe how life satisfaction varies with pain experience, the presence of a musculoskeletal condition, age group, sex, household income, province, and the combination of pain and condition status. On their own, these weighted descriptive inputs do not prove a causal arthritis-attributable welfare loss.

The full parameterisation therefore combines Canadian well-being inputs with peer-reviewed evidence on pain severity, disability gradients, disease activity, remission, duration, and adaptation. Because the model strata are more granular than the published arthritis-specific life-satisfaction evidence, the method uses bridged evidence from health-related quality of life, pain-burden, or disease-activity studies. Those bridging assumptions should be read as part of the model specification rather than as directly observed survey estimates.

The resulting social value estimate is conditional on four things: the welfare parameter set, the modelled allocation of pain and disability, the disease-activity and remission pathways, and the assumption that adaptation is partial rather than complete. Sensitivity to alternative welfare parameters belongs in Appendix I.

The interpretation is therefore evidence-informed and model-based. It should be read as the estimated income-equivalent welfare loss produced by the modelled arthritis pathways, not as a direct survey total of arthritis-attributable life satisfaction loss.

G.8 Distinction from Direct and Indirect Costs

Social value loss is reported in dollar-equivalent terms, but it is not a budgetary expenditure. It does not represent a public payer outlay, a private out-of-pocket spend, or a productivity loss. The dollar unit is an income-equivalent welfare unit used for comparability and decision support.

Because social value is expressed in dollars, it must be reconciled carefully with economic burden estimates before any combined total burden is presented. The same welfare pathway should not be counted twice. For example, if a loss in participation affects both income and life satisfaction, the total-burden framework must define whether and how those elements are combined. Appendix H provides the no-double-counting reconciliation for total burden accounting.

The preferred convention is therefore:

- Report direct costs, indirect costs, and social value as separate components.
- Explain which channels are included in each component.
- Combine components only under explicit total-burden rules.
- Show sensitivity where assumptions about overlap, valuation, adaptation, or severity materially affect results.

G.9 Worked Example Calculations (Illustrative)

The examples below make the social burden arithmetic transparent. Values are illustrative only and are not the calibrated ONEMODEL parameter values used for Chapter 7. The structure matches the model logic: simulate the same individual with and without arthritis, take the difference in life satisfaction or welfare, convert to an income-equivalent dollar amount, then aggregate across people and time.

Example 1: One person, one year

1. Model outputs on a 0-10 life-satisfaction scale: with arthritis = 6.8; without arthritis = 7.4.
2. Individual difference: Delta LS = LS(without arthritis) - LS(with arthritis) = 7.4 - 6.8 = 0.6 life-satisfaction points.
3. Illustrative valuation: assume this person's circumstances imply $8,000 per 1.0 life-satisfaction point per year.
4. Income-equivalent loss: 0.6 x $8,000 = $4,800 per year.

Example 2: Same life-satisfaction change, different valuation context

Consider two otherwise-similar people who both have Delta LS = 0.5 between the no-arthritis and arthritis scenarios. Because the valuation uses a log-income relationship and can vary by other calibration characteristics, the implied dollar value of a life-satisfaction point need not be the same for both people.

- Person L: valuation implies $10,000 per 1.0 life-satisfaction point per year; annual loss = 0.5 x $10,000 = $5,000.
- Person H: valuation implies $6,000 per 1.0 life-satisfaction point per year; annual loss = 0.5 x $6,000 = $3,000.

These figures are illustrative only. The key point is that the conversion from life-satisfaction change to dollars is not a single constant applied to everyone; it is a function of income and other circumstances captured in the calibration.

Example 3: Aggregating across people

Person	Delta LS (points)	Illustrative $/LS point/year	Annual income-equivalent loss
A	0.3	$6,000	$1,800
B	0.8	$8,000	$6,400

Total annual social burden for these two people is the sum of individual income-equivalent losses: $1,800 + $6,400 = $8,200 per year. In ONEMODEL, this summation is performed across all simulated individuals and are reported by age, sex, subtype, severity, geography, or other modelled segments.

Appendix H Total Burden Accounting and No-Double-Counting

Total burden equals economic burden plus social burden. Direct costs, indirect costs, additional private disability costs, caregiving costs where included, and social burden are defined separately before combination. The same loss is not counted in both economic and social burden. This appendix provides the reconciliation table for the report.

H.1 Reconciliation of economic and social components

The reconciliation table below identifies the welfare or cost each component captures, the overlap risk against the other domain, and the accounting control applied to prevent overlap.

Component	Domain	Captures	Overlap risk	Accounting control to prevent double counting
Direct health system costs (hospitalizations, drugs, health professionals, other)	Economic	Health system expenditure attributable to arthritis	None: this is a monetary cost only	Reported in economic burden only
Productivity loss (absenteeism, presenteeism, labour force exit)	Economic	Monetary value of lost productive time	Welfare loss from work disruption could overlap with social burden utility decrements	Report productivity loss only in economic burden and report social burden as a separate welfare measure before any total is shown.
Caregiving impacts	Economic	Monetary value of caregiver time and lost caregiver productivity	Caregiver welfare losses could overlap with social burden	Do not infer caregiver welfare burden unless separately modelled and verified.
Additional private disability costs (D0/D1/D2)	Economic	Private out-of-pocket disability-related expenditures	Welfare equivalent of disability could overlap with social burden utility decrements	Report out-of-pocket disability costs as economic burden and social value loss as separate welfare burden.
Social value loss (income-equivalent welfare loss from pain, disability, participation, life satisfaction)	Social	Income-equivalent welfare burden	Could overlap with productivity-loss valuation and with disability-cost valuation in economic burden	Present social burden separately and show component boundaries before any combined total.

H.2 Worked Example for 2055

The 2055 row of the total burden trajectory illustrates the additive identity used in the report.

Component	2055 value (real 2026 terms)
Direct health costs	$25.3B
Additional private disability costs	$10.7B
Productivity and related indirect impacts	$35.3B
Economic burden (sum of layers)	$71.3B
Social value loss (welfare burden)	$151.1B
Total burden (economic + social)	$222.3B

Two reading rules apply. First, the economic and social components are conceptually distinct: economic burden is a monetary burden across direct, indirect, and additional private disability layers, while social burden is the dollar-equivalent welfare loss associated with pain, disability, participation, independence, and life-satisfaction effects. Second, the components are reported separately before the combined total, which preserves transparency about where overlap could plausibly arise (for example, between productivity loss in the economic layer and welfare burden in the social layer) and shows that the report's accounting treats the two as additive only after the no-double-counting rules in J.1 have been applied.

Appendix I Scenario and Sensitivity Details

This appendix documents sensitivity material where it is needed for technical completeness or to support material technical interpretation.

I.1 Reported Sensitivity Items

Two sensitivity views are stated:

The first view is the scenario range for additional private disability costs, presented in Chapter 6 alongside the central economic burden value. The low and high values are scenario bounds carried through from the private cost parameter table; they are not statistical confidence intervals. They are read as a plausible range under alternative private cost parameter assumptions and not as a probability distribution

The second view is the disease-group composition of headline burden, presented in Chapters 5, 6, 7, and 8. Composition shifts under alternative aggregation assumptions (for example, changes in the Any OA site mix) are interpreted as evidence-driven sensitivities rather than as scenario simulations.

I.2 Additional Sensitivity Considerations

The scenario range is interpreted using the following considerations.

- Probabilistic uncertainty ranges around model output values would require a probability framework. The reported ranges are scenario bounds.
- Counterfactual policy or programme scenarios are separate from the burden-measurement scope used in this report.
- Sensitivity around social value parameters beyond the calibration discussion in Appendix G.
- Sensitivity to demographic projection assumptions beyond this research horizon is separate from the scenarios.

These considerations help define the interpretation of the reported scenario bounds.

I.3 Related Report Locations

- Chapter 6.1 demonstrates the scenario range for the headline economic burden and identifies the additional disability-cost layer as the source of the range.
- Appendix F documents the underlying private disability-cost parameterisation and the source of the low and high scenario values.
- Appendix J records the validation checks applied to the scenario-bound treatment.

Appendix J Model Validation and Quality Assurance

This appendix summarizes validation, reconciliation, and consistency checks.

J.1 Validation Domains

Domain	Check
Source alignment	Results and method statements trace to source-supported project materials.
Output consistency	Report and detailed tables are reconciled where used together.
Terminology	The report uses agent-based modelling terminology and avoids obsolete or conflicting labels.
Accounting separation	Direct costs, indirect costs, additional private disability costs, caregiving impacts, social burden, and total burden are kept conceptually distinct.
No double counting	Economic and social burden components are shown separately before total burden is presented.
Caveats	Caveats for Any OA, SARD, JIA, gout, under-15 disability costs, scenario bounds, and lower-limit claims are checked.

J.2 Validation Treatment

Validation assesses whether values and method statements are traceable to the project outputs, source-supported methods, and cited evidence. Numeric exhibits are checked against report and appendix tables for consistency and accuracy.

J.3 Validation Summary

Validation covers consistency checks, reference and appendix citation alignment, reconciliation to model values, and review against cited sources. These checks are intended to support interpretation of the outputs within the limits of the project source base, model design, and stated assumptions.

Appendix K Detailed National Results

This appendix provides a summary of national result tables.

K.1 Headline Burden, Canada, 2025 and 2055

Measure	2025	2055	Change
People with any modelled arthritis condition	6.07M	9.99M	+3.92M
Crude prevalence	14.7%	21.0%	+6.3 pp
Economic burden	$45.9B	$71.3B	+$25.4B
Social value loss	$96.5B	$151.1B	+$54.6B
Economic plus social burden	$142.4B	$222.3B	+$79.9B

Monetary values are in real 2026 terms.

K.2 Disease Group Interpretation Notes

Any OA is a constructed aggregate and carries site-mix uncertainty. SARD results are interpreted in light of narrower evidence and parameter coverage. JIA is reported using under-15 prevalence only, with incidence suppressed because annual counts are small. Gout high-pain burden is interpreted with attention to flare exposure.

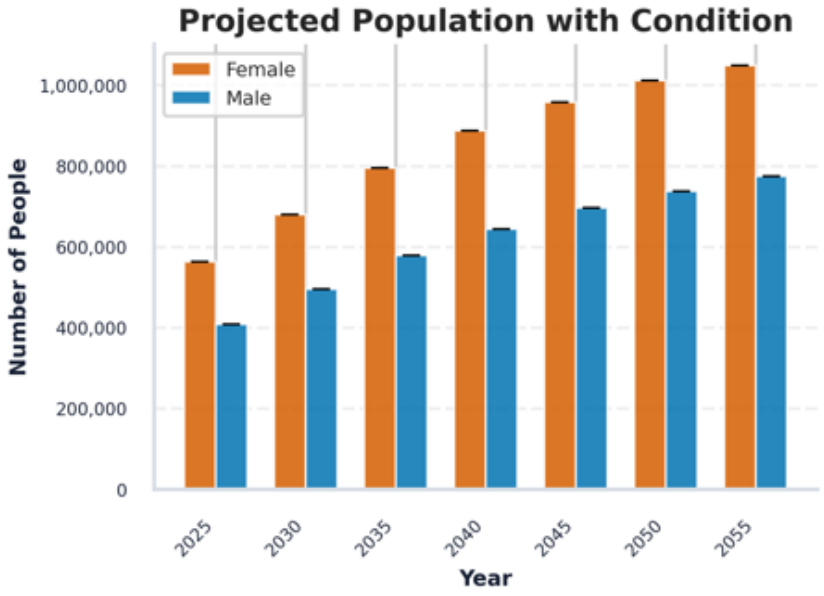
K.3 Disease-Specific Trajectory Figures

The following figures provide the national disease-specific trajectory panels from the results presentation. They are included as appendix figures because they provide more detail than the main report includes while preserving the link between headline results and the underlying disease, age, sex, and prevalence patterns.

K.3.1 Modelled Hip Osteoarthritis

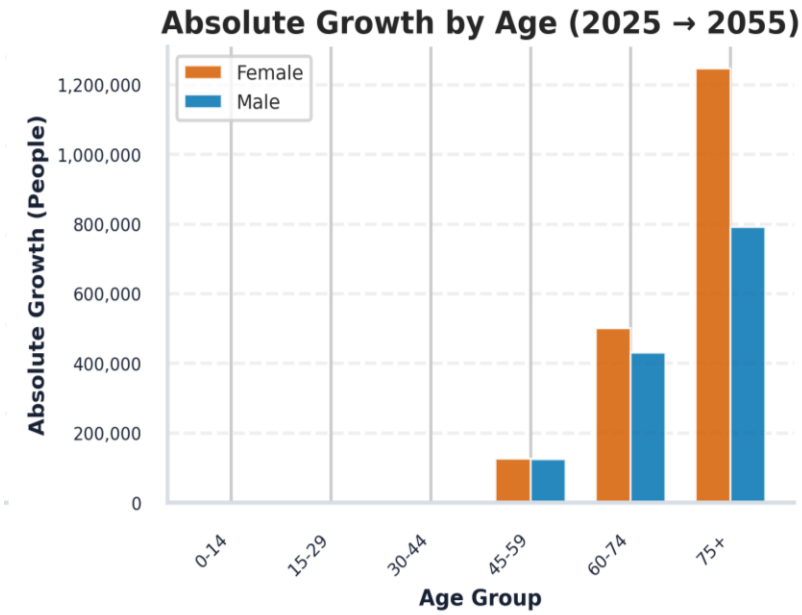
This panel documents the projected population with modelled hip osteoarthritis by sex and provides detailed national evidence behind the main-report disease-burden summary. It is placed in Appendix K because it gives disease-specific trajectory detail without overloading the main report.

Figure K.1A. Projected population with modelled hip osteoarthritis by sex, Canada, 2025 to 2055



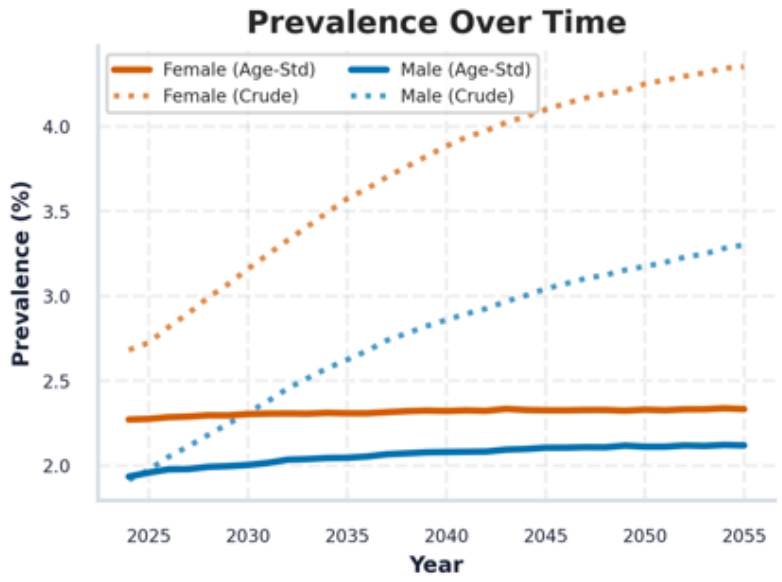
The above figure shows the projected population with modelled hip OA over time. It supports interpretation of projected disease-specific growth between 2025 and 2055.

Figure K.1B. Absolute growth in modelled hip osteoarthritis by age group and sex, Canada, 2025 to 2055



The above figure shows the age groups in which projected growth is concentrated. It supports disease-specific interpretation because age structure affects prevalence, disability, cost exposure, and social-burden interpretation differently across condition groups.

Figure K.1C. Crude and age-standardised prevalence of modelled hip osteoarthritis by sex, Canada, 2025 to 2055



This figure shows the crude and age-standardised prevalence path over time. It helps distinguish changes related to population ageing from changes in standardised prevalence.

K.3.2 Modelled Knee Osteoarthritis

This panel documents the projected population with modelled knee osteoarthritis by sex and provides detailed national evidence behind the main-report disease-burden summary. It is placed in Appendix K because it gives disease-specific trajectory detail without overloading the main report.

