
ACTUARIAL PRICING METHODOLOGY FOR PSYCHIATRIC TEMPORARY DISABILITY INSURANCE: A FREQUENCY-SEVERITY APPROACH APPLIED TO THE TUNISIAN MARKET

***¹Mehrez Ben Nasr, ²Sirine Ben Othman**

¹Certified Actuary FTUSA, Tunis, Tunisia.

²Psychiatry Department, Nabeul Hospital, Nabeul, Tunisia.

Article Received: 15 October 2025,

Article Revised: 03 November 2025,

Published on: 24 November 2025

***Corresponding Author: Mehrez Ben Nasr**

Certified Actuary FTUSA, Tunis, Tunisia.

DOI: <https://doi-doi.org/101555/ijarp.2332>

2. ABSTRACT

Psychiatric work stoppages represent a significant public health challenge affecting workforce productivity and organizational profitability globally. This study develops an actuarial pricing methodology for a psychiatric temporary disability insurance product (IJ-Psy) using a frequency-severity modeling approach. We combine a Poisson generalized linear model (GLM) for claim frequency with a Gamma GLM for claim severity to estimate the pure premium. Our analysis utilized a representative dataset of 1,000 Tunisian employees simulated and calibrated according to a 7.8% three-year incidence rate based on expert opinions. The Poisson model demonstrated adequate fit (dispersion ≈ 1.07), while the Gamma model effectively captured asymmetric cost variability. Results indicate an annual frequency of 0.0307 psychiatric leave events per employee (approximately 3% annual probability), an average claim cost of 1,315 Tunisian Dinars (TND) per event, and a resulting pure premium of approximately 40.3 TND per employee per year. Significant variation by occupational category was observed, with cadres and laborers showing higher premiums (43.9 and 43.1 TND respectively) compared to technicians and clerical staff (38.9 and 37.3 TND). These findings provide a robust empirical foundation for Tunisian insurers to develop innovative mental health insurance products while maintaining actuarial soundness and international standards compliance.

3. KEYWORDS: Actuarial science; psychiatric disability; frequency-severity model; Generalized Linear Models (GLM); insurance tarification; Tunisia; Poisson-Gamma modeling; disability insurance; mental health; occupational health

4. INTRODUCTION

Global Context and Problem Statement

Work stoppages due to psychiatric disorders represent a major global public health crisis. According to the World Health Organization (OMS), approximately one billion people worldwide live with a mental health disorder, with depression alone responsible for more than 12 billion work days lost annually[1]. The Organisation for Economic Co-operation and Development (OECD) estimates that psychiatric disorders cost member countries an average of 4% of gross domestic product (GDP) through direct healthcare expenditures, absenteeism, presenteeism, and loss of productive capacity[2].

In Europe, the European Foundation for the Improvement of Living and Working Conditions (Eurofound) reports that psychiatric disorders account for 44% of long-term work stoppages among salaried employees[3]. These figures demonstrate substantial direct impacts on organizational productivity, profitability, and employee welfare systems.

Tunisian Context

Tunisia, like many developing and emerging economies, currently experiences limited official epidemiological data regarding psychiatric work stoppages. However, human resources professionals and occupational health specialists consistently report increasing rates of psychiatric-related work stoppages, often attributed to professional stress, work overload, and diverse psychosocial risks[4]. The absence of dedicated insurance products specifically covering psychiatric temporary disability represents both a gap in risk management and an unmet market opportunity for insurers.

Research Objectives

This study proposes a comprehensive actuarial pricing methodology for a psychiatric temporary disability insurance product termed "IJ-Psy" (Incapacité de travail pour trouble Psychique). The research employs a frequency-severity modeling framework, combining Poisson-based frequency models with Gamma-based severity models to estimate pure premiums. Our analysis utilizes a simulated dataset of 1,000 Tunisian employees calibrated according to expert opinion, incorporating key socioprofessional characteristics including age, gender, occupational category, industrial sector, contract type, and annual salary.

5. MATERIALS AND METHODS

5.1 Study Design and Data Source

This study employs a frequency-severity actuarial modeling approach applied to a simulated cohort of 1,000 Tunisian employees over a three-year observation period. The dataset was constructed using expert calibration to reflect a cumulative three-year incidence rate of 7.8% for psychiatric work stoppages, consistent with industry expert estimates for the Tunisian insurance market[5].

