

EXPERIENCE STUDY — A GLOBAL ACTUARIAL PRACTICE

EPISODE 02 OF 04

MORTALITY EXPERIENCE STUDY

A/E Ratio · Exposed-to-Risk · Credibility Weighting

🕒 EXPOSED-TO-RISK

📊 A/E RATIO

⚖️ CREDIBILITY THEORY

📄 MORTALITY TABLES

Recap from Episode 01

→ Episode 02 builds on these foundations — going deeper into mortality assumption, the most data-intensive of the four assumption types.



A/E Ratio Formula

The core metric of any experience study — compares what actually happened against what was expected under the reference basis.

$$A/E = \text{Actual} \div \text{Expected} \times 100\%$$



TMI IV 2019 — Reference Mortality Table

Indonesia's standard mortality table, developed by AAJI, PAI, Indonesia Re, and READI/Waterloo — covering exact q_x values for ages 0–111.

AAJI · PAI · Indonesia Re · READI/Waterloo



5-Step Experience Study Process

Data collection → Exposure calculation → A/E comparison → Credibility weighting → Assumption update. Each step builds on the previous.

Systematic · Repeatable · Auditable



Annual Review — Regulatory Mandate

OJK POJK 8/2024 and PSAK 117 both require insurers to review experience assumptions at minimum annually. Study period: 2021–2025.

OJK POJK 8/2024 · PSAK 117 / IFRS 17

Why Mortality Needs Special Treatment

EPISODE 02 · MORTALITY

“ *You cannot measure mortality risk without first measuring **the time each life was exposed to that risk.*** ”

SOA Experience Study Calculations (2024) — Foundational Principle of Mortality Rate Estimation



$$q_x = d / E$$

CORE FORMULA

Deaths divided by Exposed-to-Risk — the foundation of all mortality rates



1,082

FULL CREDIBILITY

Deaths required for full credibility
(90% CI, ±5% margin)



136K

TMI IV DEATHS

136,094 deaths from 22.7M
exposure records across 52
companies



d ↔ E

CORRESPONDENCE

Numerator and denominator must
be defined on the same basis

SOA Experience Study Calculations (2024) • TMI IV 2019 (AAJI) — 22.7 million exposure records • Study Period 2021–2025



— KEY CONCEPT

What Is Exposed-to-Risk?

DEFINITION

Exposed-to-Risk (ETR) is the total time — measured in **policy-years** — during which a group of policyholders was exposed to the risk of death within the observation period. It is the **denominator** in the mortality rate formula:

$$q_x = \text{Deaths} / \text{ETR}.$$



Initial ETR

Used for q_x calculation

Deaths contribute **1 full year** of exposure regardless of when in the year death occurred.

✓ PREFERRED FOR Q_X



Central ETR

Used for force of mortality μ_x

Deaths contribute only the **time lived** before death — a partial-year contribution.

⚠ FOR M_X (FORCE)



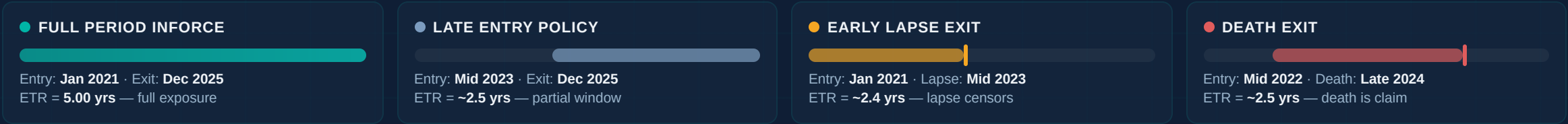
RELATIONSHIP UNDER UDD ASSUMPTION

Initial ETR $\approx$ **Central ETR** + $\frac{1}{2} \times d_x$ (Uniform Distribution of Deaths)

The Observation Window



POLICY SCENARIO EXAMPLES



ETR $\text{MAX}(0, (\text{MIN}(\text{study_end}, \text{exit_date}) - \text{MAX}(\text{study_start}, \text{entry_date})) / \text{days_in_year})$ | ANB $\text{ROUND}(|\text{policy_start} - \text{DOB}| / \text{days_in_year}, 0)$

Key rule: Only positive ETR contributes to exposure. **days_in_year** = 365 (regular year) or 366 (leap year — 2024 in this study). Exit priority: death → lapse → maturity → policy_end → study_end.