Figure K.2A. Projected population with modelled knee osteoarthritis by sex, Canada, 2025 to 2055

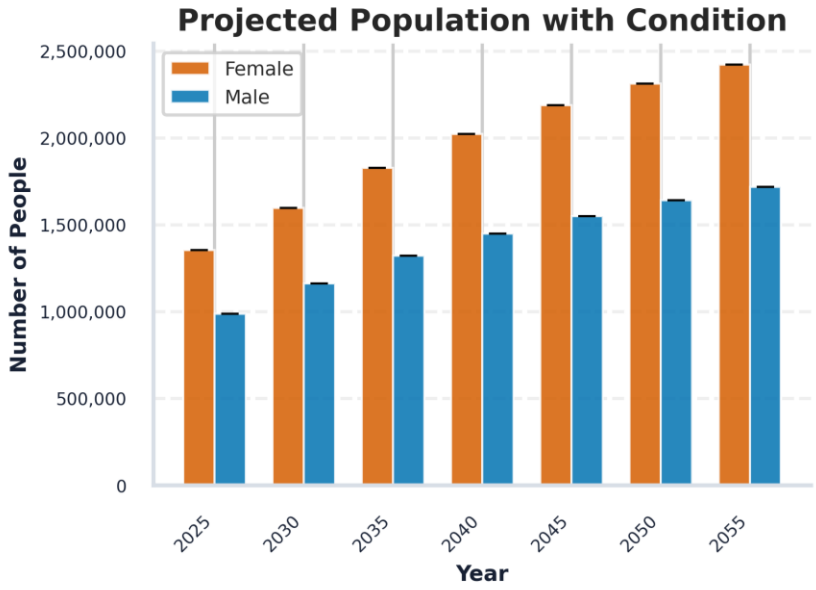
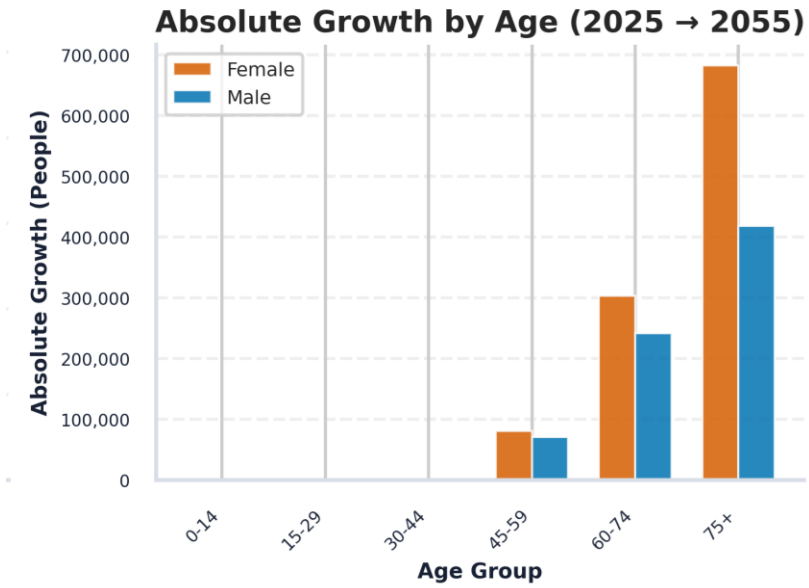
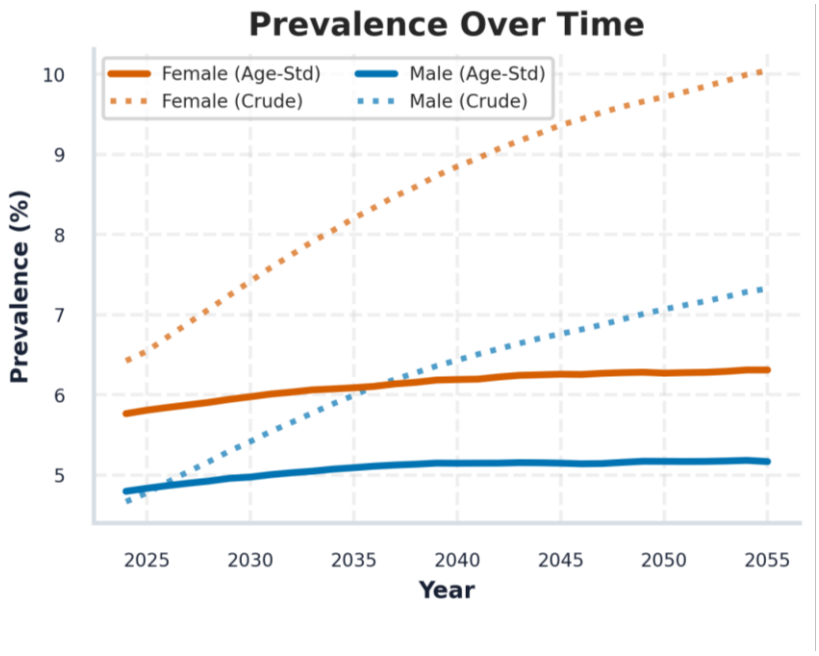


Figure K.2B. Absolute growth in modelled knee osteoarthritis by age group and sex, Canada, 2025 to 2055



The above figure shows the age groups in which projected growth is concentrated. It supports disease-specific interpretation because age structure affects prevalence, disability, cost exposure, and social-burden interpretation differently across condition groups.

Figure K.2C. Crude and age-standardised prevalence of modelled knee osteoarthritis by sex, Canada, 2025 to 2055

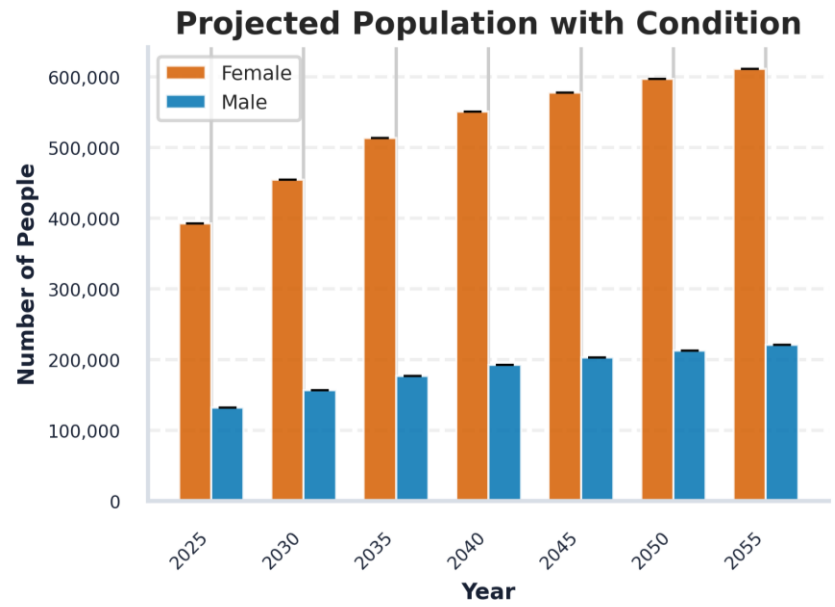


The above figure shows the crude and age-standardised prevalence path over time. It helps distinguish changes related to population ageing from changes in standardised prevalence.

K.3.3 Modelled Hand Osteoarthritis

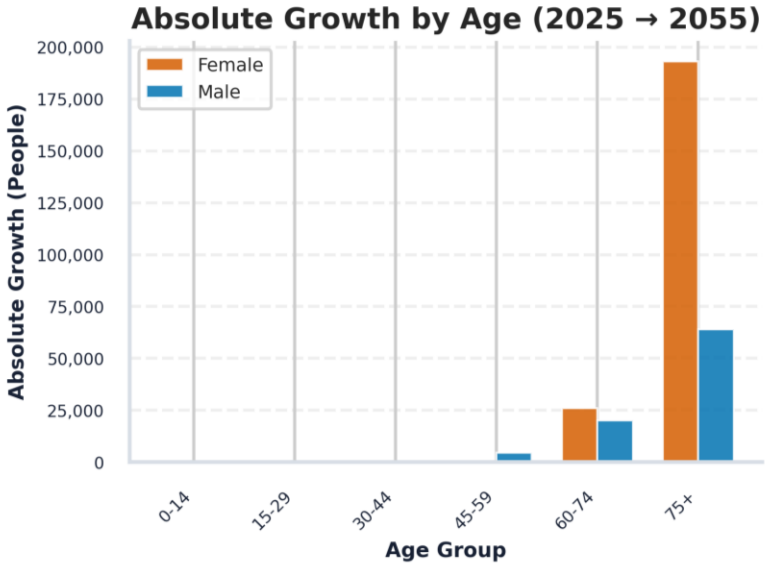
This panel documents the projected population with modelled hand osteoarthritis by sex and provides detailed national evidence behind the main-report disease-burden summary. It is placed in Appendix K because it gives disease-specific trajectory detail without overloading the main report.

Figure K.3A. Projected population with modelled hand osteoarthritis by sex, Canada, 2025 to 2055



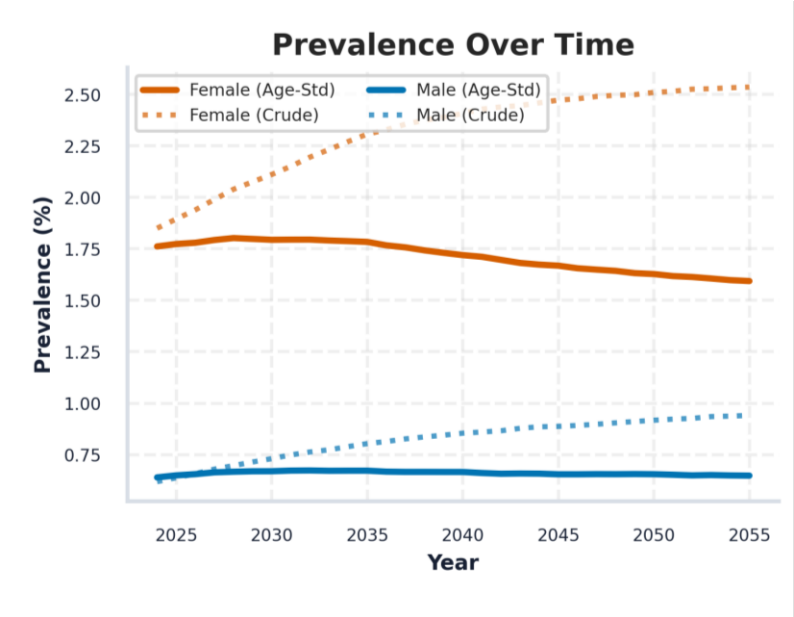
The above figure shows the projected population with modelled hand OA over time. It supports interpretation of projected disease-specific growth between 2025 and 2055.

Figure K.3B. Absolute growth in modelled hand osteoarthritis by age group and sex, Canada, 2025 to 2055.



The above figure shows the age groups in which projected growth is concentrated. It supports disease-specific interpretation because age structure affects prevalence, disability, cost exposure, and social-burden interpretation differently across condition groups.

Figure K.3C. Crude and age-standardised prevalence of modelled hand osteoarthritis by sex, Canada, 2025 to 2055.

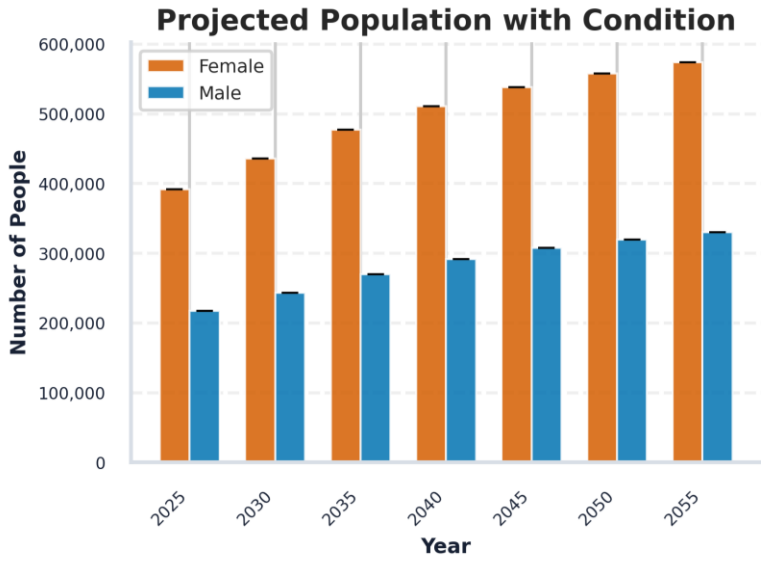


The above figure shows the crude and age-standardised prevalence path over time. It helps distinguish changes related to population ageing from changes in standardised prevalence.

K.3.4 Any Modelled Inflammatory Arthritis

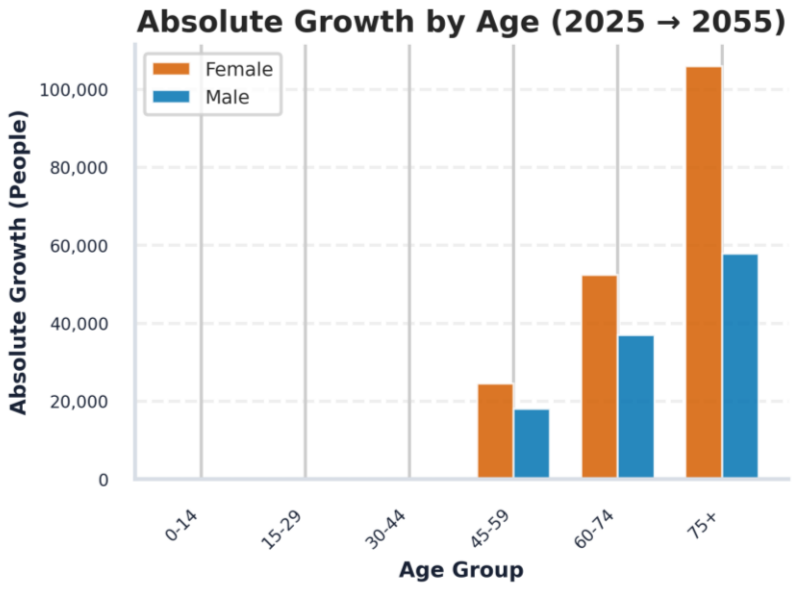
This panel documents the projected population with any modelled inflammatory arthritis by sex and provides detailed national evidence behind the main-report disease-burden summary. It is placed in Appendix K because it gives disease-specific trajectory detail without overloading the main report.

Figure K.4A. Projected population with any modelled inflammatory arthritis by sex, Canada, 2025 to 2055.



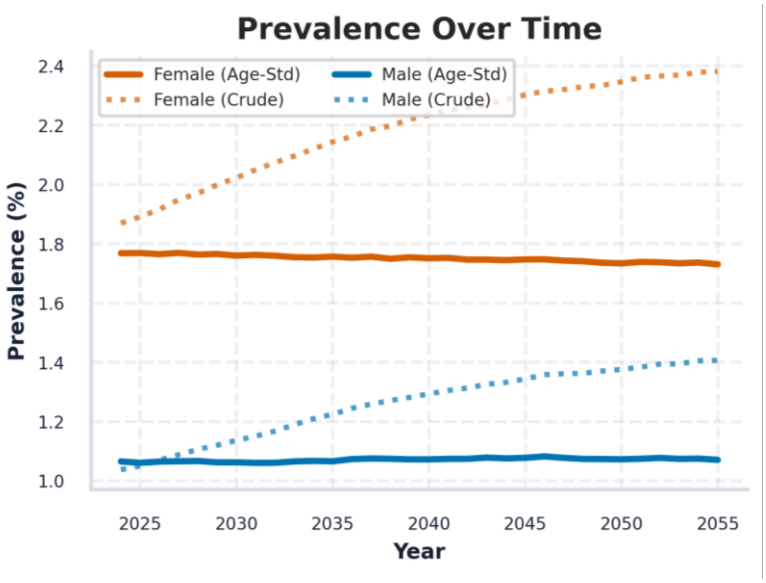
The above figure shows the projected population with modelled IA over time. It supports interpretation of projected disease-specific growth between 2025 and 2055.

Figure K.4B. Absolute growth in any modelled inflammatory arthritis by age group and sex, Canada, 2025 to 2055.



The above figure shows the age groups in which projected growth is concentrated. It supports disease-specific interpretation because age structure affects prevalence, disability, cost exposure, and social-burden interpretation differently across condition groups.

Figure K.4C. Crude and age-standardised prevalence of any modelled inflammatory arthritis by sex, Canada, 2025 to 2055

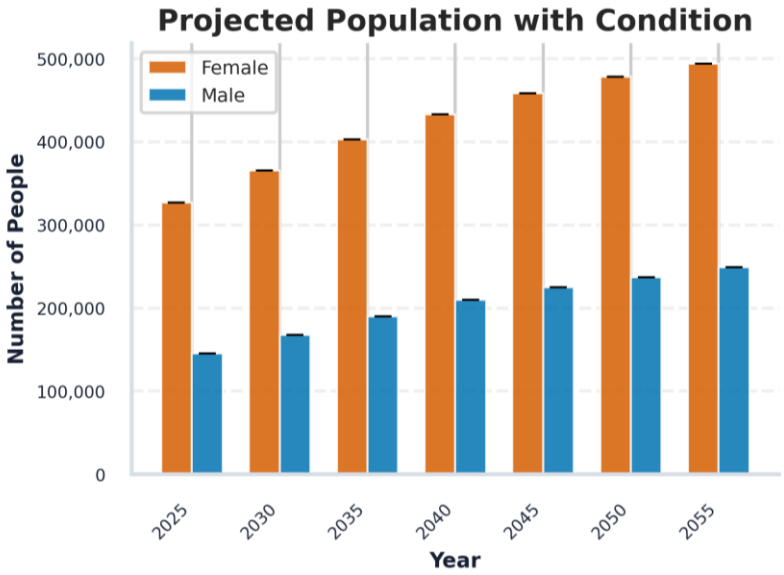


The above figure shows the crude and age-standardised prevalence path over time. It helps distinguish changes related to population ageing from changes in standardised prevalence.