5.2 Data Characteristics

The simulated dataset incorporated the following socioprofessional variables:

- Age (years)
- Gender (male/female)
- Occupational category (cadres, technicians, clerical staff, laborers)
- Industrial sector (administration, manufacturing, services, other)
- Contract type (permanent, temporary)
- Annual salary (TND)
- Number of psychiatric work stoppages over three years
- Individual claim costs per work stoppage (TND)

5.3 Frequency Modeling

We modeled the frequency of psychiatric work stoppages using a Generalized Linear Model (GLM) with Poisson family specification:

$$\log(E[N_i|X_i]) = \beta_0 + \beta^T X_i + \log(\text{exposition}_i)$$

where:

- N_i represents the number of psychiatric work stoppages for individual i
- β^T denotes the vector of regression coefficients
- X_i represents the vector of predictor variables (socioprofessional characteristics)
- $\log(\text{exposition}_i)$ is the offset term representing the exposure period (in years)
- The log link ensures non-negative predicted frequencies

We additionally tested a negative binomial specification to assess potential overdispersion:

$$\log(E[N_i|X_i]) = \beta_0 + \beta^T X_i + \log(\text{exposition}_i)$$

with dispersion parameter $\phi > 1$ allowing for variance exceeding the mean.

5.4 Severity Modeling

Claim severity (cost per work stoppage) was modeled using a GLM with Gamma family specification and logarithmic link function:

$$\log(E[C_j|X_j]) = \alpha_0 + \alpha^T X_j$$

where:

- C_j represents the total cost (in TND) of the j -th work stoppage
- α^T denotes the coefficient vector for severity modeling
- X_j represents predictor variables
- The Gamma distribution accommodates the positive-skewed, positive-valued nature of insurance claim costs

5.5 Pure Premium Estimation

The pure premium (expected cost per exposure unit) is calculated as the product of expected frequency and expected severity:

$$\pi = \lambda \times \mu$$

where:

- $\lambda = E[N_i]$ represents the expected annual frequency
- $\mu = E[C_j]$ represents the expected claim severity
- π denotes the pure premium per employee per annum

Premiums were segmented by occupational category and sector using predicted values from the frequency and severity models.

5.6 Model Assessment and Validation

Model fit was evaluated using the following criteria:

1. **Akaike Information Criterion (AIC):** Comparison of AIC values across Poisson and negative binomial frequency models and assessment of model parsimony.
2. **Dispersion Parameter:** Analysis of the dispersion statistic to assess model adequacy. For Poisson models, a dispersion near 1.0 indicates proper specification; values substantially exceeding 1.0 suggest overdispersion requiring negative binomial specification.
3. **Residual Analysis:** Examination of standardized deviance residuals for systematic patterns, heteroscedasticity, or departures from distributional assumptions.
4. **Predictive Validation:** Comparison of model-predicted cumulative frequencies against observed incidence (7.8% over three years).

6. RESULTS AND DISCUSSION

6.1 Frequency Analysis Results

6.1.1 Descriptive Frequency Results

The observed annual frequency of psychiatric work stoppages was 0.0307 events per employee-year, corresponding to approximately a 3% annual probability of experiencing at least one psychiatric work stoppage. Over the three-year observation period, this translates to a cumulative probability of approximately 8.8%, demonstrating consistency with the 7.8% expert-calibrated incidence assumption.

$$P(\text{event over 3 years}) \approx 1 - (1 - 0.03)^3 \approx 0.088 \text{ or } 8.8\%$$

6.1.2 Frequency Model Fit

The Poisson GLM demonstrated a dispersion statistic of 1.07, indicating adequate model specification with minimal overdispersion. Comparison of information criteria:

Table 1: Frequency Model Comparison: Poisson vs. Negative Binomial.

Model Specification	AIC	Dispersion
Poisson GLM	854.7	1.07
Negative Binomial GLM	853.7	—

The minimal difference in AIC values (1.0 point) indicates that the simpler Poisson specification is adequate, with no evidence of substantial overdispersion requiring the negative binomial parameterization.

6.1.3 Frequency by Occupational Category

Frequency analysis revealed relatively homogeneous distribution across occupational categories:

- Cadres: 0.0310 events per employee-year
- Laborers: 0.0305 events per employee-year
- Technicians: 0.0308 events per employee-year
- Clerical staff: 0.0302 events per employee-year

This relatively uniform distribution suggests that psychiatric morbidity affects occupational groups in a quasi-homogeneous manner, contrary to some somatic disability patterns that exhibit category-specific variation.

6.2 Severity Analysis Results

6.2.1 Descriptive Severity Results

The estimated average claim severity was 1,315 Tunisian Dinars (TND) per psychiatric work stoppage event, representing the mean cost per claim. This relatively elevated cost reflects the characteristic feature of psychiatric disabilities: lower frequency but higher average duration and associated costs compared to other medical conditions.

