

Article

Building a Life Table for Lebanon: Towards a Deeper Understanding of Our Future

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Abstract

Lebanon does not have a national mortality table that reflects its demographic and health conditions. Despite ongoing changes in mortality patterns driven by economic crises, political instability, and social changes, outdated foreign tables such as AM80 remain in use in the insurance and public sectors. This dependency introduces significant risks in actuarial calculations, policy design, and long-term planning. This study addresses this gap by building a mortality table specifically adapted to the Lebanese insurance context, together with a first estimation of population-level mortality. In the absence of any official mortality database, we collaborated directly with local insurance companies to access and organize internal records of insured lives. These data, which represent one of the few available structured sources of mortality information in the country, form the core of our analysis. We apply actuarial methods to estimate age-specific death rates and life expectancy and benchmark the results against national and international references to assess consistency and range. By offering a locally grounded, data-driven alternative to imported mortality assumptions, this work fills a critical statistical need. The resulting table supports more accurate forecasting, pricing, and demographic modeling, with applications across insurance, pensions, and public health planning in Lebanon.

Keywords: mortality table; Lebanon; actuarial modeling; insurance data; demographic analysis; life expectancy; mortality modeling; economic and health crises



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1. Introduction

Lebanon has, since 2019, entered a severe and prolonged economic collapse that the World Bank ranks among the three most dramatic economic crises worldwide since the mid-nineteenth century ([World Bank 2021](https://www.worldbank.org/en/country/lebanon/overview)). The Lebanese pound has lost more than 80% of its value, the banking sector has largely ceased to function, and the country has experienced sovereign default, hyperinflation, and institutional breakdown ([Shallal et al. 2021](#); [Snaije 2022](#)). These structural failures were further compounded by the COVID-19 pandemic, which placed additional strain on the healthcare system and social protection mechanisms ([Zahreddine et al. 2022](#)). As a result, a large share of the population has fallen into multidimensional poverty or severe socioeconomic vulnerability ([Proudfoot 2025](#)).

Beyond its economic and social consequences, this crisis has exposed a long-standing structural weakness: the absence of reliable demographic and mortality data. In contexts

of prolonged instability, this deficiency represents a source of systemic risk rather than a purely technical limitation. Without accurate mortality estimates or updated life tables, insurers, policymakers, and social institutions lack robust benchmarks for pricing, reserving, solvency assessment, and long-term planning.

However, the need for a Lebanese mortality table long predates the current crisis. Life tables constitute a fundamental tool in actuarial science and demography, providing age-specific death probabilities and forming the basis for life expectancy estimation, insurance and pension valuation, and health policy design (Preston et al. 2001). Lebanon nevertheless lacks the statistical infrastructure required to produce such references. The country has not conducted a national census since 1932, and vital registration systems remain incomplete, preventing the construction of national mortality tables (Ammar and Awar 2001). Consequently, most mortality studies rely on indirect methods or non-representative samples (Sibai et al. 2007). In practice, both the insurance sector and public institutions continue to rely on imported actuarial tables, most notably the AM80 and AF80 tables derived from insured populations in the United Kingdom in the early 1980s. These references reflect demographic, socioeconomic, and epidemiological conditions that differ substantially from those prevailing in Lebanon today, leading to potential distortions in actuarial calculations and policy assessments (Arriaga 1984; Lee and Carter 1992). From an actuarial perspective, extensive literature shows that outdated or non-representative mortality assumptions can generate material distortions in pricing, reserving, and solvency measurement. Richards and Currie (2009) demonstrate that alternative mortality calibrations may lead to markedly different liability valuations, while Cairns et al. (2006) emphasize stochastic mortality as a major source of risk affecting capital requirements. Uncertainty in longevity trends has direct implications for solvency margins (Stevens et al. 2010), and neglecting extreme mortality events can result in significant underfunding (Li and Chen 2024). Modern actuarial standards therefore stress that mortality tables must reflect the experienced mortality of the population under study in order to ensure reliable risk quantification (Salhi and Thérond 2018).

Demographic evidence further suggests that imported actuarial tables are poorly aligned with Lebanon's current mortality structure. The country has undergone a compressed demographic transition marked by rapid declines in fertility and mortality, substantial emigration of younger cohorts, and a pronounced epidemiological shift toward non-communicable diseases (Sibai et al. 2015, 2004). Mortality dynamics also vary considerably across regions and socioeconomic groups, reflecting disparities in healthcare access, living conditions, and behavioral risk factors (Blanchet et al. 2016). In a country repeatedly exposed to conflict, economic collapse, and population displacement, reliance on external actuarial assumptions risks masking structural heterogeneity and misrepresenting the true mortality profile.

These empirical and institutional constraints point to a clear gap: the absence of a mortality table calibrated to the Lebanese context and grounded in observed data.

To address this gap, the present study constructs an actuarially calibrated mortality table based on Lebanese insured lives. In the persistent absence of reliable national vital statistics (IMF 2021; World Bank 2021), the analysis relies on harmonized and anonymized data obtained directly from major insurance companies, which constitute one of the few structured and longitudinal mortality data sources available in the country. Using this dataset, we estimate age-specific mortality rates, apply appropriate smoothing and extrapolation techniques, and benchmark the resulting insured-life tables against established international actuarial references to ensure demographic plausibility and methodological consistency.

Building on this insured-life reference, the study then proposes an actuarial approximation of population-level mortality. Although insured individuals do not represent the population as a whole, the insured portfolio provides a coherent empirical basis from which population mortality can be explored through structured adjustments. Where appropriate, insured-to-population differentials documented in countries with well-established statistical systems, such as France, are used to derive population-level scenarios while preserving age-specific coherence. The analysis adopts a period life table framework based on insured lives observed between 2000 and 2021, clearly separating insured mortality estimation from subsequent population-level sensitivity analyses.

By establishing an empirically grounded insured-life mortality reference and proposing a structured exploration of population-level mortality under crisis conditions, this study contributes to a better understanding of Lebanese mortality dynamics both during periods of severe economic and health shocks and in a longer-term demographic perspective. Reliable mortality references are essential for actuarial practice, social protection design, and public health analysis, particularly in fragile and crisis-prone environments.

Beyond the Lebanese case, the methodological framework developed in this study is intended to serve as a practical reference for mortality modeling in small countries and data-scarce settings. It illustrates how insurance-based data can capture the impact of major economic and health shocks on mortality dynamics.

The remainder of the paper is organized as follows. Section 2 describes the data sources, portfolio structure, and demographic characteristics of the insured population. Section 3 presents the actuarial framework used to estimate, smooth, and extrapolate mortality rates and to construct insured life tables. Section 4 analyzes the effects of the economic and health crises on insurance exposure, mortality dynamics, and insured population alignment. Section 5 summarizes the main findings and discusses their actuarial and demographic implications. The final insured and population-based life tables, including sensitivity scenarios derived from multiplier adjustments, are reported in Appendix A.

