METRA HEALTH INTELLIGENCE

Metra Actuarial and Risk Quantification

Metabolic Risk Stratification as a Prospective Actuarial Variable: Quantifying the Pre-Claims Signal

Clinical evidence base, modeling methodology, disclosed assumptions, validation plan, and limitations underlying METRA's trend modification projections. Prepared for actuarial review.

PREPARED FOR ACTUARIAL REVIEW

> METRA has elected to publish the full assumption set and effect size derivation rather than treat the model as proprietary intellectual property. Reviewers are encouraged to reproduce the projection mechanics independently and report discrepancies.

How METRA validates projected versus realized outcomes over time

Limitations

Model boundaries, data constraints, and what METRA does not claim

CORE HYPOTHESIS

The Actuarial Claim METRA Makes, and the Evidence It Rests On

METRA's trend modification projections rest on a single testable hypothesis: that metabolic risk deterioration is measurable in the late portion of the 2 to 3 year pre-diagnosis acceleration phase identified by Tabák 2012, operationally defined as the 12 to 24 month window before first major T2D-related claim, and that clinical intervention during that window reduces the probability of T2D progression and the associated high-cost claim events. This is the actuarial bet.

> *"If metabolic risk indicators are measurable in the 12 to 24 month late acceleration phase before T2D diagnosis (Tabák 2012), and if structured metabolic intervention reduces T2D progression by 58 percent in trial populations (Knowler 2002), then a population-level monitoring and intervention program will produce a measurable reduction in T2D-related high-cost event frequency and a measurable modification of T2D-attributable claims trend."*

GROUNDED IN EVIDENCE

Hypothesis supported by four named peer-reviewed studies with full bibliographic citations.

NIH DPP ALIGNED

Intervention protocol aligned with the NIH Diabetes Prevention Program RCT, the highest-powered trial in prevention literature.

CONSERVATIVE ESTIMATES

Trend modification estimates of 1 to 2.5 percentage points are a conservative application of published intervention effect sizes, narrowed to the T2D-attributable share of high-risk cohort cost.

DISCLOSED UNCERTAINTY

METRA does not claim carrier-level actuarial certainty. Projections are plan-level estimates subject to disclosed limitations.

CLINICAL EVIDENCE BASE

Four Studies Form the Foundation. All Are Peer-Reviewed. All Are Named.

Each study addresses a distinct component of the causal chain from metabolic deterioration to actuarial cost impact.

STUDY 1 — KNOWLER ET AL., NEJM 2002

58 percent reduction in T2D progression (lifestyle intervention arm versus placebo). 3,234 participants. Randomized controlled trial, the highest level of evidence. Defines the intervention efficacy METRA's clinical protocol is aligned with. Effect size applies to individuals with prediabetes.

STUDY 2 — TABÁK ET AL., LANCET 2012

Measurable metabolic deterioration occurs 5 to 6 years before T2D diagnosis. The final 2 to 3 years pre-diagnosis show an accelerating trajectory. METRA operates in the late portion of this acceleration window, where signal-to-noise is highest.

STUDY 3 — ELY ET AL., CDC 2017

CDC analysis validates digital and remote delivery of DPP lifestyle intervention as producing clinically meaningful outcomes. Provides the basis for METRA's digitally delivered intervention. METRA's AI-assisted coaching layer extends the digitally delivered model; outcome equivalence to human-coached delivery is an assumption pending direct validation.

STUDY 4 — MILKEN INSTITUTE 2019

Cardiometabolic conditions, including diabetes, cardiovascular disease, and obesity-related comorbidities, account for the largest share of US chronic disease cost burden. Provides the population cost attribution basis for METRA's employer financial projections. (Note: Goetzel 2004 is retained in the citation register as supporting evidence on absence and presenteeism cost of metabolic conditions, but is no longer cited as the source for total expenditure share.)

POPULATION STRATIFICATION

Stratifying the Employer Population Into Three Actuarially Distinct Risk Cohorts

METRA's scoring engine classifies enrolled employees into three prospective risk tiers using a composite metabolic index. Tier distribution shown below reflects expected ranges for a typical US commercial employer population, anchored to NHANES 2017-2020 metabolic syndrome prevalence data. Plan-specific distribution will vary by demographic profile.

TIER 1 — IMPROVING

Approximately 30 to 40 percent of population

Low near-term claim probability. Trending toward stable metabolic health.

Intervention: Maintenance coaching.
Actuarial implication: Stable or declining claims contribution over projection period.