K.3.5 Modelled Rheumatoid Arthritis

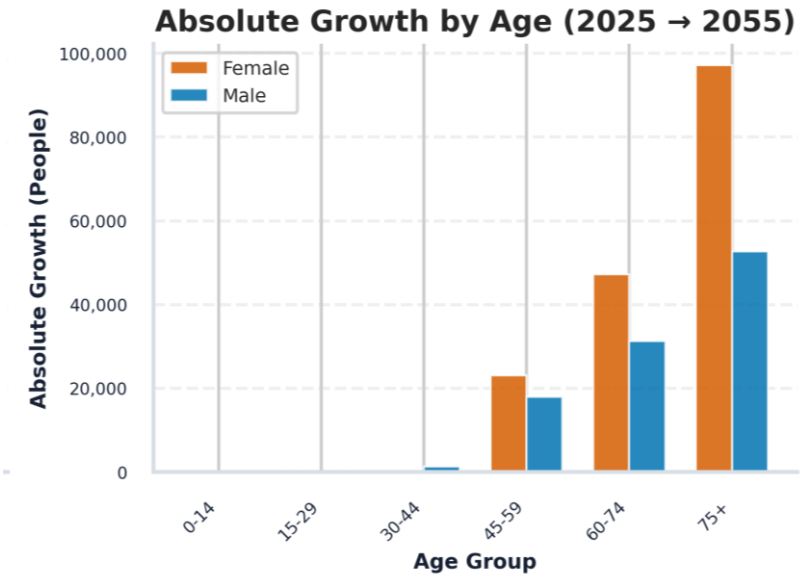
This panel documents the projected population with modelled rheumatoid arthritis by sex and provides detailed national evidence behind the main-report disease-burden summary. It is placed in Appendix K because it gives disease-specific trajectory detail without overloading the main report.

Figure K.5A. Projected population with modelled rheumatoid arthritis by sex, Canada, 2025 to 2055



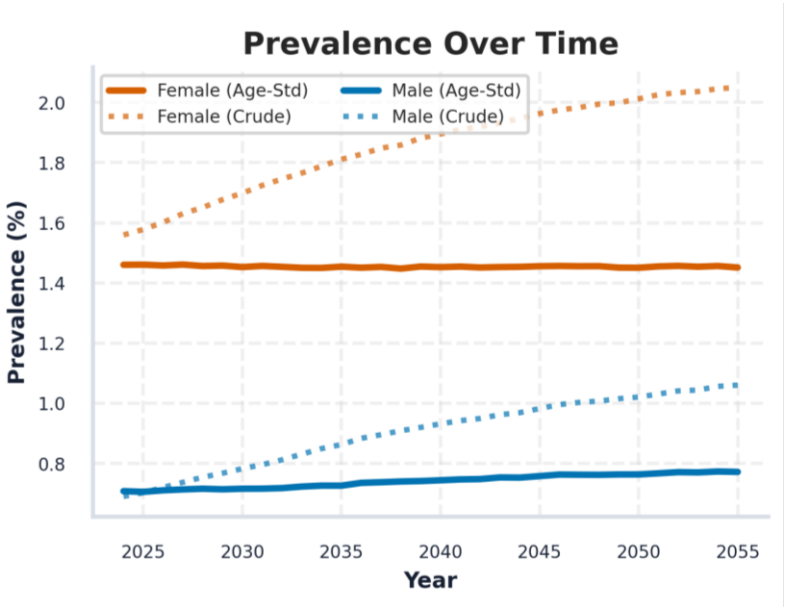
The above figure shows the projected population with modelled RA over time. It supports interpretation of projected disease-specific growth between 2025 and 2055.

Figure K.5B. Absolute growth in modelled rheumatoid arthritis by age group and sex, Canada, 2025 to 2055



The above figure shows the age groups in which projected growth is concentrated. It supports disease-specific interpretation because age structure affects prevalence, disability, cost exposure, and social-burden interpretation differently across condition groups.

Figure K.5C. Crude and age-standardised prevalence of modelled rheumatoid arthritis by sex, Canada, 2025 to 2055

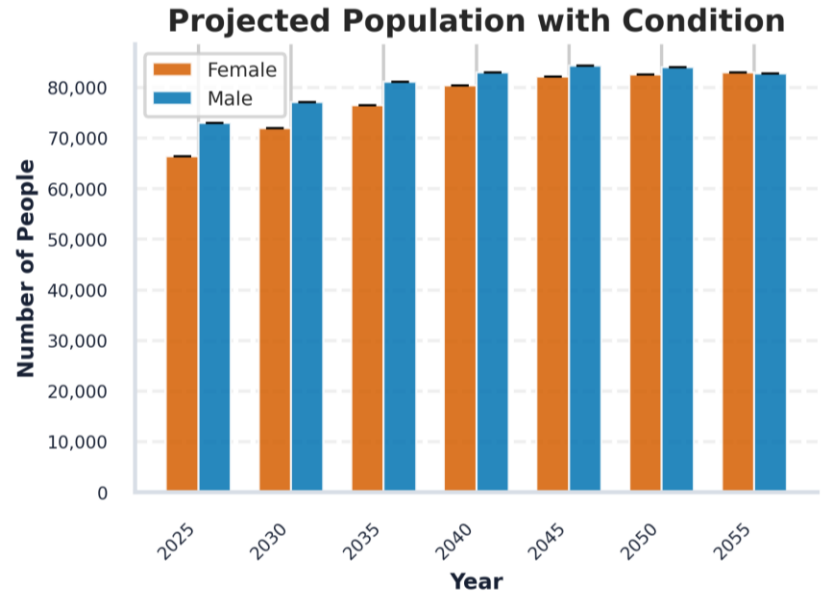


The above figure shows the crude and age-standardised prevalence path over time. It helps distinguish changes related to population ageing from changes in standardised prevalence.

K.3.6 Any Modelled Spondyloarthritis

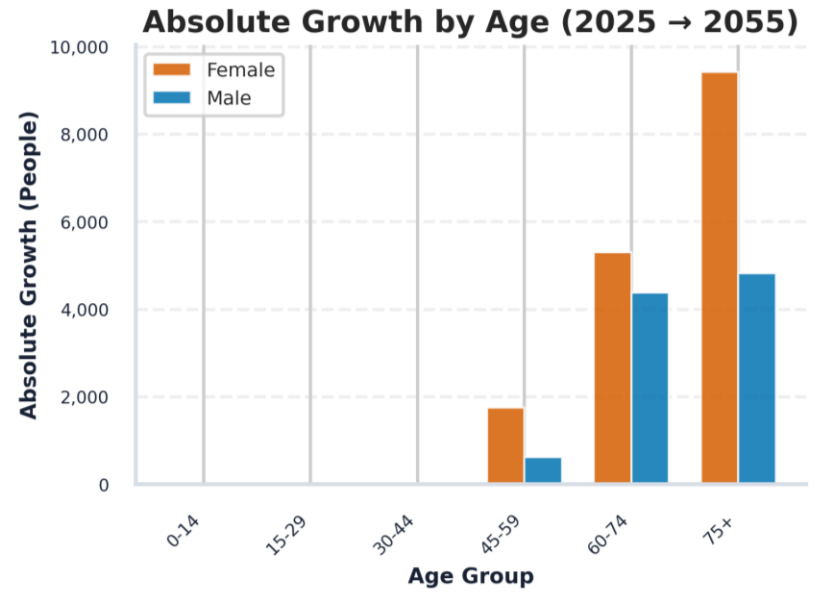
This panel documents the projected population with any modelled spondyloarthritis by sex and provides detailed national evidence behind the main-report disease-burden summary. It is placed in Appendix K because it gives disease-specific trajectory detail without overloading the main report.

Figure K.6A. Projected population with any modelled spondyloarthritis by sex, Canada, 2025 to 2055



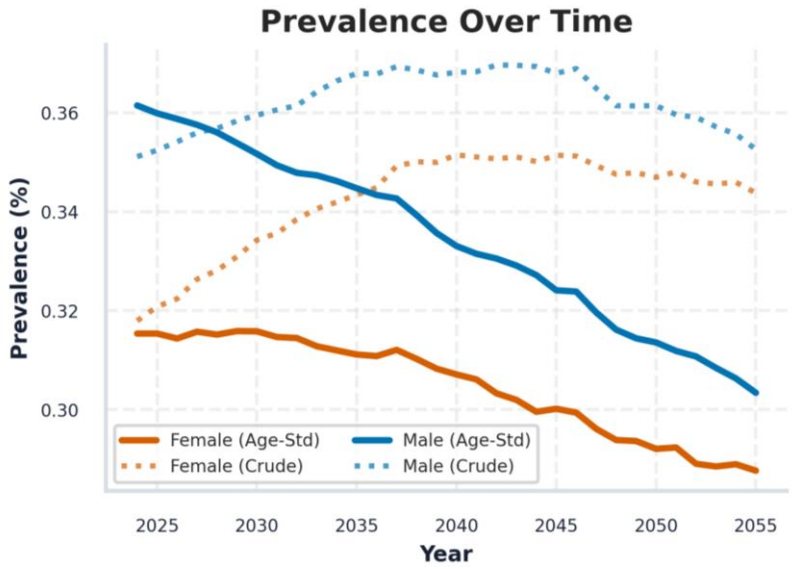
The above figure shows the projected population with modelled SpA over time. It supports interpretation of projected disease-specific growth between 2025 and 2055.

Figure K.6B. Absolute growth in any modelled spondyloarthritis by age group and sex, Canada, 2025 to 2055



The above figure shows the age groups in which projected growth is concentrated. It supports disease-specific interpretation because age structure affects prevalence, disability, cost exposure, and social-burden interpretation differently across condition groups.

Figure K.6C. Crude and age-standardised prevalence of any modelled spondyloarthritis by sex, Canada, 2025 to 2055

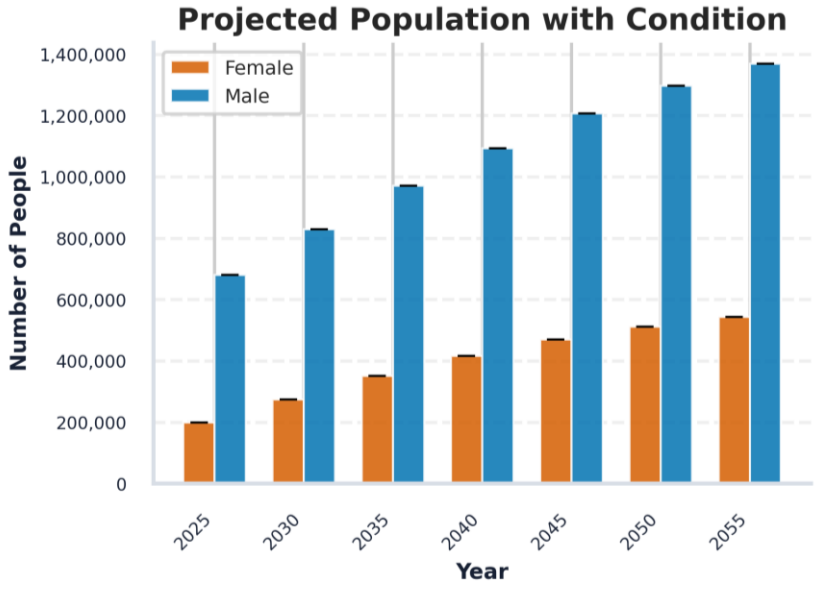


The above figure shows the crude and age-standardised prevalence path over time. It helps distinguish changes related to population ageing from changes in standardised prevalence.

K.3.7 Modelled Gout

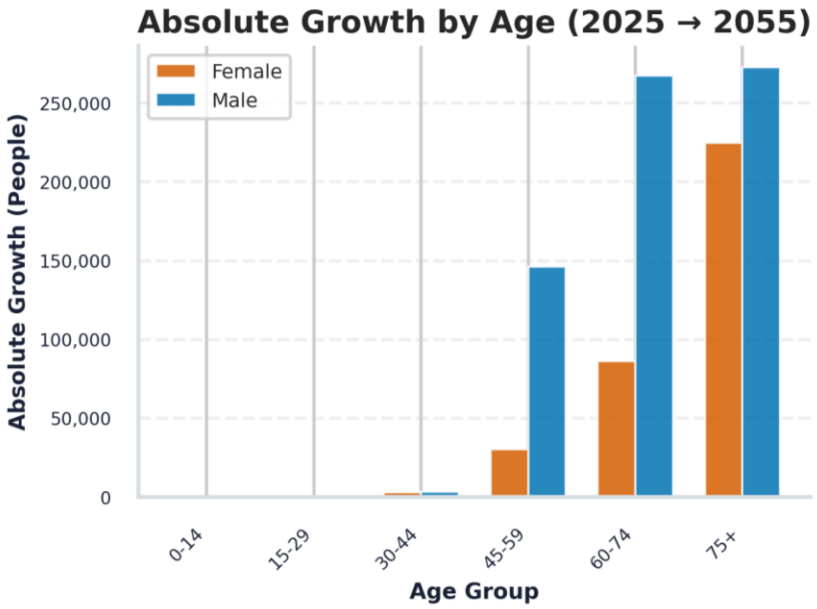
This panel documents the projected population with modelled gout by sex and provides detailed national evidence behind the main-report disease-burden summary. It is placed in Appendix K because it gives disease-specific trajectory detail without overloading the main report.

Figure K.7A. Projected population with modelled gout by sex, Canada, 2025 to 2055



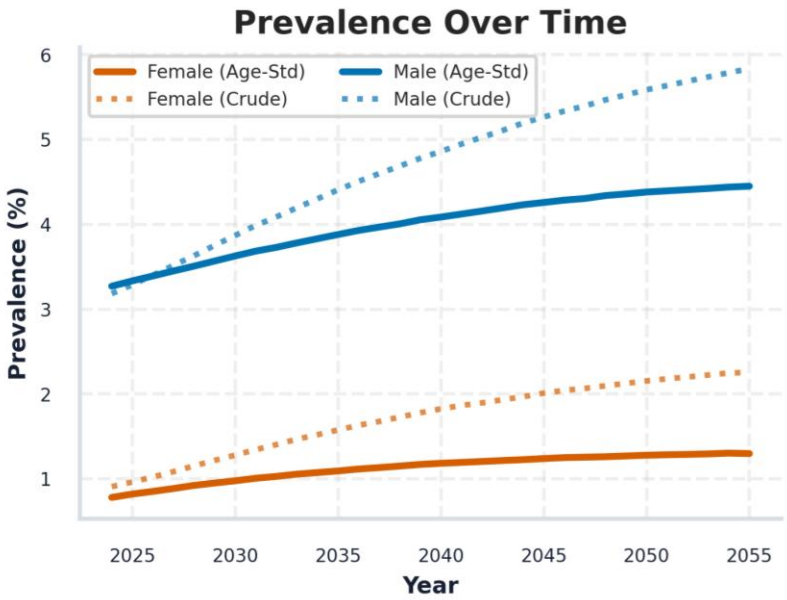
The above figure shows the projected population with modelled Gout over time. It supports interpretation of projected disease-specific growth between 2025 and 2055.

Figure K.7B. Absolute growth in modelled gout by age group and sex, Canada, 2025 to 2055



The above figure shows the age groups in which projected growth is concentrated. It supports disease-specific interpretation because age structure affects prevalence, disability, cost exposure, and social-burden interpretation differently across condition groups.

Figure K.7C. Crude and age-standardised prevalence of modelled gout by sex, Canada, 2025 to 2055



The above figure shows the crude and age-standardised prevalence path over time. It helps distinguish changes related to population ageing from changes in standardised prevalence.

Appendix L Detailed Provincial Results

This appendix provides provincial result tables. Provincial results are interpreted in relation to population size, age structure, disease mix, and output definitions. Provincial totals are not performance rankings.

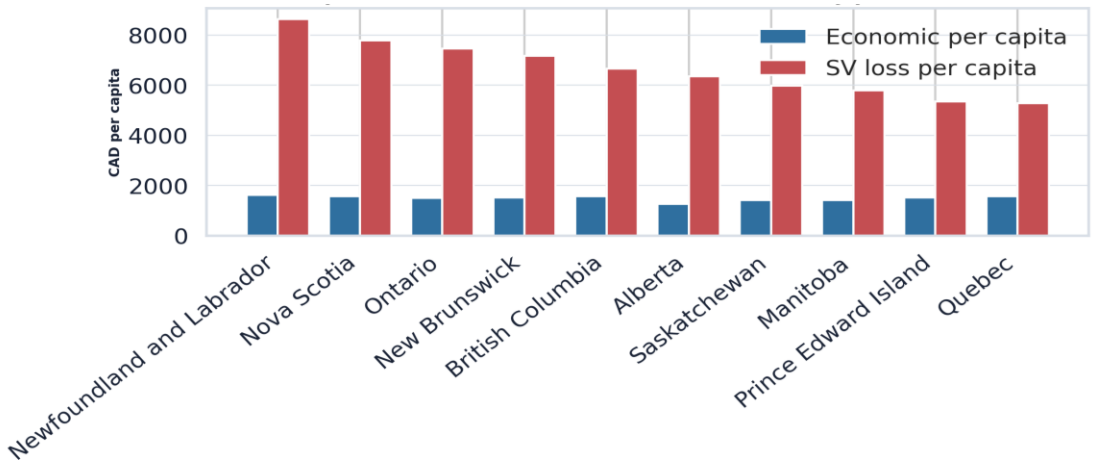
L.1 Provincial Summary, 2055

Province	People with any arthritis	Crude prevalence	Economic burden	Social value loss
Alberta	1.28M	17.6%	$9.23B	$20.6B
British Columbia	1.54M	22.6%	$10.84B	$23.9B
Manitoba	0.32M	18.7%	$2.42B	$4.7B
New Brunswick	0.19M	22.4%	$1.28B	$2.6B
Newfoundland and Labrador	0.11M	25.4%	$0.69B	$1.4B
Nova Scotia	0.23M	22.5%	$1.63B	$3.3B
Ontario	3.96M	21.2%	$28.31B	$61.3B
Prince Edward Island	0.04M	21.4%	$0.29B	$0.6B
Quebec	2.04M	22.3%	$14.37B	$28.3B
Saskatchewan	0.28M	18.3%	$2.21B	$4.3B

Monetary values in real 2026 terms

Figure L.1 compares economic burden and social value loss per provincial resident while keeping the two burden domains separate. These measures use the total provincial population as the denominator; they are not burden per arthritis case. Economic burden per resident is relatively similar across provinces because the main cost components are applied within a common national accounting structure. Social value loss per resident varies more because it also reflects differences in crude prevalence, age and sex composition, disease mix, and the distribution of pain and disability states.