2. Foundation for Mortality Modeling: Dataset, Structure, and Demographic Insights

Constructing a mortality table for Lebanon requires addressing major limitations in national demographic data. As a small country with incomplete census and vital registration systems, Lebanon lacks comprehensive population-level mortality statistics (Ammar and Awar 2001; Sibai et al. 2007). To overcome these constraints, the present study relies on harmonized and anonymized datasets obtained directly from major Lebanese insurance companies. The data cover the period from 1 October 2000 to 31 December 2021, and include 312,863 unique insured individuals and 1408 recorded deaths, extracted from an initial pool of 672,255 records. After systematic validation, removal of duplicates and inconsistencies, and consolidation of production and claims files, the final dataset was internally coherent and suitable for actuarial mortality analysis.

The age structure of portfolio movements is illustrated in Figure 1. Entries are concentrated at young adult ages, peaking around 26–27 years, while exits are more dispersed but display a similar concentration. A pronounced spike in exits at age 75 reflects contractual termination rules commonly applied in Lebanese insurance policies.

Exposure by age provides further insight into the distribution of insured coverage. Exposure, measured in cumulative person-years, peaks at age 36 for men and at age 29 for women (Figure 2). Approximately 75% of total exposure is concentrated below age 50, reflecting the relatively young structure of the insured population. This concentration directly affects the statistical stability of mortality estimates, particularly at younger and older ages where exposure is sparse.

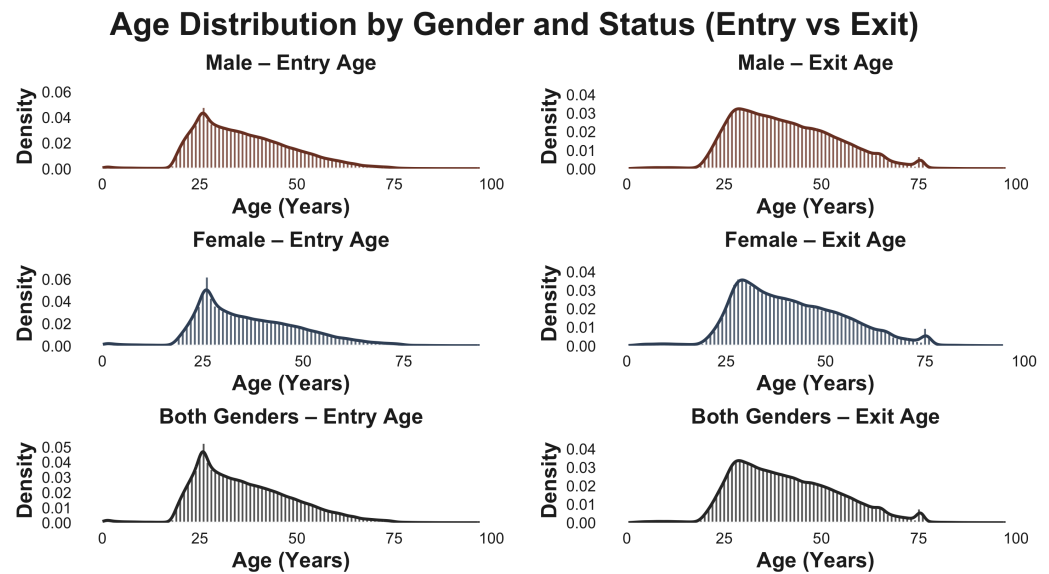


Figure 1. Age distribution of entries and exits in the portfolio.

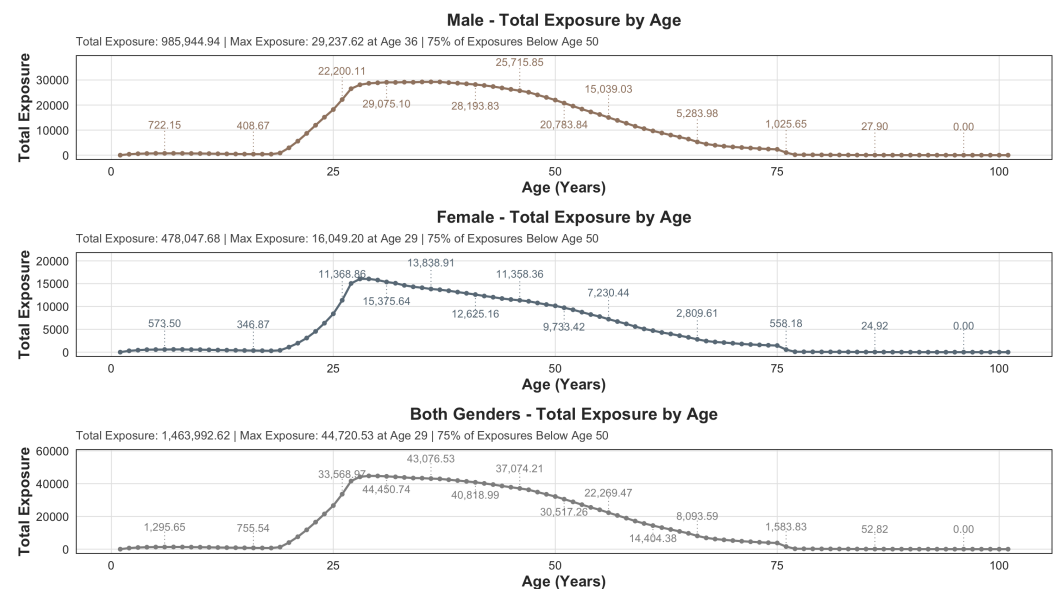


Figure 2. Total exposure by age for males, females, and both genders.

In actuarial and demographic estimation, ages with limited exposure are known to produce highly unstable mortality rates dominated by random fluctuation (Kostaki and Zafeiris 2019; Promislow et al. 1999). Rather than imposing an arbitrary cutoff, exposure sufficiency was assessed by examining the full exposure profile relative to the maximum observed exposure,

$$E_x^* = p_x \times E_{\max},$$

allowing identification of age ranges with dense, coherent information and those requiring smoothing or down-weighting. In the present dataset, maximum exposure reaches 29,238 for men, 16,049 for women, and 44,721 when genders are combined, producing the triangular exposure pattern typical of insured populations.

Statistical reliability was further evaluated using expected-death criteria, where the expected number of deaths at age x is given by $E_x = N_x q_x$. Male mortality estimates are generally stable between ages 20 and 65, while female estimates meet reliability criteria at fewer ages due to lower exposure and mortality levels. Although aggregation across genders increases stability, it conceals gender-specific disparities. These findings motivate

the use of smoothing, sample-weighted averaging, and indirect calibration techniques described in Section 3.

Crude mortality rates with 95% confidence intervals (Figure 3) further illustrate these patterns, with greater uncertainty at extreme ages and narrower intervals around ages 26–27, where exposure is highest.