ETR Calculation & Policy Scenarios

Exact Exposed-to-Risk formula · Initial vs Central ETR · 4 worked examples

📅 Study Period: 1 Jan 2021 – 31 Dec 2025

MASTER FORMULA — PER POLICY

$$\text{ETR}_i = \text{MAX}(0, \text{MIN}(\text{study_end}, \text{exit_date}_i) - \text{MAX}(\text{study_start}, \text{entry_date}_i)) / \text{days_in_year}$$

exit_date = MIN(lapse, death, maturity, policy_end, study_end)
days_in_year: 365 regular · 366 leap year (2024)

📅 Initial ETR → for q_x

Deaths contribute **1 full year** — TMI IV & SOA standard

$$\text{Initial} = \text{Central} + (1 - t_{\text{death}}) \text{ per death}$$

⌚ Central ETR → for μ_x

Deaths contribute **time lived only** ($t_{\text{death}} < 1$)

$$\text{Central} = \sum \text{time_lived}_i \text{ (deaths: } t_i < 1 \text{)}$$

$$E_x(\text{initial}) = E_x(\text{central}) + \tfrac{1}{2} \cdot d_x$$

UDD: deaths occur on average at mid-year — each death adds ½ year when converting Central → Initial ETR.

☰ 4 POLICY SCENARIO EXAMPLES — DATE ARITHMETIC STEP BY STEP

A

INFORCE THROUGHOUT

ENTRY 1 Jan 2021
EXIT 31 Dec 2025

$$\begin{aligned} & (31 \text{ Dec } 2025 - 1 \text{ Jan } 2021) \\ &= 1,826 \text{ days (incl. 2024 leap)} \\ &\div \text{days_in_year} \end{aligned}$$

ETR (CENTRAL = INITIAL)

5.000 yrs

Full study period — no truncation

B

NEW BUSINESS

ENTRY 1 Jul 2022
EXIT 31 Dec 2025

$$\begin{aligned} & (31 \text{ Dec } 2025 - 1 \text{ Jul } 2022) \\ &= 1,279 \text{ days (incl. 2024 leap)} \\ &\div \text{days_in_year} \end{aligned}$$

ETR (CENTRAL = INITIAL)

3.504 yrs

Entry mid-study → partial exposure

C

LAPSED

ENTRY 1 Jan 2021
LAPSE 30 Jun 2023

$$\begin{aligned} & (30 \text{ Jun } 2023 - 1 \text{ Jan } 2021) \\ &= 911 \text{ days (no leap year)} \\ &\div \text{days_in_year} \end{aligned}$$

ETR (CENTRAL = INITIAL)

2.496 yrs

Exits at lapse — no death adjustment

D

DEATH CLAIM

ENTRY 1 Jan 2021
DEATH 15 Mar 2024

$$\begin{aligned} & (15 \text{ Mar } 2024 - 1 \text{ Jan } 2021) \\ &= 3.204 \text{ yrs (2024 = leap)} \\ &\text{Central ETR} \end{aligned}$$

$$\begin{aligned} & \text{INITIAL ETR ADJUSTMENT (SOA)} \\ & 3.204 + (1 - 0.204) = 3.204 + 0.796 \\ &= 4.000 \text{ yrs} \end{aligned}$$

INITIAL ETR (DEATH YEAR = FULL YEAR)

4.000 yrs

Death year adds back unexpired portion



Common ETR Mistakes

SOA Experience Study Calculations (2024)



ANB vs ALB Confusion

Using Age Last Birthday instead of Age Nearest Birthday shifts policies into wrong age bands. $ANB = \text{ROUND}(|DOB - \text{Commencement}| / \text{days_in_year})$ per TMI IV methodology.

$ANB = \text{ROUND}(|DOB - \text{Entry}| / \text{days_in_year})$

↑ A/E Ratio Biased by Age Band



Death Year Zero Exposure

Assigning zero exposure in the death year instead of 1 full year (Initial ETR) understates total ETR. Deaths must contribute a full policy year to the denominator.