Figure L.1. Economic burden and social value loss per provincial resident, Canada, 2055



L.2 Per-Province Trajectories, 2025 to 2055

Each province is reported across selected years. Per-person measures use the total province population denominator where shown. Counts are millions of people; monetary values are in real 2026 terms.

L.2.1 Alberta

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	0.62M	12.6%	14.1%	$5.1B	$10.3B	$1,025	$2,081
2030	0.73M	13.7%	13.9%	$5.8B	$12.0B	$1,087	$2,239
2040	0.97M	15.7%	13.6%	$7.4B	$15.6B	$1,203	$2,544
2055	1.28M	17.6%	13.5%	$9.2B	$20.6B	$1,273	$2,840

L.2.2 British Columbia

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	0.86M	15.0%	14.3%	$6.5B	$14.0B	$1,135	$2,437
2030	1.03M	17.0%	14.3%	$7.5B	$16.3B	$1,238	$2,704
2040	1.26M	19.6%	14.3%	$9.0B	$19.7B	$1,400	$3,045
2055	1.54M	22.6%	14.2%	$10.8B	$23.9B	$1,587	$3,505

L.2.3 Manitoba

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	0.20M	13.2%	14.5%	$1.5B	$3.1B	$1,023	$2,067
2030	0.23M	15.0%	14.8%	$1.8B	$3.6B	$1,158	$2,298
2040	0.27M	16.8%	14.9%	$2.1B	$4.1B	$1,285	$2,530
2055	0.32M	18.7%	15.1%	$2.4B	$4.7B	$1,422	$2,773

L.2.4 New Brunswick

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	0.14M	16.8%	14.2%	$1.0B	$2.2B	$1,172	$2,526
2030	0.16M	18.8%	14.6%	$1.1B	$2.4B	$1,282	$2,768
2040	0.18M	21.2%	15.2%	$1.2B	$2.6B	$1,431	$3,036
2055	0.19M	22.4%	15.4%	$1.3B	$2.6B	$1,530	$3,159

L.2.5 Newfoundland and Labrador

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	0.10M	18.1%	14.4%	$0.6B	$1.5B	$1,192	$2,690
2030	0.11M	20.7%	15.1%	$0.7B	$1.6B	$1,326	$2,977
2040	0.12M	24.1%	15.8%	$0.7B	$1.7B	$1,503	$3,350
2055	0.11M	25.4%	16.1%	$0.7B	$1.4B	$1,630	$3,446

L.2.6 Nova Scotia

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	0.18M	16.5%	14.3%	$1.3B	$2.7B	$1,182	$2,527
2030	0.20M	18.6%	14.7%	$1.4B	$3.0B	$1,270	$2,765
2040	0.22M	20.8%	15.2%	$1.5B	$3.3B	$1,416	$3,021
2055	0.23M	22.5%	15.2%	$1.6B	$3.3B	$1,585	$3,223

L.2.7 Ontario

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	2.33M	14.4%	14.2%	$17.8B	$38.2B	$1,095	$2,354
2030	2.72M	16.1%	14.4%	$20.1B	$43.6B	$1,191	$2,587
2040	3.33M	18.7%	14.7%	$24.1B	$52.0B	$1,354	$2,921
2055	3.96M	21.2%	14.8%	$28.3B	$61.3B	$1,516	$3,280

L.2.8 Prince Edward Island

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	0.03M	15.3%	14.4%	$0.2B	$0.4B	$1,116	$2,277
2030	0.03M	17.2%	14.7%	$0.2B	$0.5B	$1,213	$2,599
2040	0.04M	19.6%	14.7%	$0.3B	$0.5B	$1,318	$2,850
2055	0.04M	21.4%	14.6%	$0.3B	$0.6B	$1,526	$3,099

L.2.9 Quebec

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	1.44M	15.8%	14.4%	$10.5B	$21.4B	$1,157	$2,361
2030	1.66M	18.0%	14.9%	$12.0B	$24.1B	$1,299	$2,619
2040	1.91M	20.6%	15.5%	$13.7B	$27.0B	$1,478	$2,906
2055	2.04M	22.3%	15.7%	$14.4B	$28.3B	$1,573	$3,100

L.2.10 Saskatchewan

Year	People with any arthritis	Crude prevalence	Age-standardised prevalence	Economic burden	Social value loss	Economic per person (population)	Social value loss per person (population)
2025	0.17M	13.5%	14.4%	$1.4B	$2.7B	$1,090	$2,151
2030	0.19M	14.9%	14.6%	$1.5B	$3.0B	$1,171	$2,305
2040	0.24M	16.7%	14.8%	$1.8B	$3.6B	$1,304	$2,529
2055	0.28M	18.3%	14.9%	$2.2B	$4.3B	$1,431	$2,756

L.3 Interpretation

Provincial differences reflect the joint contribution of population size, age structure, disease mix, modelled prevalence, economic burden, and social burden. Per-person measures and age-standardised measures are used where the analytical question is comparative rather than total burden. The summary table in L.1 reports 2055 totals; the per-province tables in L.2 record selected-year trajectories so that the relative contribution of population growth, prevalence change, and per-person burden can be read together.

Appendix M Detailed Age, Sex, and Distributional Results

This appendix records key distributional results.

M.1 Sex-Specific Prevalence and Burden, Selected Years

Year	Sex	People with any arthritis	Population	Crude prevalence	Economic burden	Social value loss
2025	Female	3.39M	20.7M	16.4%	$24.4B	$64.3B
2025	Male	2.68M	20.6M	12.9%	$21.5B	$32.2B
2025	Total	6.07M	41.4M	14.7%	$45.9B	$96.5B
2030	Female	3.91M	21.5M	18.1%	$27.6B	$72.8B
2030	Male	3.16M	21.4M	14.8%	$24.5B	$37.3B
2030	Total	7.07M	43.0M	16.4%	$52.1B	$110.0B
2040	Female	4.71M	22.9M	20.6%	$32.5B	$86.0B
2040	Male	3.84M	22.5M	17.1%	$29.4B	$44.1B
2040	Total	8.55M	45.4M	18.8%	$62.0B	$130.1B
2055	Female	5.46M	24.2M	22.6%	$37.0B	$99.3B
2055	Male	4.53M	23.4M	19.3%	$34.3B	$51.8B
2055	Total	9.99M	47.6M	21.0%	$71.3B	$151.1B

M.2 Economic and Social Burden by Highest Age and Sex Segments, 2025 and 2055

Age and sex segment	2025 people with arthritis	2055 people with arthritis	2025 economic burden	2055 economic burden	2025 social value loss	2055 social value loss
Female, 50-59	0.46M	0.64M	$5.4B	$7.9B	$9.6B	$13.2B
Female, 60-69	0.92M	1.28M	$6.8B	$9.8B	$18.0B	$24.6B
Female, 70+	1.71M	3.27M	$7.3B	$14.8B	$31.7B	$56.9B
Male, 50-59	0.41M	0.67M	$5.1B	$8.6B	$4.8B	$7.9B
Male, 60-69	0.76M	1.17M	$6.4B	$10.4B	$9.6B	$14.5B
Male, 70+	1.19M	2.35M	$5.1B	$10.5B	$13.6B	$25.3B

Disease and age-sex social value views are complementary and are not summed together.

M.3 Age Profile of Any-Arthritis Prevalence, 2055

Age band	Population	People with any arthritis	Crude prevalence
0-4	2.13M	0.00M	0.0%
5-9	2.20M	0.00M	0.1%
10-14	2.23M	0.00M	0.2%
15-19	2.16M	0.00M	0.2%
20-24	2.15M	0.01M	0.4%
25-29	2.19M	0.02M	1.0%
30-34	2.32M	0.04M	1.9%
35-39	2.64M	0.09M	3.5%
40-44	2.77M	0.16M	5.7%
45-49	2.80M	0.26M	9.3%
50-54	3.28M	0.49M	15.1%
55-59	3.61M	0.82M	22.7%
60-64	3.69M	1.14M	31.0%
65-69	3.39M	1.31M	38.5%
70-74	3.01M	1.40M	46.3%
75-79	2.47M	1.33M	53.8%
80-84	1.97M	1.19M	60.3%
85-89	1.45M	0.96M	66.2%
90-94	0.82M	0.58M	70.5%
95-99	0.29M	0.21M	73.3%
100+	0.03M	0.02M	76.4%

Note: pediatric and youth bands display 0.00M only because they round to less than 0.01M at the report's two-decimal precision. The underlying model has non-zero counts (for example, 480 people in the 0-4 band in 2025).

M.4 CCHS Wellbeing Calibration Inputs

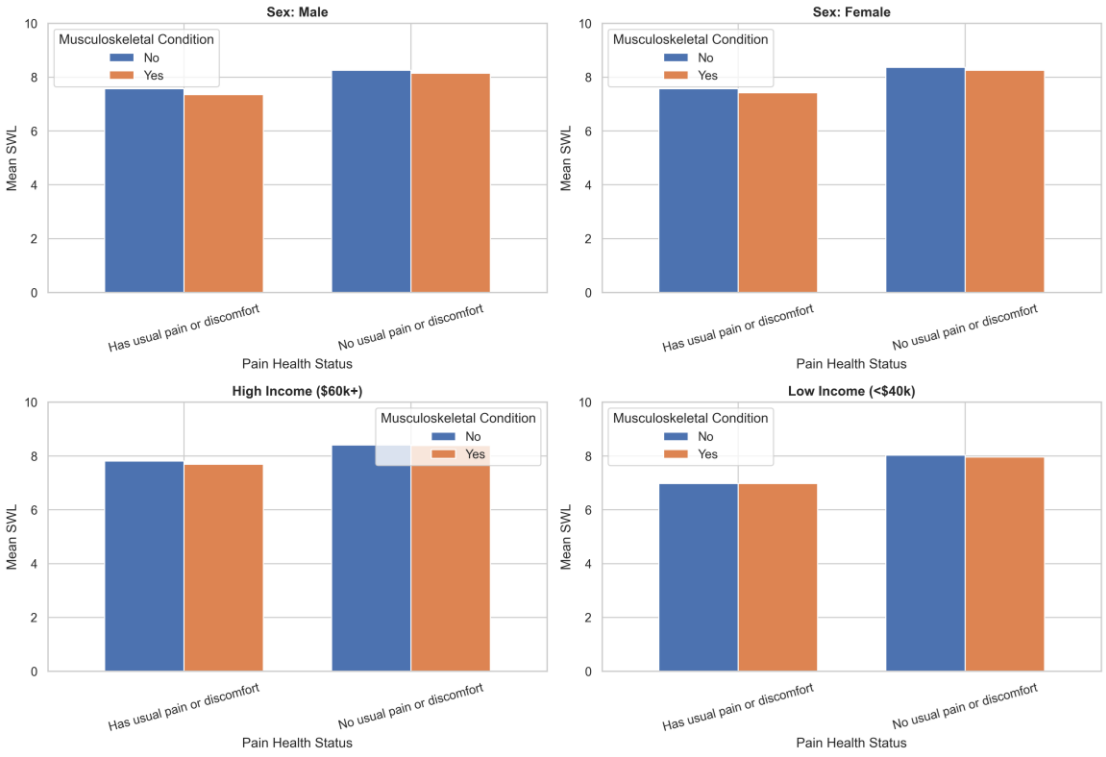
The Canadian Community Health Survey provides descriptive wellbeing differences associated with usual pain, the presence of a musculoskeletal condition, and their combination. These values are calibration inputs for the social burden method, not causal estimates.

Comparison	SWL difference (%)	Exposed mean SWL	Reference mean SWL
Usual pain/discomfort vs none	-9.5%	7.46	8.24
Musculoskeletal condition vs none	-4.7%	7.75	8.14
Pain and musculoskeletal condition vs neither	-11.1%	7.33	8.25

SWL refers to satisfaction-with-life on the standard 0-10 scale used in the CCHS instrument using the latest 3 cycles which reported these categories (2015/16, 2017/18, 2019/20).

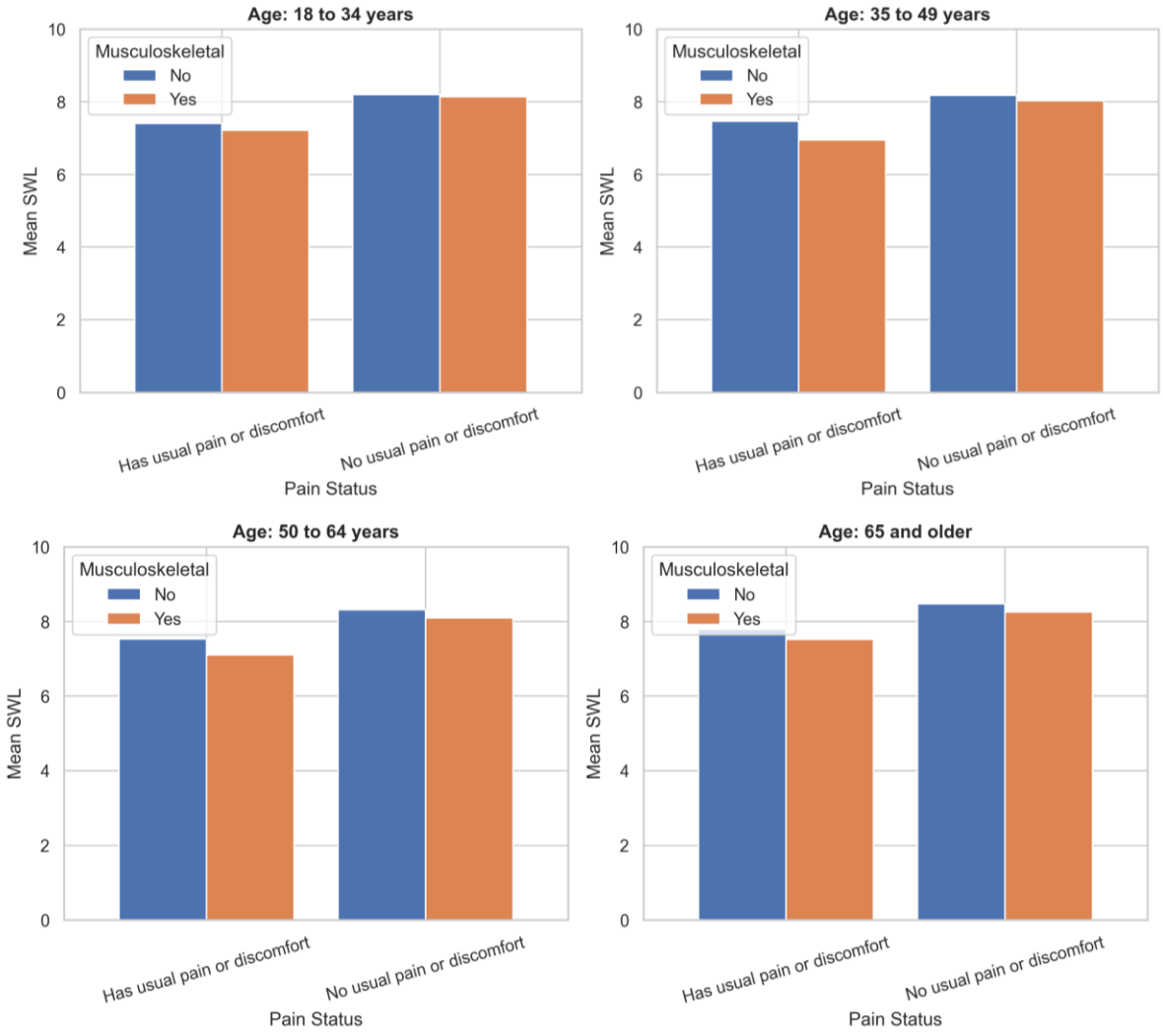
The figure below shows how the CCHS wellbeing calibration distinguishes pain status, musculoskeletal condition status, and age group rather than using a single unstratified wellbeing decrement. Musculoskeletal-condition status is used because it is available in more consistent categories across multiple CCHS cycles and aligns more consistently with the pain and life-satisfaction measures than the arthritis-specific variable. The pattern is interpreted as descriptive calibration evidence: it supports the social-burden parameterisation, but it does not by itself estimate a causal arthritis-attributable life-satisfaction loss.