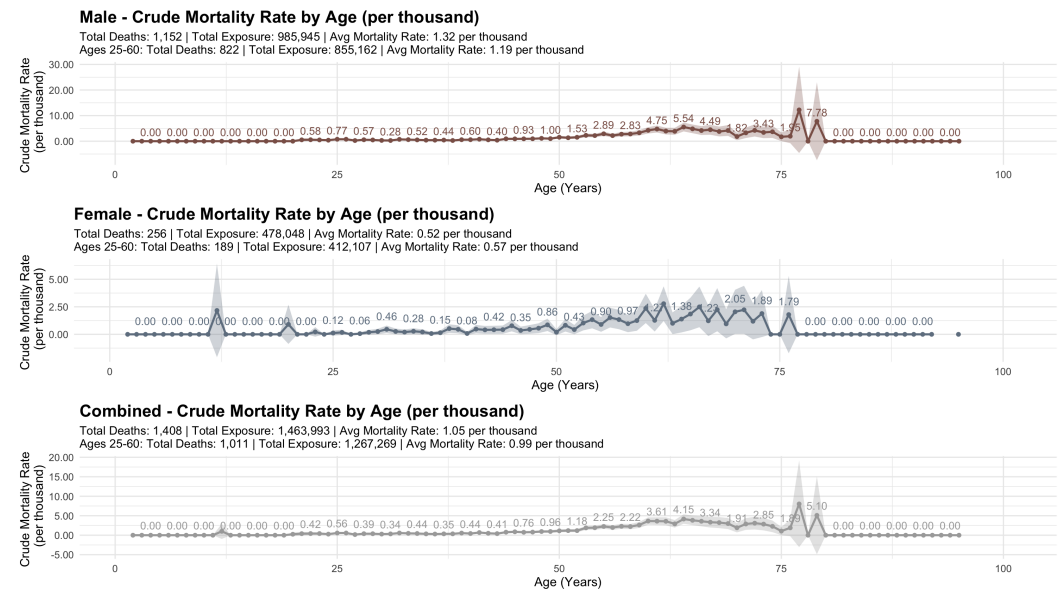


Figure 3. Crude mortality rates with 95% confidence intervals.

The dataset exhibits a marked gender imbalance: men account for approximately 67% of insured lives and 82% of recorded deaths. This pattern is consistent with well-documented sex differentials in mortality driven by biological, behavioral, and social factors (Kruger and Nesse 2004; Luy and Gast 2014; Rogers et al. 2010). Mortality is therefore modeled separately for men and women in order to preserve gender-specific risk profiles.

Insurance product composition further shapes mortality selection within the portfolio. Protection products, which directly expose insurers to biometric risk, represent approximately 69% of policies, while mixed and savings products account for 15% and 16%, respectively. Protection contracts typically involve stricter medical underwriting, implying that the insured population constitutes a healthier and more socioeconomically advantaged subset of the national population. Mortality rates derived from insurance data are therefore expected to lie below population-level mortality.

Temporal analysis highlights the central role of external shocks in shaping portfolio dynamics. As shown in Figure 4, total exposure increased steadily until 2015, declined between 2016 and 2018, and collapsed sharply after 2019. This contraction coincides with the banking system failure, currency depreciation exceeding 80%, and sovereign default (Shallal et al. 2021; Snaije 2022; Uwaydah and Kassir 2024), which substantially reduced households' capacity to maintain insurance coverage.

During this period, portfolio inflows and outflows diverged markedly. Exits increased by 120% between 2019 and 2020 and by a further 22% between 2020 and 2021, while new entries declined sharply (Figure 5), leading to a pronounced contraction of the exposure base.

Despite this contraction, the absolute number of deaths remained relatively stable, fluctuating between 106 and 133 per year since 2013 (Figure 6). The crisis therefore did not translate into a surge in raw mortality counts within the insured pool.

When mortality is expressed per 1000 insured individuals, rates increased sharply, rising from 0.7 to 1.1 between 2019 and 2020 (+57%) and to 1.7 in 2021 (+55%) (Figure 7). This

apparent deterioration reflects a selection effect driven by portfolio contraction rather than an increase in deaths, as individuals exiting coverage during the crisis differ systematically from those remaining insured.

To contextualize these dynamics, the distribution of causes of death provides a useful epidemiological reference. Figure 8 shows that cardiovascular diseases and cancers are the leading causes of death among the insured population, consistent with an advanced stage of the epidemiological transition characterized by the predominance of non-communicable diseases over infectious causes (GBD 2019 Diseases and Injuries Collaborators 2020; Omran 1971, 1998; Preston et al. 2001).

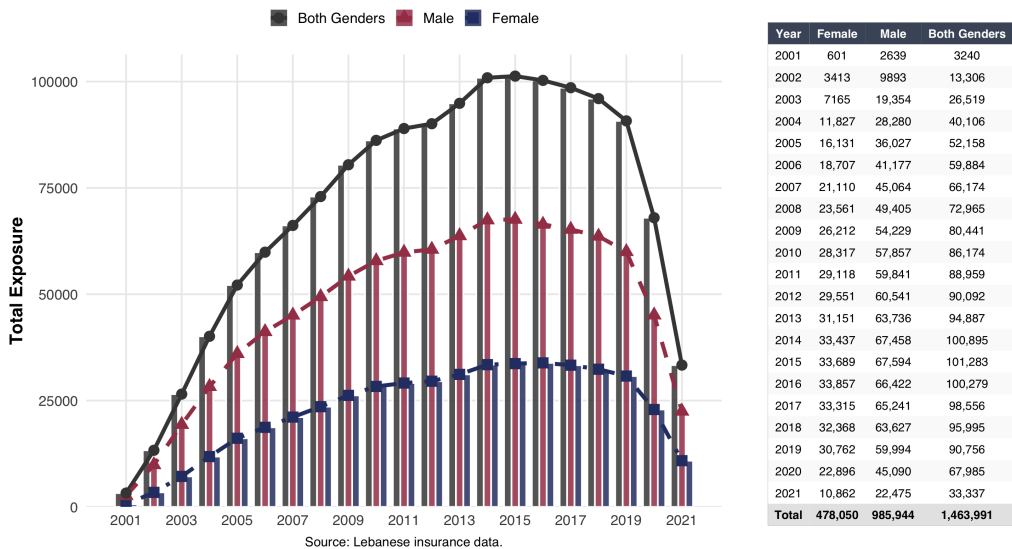


Figure 4. Total exposure in Lebanon’s insurance portfolio over time.