Initial ETR: death year = 1.000 yr

↑ Crude Rate Inflated



Study Boundary Error

Including policies that lapsed before the study start date overstates exposure. Only policies with positive ETR within the study window should contribute.

$ETR > 0$ within [Study Start, Study End]

↑ ETR Denominator Overstated



Reinstatement Double-Counting

Counting reinstated policies as new entries without excluding the lapse-to-reinstatement gap inflates exposure. The gap period must be removed from ETR calculation.

Exclude: lapse date → reinstatement date

↓ A/E Ratio Understated



Partial First Year Overstatement

Treating all new business as full-year exposure overstates ETR for mid-year entrants. Exposure must be prorated from actual entry date to study end or exit date.

$ETR = (\text{Exit} - \text{Entry}) / \text{days_in_year}$

↓ Crude Rate Understated



Negative ETR — Missing Guard

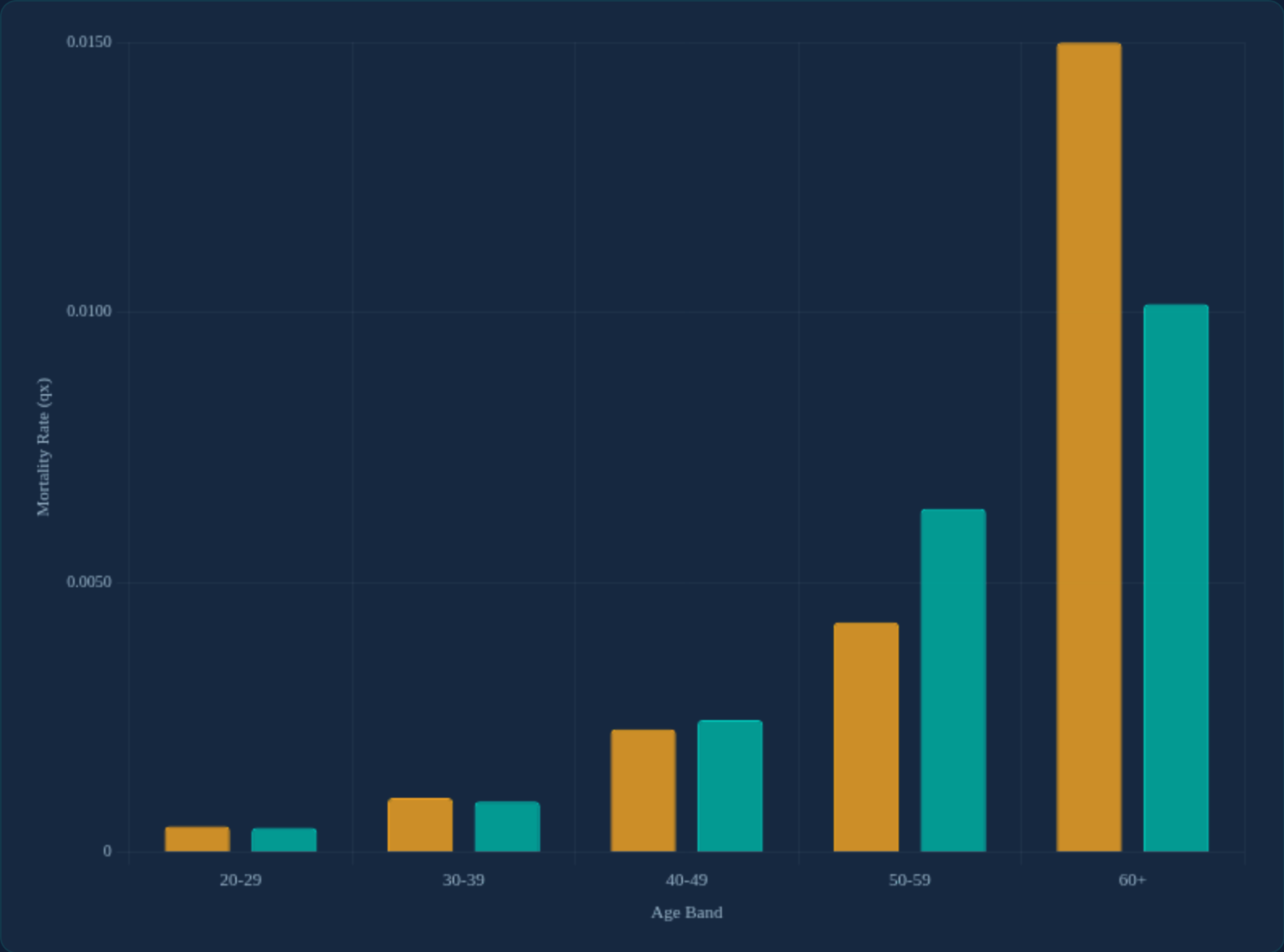
Omitting the $\text{MAX}(0, \dots)$ guard allows negative ETR contributions from policies that exited before the study start. Negative values corrupt the exposure denominator.