Figure M.1. CCHS life-satisfaction patterns by age group, pain status, and musculoskeletal condition



The figure below documents the calibration evidence used to assess whether wellbeing differences vary across sex and income strata in addition to pain and musculoskeletal condition status. It supports the report's caution that social value estimates depend on descriptive wellbeing patterns and are not read as direct causal estimates.

Figure M.2. CCHS life-satisfaction patterns by sex, income, pain status, and musculoskeletal condition status



Appendix N References

- Canadian Rheumatology Association Annual Scientific Meeting TELUS Convention Centre Calgary, Alberta, Canada February 26–March 1, 2025. The Journal of Rheumatology, 52(Suppl 2), 8-9. https://doi.org/10.3899/jrheum.2025-0314
- Al Dhanhani, A. M., Gignac, M. A. M., Beaton, D. E., Su, J., & Fortin, P. R. (2015). Job accommodations availability and utilization among people with lupus: An examination of workplace activity limitations and work context factors. Arthritis Care & Research, 67(11), 1536–1544. https://doi.org/10.1002/acr.22662
- Alyousef, Y. S., Johnston, V., & Smith, M. D. (2023). Work-related outcomes in individuals with and without lower limb osteoarthritis: an online survey. BMC Public Health, 23(1). https://doi.org/10.1186/s12889-023-16723-3
- Anke, A., Damsgard, E., & Roe, C. (2013). Life satisfaction in subjects with long-term musculoskeletal pain in relation to pain intensity, pain distribution and coping. Journal of Rehabilitation Medicine, 45(3), 277–285. https://doi.org/10.2340/16501977-1102
- Appleyard, T., Thomas, M. J., Antcliff, D., & Peat, G. (2023). Prediction Models to Estimate the Future Risk of Osteoarthritis in the General Population: A Systematic Review. Arthritis Care & Research, 75(7), 1481-1493. https://doi.org/10.1002/acr.25035
- Arthritis Community Research and Epidemiology Unit. (2021). Updated population estimates for number of people in Canada with various types of arthritis.
- Australian Institute of Health and Welfare. (2021). Australian Burden of Disease Study: Methods and supplementary material 2018. Disease specific methods — morbidity. Australian Institute of Health and Welfare.
- Badley, E. M., Canizares, M., & Perruccio, A. V. (2017). Population-Based Study of Changes in Arthritis Prevalence and Arthritis Risk Factors Over Time: Generational Differences and the Role of Obesity. Arthritis Care & Research, 69(12), 1818-1825. https://doi.org/10.1002/acr.23213
- Badley, E. M., Goulart, C. M., Millstone, D. B., & Perruccio, A. V. (2019). An Update on Arthritis in Canada — National and Provincial Data Regarding the Past, Present, and Future. The Journal of Rheumatology, 46(6), 579-586. https://doi.org/10.3899/jrheum.180147
- Badley, E. M., Wilfong, J. M., Chan, C. H., Canizares, M., & Perruccio, A. V. (2022). I don't know what type of arthritis I have: A population-based comparison of people with arthritis who knew their specific type and those who didn't. PLOS ONE, 17(6), e0270029. https://doi.org/10.1371/journal.pone.0270029
- Badley, E. M., Zahid, S., Wilfong, J. M., & Perruccio, A. V. (2024). Labor Force Participation in Adults With Osteoarthritis or Joint Symptoms Typical of Osteoarthritis: Findings From a Canadian Longitudinal Study on Aging. Arthritis Care & Research, 76(11), 1471-1478. https://doi.org/10.1002/acr.25398

- Badley, E. M., Wilfong, J. M., & Perruccio, A. V. (2020). Joint symptoms another risk marker for later osteoarthritis: A longitudinal population based study of knee osteoarthritis incidence [Conference abstract]. Osteoarthritis and Cartilage, 28(Suppl 1). OARSI World Congress.
- Bansback, N., Trenaman, L., MacDonald, K. V., Durand, D., Hawker, G., Johnson, J. A., Smith, C., Stacey, D., & Marshall, D. A. (2022). An online individualised patient decision aid improves the quality of decisions in patients considering total knee arthroplasty in routine care: A randomized controlled trial. Osteoarthritis and Cartilage Open, 4(3), 100286. https://doi.org/10.1016/j.ocarto.2022.100286
- Bansback, N., Trenaman, L., MacDonald, K. V., Hawker, G., Johnson, J. A., Stacey, D., & Marshall, D. A. (2019). An individualized patient-reported outcome measure (PROM) based patient decision aid and surgeon report for patients considering total knee arthroplasty: protocol for a pragmatic randomized controlled trial. BMC Musculoskeletal Disorders, 20(1). https://doi.org/10.1186/s12891-019-2434-2
- Barber, C. E., Lacaille, D., Croxford, R., Barnabe, C., Marshall, D. A., Abrahamowicz, M., Xie, H., Aviña-Zubieta, J. A., Esdaile, J. M., Hazlewood, G. S., Faris, P., Katz, S., MacMullan, P., Mosher, D., & Widdifield, J. (2023). Investigating Associations Between Access to Rheumatology Care, Treatment, Continuous Care, and Healthcare Utilization and Costs Among Older Individuals With Rheumatoid Arthritis. The Journal of Rheumatology, 50(5), 617-624. https://doi.org/10.3899/jrheum.220729
- Barber, M. R. W., Falasinnu, T., Ramsey-Goldman, R., & Clarke, A. E. (2023). The global epidemiology of SLE: narrowing the knowledge gaps. Rheumatology, 62(Supplement_1), i4-i9. https://doi.org/10.1093/rheumatology/keac610
- Barber, T., Sharif, B., Teare, S., Miller, J., Shewchuk, B., Green, L. A., Marlett, N., Cibere, J., Mrklas, K., Wasylak, T., Li, L. C., Campbell-Scherer, D., & Marshall, D. A. (2019). Qualitative study to elicit patients' and primary care physicians' perspectives on the use of a self-management mobile health application for knee osteoarthritis. BMJ Open, 9(1), e024016. https://doi.org/10.1136/bmjopen-2018-024016
- Barnabe, C., Joseph, L., Belisle, P., Labrecque, J., Edworthy, S., Barr, S. G., Fritzler, M., Svenson, L. W., Hemmelgarn, B., & Bernatsky, S. (2012). Prevalence of systemic lupus erythematosus and systemic sclerosis in the First Nations population of Alberta, Canada. Arthritis Care & Research, 64(1), 138-143. https://doi.org/10.1002/acr.20656
- Barnabe, C., Miller, J., Teare, S., Eaglespeaker, C., Roland, B., Eshkakogan, N., Crowshoe, L., Lopatina, E., & Marshall, D. (2019). Solution Model for Enhancing the Experiences of Urban First Nations and Métis Patients Accessing and Navigating the Health System for Inflammatory Arthritis Care. International Indigenous Policy Journal, 10(2), 1-13. https://doi.org/10.18584/iipj.2019.10.2.3
- Berkovic, D., Briggs, A. M., Ayton, D., Parker, C., & Ackerman, I. (2021). Arthritis-related work outcomes experienced by younger to middle-aged adults: a systematic review. Occupational and Environmental Medicine, 78(4), 225-236. https://doi.org/10.1136/oemed-2020-106640

- Blomjous et al. (2025). A 6-year prospective study on work participation and the associated factors in Dutch patients with systemic lupus erythematosus (SLE). https://doi.org/10.116/s13075-025-03631-7
- Bombardier, C., Hawker, G., & Mosher, D. (2011). *The impact of arthritis in Canada: Today and over the next 30 years*. Arthritis Alliance of Canada.
- Burn, E., Murray, D., Hawker, G., Pinedo-Villanueva, R., & Prieto-Alhambra, D. (2019). Lifetime risk of knee and hip replacement following a GP diagnosis of osteoarthritis: a real-world cohort study. Osteoarthritis and Cartilage, 27(11), 1627-1635. https://doi.org/10.1016/j.joca.2019.06.004
- Canizares, M., & Badley, E. M. (2012). Comparison of health-related outcomes for arthritis, chronic joint symptoms, and sporadic joint symptoms: A population-based study. Arthritis Care & Research, 64(11), 1708-1714. https://doi.org/10.1002/acr.21735
- Demoruelle, M. K., Deane, K. D., & Holers, V. M. (2016). Genetic and environmental risk factors for rheumatoid arthritis. Best Practice & Research Clinical Rheumatology, 30(1), 2-18. https://doi.org/10.1016/j.berh.2016.02.003
- Carr, E. C. J., Patel, J. N., Ortiz, M. M., Miller, J. L., Teare, S. R., Barber, C. E. H., & Marshall, D. A. (2019). Co-design of a patient experience survey for arthritis central intake: an example of meaningful patient engagement in healthcare design. BMC Health Services Research, 19(1). https://doi.org/10.1186/s12913-019-4196-9
- Carr, E. C., Ortiz, M. M., Patel, J. N., Barber, C. E., Katz, S., Robert, J., Mosher, D., Teare, S. R., Miller, J., Homik, J., Dinsmore, K., & Marshall, D. A. (2020). Models of Arthritis Care: A Systems-level Evaluation of Acceptability as a Dimension of Quality of Care. The Journal of Rheumatology, 47(9), 1431-1439. https://doi.org/10.3899/jrheum.190501
- Cavallo, M., Badley, E. M., & Perruccio, A. V. (2025). Insomnia symptoms among individuals with osteoarthritis and symptoms indicative of osteoarthritis: A population-based cross-sectional study using the CLSA. PLOS One, 20(5), e0322361. https://doi.org/10.1371/journal.pone.0322361
- Cañizares, M., Power, J. D., Perruccio, A. V., & Badley, E. M. (2008). Association of regional racial/cultural context and socioeconomic status with arthritis in the population: A multilevel analysis. Arthritis Care & Research, 59(3), 399-407. https://doi.org/10.1002/art.23316
- Cooper, N. J., Mugford, M., Symmons, D. P. M., Barrett, E. M., & Scott, D. G. I. (2002). Total costs and predictors of costs in individuals with early inflammatory polyarthritis: A community-based prospective study. Rheumatology, 41(7), 767–774.
- Costa, D., Lopes, D. G., Cruz, E. B., Henriques, A. R., Branco, J., Canhao, H., & Rodrigues, A. M. (2023). Trajectories of physical function and quality of life in people with osteoarthritis: Results from a 10-year population-based cohort. BMC Public Health, 23, 1407. https://doi.org/10.1186/s12889-023-16167-9
- Cram, P., Landon, B. E., Matelski, J., Ling, V., Stukel, T. A., Paterson, J. M., Gandhi, R., Hawker, G. A., & Ravi, B. (2018). Utilization and Short-Term Outcomes of Primary Total Hip

and Knee Arthroplasty in the United States and Canada. Arthritis & Rheumatology, 70(4), 547-554. https://doi.org/10.1002/art.40407

- Currie, G. R., Kennedy, B. L., Benseler, S. M., Yeung, R. S. M., Swart, J. F., Vastert, S. J., Wulffraat, N. M., Kip, M. M. A., MacKean, G., & Marshall, D. A. (2023). Managing juvenile idiopathic arthritis within the context of their life: What we learnt from children and youth living with juvenile idiopathic arthritis and their parents. Musculoskeletal Care, 21(4), 1396–1406. https://doi.org/10.1002/msc.1805
- Dalbeth, N., Gosling, A. L., Gaffo, A., & Abhishek, A. (2021). Gout. The Lancet, 397(10287), 1843-1855. https://doi.org/10.1016/s0140-6736(21)00569-9
- Dehlin, M., Jacobsson, L., & Roddy, E. (2020). Global epidemiology of gout: prevalence, incidence, treatment patterns and risk factors. Nature Reviews Rheumatology, 16(7), 380-390. https://doi.org/10.1038/s41584-020-0441-1
- Dong, H.-J., Larsson, B., Dragioti, E., Bernfort, L., Levin, L.-A., & Gerdle, B. (2020). Factors associated with life satisfaction in older adults with chronic pain (PainS65+). Journal of Pain Research, 13, 475–489. https://doi.org/10.2147/JPR.S234565
- Duong, V., Abdel Shaheed, C., Ferreira, M. L., Narayan, S. W., Venkatesha, V., Hunter, D. J., Zhu, J., Atukorala, I., Kobayashi, S., Goh, S. L., Briggs, A. M., Cross, M., Espinosa-Morales, R., Fu, K., Guillemin, F., Keefe, F., Stefan Lohmander, L., March, L., Milne, G. J., & Mei, Y. (2025). Risk factors for the development of knee osteoarthritis across the lifespan: A systematic review and meta-analysis. Osteoarthritis and Cartilage, 33(10), 1162-1179. https://doi.org/10.1016/j.joca.2025.03.003
- Eder, L., et al. (2020). Identifying and characterizing psoriasis and psoriatic arthritis patients in Ontario administrative data: A population-based study from 1991 to 2015.
- Eder, L., Lee, K., Chandran, V., Widdifield, J., Drucker, A. M., Ritchlin, C., Rosen, C. F., Cook, R. J., & Gladman, D. D. (2025). Derivation of a Multivariable Psoriatic Arthritis Risk Estimation Tool (PRESTO): A Step Towards Prevention. Arthritis & Rheumatology, 77(6), 686-695. https://doi.org/10.1002/art.42661
- Fatoye, F., Gebrye, T., & Svenson, L. W. (2018). Real-world incidence and prevalence of systemic lupus erythematosus in Alberta, Canada. Rheumatology International, 38(9), 1721-1726. https://doi.org/10.1007/s00296-018-4091-4
- Fischer, A., Cloutier, M., Goodfield, J., Borrelli, R., Marvin, D., & Dziarmaga, A. (2017). The Direct Economic Burden of Gout in an Elderly Canadian Population. The Journal of Rheumatology, 44(1), 95-101. https://doi.org/10.3899/jrheum.160300
- Frank, C., Marshall, D., Faris, P., & Smith, C. (2011). Essay for the CIHR/CMAJ award: improving access to hip and knee replacement and its quality by adopting a new model of care in Alberta. Canadian Medical Association Journal, 183(6), E347-E350. https://doi.org/10.1503/cmaj.110358
- GBD 2021 Osteoarthritis Collaborators. (2023). Global, regional, and national burden of osteoarthritis, 1990–2020 and projections to 2050: A systematic analysis for the Global

Burden of Disease Study 2021. The Lancet Rheumatology, 5(9), e508–e522. https://doi.org/10.1016/S2665-9913(23)00163-7

- Gergianaki, I., Bortoluzzi, A., & Bertsias, G. (2018). Update on the epidemiology, risk factors, and disease outcomes of systemic lupus erythematosus. Best Practice & Research Clinical Rheumatology, 32(2), 188-205. https://doi.org/10.1016/j.berh.2018.09.004
- Gignac, M. A. M., Cao, X., & McAlpine, J. (2015). Availability, Need for, and Use of Work Accommodations and Benefits: Are They Related to Employment Outcomes in People With Arthritis?. Arthritis Care & Research, 67(6), 855-864. https://doi.org/10.1002/acr.22508
- Gignac, M. A. M., Cao, X., Lacaille, D., Anis, A. H., & Badley, E. M. (2008). Arthritis-related work transitions: A prospective analysis of reported productivity losses, work changes, and leaving the labor force. Arthritis Care & Research, 59(12), 1805-1813. https://doi.org/10.1002/art.24085
- Gignac, M. A. M., Cao, X., Tang, K., & Beaton, D. E. (2011). Examination of arthritis-related work place activity limitations and intermittent disability over four-and-a-half years and its relationship to job modifications and outcomes. Arthritis Care & Research, 63(7), 953-962. https://doi.org/10.1002/acr.20456
- Gignac, M. A. M., Kristman, V., Smith, P. M., Beaton, D. E., Badley, E. M., Ibrahim, S., & Mustard, C. A. (2018). Are There Differences in Workplace Accommodation Needs, Use and Unmet Needs Among Older Workers With Arthritis, Diabetes and No Chronic Conditions? Examining the Role of Health and Work Context. Work, Aging and Retirement, 4(4), 381-398. https://doi.org/10.1093/workar/way004
- Gleicher, Y., Croxford, R., Hochman, J., & Hawker, G. (2011). A prospective study of mental health care for comorbid depressed mood in older adults with painful osteoarthritis. BMC Psychiatry, 11(1). https://doi.org/10.1186/1471-244x-11-147
- Gooch, K. L., Smith, D., Wasylak, T., Faris, P. D., Marshall, D. A., Khong, H., Hibbert, J. E., Parker, R. D., Zernicke, R. F., Beaupre, L., Pearce, T., Johnston, D. W. C., & Frank, C. B. (2009). The Alberta hip and knee replacement project: A model for health technology assessment based on comparative effectiveness of clinical pathways. International Journal of Technology Assessment in Health Care, 25(2), 113-123. https://doi.org/10.1017/s0266462309090163
- Gooch, K., Marshall, D., Faris, P., Khong, H., Wasylak, T., Pearce, T., Johnston, D., Arnett, G., Hibbert, J., Beaupre, L., Zernicke, R., & Frank, C. (2012). Comparative effectiveness of alternative clinical pathways for primary hip and knee joint replacement patients: a pragmatic randomized, controlled trial. Osteoarthritis and Cartilage, 20(10), 1086-1094. https://doi.org/10.1016/j.joca.2012.06.017
- Gorasso, V., Van der Heyden, J., De Pauw, R., Pelgrims, I., De Clercq, E. M., De Ridder, K., Vandevijvere, S., Vansteelandt, S., Vaes, B., De Smedt, D., & Devleesschauwer, B. (2023). The health and economic burden of musculoskeletal disorders in Belgium from 2013 to 2018. Population Health Metrics, 21(1). https://doi.org/10.1186/s12963-023-00303-z