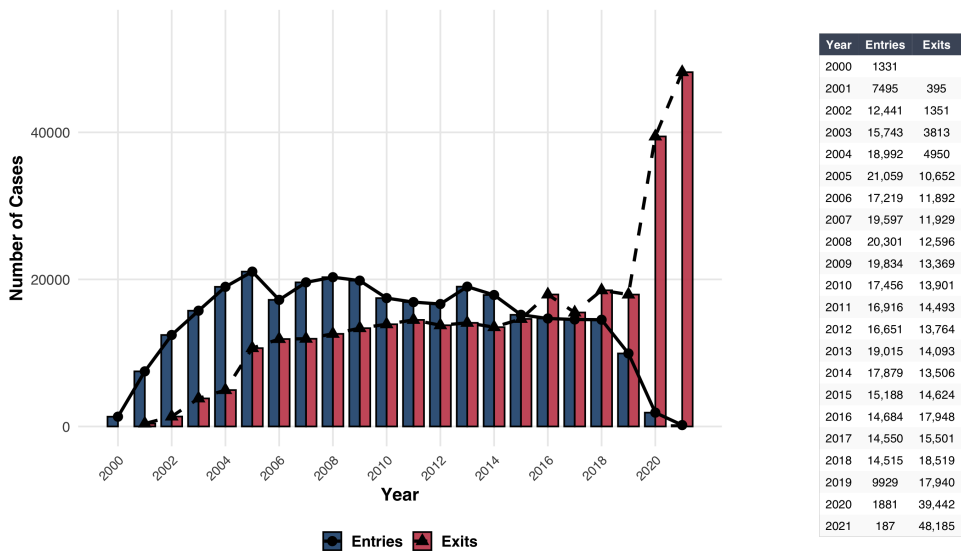


Figure 5. Annual entries and exits, 2000–2021.

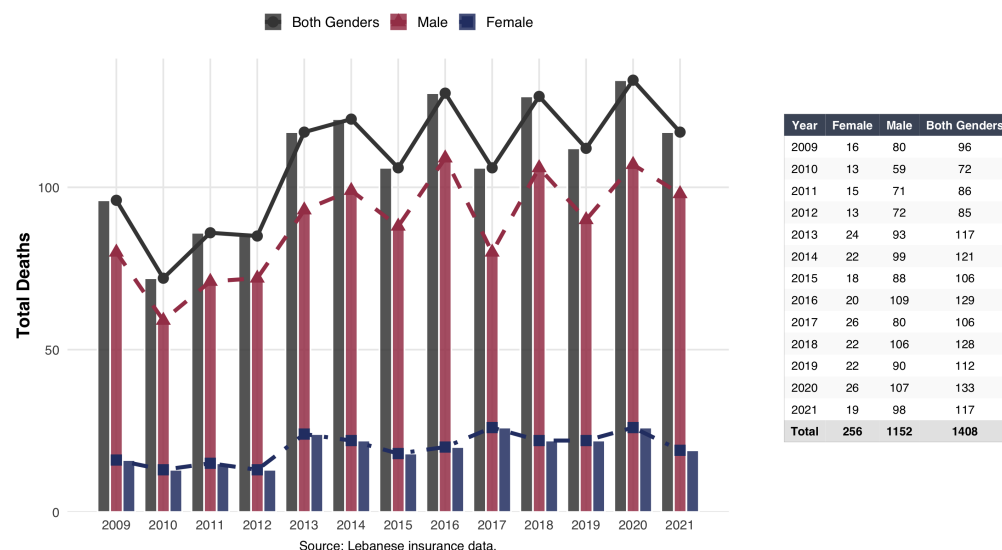


Figure 6. Total deaths in Lebanon's insured population.

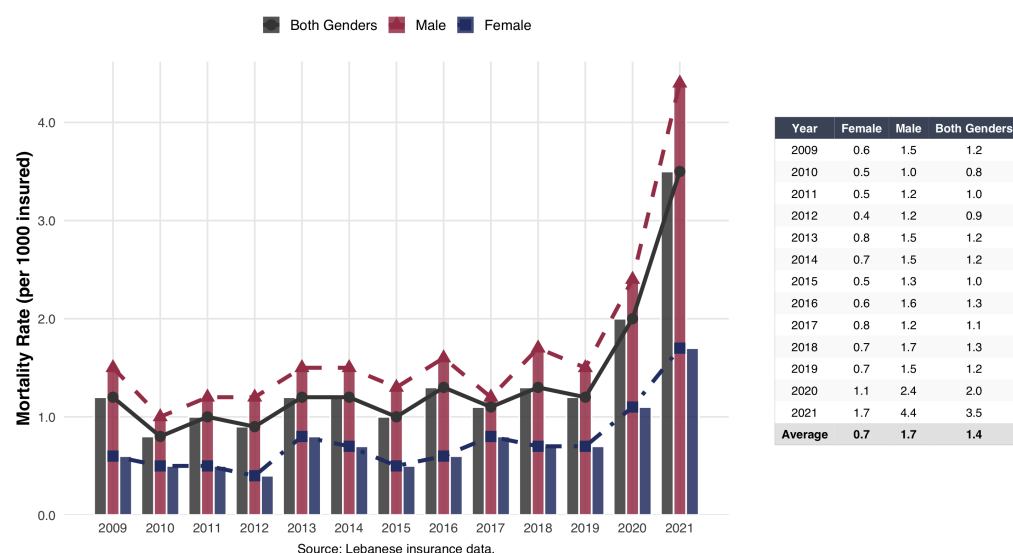


Figure 7. Mortality rates per 1000 insured individuals in Lebanon.

External causes, and in particular road traffic accidents, represent a non-negligible share of insured mortality, ranking among the leading causes of death, especially for men. This pattern is consistent with well-documented gender differentials in exposure to external and behavioral risks, whereby men are more frequently exposed to injuries and accidents due to occupational, behavioral, and mobility-related factors (GBD 2019 Diseases and Injuries Collaborators 2020; Kruger and Nesse 2006; World Health Organization 2018). These mechanisms contribute to excess male mortality at young and middle-adult ages.

Infectious causes remain limited in the insured portfolio. COVID-19 accounts for approximately 3% of recorded deaths, a proportion that does not materially affect life table construction but illustrates how acute health shocks may temporarily influence mortality patterns (Di Bari et al. 2022; Lenz et al. 2024; Meagher 2024; Serviente et al. 2022).

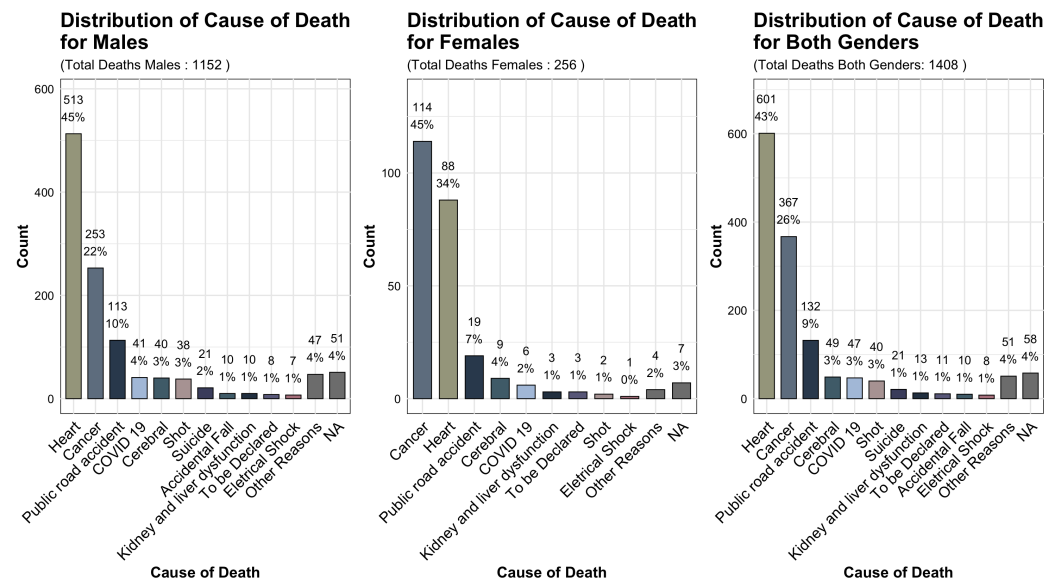


Figure 8. Distribution of causes of death among the Lebanese insured population. NA denotes deaths for which the cause of death was not reported in the insurance records at the time of data extraction.