6.2.2 Severity Model Results

The Gamma GLM for severity identified the industrial sector as a significant predictor. Specifically, the Administration sector showed significantly lower expected costs compared to baseline categories:

- Administration sector: coefficient ≈ -0.18 , suggesting approximately 16.5% lower costs
- Other sectors: homogeneous cost structure
- Mean severity: 1,315 TND per claim

The Gamma distribution effectively captured the positive-skewed nature of cost distribution, accommodating the empirical observation that most claims cluster in the lower range with a substantial right tail of higher-cost claims.

6.2.3 Severity by Occupational Category

Mean severity by occupational category:

- Cadres: 1,418 TND per claim
- Laborers: 1,380 TND per claim
- Technicians: 1,263 TND per claim
- Clerical staff: 1,241 TND per claim

The variation in severity may reflect differences in average salary levels, with higher-wage categories generating higher-cost disability claims due to wage-replacement mechanisms in insurance benefits.

6.3 Pure Premium Results

6.3.1 Overall Pure Premium

The estimated pure premium (expected annual cost per employee) is:

$$\pi = 0.0307 \times 1,314.6 = 40.3 \text{ TND per employee per annum}$$

This premium represents the minimum loading-free (pure) cost necessary to cover expected claims.

6.3.2 Pure Premium by Occupational Category

Table 2: Pure Premium by Occupational Category.

Occupational Category	Frequency	Mean Severity (TND)	Pure Premium (TND)
Cadres	0.0310	1,418	43.9
Laborers	0.0305	1,380	43.1
Technicians	0.0308	1,263	38.9
Clerical Staff	0.0302	1,241	37.3
Overall Average	0.0307	1,315	40.3

Premium variation across occupational categories principally reflects differences in claim severity rather than frequency, with cadres and laborers requiring the highest premiums (43.9 and 43.1 TND respectively) and technicians and clerical staff the lowest (38.9 and 37.3 TND).

6.4 DISCUSSION

6.4.1 Comparison with International Literature

Our findings demonstrate substantial consistency with international psychiatric disability research. The low frequency but high severity pattern observed in this Tunisian analysis aligns with European epidemiological data. Specifically:

Frequency Comparison: The observed annual frequency of 3% is consistent with psychiatric disorder prevalence studies in developed economies. The European Network for Occupational Safety and Health reports psychiatric-related disability frequencies ranging from 2.5% to 4.0% annually across EU member states[6].

Severity Comparison: The mean claim cost of 1,315 TND (approximately €410 USD equivalent at current exchange rates) compares favorably with European data. After currency conversion, similar psychiatric disability claims in European systems range from €350 to €450, confirming that Tunisian psychiatric disability costs follow expected international patterns.

Duration Implications: The elevated average cost per claim reflects the well-documented finding that psychiatric disabilities involve substantially longer average durations compared to somatic conditions. Psychiatric work stoppages average 60-90 days in European systems, whereas most somatic disabilities average 10-30 days[7].

6.4.2 Model Appropriateness and Technical Soundness

The Poisson-Gamma frequency-severity framework demonstrates superior appropriateness compared to alternative specifications:

1. **Poisson Appropriateness:** The dispersion statistic of 1.07, near the theoretical value of 1.0 for Poisson processes, indicates that claim counts follow a distribution consistent with random, independent events. This validates the Poisson assumption of claim occurrence as a homogeneous Poisson process.
2. **Gamma Appropriateness:** The Gamma distribution's ability to accommodate positive-valued, positively-skewed data makes it particularly suited for insurance claim costs. The logarithmic link function ensures monotonicity and provides interpretable elasticities in the coefficient structure.
3. **Homogeneity in Frequency:** The near-invariance of frequency across occupational categories suggests that psychiatric disorder risk operates as a population-wide phenomenon, not concentrated in particular occupational strata. This finding contrasts with many physical disabilities, which exhibit strong occupational gradients.

6.4.3 Actuarial Implications for Product Development

These results provide Tunisian insurers with actionable tariffication guidance:

1. **Risk-Based Pricing:** The observed variation in claims severity by occupational category justifies occupational category-based premiums, with a 17.7% spread from lowest to highest (37.3 to 43.9 TND).
2. **Segmentation Strategy:** Given the observed administrative sector severity reduction, insurers may develop specialized products for administrative sectors with slightly reduced premiums reflecting lower empirical costs.
3. **Loading Application:** The pure premium of 40.3 TND serves as the baseline for applying commercial loadings (for acquisition costs, administrative expenses, profit margin, and risk contingency reserves). Typical commercial premiums would target 80-120% loading over pure premium, yielding market premiums of 72-89 TND.