- Grazziotin, L. R., Currie, G., Kip, M. M. A., IJzerman, M. J., Twilt, M., Lee, R., & Marshall, D. A. (2020). Health State Utility Values in Juvenile Idiopathic Arthritis: What is the Evidence?. PharmacoEconomics, 38(9), 913-926. https://doi.org/10.1007/s40273-020-00921-7
- Grazziotin, L. R., Currie, G., Twilt, M., Ijzerman, M. J., Kip, M. M. A., Koffijberg, H., Benseler, S. M., Swart, J. F., Vastert, S. J., Wulffraat, N. M., Yeung, R. S. M., & Marshall, D. A. (2022). Real-world data reveals the complexity of disease modifying anti-rheumatic drug treatment patterns in juvenile idiopathic arthritis: an observational study. Pediatric Rheumatology, 20(1). https://doi.org/10.1186/s12969-022-00682-x
- Grazziotin, L. R., Currie, G., Twilt, M., Ijzerman, M. J., Kip, M. M. A., Koffijberg, H., Benseler, S. M., Swart, J. F., Vastert, S. J., Wulffraat, N. M., Yeung, R. S. M., Johnson, N., Luca, N. J., Miettunen, P. M., Schmeling, H., & Marshall, D. A. (2021). Evaluation of Real-World Healthcare Resource Utilization and Associated Costs in Children with Juvenile Idiopathic Arthritis: A Canadian Retrospective Cohort Study. Rheumatology and Therapy, 8(3), 1303-1322. https://doi.org/10.1007/s40744-021-00331-x
- Grazziotin, L. R., Currie, G., Twilt, M., IJzerman, M. J., Kip, M. M. A., Koffijberg, H., Bonsel, G., Benseler, S. M., Swart, J. F., Vastert, S. J., Wulffraat, N. M., Yeung, R. S. M., Armbrust, W., van den Berg, J. M., & Marshall, D. A. (2022). Factors associated with care- and health-related quality of life of caregivers of children with juvenile idiopathic arthritis. Pediatric Rheumatology, 20(1). https://doi.org/10.1186/s12969-022-00713-7
- Greenwood-Lee, J., Jewett, L., Woodhouse, L., & Marshall, D. A. (2018). A categorisation of problems and solutions to improve patient referrals from primary to specialty care. BMC Health Services Research, 18, 986. https://doi.org/10.1186/s12913-018-3745-y
- Han, A., & Gellhorn, A. C. (2018). Trajectories of quality of life and associated risk factors in patients with knee osteoarthritis: Findings from the Osteoarthritis Initiative. American Journal of Physical Medicine & Rehabilitation, 97(9), 620–627. https://doi.org/10.1097/PHM.0000000000000926
- Haridoss, M., Bagepally, B. S., & Natarajan, M. (2021). Health-related quality of life in rheumatoid arthritis: Systematic review and meta-analysis of EuroQoL (EQ-5D) utility scores from Asia. International Journal of Rheumatic Diseases, 24(3), 314–326. https://doi.org/10.1111/1756-185X.14066
- Haroon, N. N., Paterson, J. M., Li, P., & Haroon, N. (2014). Increasing proportion of female patients with ankylosing spondylitis: a population-based study of trends in the incidence and prevalence of AS. BMJ Open, 4(12), e006634. https://doi.org/10.1136/bmjopen-2014-006634
- Haroon, N. N., Paterson, J. M., Li, P., Inman, R. D., & Haroon, N. (2015). Patients With Ankylosing Spondylitis Have Increased Cardiovascular and Cerebrovascular Mortality. Annals of Internal Medicine, 163(6), 409-416. https://doi.org/10.7326/m14-2470
- Hassen, N., Lacaille, D., Xu, A., Alandejani, A., Sidi, S., Mansourian, M., Butt, Z. A., Cahill, L. E., Iyamu, I. O., Lang, J. J., Rana, J., Somayaji, R., Sarrafzadegan, N., & Kopec, J. A. (2024). National burden of rheumatoid arthritis in Canada, 1990–2019: findings from the Global

Burden of Disease Study 2019 – a GBD collaborator-led study. RMD Open, 10(1), e003533. https://doi.org/10.1136/rmdopen-2023-003533

- Hawker, G. A. (2019). Osteoarthritis is a serious disease.
- Hawker, G. A., & King, L. K. (2022). The Burden of Osteoarthritis in Older Adults. Clinics in Geriatric Medicine, 38(2), 181-192. https://doi.org/10.1016/j.cger.2021.11.005
- Hawker, G. A., Conner-Spady, B. L., Bohm, E., Dunbar, M. J., Jones, C. A., Ravi, B., Noseworthy, T., Dick, D., Powell, J., Paul, P., & Marshall, D. A. (2021). Patients' Preoperative Expectations of Total Knee Arthroplasty and Satisfaction With Outcomes at One Year: A Prospective Cohort Study. Arthritis & Rheumatology, 73(2), 223-231. https://doi.org/10.1002/art.41510
- Hawker, G. A., Croxford, R., Bierman, A. S., Harvey, P. J., Ravi, B., Stanaitis, I., & Lipscombe, L. L. (2014). All-Cause Mortality and Serious Cardiovascular Events in People with Hip and Knee Osteoarthritis: A Population Based Cohort Study. PLoS ONE, 9(3), e91286. https://doi.org/10.1371/journal.pone.0091286
- Hawker, G. A., Gignac, M. A. M., Badley, E., Davis, A. M., French, M. R., Li, Y., Perruccio, A. V., Power, J. D., Sale, J., & Lou, W. (2011). A longitudinal study to explain the pain-depression link in older adults with osteoarthritis. Arthritis Care & Research, 63(10), 1382-1390. https://doi.org/10.1002/acr.20298
- Hawker, G., Croxford, R., Bierman, A., Harvey, P., Ravi, B., Kendzerska, T., Stanaitis, I., King, L., & Lipscombe, L. (2017). Osteoarthritis-related difficulty walking and risk for diabetes complications. Osteoarthritis and Cartilage, 25(1), 67-75. https://doi.org/10.1016/j.joca.2016.08.003
- Hawker et al. (2023). Abstracts / Osteoarthritis and Cartilage 31 (2023).
- Howard Wilsher, S., Afolabi, O., Mishra, M., Xydopoulos, G., Zanghelini, F., & Fordham, R. (2022). The economic cost of delayed diagnosis of axial spondyloarthritis in the UK. University of East Anglia.
- Howard Wilsher, S., Afolabi, O., Mishra, M., Xydopoulos, G., Zanghelini, F., & Fordham, R. (2022). The economic cost of delayed diagnosis of axial spondyloarthritis in the UK [Technical report]. National Axial Spondyloarthritis Society.
- Hutchings, A., Calloway, M., Choy, E., Hooper, M., Hunter, D. J., Jordan, J. M., Zhang, Y., Baser, O., Long, S., & Palmer, L. (2007). The longitudinal examination of arthritis pain (LEAP) study: Relationships between weekly fluctuations in patient-rated joint pain and other health outcomes. The Journal of Rheumatology, 34(11), 2291–2300.
- Ikram, M., Shaikh, N. F., & Sambamoorthi, U. (2022). *A linear decomposition approach to explain excess direct healthcare expenditures associated with pain among adults with osteoarthritis*. Health Services Insights, 15. https://doi.org/10.1177/11786329221133957
- Inman, R. D., Garrido-Cumbrera, M., Chan, J., Cohen, M., de Brum-Fernandes, A. J., Gerhart, W., Haroon, N., Jovaisas, A. V., Major, G., Mallinson, M. G., Rohekar, S., Leclerc, P., & Rahman, P. (2023). Work-Related Issues and Physical and Psychological Burden in Canadian

Patients With Axial Spondyloarthritis: Results From the International Map of Axial Spondyloarthritis. The Journal of Rheumatology, 50(5), 625-633. https://doi.org/10.3899/jrheum.220596

- Jetha, A., Badley, E., Beaton, D., Fortin, P. R., Shiff, N. J., & Gignac, M. A. M. (2015). Unpacking Early Work Experiences of Young Adults With Rheumatic Disease: An Examination of Absenteeism, Job Disruptions, and Productivity Loss. Arthritis Care & Research, 67(9), 1246-1254. https://doi.org/10.1002/acr.22601
- Johnson, J. A., Itiola, A. J., Rahman, S., Smith, C., Soprovich, A., Wozniak, L. A., & Marshall, D. A. (2025). Usability testing of an individualized decision aid for total knee arthroplasty. PEC Innovation, 7, 100421. https://doi.org/10.1016/j.pecinn.2025.100421
- Johnson, J. A., Itiola, A., Rahman, S., Smith, C., Soprovich, A., Wozniak, L. A., & Marshall, D. A. (2024). Exploring patient perspectives on EQ-5D-5L data visualization within an individualized decision aid for total knee arthroplasty (TKA) in Alberta, Canada. BMC Musculoskeletal Disorders, 25(1). https://doi.org/10.1186/s12891-024-07304-5
- Kamp, T., Gademan, M. G. J., van Zon, S. K. R., Nelissen, R. G. H. H., Vliet Vlieland, T. P. M., Stevens, M., & Brouwer, S. (2023). Time to return to work by occupational class after total hip or knee arthroplasty. The Bone & Joint Journal, 105-B(9), 977-984. https://doi.org/10.1302/0301-620x.105b9.bjj-2023-0190.r1
- Karlsson, B., Berglin, E., & Wallberg-Jonsson, S. (2006). Life satisfaction in early rheumatoid arthritis: A prospective study. Scandinavian Journal of Occupational Therapy, 13(3), 193–199. https://doi.org/10.1080/11038120500462337
- Kendzerska, T., Jüni, P., King, L., Croxford, R., Stanaitis, I., & Hawker, G. (2017). The longitudinal relationship between hand, hip and knee osteoarthritis and cardiovascular events: a population-based cohort study. Osteoarthritis and Cartilage, 25(11), 1771-1780. https://doi.org/10.1016/j.joca.2017.07.024
- Kendzerska, T., King, L. K., Lipscombe, L., Croxford, R., Stanaitis, I., & Hawker, G. A. (2018). The impact of hip and knee osteoarthritis on the subsequent risk of incident diabetes: a population-based cohort study. Diabetologia, 61(11), 2290-2299. https://doi.org/10.1007/s00125-018-4703-2
- King, L. K., Kendzerska, T., Waugh, E. J., & Hawker, G. A. (2018). Impact of Osteoarthritis on Difficulty Walking: A Population-Based Study. Arthritis Care & Research, 70(1), 71-79. https://doi.org/10.1002/acr.23250
- King, L. K., Marshall, D. A., Faris, P., Woodhouse, L. J., Jones, C. A., Noseworthy, T., Bohm, E., Dunbar, M. J., & Hawker, G. A. (2020). Use of Recommended Non-surgical Knee Osteoarthritis Management in Patients prior to Total Knee Arthroplasty: A Cross-sectional Study. The Journal of Rheumatology, 47(8), 1253-1260. https://doi.org/10.3899/jrheum.190467
- King, L. K., Waugh, E. J., Jones, C. A., Bohm, E., Dunbar, M., Woodhouse, L., Noseworthy, T., Marshall, D. A., & Hawker, G. A. (2021). Comorbidities do not limit improvement in pain and physical function after total knee arthroplasty in patients with knee osteoarthritis: the BEST-

Knee prospective cohort study. BMJ Open, 11(6), e047061. https://doi.org/10.1136/bmjopen-2020-047061

- King, L., Marshall, D., Jones, C., Woodhouse, L., Ravi, B., Faris, P., Hawker, G., Hawker, G., Marshall, D., Bohm, E., Dunbar, M., Faris, P., Allyson Jones, C., Noseworthy, T., Ravi, B., & Woodhouse, L. (2020). Are medical comorbidities contributing to the use of opioid analgesics in patients with knee osteoarthritis?. Osteoarthritis and Cartilage, 28(8), 1030-1037. https://doi.org/10.1016/j.joca.2020.04.012
- King, L. K., Marshall, D. A., Jones, C. A., Woodhouse, L. J., Ravi, B., Faris, P. D., & Hawker, G. A. (2020). Are medical comorbidities contributing to the use of opioid analgesics in patients with knee osteoarthritis?. Osteoarthritis and Cartilage, 28(8), 1030–1037. https://doi.org/10.1016/j.joca.2020.04.006
- King, L. K., Waugh, E. J., Jones, C. A., Bohm, E., Dunbar, M., Woodhouse, L., Noseworthy, T., Marshall, D. A., & Hawker, G. A. (2021). Comorbidities do not limit improvement in pain and physical function after total knee arthroplasty in patients with knee osteoarthritis: The BEST-Knee prospective cohort study. BMJ Open, 11(8), e046575. https://doi.org/10.1136/bmjopen-2020-046575
- Kip, M. M. A., de Roock, S., Currie, G., Marshall, D. A., Grazziotin, L. R., Twilt, M., Yeung, R. S. M., Benseler, S. M., Schreijer, M. A., Vastert, S. J., Wulffraat, N., van Royen-Kerkhof, A., Swart, J. F., & IJzerman, M. J. (2021). Costs of medication use among patients with juvenile idiopathic arthritis in the Dutch healthcare system. Expert Review of Pharmacoeconomics & Outcomes Research, 21(5), 975-984. https://doi.org/10.1080/14737167.2021.1857241
- Kip, M. M. A., de Roock, S., Currie, G., Marshall, D. A., Grazziotin, L. R., Twilt, M., Yeung, R. S. M., Benseler, S. M., Vastert, S. J., Wulffraat, N., Swart, J. F., & IJzerman, M. J. (2023). Pharmacological treatment patterns in patients with juvenile idiopathic arthritis in the Netherlands: a real-world data analysis. Rheumatology, 62(SI2), SI170-SI180. https://doi.org/10.1093/rheumatology/keac299
- Kip, M. M. A., de Roock, S., van den Berg, I., Currie, G., Marshall, D. A., Grazziotin, L. R., Twilt, M., Yeung, R. S. M., Benseler, S. M., Vastert, S. J., Wulffraat, N., Swart, J. F., & IJzerman, M. J. (2022). Costs of Hospital-Associated Care for Patients With Juvenile Idiopathic Arthritis in the Dutch Health Care System. Arthritis Care & Research, 74(10), 1585-1592. https://doi.org/10.1002/acr.24621
- Kotlarz, H., Gunnarsson, C. L., Fang, H., & Rizzo, J. A. (2009). Insurer and out-of-pocket costs of osteoarthritis in the US: Evidence from national survey data. Arthritis & Rheumatism, 60(12), 3546–3553. https://doi.org/10.1002/art.24984
- Lenssinck, M. B., Burdorf, A., Boonen, A., Gignac, M. A., Hazes, J. M. W., & Luime, J. J. (2013). Consequences of inflammatory arthritis for workplace productivity loss and sick leave: a systematic review. Annals of the Rheumatic Diseases, 72(4), 493-505. https://doi.org/10.1136/annrheumdis-2012-201998