3. Constructing a Period Life Table for Lebanon

We rely on period life tables to construct mortality tables for the Lebanese insured population. Period life tables summarize observed age-specific mortality over a given period and represent the standard framework in actuarial practice for pricing, reserving, and solvency analysis (Olivieri and Pitacco 2012; Pitacco 2008).

3.1. Estimating Mortality Rates

Analyses are stratified by men, women, and the combined population in order to preserve subgroup-specific mortality patterns. Age-specific mortality rates are estimated using the Kaplan–Meier estimator, a standard nonparametric method that properly accounts for right censoring (individuals alive at the end of follow-up or otherwise censored), thereby avoiding bias in mortality estimation (Kaplan and Meier 1958). Kaplan–Meier estimates closely match crude mortality rates across all groups (Figure 9), with the strongest agreement observed at ages with high exposure and only minor deviations at advanced ages where exposure becomes limited.

Estimator accuracy is quantified using the Mean Absolute Error (MAE) and the Root Mean Square Error (RMSE). Both indicators remain low across all populations, confirming strong agreement between Kaplan–Meier and crude mortality rates (men: MAE = 0.26, RMSE = 1.10; women: MAE = 0.07, RMSE = 0.17; combined population: MAE = 0.19, RMSE = 0.73).

Beyond rate-level agreement, the internal coherence of the Kaplan–Meier estimator is assessed by comparing the expected number of deaths implied by the model with the observed death counts. Across all groups, expected and observed deaths are closely aligned, confirming the consistency of the estimator. Relative discrepancies remain limited, at 6.1% for men, 12.8% for women, and 5.5% for the combined population, with the larger deviation for women reflecting smaller exposure and higher variability at older ages.

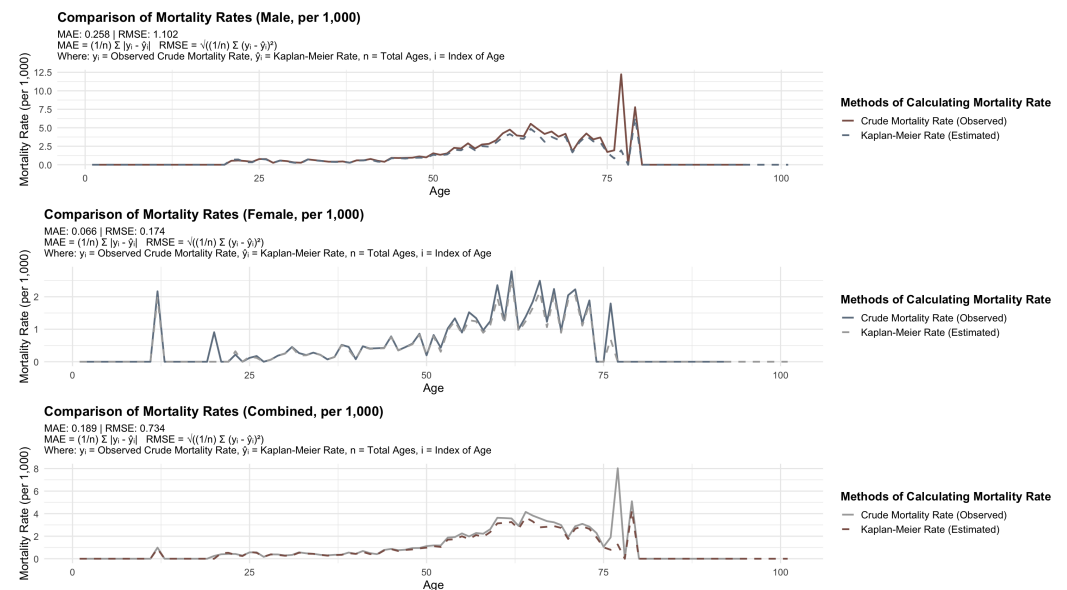


Figure 9. Comparison of crude and Kaplan–Meier mortality rates (male, female, and combined, per 1000). MAE and RMSE values quantify the accuracy of Kaplan–Meier estimates relative to crude rates.

The Kaplan–Meier framework provides an accurate and statistically reliable representation of mortality dynamics in the Lebanese insured population and serves as a baseline for subsequent smoothing, extrapolation, and life table construction procedures.

3.2. Development of Smoothing and Hybrid Methods

To construct a smooth and demographically coherent mortality curve, we rely on two classical actuarial models: Makeham’s law and the Brass relational model, which are briefly recalled here for completeness and motivation.

Makeham’s law represents adult and older-age mortality as the sum of an age-independent component and an exponentially increasing age-dependent component:

$$\mu_x = A + B e^{Cx},$$

where A captures background mortality and Be^{Cx} reflects biological aging.

Makeham’s law is formulated in continuous time through the instantaneous force of mortality μ_x . The corresponding annual mortality probability is given by

$$q_x = 1 - \exp\left(-\int_x^{x+1} \mu_t dt\right).$$

Introduced in the nineteenth century (Makeham 1860, 1878), this model remains widely used because it produces smooth, monotonic mortality patterns that remain stable when exposure becomes sparse at advanced ages.

The Brass relational model adjusts observed mortality to a reference table by assuming a linear relationship between the logits of survival functions:

$$\text{logit}(l_x^{\text{Leb}}) = \alpha + \beta \text{logit}(l_x^{\text{Ref}}),$$

where α controls the overall mortality level and β the age gradient. Since its introduction by (Brass 1971), this approach has been extensively used to stabilize mortality estimation when data are incomplete or irregular.

In this study, the two models play complementary roles: Makeham ensures actuarial smoothness at older ages, while Brass preserves demographic coherence at ages with limited exposure by borrowing strength from established references such as AM80/AF80.

Although the Kaplan–Meier estimator provides a robust nonparametric baseline, it may exhibit local irregularities, particularly at advanced ages where exposure is limited. Because actuarial applications require a smooth and continuous mortality trajectory, several smoothing strategies were explored. The Whittaker–Henderson technique was tested but failed to deliver stable tail behavior and was therefore not retained. Parametric approaches based on Makeham’s law and the Brass relational model were subsequently favored for their actuarial interpretability and demographic stability.