$ETR = \text{MAX}(0, (\text{Exit} - \text{Entry}) / \text{days_in_year})$

! Corrupted Denominator

From ETR to Crude Mortality Rate

CRUDE Q_x VS TMI IV Q_x — MALES BY AGE BAND



KEY FORMULAE

Crude $q_x = \text{Deaths} \div \text{ETR}$ (per age $\times$ gender)

A/E = Crude $q_x \div \text{TMI IV } q_x \times 100\%$

KEY OBSERVATIONS

📊 **Crude rates are noisy** — small sample sizes at individual age bands cause high volatility, especially at older ages.

⚠️ Ages **50–54** show the largest divergence: crude rate **0.00635** vs TMI IV **0.00508** — A/E $\approx 125\%$.

🎓 **Graduation** (Whittaker-Henderson) smooths crude rates to produce a stable, monotone mortality table for pricing.

A/E **Actual-to-Expected Ratio**
A/E > 100% → company mortality worse than TMI IV;
A/E < 100% → better than expected.

A/E Results: Male vs Female

96.8%
MALE A/E OVERALL

102.3%
FEMALE A/E OVERALL

98.8%
COMBINED A/E

Male A/EFemale A/E100% Reference

>110% Review90–110% OK<90% Low



KEY OBSERVATIONS

MALE OVERALL A/E

96.8% — Within Range

Male A/E = 96.8% overall — within acceptable range. However, 60+ M shows 142.4% — review needed for older age band.

FEMALE OVERALL A/E

Within Range for Most Bands

Female A/E = 102.3% overall — within range. 60+ F shows 154.6% — review needed.

YOUNG AGES (20–39)

Volatile A/E — Low Credibility

20-29: M=83%, F=139%. 30-39: M=123%, F=86%. Small death counts (4–19 deaths/band) amplify random fluctuation — Z < 14%, results statistically unreliable.

OLDER AGES (60+) — REVIEW NEEDED

142% M · 155% F — Adverse

60+ band shows significantly higher mortality than TMI IV. M=79 deaths (Z=27%), F=55 deaths (Z=22.5%) — most credible band; adverse result warrants assumption review.

CREDIBILITY FORMULA & BLENDED ASSUMPTION

$$Z = \text{MIN}(1, \text{SQRT}(\text{Actual Deaths} / 1,082))$$

$$q_x(\text{final}) = Z \times q_x(\text{company}) + (1 - Z) \times q_x(\text{TMI IV})$$

When experience lacks full credibility, blend it — weight company data by Z, reference table by (1 - Z)