- Ljung, L., & Rantapää-Dahlqvist, S. (2016). Abdominal obesity, gender and the risk of rheumatoid arthritis - a nested case-control study. Arthritis Research & Therapy, 18, 277. https://doi.org/10.1186/s13075-016-1171-2
- Macal, C. M., & North, M. J. (2010). Tutorial on agent-based modelling and simulation. Journal of Simulation, 4, 151-162. https://doi.org/10.1057/jos.2010.3
- Leyland, K. M., Gates, L. S., Sanchez-Santos, M. T., Nevitt, M. C., Felson, D., Jones, G., Jordan, J. M., Judge, A., Prieto-Alhambra, D., Yoshimura, N., Newton, J. L., Callahan, L. F., Cooper, C., Batt, M. E., Lin, J., Liu, Q., Cleveland, R. J., Collins, G. S., & Arden, N. K. (2021). Knee osteoarthritis and time-to all-cause mortality in six community-based cohorts: an international meta-analysis of individual participant-level data. Aging Clinical and Experimental Research, 33(3), 529-545. https://doi.org/10.1007/s40520-020-01762-2
- Liu, X., Barber, C. E. H., Katz, S., Homik, J., Bertazzon, S., Patel, A. B., Robert, J., Smith, C., Mosher, D., & Marshall, D. A. (2021). Geographic Variation in the Prevalence of Rheumatoid Arthritis in Alberta, Canada. ACR Open Rheumatology, 3(5), 324-332. https://doi.org/10.1002/acr2.11251
- Liu, X., Seidel, J. E., McDonald, T., Patel, A. B., Waters, N., Bertazzon, S., Shahid, R., & Marshall, D. A. (2022). Rural–Urban Disparities in Realized Spatial Access to General Practitioners, Orthopedic Surgeons, and Physiotherapists among People with Osteoarthritis in Alberta, Canada. International Journal of Environmental Research and Public Health, 19(13), 7706. https://doi.org/10.3390/ijerph19137706
- Liu, X., Seidel, J. E., McDonald, T., Waters, N., Patel, A. B., Shahid, R., Bertazzon, S., & Marshall, D. A. (2022). Rural–Urban Differences in Non-Local Primary Care Utilization among People with Osteoarthritis: The Role of Area-Level Factors. International Journal of Environmental Research and Public Health, 19(11), 6392. https://doi.org/10.3390/ijerph19116392
- Liu, X., Shahid, R., Patel, A. B., McDonald, T., Bertazzon, S., Waters, N., Seidel, J. E., & Marshall, D. A. (2020). Geospatial patterns of comorbidity prevalence among people with osteoarthritis in Alberta Canada. BMC Public Health, 20(1). https://doi.org/10.1186/s12889-020-09599-0
- Lopatina, E., Miller, J. L., Teare, S. R., Marlett, N. J., Patel, J., Barber, C. E. H., Mosher, D. P., Wasylak, T., Woodhouse, L. J., & Marshall, D. A. (2019). The voice of patients in system redesign: A case study of redesigning a centralized system for intake of referrals from primary care to rheumatologists for patients with suspected rheumatoid arthritis. Health Expectations, 22(3), 348–363. https://doi.org/10.1111/hex.12855
- Marshall, D. A., et al. (2014). Outcomes after total hip replacement [Conference abstract]. Osteoarthritis and Cartilage, 22(Suppl), S57–S489.
- Marshall, D. A., Bischak, D. P., Zaerpour, F., Sharif, B., Smith, C., Reczek, T., Robert, J., Werle, J., & Dick, D. (2022). Wait time management strategies at centralized intake system for hip and knee replacement surgery: A need for a blended evidence-based and patient-centered

approach. Osteoarthritis and Cartilage Open, 4(4), 100314. https://doi.org/10.1016/j.ocarto.2022.100314

- Marshall, D. A., Jin, X., Pittman, L. B., & Smith, C. J. (2021). The use of patient-reported outcome measures in hip and knee arthroplasty in Alberta. Journal of Patient-Reported Outcomes, 5(S2). https://doi.org/10.1186/s41687-021-00362-6
- Marshall, D. A., Liu, X., Barnabe, C., Yee, K., Faris, P. D., Barber, C., Mosher, D., Noseworthy, T., Werle, J., & Lix, L. (2019). Existing comorbidities in people with osteoarthritis: a retrospective analysis of a population-based cohort in Alberta, Canada. BMJ Open, 9(11), e033334. https://doi.org/10.1136/bmjopen-2019-033334
- Marshall, D. A., Liu, X., Shahid, R., Bertazzon, S., Seidel, J. E., Patel, A. B., Nasr, M., Barber, C. E., McDonald, T., Sharma, R., Briggs, T., Faris, P., & Waters, N. (2019). Geographic variation in osteoarthritis prevalence in Alberta: A spatial analysis approach. Applied Geography, 103, 112-121. https://doi.org/10.1016/j.apgeog.2019.01.004
- Marshall, D. A., Pham, T., Faris, P., Chen, G., O'Donnell, S., Barber, C. E. H., LeClercq, S., Katz, S., Homik, J., Patel, J. N., Lopatina, E., Roberts, J., & Mosher, D. (2020). Determination of Rheumatoid Arthritis Incidence and Prevalence in Alberta Using Administrative Health Data. ACR Open Rheumatology, 2(7), 424-429. https://doi.org/10.1002/acr2.11158
- Marshall, D. A., Trenaman, L., MacDonald, K. V., Johnson, J. A., Stacey, D., Hawker, G., Smith, C., Durand, D., & Bansback, N. (2023). Impact of an online, individualised, patient reported outcome measures based patient decision aid on patient expectations, decisional regret, satisfaction, and health-related quality-of-life for patients considering total knee arthroplasty: Results from a randomised controlled trial. Journal of Evaluation in Clinical Practice, 29(3), 513-524. https://doi.org/10.1111/jep.13804
- Marshall, D. A., Vanderby, S., Barnabe, C., MacDonald, K. V., Maxwell, C., Mosher, D., Wasylak, T., Lix, L., Enns, E., Frank, C., & Noseworthy, T. (2015). Estimating the Burden of Osteoarthritis to Plan for the Future. Arthritis Care & Research, 67(10), 1379-1386. https://doi.org/10.1002/acr.22612
- Marshall, D. A., Wasylak, T., Khong, H., Parker, R. D., Faris, P. D., & Frank, C. (2012). Measuring the Value of Total Hip and Knee Arthroplasty: Considering Costs Over the Continuum of Care. Clinical Orthopaedics & Related Research, 470(4), 1065-1072. https://doi.org/10.1007/s11999-011-2026-4
- Marshall, D., Deal, K., Conner-Spady, B., Bohm, E., Hawker, G., Loucks, L., MacDonald, K., & Noseworthy, T. (2018). How do patients trade-off surgeon choice and waiting times for total joint replacement: a discrete choice experiment. Osteoarthritis and Cartilage, 26(4), 522-530. https://doi.org/10.1016/j.joca.2018.01.008
- Marshall, D. A., Christiansen, T., Smith, C., Squire Howden, J., Werle, J., Faris, P., & Frank, C. (2015). Continuous quality improvement program for hip and knee replacement. American Journal of Medical Quality, 30(5), 425–431. https://doi.org/10.1177/1062860614540512
- Marshall, D. A., Tagimacruz, T., Cepoiu-Martin, M., Robert, J., Ring, B., Burston, M., Higgins, S., Hess, M., & White, J. (2023). A simulation modelling study of referral distribution policies

in a centralized intake system for surgical consultation. Journal of Medical Systems, 47(1), 4. https://doi.org/10.1007/s10916-022-01897-x

- Marshall, D. A., Grazziotin, L. R., Engel, L., Geng, Y., Geng, F., & Kip, M. M. A. (2024). Impact of juvenile idiopathic arthritis on caregiver quality of life and work impairment [Conference poster]. Value in Health, 27(12), S535. ISPOR 2024.
- Martikainen, J. A., Kautiainen, H., Rantalaiho, V., & Puolakka, K. T. (2016). Longterm Work Productivity Costs Due to Absenteeism and Permanent Work Disability in Patients with Early Rheumatoid Arthritis: A Nationwide Register Study of 7831 Patients. The Journal of Rheumatology, 43(12), 2101-2105. https://doi.org/10.3899/jrheum.160103
- Maynard, C., Mikuls, T. R., Cannon, G. W., England, B. R., Conaghan, P. G., Ostergaard, M., Baker, D. G., Kerr, G., George, M. D., Barton, J. L., & Baker, J. F. (2020). Sex differences in the achievement of remission and low disease activity in rheumatoid arthritis. Arthritis Care & Research, 72(3), 326–333. https://doi.org/10.1002/acr.23873
- Mazzei, D. R., Whittaker, J. L., Faris, P., Wasylak, T., & Marshall, D. A. (2025). Estimating Budget Impact and Joint Replacement Avoidance by Implementing a Standardized Education and Exercise Therapy Program for Hip and Knee Osteoarthritis in a Publicly Insured Health Care System. Arthritis Care & Research, 77(6), 744-752. https://doi.org/10.1002/acr.25492
- Mazzei, D., Ademola, A., Abbott, J., Sajobi, T., Hildebrand, K., & Marshall, D. (2021). Are education, exercise and diet interventions a cost-effective treatment to manage hip and knee osteoarthritis? A systematic review. Osteoarthritis and Cartilage, 29(4), 456-470. https://doi.org/10.1016/j.joca.2020.10.002
- Mazzei, D., Whittaker, J., Kania-Richmond, A., Faris, P., Wasylak, T., Robert, J., Hawker, G., & Marshall, D. (2022). Do people with knee osteoarthritis use guideline-consistent treatments after an orthopaedic surgeon recommends nonsurgical care? A cross-sectional survey with long-term follow-up. Osteoarthritis and Cartilage Open, 4(2), 100256. https://doi.org/10.1016/j.ocarto.2022.100256
- Mazzei, D. R., Ademola, A., Abbott, J. H., Sajobi, T., Hildebrand, K., & Marshall, D. A. (2020). Systematic review of economic evaluations investigating education, exercise, and dietary weight management to manage hip and knee osteoarthritis: Protocol. Systematic Reviews, 9, 229. https://doi.org/10.1186/s13643-020-01492-6
- Mazzei, D. R., Ademola, A., Abbott, J. H., Sajobi, T., Hildebrand, K., & Marshall, D. A. (2021). Are education, exercise and diet interventions a cost-effective treatment to manage hip and knee osteoarthritis? A systematic review. Osteoarthritis and Cartilage, 29(4), 456–470. https://doi.org/10.1016/j.joca.2020.12.009
- Mazzei, D. R., Whittaker, J. L., Kania-Richmond, A., Faris, P., Wasylak, T., Robert, J., Hawker, G., & Marshall, D. A. (2022). Do people with knee osteoarthritis use guideline-consistent treatments after an orthopaedic surgeon recommends nonsurgical care? A cross-sectional survey with long-term follow-up. Osteoarthritis and Cartilage Open, 4(2), 100256. https://doi.org/10.1016/j.ocarto.2022.100256

- Mazzei, D. R., Whittaker, J. L., Faris, P., Wasylak, T., & Marshall, D. A. (2025). Real-world cost-effectiveness of a standardized education and exercise therapy program for hip and knee osteoarthritis compared to usual care. Arthritis Care & Research, 77(10), 1194–1203. https://doi.org/10.1002/acr.25555
- McCormick, N., Marra, C. A., Sadatsafavi, M., Kopec, J. A., & Aviña-Zubieta, J. A. (2019). Excess Productivity Costs of Systemic Lupus Erythematosus, Systemic Sclerosis, and Sjögren's Syndrome: A General Population–Based Study. Arthritis Care & Research, 71(1), 142-154. https://doi.org/10.1002/acr.23573
- McCormick et al. (2017). Socioeconomic Status at Diagnosis Influences the Incremental Direct Medical Costs of Systemic Lupus Erythematosus: A Longitudinal Population-Based Study.
- McNamee, P., & Mendolia, S. (2014). The effect of chronic pain on life satisfaction: Evidence from Australian data. Social Science & Medicine, 121, 65–73. https://doi.org/10.1016/j.socscimed.2014.09.019
- Mezey, G. A., Paulik, E., & Mate, Z. (2023). Effect of osteoarthritis and its surgical treatment on patients' quality of life: A longitudinal study. BMC Musculoskeletal Disorders, 24, 537. https://doi.org/10.1186/s12891-023-06662-w
- Miller, J. L., Teare, S. R., Marlett, N., Shklarov, S., & Marshall, D. A. (2016). Support for living a meaningful life with osteoarthritis: A patient-to-patient research study. Patient, 9(5), 457–464. https://doi.org/10.1007/s40271-016-0169-9
- Moghaddam, B., Marozoff, S., Li, L., Sayre, E. C., & Zubieta, J. A. A. (2021). All-cause and cause-specific mortality in systemic lupus erythematosus: a population-based study. Rheumatology, 61(1), 367-376. https://doi.org/10.1093/rheumatology/keab362
- Movahedi, M., Cesta, A., Li, X., & Bombardier, C. (2022). Disease activity trajectories for early and established rheumatoid arthritis: Real-world data from a rheumatoid arthritis cohort. PLOS ONE, 17(9), e0274264. https://doi.org/10.1371/journal.pone.0274264
- Mrklas, K. J., Barber, T., Campbell-Scherer, D., Green, L. A., Li, L. C., Marlett, N., Miller, J., Shewchuk, B., Teare, S., Wasylak, T., & Marshall, D. A. (2020). Co-Design in the Development of a Mobile Health App for the Management of Knee Osteoarthritis by Patients and Physicians: Qualitative Study. JMIR mHealth and uHealth, 8(7), e17893. https://doi.org/10.2196/17893
- Nakata, K., Tsuji, T., Vietri, J., & Jaffe, D. H. (2018). Work impairment, osteoarthritis, and health-related quality of life among employees in Japan. Health and Quality of Life Outcomes, 16(1). https://doi.org/10.1186/s12955-018-0896-9
- Nathan, N., Nguyen, A. D., Stocker, S., Laba, T.-L., Baysari, M. T., & Day, R. O. (2021). Out-of-pocket spending among a cohort of Australians living with gout. International Journal of Rheumatic Diseases, 24(3), 327–334. https://doi.org/10.1111/1756-185X.13979

- Ng, R., Bernatsky, S., & Rahme, E. (2013). Observation Period Effects on Estimation of Systemic Lupus Erythematosus Incidence and Prevalence in Quebec. The Journal of Rheumatology, 40(8), 1334-1336. https://doi.org/10.3899/jrheum.121215
- Nielsen, R. L., Monfeuga, T., Kitchen, R. R., Egerod, L., Leal, L. G., Schreyer, A. T. H., Gade, F. S., Sun, C., Helenius, M., Simonsen, L., Willert, M., Tahrani, A. A., McVey, Z., & Gupta, R. (2024). Data-driven identification of predictive risk biomarkers for subgroups of osteoarthritis using interpretable machine learning. Nature Communications, 15(1). https://doi.org/10.1038/s41467-024-46663-4
- Nianogo, R. A., & Arah, O. A. (2015). Agent-based modeling of noncommunicable diseases: A systematic review. American Journal of Public Health, 105(3), e20-e31. https://doi.org/10.2105/AJPH.2014.302426
- Ohno, T., Aune, D., & Heath, A. K. (2020). Adiposity and the risk of rheumatoid arthritis: A systematic review and meta-analysis of cohort studies. Scientific Reports, 10, 16006. https://doi.org/10.1038/s41598-020-71676-6
- Nikiphorou, E., Norton, S. J., Carpenter, L., Walsh, D. A., Creamer, P., Dixey, J., Young, A., & Kiely, P. D. W. (2020). Remission vs low disease activity: Function, quality of life and structural outcomes in the Early Rheumatoid Arthritis Study and Network. Rheumatology, 59(6), 1272–1280. https://doi.org/10.1093/rheumatology/kez461
- Osteoarthritis Research Society International. (2008). Osteoarthritis: A serious disease, submitted to the U.S. Food and Drug Administration.
- Oswald, A. J., & Powdthavee, N. (2008). Does happiness adapt? A longitudinal study of disability with implications for economists and judges. Journal of Public Economics, 92(5–6), 1061–1077. https://doi.org/10.1016/j.jpubeco.2008.01.002
- O'Donnell, S., Rusu, C., Hawker, G. A., Bernatsky, S., McRae, L., Canizares, M., MacKay, C., & Badley, E. M. (2015). Arthritis has an impact on the daily lives of Canadians young and old: results from a population-based survey. BMC Musculoskeletal Disorders, 16(1). https://doi.org/10.1186/s12891-015-0691-2
- Perruccio, A. V., Cavallo, M., Yip, C., Wilfong, J. M., & Badley, E. M. (2025). Burden of arthritis-associated disability in Canada [Special report]. Arthritis Community Research and Epidemiology Unit (ACREU).
- Perruccio, A. V., Kral, C., Yip, C., Eder, L., Power, J. D., Canizares, M., Wilfong, J. M., Heckman, G., & Badley, E. (2025). The role of sex and systemic inflammation in the development of cardiovascular disease in osteoarthritis: A population-based cohort study using the CLSA. Seminars in Arthritis and Rheumatism, 74, 152804. https://doi.org/10.1016/j.semarthrit.2025.152804
- Perruccio, A. V., Yip, C., Power, J. D., Canizares, M., & Badley, E. M. (2024). Examining the longitudinal associations between activity limitations, instrumental supports and social participation in osteoarthritis: A CLSA population-based study. PLOS ONE, 19(3), e0299894. https://doi.org/10.1371/journal.pone.0299894