As neither model alone fully reconciled data limitations with demographic plausibility, we introduce a hybrid approach, the Sample Weighted Average (SWA). The SWA combines Brass and Makeham estimates through a logistic weighting scheme driven by local exposure density. Let N_x denote exposure at age x , normalized as $w_x = N_x / \max_x N_x$. The weight is defined as

$$\omega(x) = \frac{1}{1 + \exp[-b(w_x - a)]},$$

where the parameters a and b control the location and steepness of the transition between the two models. Specifically, a represents the exposure level (expressed as a proportion of the maximum) at which the weight shifts from favoring Brass to favoring Makeham, while b determines how abruptly this transition occurs. In this study, $a = 0.3$ and $b = 1$ were chosen after sensitivity testing to achieve a smooth, yet responsive transition. The value $a = 0.3$ ensures that when exposure exceeds roughly 30% of its maximum observed level, the Makeham component begins to dominate, reflecting sufficient data reliability. The moderate slope parameter $b = 1$ prevents abrupt switching between methods, maintaining numerical stability and demographic continuity between ages. The resulting rate is

$$q_x^{\text{SWA}} = \omega(x) q_x^{\text{Makeham}} + [1 - \omega(x)] q_x^{\text{Brass}},$$

which produces a continuous, demographically coherent curve. It leans on Brass when data are sparse and on Makeham when exposure is strong, ensuring smooth and stable estimates suitable for actuarial use. A simpler fixed-weight Weighted Average (WA) was also implemented as a benchmark, confirming the robustness of the SWA results.

3.3. Evaluation of Smoothing Methods

To assess the plausibility of mortality estimates derived from Lebanese insurance data, we compare them with the French insurance life tables TGH05 (males) and TGF05 (females), published by SPAC Actuaire [SPAC Actuaire \(2005\)](#). These tables are provided as cohort life tables reporting the number of survivors l_x at each age.

To ensure consistency with our period-based framework, cohort tables were converted into period mortality rates using

$$q_x = \frac{l_x - l_{x+1}}{l_x},$$

and values corresponding to calendar year 2005 were extracted to reconstruct the associated period life tables.

Mortality rates were expressed on a radix of 100,000 and plotted on a logarithmic scale to highlight both absolute levels and relative deviations. Figures 10 and 11 compare Lebanese mortality estimates obtained from the Kaplan–Meier baseline and from the different smoothing methods (Brass, Makeham, Whittaker–Henderson, Weighted Average, and Sample Weighted Average) with the French references TGH05 and TGF05.

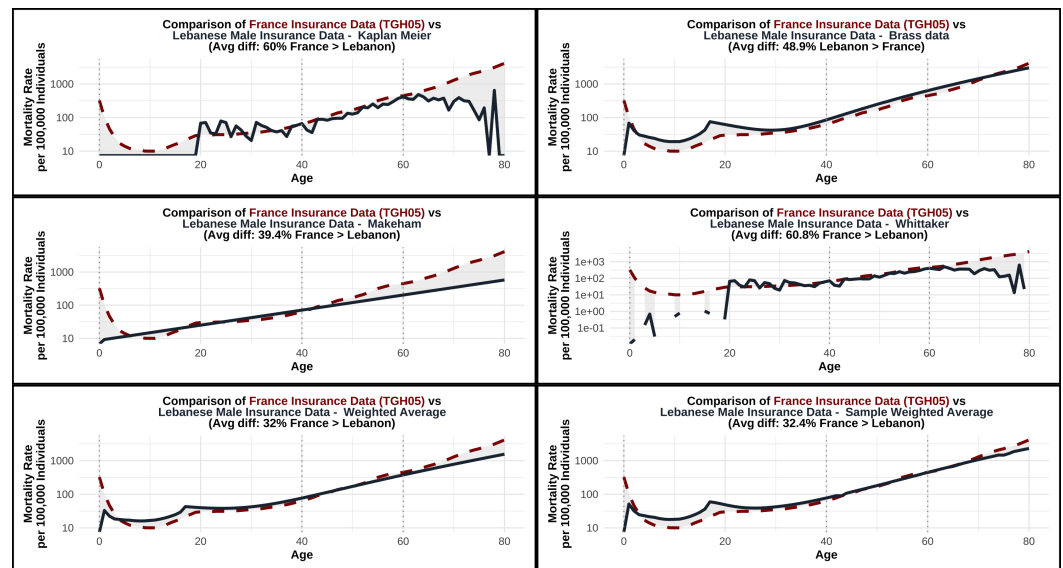


Figure 10. Male mortality: Lebanese insurance data (solid lines) versus French insurance reference TGH05 (dashed lines).

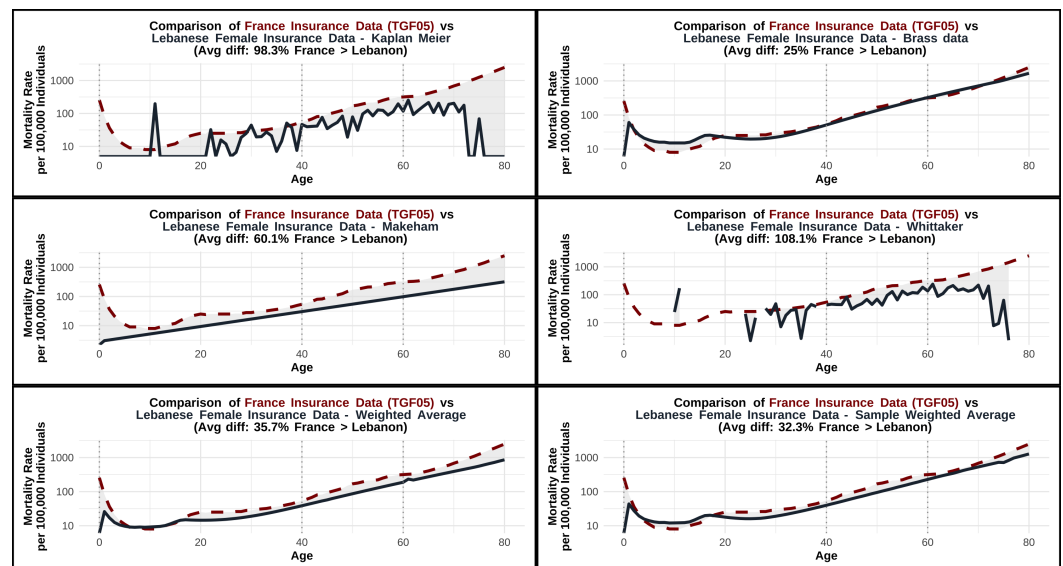


Figure 11. Female mortality: Lebanese insurance data (solid lines) versus French insurance reference TGF05 (dashed lines).