TIER 2 — NEUTRAL / ELEVATED

Approximately 40 to 50 percent of population

Moderate metabolic risk. Stable markers but at elevated baseline.

Intervention: Active monitoring and behavioral coaching.
Actuarial implication: Moderate claims growth, partially reducible with intervention.

TIER 3 — DECLINING

Approximately 10 to 20 percent of population

High near-term claim probability for metabolically driven conditions. Accelerating metabolic deterioration consistent with Tabák 2012 pre-diagnosis trajectory.

Intervention: Structured clinical program, DPP-aligned.
Actuarial implication: Without intervention, primary driver of T2D-attributable trend.

Tier 3 metabolic risk overlaps with but is not identical to the top 10 percent of plan cost. METRA's intervention effect applies specifically to the metabolically driven share of Tier 3 cost, not to high-cost claims attributable to non-metabolic causes such as oncology, trauma, or maternity. AHRQ MEPS 2024 cost concentration data is referenced for context, not as the basis for the intervention effect.

TREND MODIFICATION MODEL

How METRA Projects a 1 to 2.5 Point Trend Reduction

METRA's trend modification estimate is built from a four-step projection model. Each step applies published effect sizes from the clinical literature to a plan's specific population profile. Assumptions are disclosed explicitly on the following page.

STEP 01

Baseline Trend Establishment

Start with PwC HRI 2025 national employer trend (9.4 percent). Where available, plan-specific loss ratio and prior-year claims experience (provided by employer or carrier) replace the national benchmark. Where not available, the national benchmark applies with a wider sensitivity range disclosed.

STEP 02

High-Risk Cohort Identification

Apply METRA Score stratification. Identify Tier 3 population (estimated 10 to 20 percent of enrolled employees). Model this cohort's forward contribution to T2D-attributable plan trend.

STEP 03

Intervention Effect Application

Apply DPP effect size of 58 percent T2D progression reduction (Knowler 2002) to the T2D-attributable share of Tier 3 cost burden, not to the full Tier 3 cost share. T2D-attributable share is estimated at 25 to 40 percent of Tier 3 cost based on ADA 2024 disease-specific cost decomposition. Apply effective participation factor (defined on next page). Model avoided T2D-related claims only. Other metabolic conditions (cardiovascular disease, NAFLD, obesity-related musculoskeletal) are not credited in the central estimate.

STEP 04

Net Trend Modification Output

Compute net trend after avoided T2D-related claims. Central estimate: 1 to 2.5 percentage points below baseline. Range output: sensitivity tested at plus or minus 0.8 points across the three highest-impact variables.

ASSUMPTIONS REGISTER

All Material Assumptions Disclosed. All Are Auditable.

Every input driving METRA's trend modification estimate is named, sourced, and bounded. The following table constitutes the formal assumptions register for actuarial review.

Assumption	Value	Source	Limitation
Baseline trend	9.4%	PwC HRI 2025	National benchmark; plan-specific may vary
Tier 3 cohort size	10 to 20% of enrolled	NHANES 2017-2020 metabolic syndrome prevalence	Subject to plan demographic variation
Tier 3 cost concentration	50 to 65% of plan cost (T2D-attributable share isolated separately)	AHRQ MEPS 2024 (referenced for context)	Tier 3 is not equal to the top 10% by cost; non-metabolic high-cost claims excluded from intervention effect
T2D-attributable share of Tier 3 cost	25 to 40%	ADA 2024 disease-specific cost decomposition	Plan-specific disease mix may shift this share
T2D prevention effect size	58% reduction in T2D progression	Knowler et al., NEJM 2002	RCT; lifestyle intervention arm; effect specific to prediabetic individuals
Net effective participation	10 to 25% of Tier 3 cohort engaged and completing	Modeled as enrollment rate (15 to 30%) × completion rate (70 to 80%)	Conservative versus DPP trial 74% completion; commercial population reach is materially lower
Metabolic detection window	12 to 24 months pre-diagnosis (late acceleration phase)	Tabák et al., Lancet 2012	Earlier detection possible across broader 5 to 6 year trajectory but with lower signal-to-noise ratio
T2D annual cost premium	$9,601 to $12,022 versus non-diabetic	ADA Diabetes Care 2024	Used to value avoided T2D events

METRA SCORE METHODOLOGY

What the METRA Score Measures. How It Is Constructed. What It Predicts.

The METRA Score is a composite metabolic health index, constructed from four input categories and updated continuously as employee data changes.