1,082

FULL CREDIBILITY STANDARD

90% CI, ±5% margin
 $n_{\text{full}} = (1.645 / 0.05)^2$



49.1%

OVERALL Z — 261 DEATHS

Still low credibility
Heavily weighted to TMI IV



6.1%

AGE 20-24 BAND

~4 deaths only
Use TMI IV almost entirely



27.0%

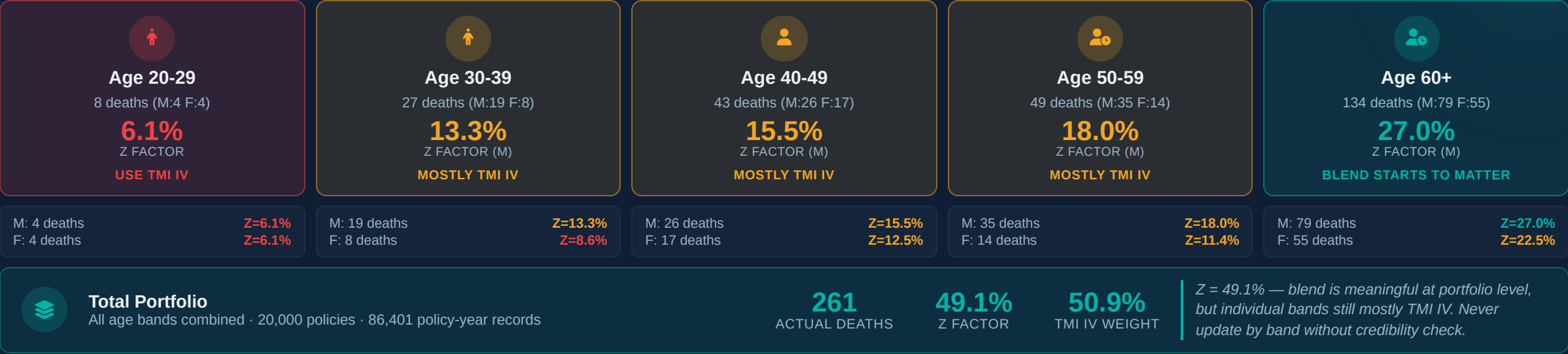
AGE 60-64 BAND

~79 deaths
Still mostly TMI IV

Credibility in Practice

20,000-policy example · Study period 2021–2025 · TMI IV 2019 reference · Age bands: 20-29, 30-39, 40-49, 50-59, 60+

Z THRESHOLD: ■ Z < 10% — Use TMI IV (very low credibility) ■ Z 10–30% — Mostly TMI IV (partial blend) ■ Z > 30% — Blend starts to matter