- Perruccio, A. V., Yip, C., Power, J. D., Canizares, M., Gignac, M. A. M., & Badley, E. M. (2021). Understanding the Association Between Osteoarthritis and Social Participation: The Canadian Longitudinal Study on Aging. Arthritis Care & Research, 73(11), 1638-1647. https://doi.org/10.1002/acr.24366
- Perruccio, A. V. (n.d.). Variables included in model [Data file].
- Power, J. D., Perruccio, A. V., Paterson, J. M., Canizares, M., Veillette, C., Coyte, P. C., Badley, E. M., Mahomed, N. N., & Rampersaud, Y. R. (2022). Healthcare Utilization and Costs for Musculoskeletal Disorders in Ontario, Canada. The Journal of Rheumatology, 49(7), 740-747. https://doi.org/10.3899/jrheum.210938
- Public Health Agency of Canada. (2020). Rheumatoid arthritis in Canada.
- Rahman, P., Garrido-Cumbrera, M., Rohekar, S., Mallinson, M. G., Karam, E., Jovaisas, A. V., Haroon, N., Beach, J., de Brum-Fernandes, A. J., Cohen, M., Chan, J., Correa-Fernández, J., Leclerc, P., & Inman, R. D. (2024). Canadian Patients With Axial Spondyloarthritis Require Almost a Decade To Be Diagnosed Leading to Severe Functional Limitation. Results From the International Map of Axial Spondyloarthritis (IMAS). Musculoskeletal Care, 22(4). https://doi.org/10.1002/msc.70010
- Rai, S. K., Aviña-Zubieta, J. A., McCormick, N., De Vera, M. A., Shojania, K., Sayre, E. C., & Choi, H. K. (2017). The rising prevalence and incidence of gout in British Columbia, Canada: Population-based trends from 2000 to 2012. Seminars in Arthritis and Rheumatism, 46(4), 451-456. https://doi.org/10.1016/j.semarthrit.2016.08.006
- Ravi, B., & Hawker, G. (2022). Joint replacement and cardiovascular health. Osteoarthritis and Cartilage, 30(3), 355-356. https://doi.org/10.1016/j.joca.2021.11.011
- Ravi, B., Croxford, R., Austin, P. C., Lipscombe, L., Bierman, A. S., Harvey, P. J., & Hawker, G. A. (2013). The relation between total joint arthroplasty and risk for serious cardiovascular events in patients with moderate-severe osteoarthritis: propensity score matched landmark analysis. BMJ, 347(oct30 1), f6187-f6187. https://doi.org/10.1136/bmj.f6187
- Runhaar, J., van Berkel, A. C., Agricola, R., van Meurs, J., & Bierma-Zeinstra, S. M. A. (2023). Risk Factors and Population-Attributable Fractions for Incident Hip Osteoarthritis. HSS Journal®: The Musculoskeletal Journal of Hospital for Special Surgery, 19(4), 407-412. https://doi.org/10.1177/15563316231192461
- Sanghera, S., & Coast, J. (2020). Measuring quality-adjusted life-years when health fluctuates. Value in Health, 23(3), 343–350. https://doi.org/10.1016/j.jval.2019.09.2753
- Sargent, R. G. (2015). An interval statistical procedure for use in validation of simulation models. Journal of Simulation, 9(3), 232–237. https://doi.org/10.1057/jos.2014.30
- Salomon, J. A., Haagsma, J. A., Davis, A., de Noordhout, C. M., Polinder, S., Havelaar, A. H., Cassini, A., Devleesschauwer, B., Kretzschmar, M., Speybroeck, N., Murray, C. J. L., & Vos, T. (2015). Disability weights for the Global Burden of Disease 2013 study. The Lancet Global Health, 3(11), e712-e723. https://doi.org/10.1016/S2214-109X(15)00069-8

- Sharif, B., Garner, R., Hennessy, D., Sanmartin, C., Flanagan, W., & Marshall, D. (2017). Productivity costs of work loss associated with osteoarthritis in Canada from 2010 to 2031. Osteoarthritis and Cartilage, 25(2), 249-258. https://doi.org/10.1016/j.joca.2016.09.011
- Sharif, B., Garner, R., Sanmartin, C., Flanagan, W. M., Hennessy, D., & Marshall, D. A. (2016). Risk of work loss due to illness or disability in patients with osteoarthritis: a population-based cohort study. Rheumatology, 55(5), 861-868. https://doi.org/10.1093/rheumatology/kev428
- Sharif, B., Kopec, J., Bansback, N., Rahman, M. M., Flanagan, W. M., Wong, H., Fines, P., & Anis, A. (2015). Projecting the direct cost burden of osteoarthritis in Canada using a microsimulation model. Osteoarthritis and Cartilage, 23(10), 1654–1663. https://doi.org/10.1016/j.joca.2015.05.029
- Shewchuk, B., Green, L. A., Barber, T., Miller, J., Teare, S., Campbell-Scherer, D., Mrklas, K. J., Li, L. C., Marlett, N., Wasylak, T., Lopatina, E., McCaughey, D., & Marshall, D. A. (2021). Patients' Use of Mobile Health for Self-management of Knee Osteoarthritis: Results of a 6-Week Pilot Study. JMIR Formative Research, 5(11), e30495. https://doi.org/10.2196/30495
- Shklarov, S., Marshall, D. A., Wasylak, T., & Marlett, N. J. (2017). "Part of the Team": Mapping the outcomes of training patients for new roles in health research and planning. Health Expectations, 20(6), 1428–1436. https://doi.org/10.1111/hex.12591
- Snoeker, B., Turkiewicz, A., Magnusson, K., Frobell, R., Yu, D., Peat, G., & Englund, M. (2020). Risk of knee osteoarthritis after different types of knee injuries in young adults: a population-based cohort study. British Journal of Sports Medicine, 54(12), 725-730. https://doi.org/10.1136/bjsports-2019-100959
- Song, J., Chang, A. H., Chang, R. W., Lee, J., Pinto, D., Hawker, G., Nevitt, M., & Dunlop, D. D. (2018). Relationship of knee pain to time in moderate and light physical activities: Data from Osteoarthritis Initiative. Seminars in Arthritis and Rheumatism, 47(Suppl). https://doi.org/10.1016/S0049-0172(17)30544-9
- Stacey et al. (2017). Decision aids for people facing health treatment or screening decisions (Review). https://doi.org/PMID: 27893033
- Staszkiewicz, M., Kulesa-Mrowiecka, M., Szklarczyk, J., & Jaworek, J. (2023). Life satisfaction, generalized sense of self-efficacy and acceptance of illness in rheumatoid arthritis patients depending on age and severity of the disease. Reumatologia, 61(3), 175–185. https://doi.org/10.5114/reum/168294
- Stigmar, K., Dahlberg, L. E., Zhou, C., Jacobson Lidgren, H., Petersson, I. F., & Englund, M. (2017). Sick leave in Sweden before and after total joint replacement in hip and knee osteoarthritis patients. Acta Orthopaedica, 88(2), 152-157. https://doi.org/10.1080/17453674.2016.1269051
- Stockel, J., van Exel, J., & Brouwer, W. B. F. (2023). Adaptation in life satisfaction and self-assessed health to disability: Evidence from the UK. Social Science & Medicine, 328, 115996. https://doi.org/10.1016/j.socscimed.2023.115996

- Sugiyama, D., Nishimura, K., Tamaki, K., Tsuji, G., Nakazawa, T., Morinobu, A., Kumagai, S., & van der Helm-van Mil, A. H. M. (2010). Impact of smoking as a risk factor for developing rheumatoid arthritis: A meta-analysis of observational studies. Annals of the Rheumatic Diseases, 69(1), 70-81. https://doi.org/10.1136/ard.2008.096487
- Stolwijk, C., van Onna, M., Boonen, A., & van Tubergen, A. (2016). Global Prevalence of Spondyloarthritis: A Systematic Review and Meta-Regression Analysis. Arthritis Care & Research, 68(9), 1320-1331. https://doi.org/10.1002/acr.22831
- Strand, V., Rao, S. A., Shillington, A. C., Cifaldi, M. A., Mcguire, M., & Ruderman, E. M. (2013). Prevalence of Axial Spondyloarthritis in United States Rheumatology Practices: Assessment of SpondyloArthritis International Society Criteria Versus Rheumatology Expert Clinical Diagnosis. Arthritis Care & Research, 65(8), 1299-1306. https://doi.org/10.1002/acr.21994
- Sumner, T., et al. (2015). Impact of arthritis and multiple chronic conditions on selected life domains — United States, 2013. Morbidity and Mortality Weekly Report, 64(21).
- Szilagyi, I. A., Waarsing, J. H., van Meurs, J. B. J., Bierma-Zeinstra, S. M. A., & Schiphof, D. (2023). A systematic review of the sex differences in risk factors for knee osteoarthritis. Rheumatology, 62(6), 2037-2047. https://doi.org/10.1093/rheumatology/keac688
- Tagimacruz, T., Bischak, D. P., & Marshall, D. A. (2021). Alternative care providers in rheumatoid arthritis patient care: a queueing and simulation analysis. Health Systems, 10(4), 249-267. https://doi.org/10.1080/20476965.2020.1771619
- Tagimacruz, T., Cepoiu-Martin, M., & Marshall, D. A. (2025). Exploratory analysis using discrete event simulation modelling of the wait times and service costs associated with the maximum wait time guarantee policy applied in a rheumatology central intake clinic. Health Systems, 14(1), 1-11. https://doi.org/10.1080/20476965.2023.2219293
- Tormalehto, S., Aarnio, E., Mononen, M. E., Arokoski, J. P. A., Korhonen, R. K., & Martikainen, J. A. (2019). Eight-year trajectories of changes in health-related quality of life in knee osteoarthritis: Data from the Osteoarthritis Initiative (OAI). PLOS ONE, 14(7), e0219902. https://doi.org/10.1371/journal.pone.0219902
- Trenaman, L., Kaal, K. J., Laba, T.-L., Safari, A., Aguiar, M., Burch, T., Beckett, J., Munro, S., Hudson, M., & Harrison, M. (2023). The financial burden of accessing care for people with scleroderma in Canada: A patient-oriented, cross-sectional survey. CMAJ Open, 11(4), E630–E636. https://doi.org/10.9778/cmajo.20220227
- Tselios, K., Gladman, D. D., Sheane, B. J., Su, J., & Urowitz, M. (2019). All-cause, cause-specific and age-specific standardised mortality ratios of patients with systemic lupus erythematosus in Ontario, Canada over 43 years (1971–2013). Annals of the Rheumatic Diseases, 78(6), 802-806. https://doi.org/10.1136/annrheumdis-2018-214802
- Turkiewicz, A., Petersson, I., Björk, J., Hawker, G., Dahlberg, L., Lohmander, L., & Englund, M. (2014). Current and future impact of osteoarthritis on health care: a population-based study with projections to year 2032. Osteoarthritis and Cartilage, 22(11), 1826-1832. https://doi.org/10.1016/j.joca.2014.07.015

- van Genderen, S., Plasqui, G., van der Heijde, D., van Gaalen, F., Heuft, L., Luime, J., Spoorenberg, A., Arends, S., Lacaille, D., Gignac, M., Landewe, R., & Boonen, A. (2018). Social role participation and satisfaction with life: A study among patients with ankylosing spondylitis and population controls. Arthritis Care & Research, 70(4), 600–607. https://doi.org/10.1002/acr.23304
- Vanderby, S. A., Carter, M. W., Noseworthy, T., & Marshall, D. A. (2015). Modelling the complete continuum of care using system dynamics: the case of osteoarthritis in Alberta. Journal of Simulation, 9(2), 156-169. https://doi.org/10.1057/jos.2014.43
- Veltri, C., Albrecht, K., Kiltz, U., Meyer-Olson, D., Späthling, S., Strangfeld, A., Thiele, K., & Callhoff, J. (2025). Trends in work participation among patients with inflammatory rheumatic musculoskeletal diseases (iRMDs): Data from the German National Database (2010–2022). RMD Open, 11(1), e004980. https://doi.org/10.1136/rmdopen-2024-004980
- Ward, M. M. (2022). Trends in Permanent Work Disability Associated With Rheumatoid Arthritis in the United States, 1999–2015. Arthritis Care & Research, 74(8), 1321-1324. https://doi.org/10.1002/acr.24575
- Whittaker, J. L., Losciale, J. M., Juhl, C. B., Thorlund, J. B., Lundberg, M., Truong, L. K., Miciak, M., van Meer, B. L., Culvenor, A. G., Crossley, K. M., Roos, E. M., Lohmander, S., & van Middelkoop, M. (2022). Risk factors for knee osteoarthritis after traumatic knee injury: a systematic review and meta-analysis of randomised controlled trials and cohort studies for the OPTIKNEE Consensus. British Journal of Sports Medicine, 56(24), 1406-1421. https://doi.org/10.1136/bjsports-2022-105496
- Widdifield, J., Paterson, J. M., Bernatsky, S., Tu, K., Thorne, J. C., Ahluwalia, V., Ivers, N., Butt, D., Jaakkimainen, R. L., Tomlinson, G., & Bombardier, C. (2013). The rising burden of rheumatoid arthritis surpasses rheumatology supply in Ontario. Canadian Journal of Public Health, 104(7), e450–e455.
- Widdifield, J., Eder, L., Chen, S., Kwong, J. C., Hitchon, C., Lacaille, D., Aviña-Zubieta, J. A., Svenson, L. W., & Bernatsky, S. (2022). COVID-19 Vaccination Uptake Among Individuals With Immune-mediated Inflammatory Diseases in Ontario, Canada, Between December 2020 and October 2021: A Population-based Analysis. The Journal of Rheumatology, 49(5), 531-536. https://doi.org/10.3899/jrheum.211148
- Widdifield, J., Jaakkimainen, R. L., Gatley, J. M., Hawker, G. A., Lix, L. M., Bernatsky, S., Ravi, B., Wasserstein, D., Yu, B., & Tu, K. (2020). Validation of canadian health administrative data algorithms for estimating trends in the incidence and prevalence of osteoarthritis. Osteoarthritis and Cartilage Open, 2(4), 100115. https://doi.org/10.1016/j.ocarto.2020.100115
- Widdifield, J., Paterson, J. M., Bernatsky, S., Tu, K., Tomlinson, G., Kuriya, B., Thorne, J. C., & Bombardier, C. (2014). The Epidemiology of Rheumatoid Arthritis in Ontario, Canada. Arthritis & Rheumatology, 66(4), 786-793. https://doi.org/10.1002/art.38306

- Widdifield, J., Paterson, J. M., Huang, A., & Bernatsky, S. (2018). Causes of Death in Rheumatoid Arthritis: How Do They Compare to the General Population?. Arthritis Care & Research, 70(12), 1748-1755. https://doi.org/10.1002/acr.23548
- Wilfong, J. M., Badley, E. M., & Perruccio, A. V. (2022). Risk factors for incident hand osteoarthritis depend on the presence of osteoarthritis in other joints: Findings from the Canadian Longitudinal Study on Aging [Conference abstract]. Osteoarthritis and Cartilage, 31(Suppl 1). OARSI World Congress.
- Wilfong, J. M., Badley, E. M., & Perruccio, A. V. (2023). Risk factors for incident osteoarthritis diagnosis in middle-aged and older adults: A population-based study [Conference abstract]. Osteoarthritis and Cartilage, 31(Suppl 1). OARSI World Congress.
- Wilfong, J. M., Badley, E. M., & Perruccio, A. V. (2024). Old Before Their Time? The Impact of Osteoarthritis on Younger Adults. Arthritis Care & Research, 76(10), 1400-1408. https://doi.org/10.1002/acr.25374
- Wilfong, J. M., Perruccio, A. V., & Badley, E. M. (2023). Examination of the Increased Risk for Falls Among Individuals With Knee Osteoarthritis: A Canadian Longitudinal Study on Aging Population-Based Study. Arthritis Care & Research, 75(11), 2336-2344. https://doi.org/10.1002/acr.25163
- Wilfong, J. M., Perruccio, A. V., Millstone, D. B., & Badley, E. M. (2021). Participation in Informal Caregiving Among People With Arthritis: Findings From a Canadian Longitudinal Study on Aging. Arthritis Care & Research, 73(10), 1528-1536. https://doi.org/10.1002/acr.24329
- Xavier, R. M., Zerbini, C. A. F., Pollak, D. F., Morales-Torres, J. L. A., Chalem, P., Restrepo, J. F. M., Duhau, J. A., Amado, J. R., Abello, M., de la Vega, M. C., Dávila, A. P., Biegun, P. M., Arruda, M. S., & Ramos-Remus, C. (2019). Burden of rheumatoid arthritis on patients' work productivity and quality of life. Advances in Rheumatology, 59(1). https://doi.org/10.1186/s42358-019-0090-8
- Yang, X., Fan, D., Xia, Q., Wang, M., Zhang, X., Li, X., Cai, G., Wang, L., Xin, L., Xu, S., & Pan, F. (2016). The health-related quality of life of ankylosing spondylitis patients assessed by SF-36: A systematic review and meta-analysis. Quality of Life Research, 25(11), 2711–2723. https://doi.org/10.1007/s11136-016-1345-z
- Yip, C., Badley, E. M., Canizares, M., Power, J. D., & Perruccio, A. V. (2020). Risk Factor Profiles for Individuals With Diagnosed OA and With Symptoms Indicative of OA: Findings From the Canadian Longitudinal Study on Aging. ACR Open Rheumatology, 2(3), 174-179. https://doi.org/10.1002/acr2.11120
- Zhao, K., Xie, H., LI, L., Aviña, A., & Esdaile, J. (2021). OP0043 INCREASED RISK OF SEVERE INFECTIONS AND MORTALITY IN PATIENTS WITH NEWLY DIAGNOSED SYSTEMIC LUPUS ERYTHEMATOSUS: A POPULATION-BASED STUDY. Annals of the Rheumatic Diseases, 80, 22-23. https://doi.org/10.1136/annrheumdis-2021-eular.17

- Zlatkovic-Svenda, M., Stojanovic, R., Sipetic-Grujicic, S., Radak-Perovic, M., & Guillemin, F. (2019). Prevalence of spondyloarthritis and its subtypes - are they really comparable?. Srpski arhiv za celokupno lekarstvo, 147(3-4), 235-242. https://doi.org/10.2298/sarh180110009z