For men (Figure 10), both the Brass and Sample Weighted Average (SWA) methods generate smooth and monotonic mortality curves, but they differ in well-exposed age ranges. SWA closely follows the empirical Kaplan–Meier estimates and remains aligned with the French TGH05 reference between ages 30 and 70, whereas the Brass model tends to overestimate Lebanese mortality when exposure is sufficient. The Makeham model provides a reasonable fit up to about age 50 but diverges at older ages, underestimating mortality relative to TGH05 and failing to capture the early-adult mortality hump. The Weighted Average method offers a stable compromise but is less adaptive than SWA. In contrast, Kaplan–Meier and Whittaker–Henderson estimates display marked irregularities at young and old ages due to sparse exposure and censoring, limiting their actuarial applicability.

For women (Figure 11), all Lebanese mortality estimates lie below the French TGF05 reference, particularly between ages 30 and 50 where exposure is strongest (Figure 2), with average differences generally exceeding 30%. Kaplan–Meier and Whittaker–Henderson estimates are highly irregular and unsuitable for actuarial use. The Makeham model pro-

duces a smooth but systematically underestimated curve, while the Brass model follows the general shape of TGF05 but overestimates mortality relative to empirical observations. The Weighted Average method yields a coherent curve slightly below the French reference. Among all approaches, SWA provides the most consistent compromise between smoothness, empirical plausibility, and adaptability to data density.

Additional validation was conducted by comparing observed deaths with those predicted by the SWA model. Predicted deaths equal 1518 for men, 384 for women, and 1672 overall, compared with observed counts of 1152, 256, and 1408, yielding relative errors of 5.03%, 9.99%, and 4.79%, respectively. Deviations remain limited across age groups and increase only at the oldest ages, where exposure declines sharply.

On this basis, the Sample Weighted Average method is retained for the construction of the Lebanese mortality tables, as it offers a coherent balance between smoothness, empirical fidelity, and demographic consistency across the full age range.

3.4. Validation Against International References

The French insured-life tables TGH05 (males) and TGF05 (females) are used as external benchmarks to assess the plausibility and actuarial consistency of the Lebanese mortality tables constructed from insurance data. These references provide a structured comparison framework and allow the identification of potential anomalies arising from data limitations or methodological choices.

The Lebanese mortality curves obtained using the Sample Weighted Average (SWA) method (Section 3.2) reflect the selection and underwriting characteristics of the insured portfolio.

At adult and older ages, mortality levels are systematically lower than those observed in TGH05 and TGF05 (Figure 12). This pattern is consistent with actuarial evidence showing that insured populations in emerging or highly selective markets often exhibit lower mortality than insured populations in mature markets, due to stricter underwriting, stronger selection effects, and smaller portfolio sizes (Bernheim 1998; Rothschild and Stiglitz 1976). Forcing convergence toward French insured mortality at these ages would therefore distort the observed Lebanese insured experience rather than improve actuarial realism.

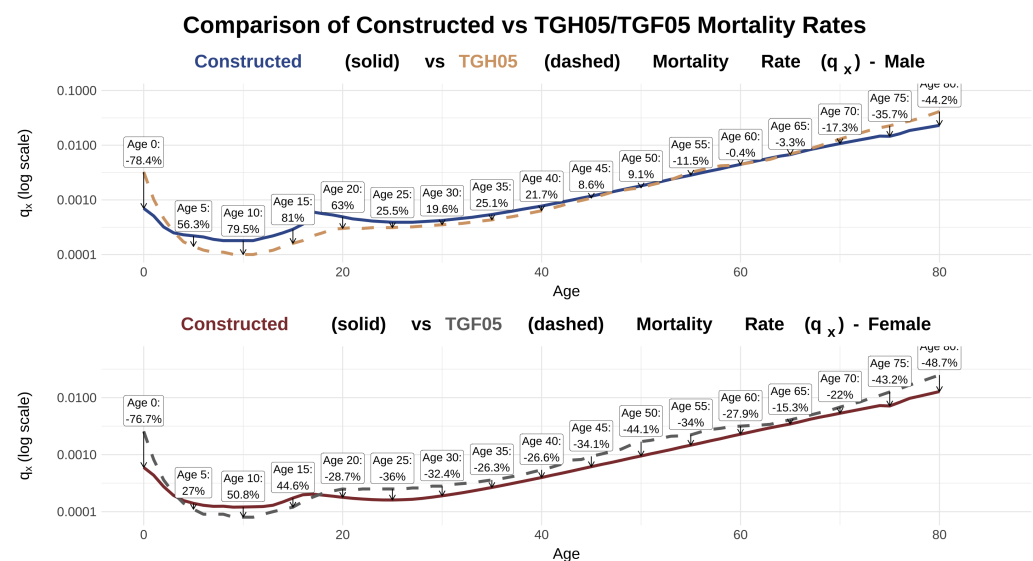


Figure 12. Comparison of Lebanese constructed mortality rates with French insurance references: males (top, vs. TGH05) and females (bottom, vs. TGF05), on a logarithmic scale. Arrows indicate relative differences, with percentage values shown every five years.

At younger adult ages, deviations from the French reference tables are more likely driven by data-related constraints than by genuine structural differences in mortality. Mortality estimation in this age range is sensitive to sparse exposure, entry and exit dynamics, and censoring effects inherent to insurance portfolios. Consequently, mortality rates at these ages are stabilized through internal smoothing and calibration procedures rather than direct alignment with external references.

3.5. Refinement of Early- and Mid-Life Mortality

At very young ages, mortality estimates derived from the Lebanese insured portfolio are implausibly low when compared with international benchmarks. This bias is primarily driven by extreme data scarcity, as very few insured lives are observed at these ages. Even after smoothing and hybrid estimation, insured-life data alone fail to reproduce a realistic early-age mortality profile.

At these ages, population-level information provides a more appropriate external reference. Newborns and young children are typically insured automatically under parental contracts, without individual medical underwriting. Early-age mortality therefore largely reflects public health conditions and the completeness of vital registration rather than insurance selection.

This interpretation is supported by international evidence showing that mortality in childhood and adolescence is mainly driven by environmental and epidemiological factors rather than insurance coverage (Patton et al. 2009). While insurance status significantly affects adult mortality, with uninsured individuals experiencing mortality ratios of approximately 1.2 to 1.3 relative to insured populations (Sorlie et al. 1994), its impact at young ages is limited (Dow et al. 2003).

World Bank indicators confirm this discrepancy: infant mortality in Lebanon reached 15–16 per 1000 live births in 2022–2023, compared with approximately 3 per 1000 in France (World Bank 2022). Relying directly on insured-life estimates at early ages would therefore substantially underestimate true demographic risk.

To correct this distortion, a LOWESS smoothing was applied to the age-specific percentage differences between Lebanese and French mortality rates for ages above four, where empirical estimates become more reliable (Figure 13). For ages 0–4, where differences were negative due to data scarcity, adjustments were obtained by linear extrapolation from age four, corresponding to the first age at which Lebanese mortality exceeds the French reference. This approach preserves demographic coherence while avoiding overfitting in poorly observed age ranges.