INPUT 01 — WEIGHT: HIGH

Primary Metabolic Markers

Fasting glucose, HbA1c (self-reported or device-linked), waist circumference, BMI, blood pressure.

Source: NCEP ATP III metabolic syndrome criteria; ADA diagnostic thresholds.

INPUT 02 — WEIGHT: MODERATE

Behavioral Risk Inputs

Physical activity frequency and intensity, dietary pattern scoring, sleep quality, stress index.

Source: Validated behavioral assessment instruments.

INPUT 03 — WEIGHT: HIGH

Trajectory Signals

30, 60, and 90-day change in primary markers; directional velocity of metabolic indicators.

Source: Tabák 2012 longitudinal trajectory model.

INPUT 04 — WEIGHT: LOW TO MODERATE

Engagement Data

Coaching session completion, milestone achievement, platform interaction frequency.

Source: DPP engagement metrics (Ely 2017) for digitally delivered intervention. METRA's AI-assisted coaching is the delivery mechanism; outcome equivalence to human-coached DPP is an assumption pending direct validation.

DATA GOVERNANCE AND PRIVACY

Data Architecture, De-Identified Inputs, and Aggregate Reporting Controls

Metra is designed around privacy-by-design principles and works with de-identified, aggregate, or otherwise non-PHI data for actuarial and compliance review. The following describes the data architecture, de-identification approach, and governance controls used in reporting and analysis.

Data Architecture

- Metra ingests de-identified population-level data and non-PHI operational inputs.
- Data is organized to support cohort analysis, trend monitoring, and actuarial review.
- Access is structured by role and purpose to limit exposure to sensitive information.

De-Identification Standard

- Employer-facing reporting uses aggregated outputs with minimum cohort thresholds.
- Small or sparse groups are suppressed to reduce re-identification risk.
- Individual-level outputs are not exposed in employer reporting views.

Actuarial Data Access

- Actuaries may review aggregate population data through governed data-sharing workflows.
- Carrier and employer analyses rely on summary-level outputs, not individual records.
- Any research or validation linkage requires a separate approved process and scoped data access.

COST PROJECTION

500-Employee Employer Reference Case. Assumptions Disclosed. Ranges Shown.

The following projection uses a 500-employee reference employer to illustrate the quantitative mechanics of METRA's trend modification model. All inputs are drawn from published benchmarks or disclosed assumptions. This is not a guarantee of outcomes.

Input	Value	Source
Enrolled employees	500	BLS 2024 reference case
Base annual healthcare cost	$9,100,000	KFF EHBS 2024: $18,200 PEPY*
Baseline trend (do nothing)	9.4%	PwC HRI 2025
Tier 3 high-risk cohort	10 to 20% of enrolled (50 to 100 EEs)	NHANES 2017-2020
Tier 3 cost share	50 to 65% of total plan cost ($4.6M to $5.9M)	AHRQ MEPS 2024 (context)
T2D-attributable share of Tier 3 cost	25 to 40% ($1.2M to $2.4M)	ADA 2024
DPP intervention effect	58% T2D progression reduction	Knowler et al., NEJM 2002
Net effective participation	10 to 25% of Tier 3	Enrollment × completion modeled separately
Avoided T2D cost per employee	$9,601 to $12,022 per year	ADA Diabetes Care 2024
Central trend modification	1 to 2.5 percentage points	Applied to baseline trend
Year 1 savings, central estimate	$90K to $230K	Renewal plus avoided claims
3-year cumulative savings	$370K to $940K	Compounding avoided baseline

**PEPY benchmark note: METRA uses KFF EHBS 2024 ($18,200 PEPY) as the primary reference for total per-employee healthcare cost in the projection model because it captures total premium plus employer contribution on a consistent annual basis. The Mercer National Survey of Employer-Sponsored Health Plans 2024 ($16,501*

PEPY) measures total health benefit cost on a slightly different methodological basis. Both surveys are accepted industry benchmarks and the difference reflects measurement scope, not disagreement on cost magnitude. Plan-level projections substitute actual plan cost where available.

SENSITIVITY ANALYSIS

The Trend Modification Estimate Tested Across Key Variable Ranges

Single-variable sensitivity analysis on the three inputs with the greatest impact on projected trend modification. All scenarios use the 500-EE reference employer from the previous page.