Mortality Improvement: TMI IV vs TMI III

5.33%

MALE IMPROVEMENT

5.06%

FEMALE IMPROVEMENT

TMI IV

AAJI 2019

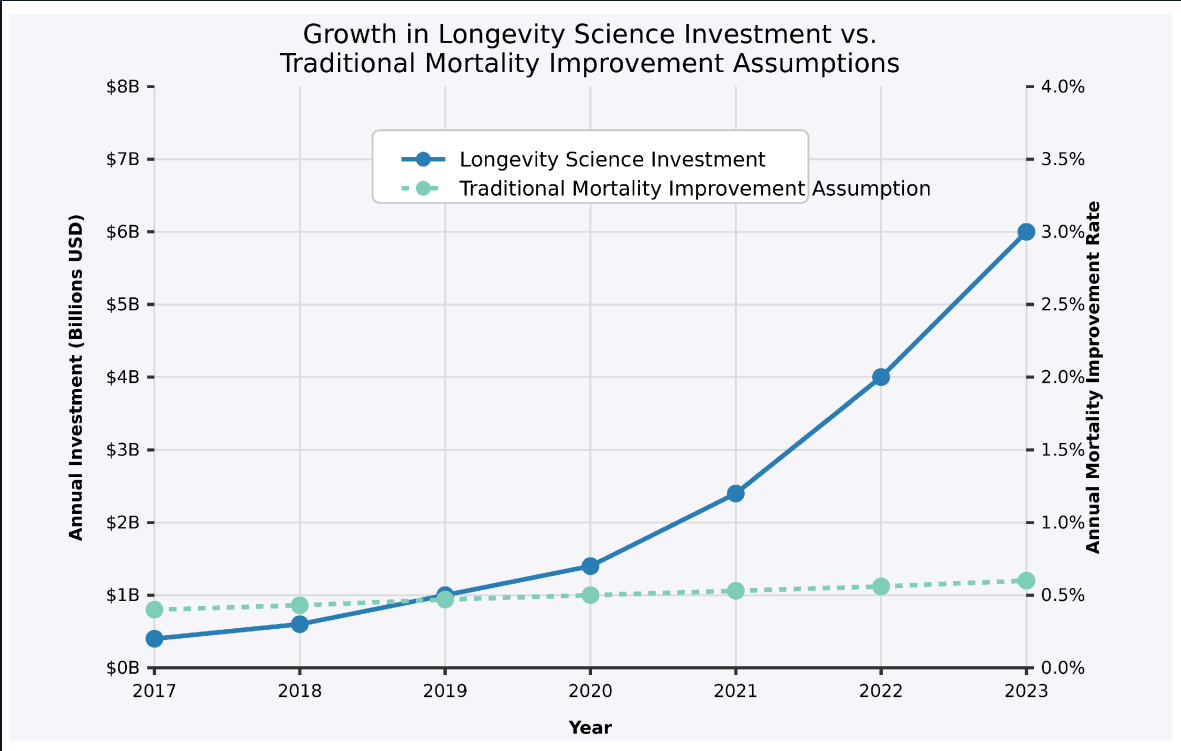
- 📈

Older ages (60+): significant improvement — people are living longer; actual deaths lower than expected under TMI III.
- ⚠️

Younger ages (20–40): slight adverse — TMI IV rates marginally higher than TMI III due to lifestyle factors.

RATE COMPARISON — MALE (Q _x)					
Age 60	TMI III	0.02100	→ TMI IV	0.00999	↓ 52% lower — significant improvement
Age 40	TMI III	0.00153	→ TMI IV	0.00173	↑ slight adverse — lifestyle factors

⚖️ PSAK 117 / IFRS 17: Current estimates must use up-to-date assumptions. Using TMI III when TMI IV is available may not satisfy the current estimates requirement — assumption update required.



Mortality rate curve — illustrative comparison of TMI III vs TMI IV across age bands

Assumption **Update** Decision

WHEN TO REVISE MORTALITY ASSUMPTIONS BASED ON EXPERIENCE STUDY RESULTS



UPDATE Assumption

Act now

↗ A/E ratio consistently **outside 90–110%** range for **2+ consecutive years** — not a random fluctuation

🛡 Credibility factor **Z > 50%** (equivalent to ~270+ actual deaths) — company experience is statistically dominant

⚖ Financial impact of deviation **exceeds materiality threshold** — dual criteria: data volume AND financial tolerance

👤 **Appointed actuary sign-off** obtained — OJK POJK 8/2024 requires actuary accountability for assumption changes



WAIT & Monitor

Observe further

⚠ **Single-year deviation** only — could be random volatility; SOA recommends observing **2–3 years** of consistent deviation

📉 Credibility factor **Z < 20%** — insufficient data volume; industry table (TMI IV) should continue to dominate the blend

💰 Financial impact **below materiality threshold** — deviation does not meet dual materiality criteria (Nityasa Niscita, Dec 2024)

👤 Preparer → Reviewer → **Appointed Actuary** — sign-off chain required

OR

PSAK 117 / IFRS 17

→ **Future service** assumption changes → adjust the CSM (deferred, released over coverage period)

→ **Past / current service** assumption changes → go directly to P&L (immediate impact)

📌 **Current estimates** must use up-to-date assumptions at each reporting date

What's **Next** in This Series

EP02 COVERED

👤 20,000 policies · 5 age bands (20-29, 30-39, 40-49, 50-59, 60+)

💀 261 deaths · 86,401 policy-year records

📈 Overall A/E = **98.8%** · Z = **49.1%**

📅 TMI IV 2019 · Study 2021–2025 · Exact days (365/366)

→ COMING UP NEXT

EP 03

Lapse Experience Study

Lapse Rate Calculation, Trends & Assumption Validation

- Lapse rate calculation by policy year and product segment
- Policy year analysis — early lapse spikes and seasonal patterns
- Trend analysis — identifying structural shifts in policyholder behavior
- Assumption validation — comparing current assumptions to observed experience

EP 04

Expense Experience Study

Unit Cost Analysis & Expense Allocation Methods

- Unit cost analysis — per policy, per claim, per transaction
- Expense allocation — direct vs. indirect expense methods
- Inflation adjustment — projecting future expense assumptions
- IFRS 17 / PSAK 117 cash flow projections — connecting to financial reporting



Download the Ep02 Excel Worked Example

20,000 policies · Exact days ETR (365/366) · TMI IV VLOOKUP · A/E by age band × gender · Credibility Z · Blended assumption — gusta-act.netlify.app

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