6.4.4 Limitations and Research Extensions

Several limitations warrant acknowledgment:

1. **Data Simulation:** The analysis utilized simulated rather than actual claims data. Validation with genuine historical claims data from Tunisian insurers would strengthen findings.

2. **Medical Factors:** Our analysis did not incorporate specific psychiatric diagnoses, severity classifications, or treatment modalities. Integration of clinical data would refine risk stratification.
3. **State-Space Models:** Traditional frequency-severity approaches assume independence between frequency and severity. Multi-state models capturing transitions in disability status (e.g., work → partial disability → work) may provide enhanced accuracy.
4. **Temporal Dynamics:** This cross-sectional analysis does not capture potential secular trends in psychiatric disability incidence or cost inflation specific to mental health services.

6.4.5 International Standards Alignment

The methodology employed aligns with International Actuarial Association standards for disability insurance pricing[8]. The transparent decomposition into frequency and severity components facilitates:

- Regulatory review and validation
- Comparison with peer actuarial analyses
- Adoption of best practices in risk segmentation
- Integration with insurance supervision frameworks

7. CONCLUSION

This study develops and validates an actuarial pricing methodology for psychiatric temporary disability insurance in the Tunisian context. Employing a Poisson-Gamma frequency-severity framework on a calibrated dataset of 1,000 employees over three years, we establish key actuarial parameters:

Key Findings:

- Annual frequency: 0.0307 events per employee (approximately 3% annual probability)
- Mean severity: 1,315 TND per claim
- Overall pure premium: 40.3 TND per employee per annum
- Premium range by occupational category: 37.3 to 43.9 TND (17.7% variation)

These parameters provide Tunisian insurers with an empirically grounded foundation for developing innovative mental health insurance products while maintaining actuarial soundness, regulatory compliance, and international standards alignment. The decomposition into frequency and severity enables transparent risk segmentation and rational premium differentiation by occupational category.

Future Research Directions:

This foundational work may be extended through:

1. Validation using actual claims data from Tunisian insurance companies
2. Integration of psychiatric diagnostic classifications and clinical severity measures
3. Development of multi-state models capturing disability trajectory transitions
4. Comparative analysis with disability insurance products in other African and Mediterranean economies
5. Incorporation of prevention and occupational health intervention effects on frequency and severity
6. Analysis of long-term cost trends and inflation specific to mental health services

The methodology and findings herein contribute to closing the research gap regarding actuarial pricing of mental health insurance in developing economies and advance the broader agenda of mental health policy and occupational well-being in Tunisia.

8. ACKNOWLEDGEMENTS

The author acknowledges the valuable guidance of actuarial colleagues in the Tunisian insurance sector who provided expert calibration inputs regarding psychiatric disability incidence rates. Appreciation is extended to occupational health specialists and human resources professionals whose field observations informed the epidemiological assumptions underlying this analysis. The author further acknowledges the contribution of academic institutions in Tunisia and internationally that support actuarial science education and research advancement.

9. REFERENCES

1. World Health Organization. (2023). Mental Health: Fact Sheets. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/mental-health>
2. Organisation for Economic Co-operation and Development. (2023). Health at a Glance: Europe 2023 – State of Health in the EU Cycle. OECD Publishing.
3. European Foundation for the Improvement of Living and Working Conditions (Eurofound). (2023). Sixth European Working Conditions Survey: Overview Report. Publications Office of the European Union.
4. Ben Nasr, M. (2024). Occupational Health and Psychiatric Morbidity in Tunisia: Expert Assessment Report. Private Sector Insurance Analysis.

5. Expert Panel on Disability Insurance, Tunisian Insurance Association. (2024). Incidence Rate Assessment: Psychiatric Temporary Disability. Internal Technical Report.
6. European Network for Occupational Safety and Health (EU-OSHA). (2023). Psychosocial Risks and Mental Health in the Workplace. Publications of the European Agency for Safety and Health at Work.
7. Schuring, M., Mackenbach, J. P., Voorham, T. A., & Burdorf, A. (2011). The contribution of health status and health behaviors to the duration of sickness absence. *Journal of Occupational Rehabilitation*, 21(2), 168–176. <https://doi.org/10.1007/s10926-010-9258-0>
8. International Actuarial Association. (2022). Actuarial Standards of Practice: Income Protection Insurance. IAA Standards of Practice Committee.