Net Effective Participation

Scenario	Participation	Trend Modification
Low	8% of Tier 3 (engaged and completing)	0.5 pts
Central	10 to 25%	1 to 2.5 pts
High	40% (engaged and completing)	3.4 pts

Trial-level participation is unrealistic in commercial populations. Low end reflects realistic voluntary uptake at small employers without active enrollment campaigns.

Tier 3 Cohort Size

Scenario	Cohort Size	Trend Modification
Low	8% of enrolled	0.4 pts
Central	10 to 20%	1 to 2.5 pts
High	25% of enrolled	3.1 pts

Cohort size depends on plan demographic profile. Older populations or plans with existing chronic disease concentration may see higher Tier 3 prevalence.

T2D-Attributable Share of Tier 3 Cost

Scenario	T2D Share of Tier 3 Cost	Trend Modification
Low	20%	0.7 pts
Central	25 to 40%	1 to 2.5 pts
High	50%	3.0 pts

Plan-specific disease mix drives this share. Plans with high diabetes prevalence at baseline will see higher T2D-attributable share and larger trend modification potential.

VALIDATION PLAN

How METRA Validates Projected Versus Realized Outcomes

METRA treats the trend modification projection as a falsifiable prediction, not a marketing claim. The validation pathway has three components, each designed to compare projected outcomes against realized outcomes on a defined cadence.

COMPONENT 01

Continuous Cohort Outcome Tracking

For every employer deployment, METRA tracks projected versus realized cohort outcomes at 6, 12, and 24 month intervals. The tracked metrics include Tier 3 progression rate, intervention completion rate, biometric trajectory by tier, and T2D-attributable claims emergence where claims data is shared. Discrepancies between projected and realized outcomes inform iterative model calibration on a quarterly basis.

COMPONENT 02

Annual Retrospective Trend Comparison

Once per plan year, METRA publishes a retrospective comparison of predicted trend modification against observed plan trend, controlling for plan design changes (deductible adjustments, formulary changes, network changes) that would otherwise contaminate the comparison. The retrospective is shared with the contracting employer and made available in summary form for actuarial review under governed access.

COMPONENT 03

Independent Actuarial Replication

An independent actuarial replication study is being scoped for the second full deployment year. The structure: an outside actuary, contracted at arms length from METRA, reproduces the projection mechanics on a deployed cohort using the published assumptions register and reports any discrepancies. Findings will be published in summary form regardless of outcome. This is the structural commitment that converts the model from "trust us" to "verify us."

METRA's position: a model that is unwilling to be tested against its own predictions is not a model. It is a marketing claim. The validation pathway is the structural commitment to the former and against the latter.

MODEL LIMITATIONS

What METRA Does Not Claim. And Where the Model Has Boundaries.

The following limitations are disclosed in full. Actuarial review should take these into account when evaluating METRA's trend modification projections for plan pricing, reserve setting, or renewal negotiation support.

Individual Clinical Outcomes

METRA does not make clinical predictions about individual employees. The METRA Score is a risk stratification index, not a diagnostic instrument. It should not be used as a substitute for clinical evaluation.

Carrier-Level Actuarial Certification

METRA's trend modification projections are plan-level estimates, not actuarially certified trend indications. They are not a substitute for carrier underwriting or an actuarial opinion prepared for regulatory purposes.

Causal Claims

ROI projections reflect expected value of intervention at scale, not a guaranteed outcome for any specific plan. These are applications of published effect sizes, not causal attributions.

Participation Assumption

Trend modification projections assume net effective participation of 10 to 25 percent among the Tier 3 cohort, defined as the product of enrollment rate (15 to 30 percent) and program completion rate (70 to 80 percent). If actual participation is lower than the central range, the trend modification impact will be proportionally reduced.

Small Plan Applicability

Plans below 100 enrolled employees will receive wider confidence intervals on all projections. The stratification model requires a minimum enrolled population to generate statistically stable cohort estimates.

Data Completeness

METRA Scores are more accurate with more complete self-reported data and device-linked biometric inputs. Employees who do not fully complete onboarding will receive lower-confidence scores.

Non-Metabolic Cost Categories

METRA's trend modification estimate is restricted to T2D-attributable claims within the high-risk cohort. Claims attributable to oncology, trauma, maternity, mental health, and other non-metabolic categories are not credited in the central estimate, even where they appear within the same high-risk cohort population. Plans where non-metabolic high-cost claims dominate will see proportionally smaller trend modification impact.

FULL CITATION REGISTER

METRA Full Citation Register: All 14 References. Full Bibliographic Form.

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