From an actuarial perspective, this refinement is essential, as infant and neonatal risks are among the most costly in life and health insurance. For instance, the lifetime incremental cost of a preterm birth was estimated at \$51,800 in 2005 and \$64,800 in 2016 after adjustment for inflation and medical cost growth (Waitzman et al. 2021), justifying a conservative and externally calibrated treatment of early-age mortality.

Residual irregularities during childhood and adolescence were further smoothed using a parabolic adjustment applied to $\log(q_x)$ between ages 4 and 17. A quadratic polynomial was fitted within a moving 13-year window and exponentiated back to the mortality scale, ensuring a continuous transition between early-age adjustments and the observed adult curve.

At selected adult ages with missing or inconsistent values (notably ages 65–66 and 75–76), continuity was ensured through linear interpolation between adjacent observed ages. These targeted corrections preserve smoothness without altering the overall mortality structure.

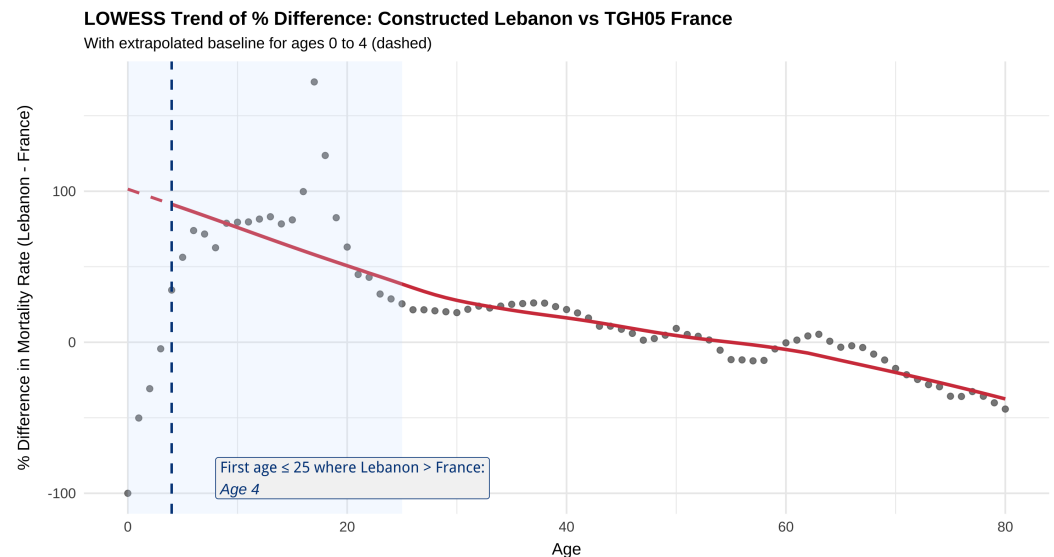


Figure 13. LOWESS smoothing of the percentage difference between Lebanese and French (TGH05) mortality. Grey dots denote observed age-specific percentage differences, the red curve shows the LOWESS-smoothed trend, and the shaded area highlights the early-age range with sparse exposure. Extrapolation for ages 0–4 (dashed) is based on the initial slope of the smoothed curve.

The resulting male mortality profile (Figure 14) integrates LOWESS-based correction at early ages, parabolic smoothing throughout childhood and adolescence, and targeted interpolation at specific adult ages.

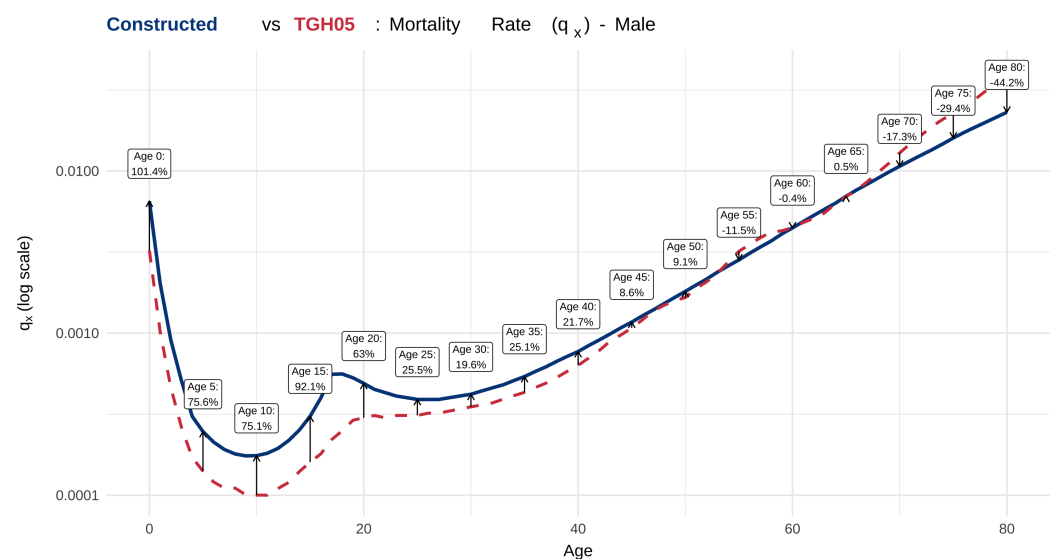


Figure 14. Final smoothed male mortality curve for Lebanon (solid blue) compared with TGH05 (dashed red), after early-age correction and smoothing.

3.6. Extrapolation Beyond Age 80

Beyond age 80, observed mortality in the Lebanese insured portfolio becomes sparse and statistically unstable (Brass 1975; Kinsella and Phillips 2005). Several extrapolation approaches were therefore examined to project mortality at advanced ages while preserving the empirical structure observed at ages with sufficient exposure.

Three classical extrapolation approaches were considered: the Coale–Kisker method, Makeham’s law, and a level-adjusted extrapolation based on the French TGH05 insured-life table. All methods were calibrated to the Lebanese experience and extrapolated up to

age 120, after which mortality was capped at $q_x = 1$, consistent with standard actuarial and demographic practice (Aarssen and de Haan 1994; Richmond and Roehner 2016).

The Coale–Kisker model (Coale and Kisker 1990), specifically designed for old-age mortality extrapolation, allows for a gradual deceleration in mortality growth at very advanced ages. For ages $x > 80$, mortality is defined as

$$q_x = q_{80} \exp[r(x - 80) - 0.0005(x - 80)^2], \quad r = \frac{\log(q_{80}) - \log(q_{65})}{15}.$$

Makeham’s law (Makeham 1860) was also considered, with parameters estimated over ages 65–80. When extrapolated beyond this range, it implies a strictly exponential increase in mortality, which tends to produce conservative levels at the highest ages.

A level-adjusted extrapolation based on the French TGH05 table was used as a benchmark. The TGH05 age profile was retained and scaled to the Lebanese insured experience using a fixed multiplier computed at age 40, where exposure remains substantial and mortality estimates are statistically reliable. Figure 15 shows that this multiplier-based extrapolation already yields mortality levels above those obtained from internally constructed extrapolations, suggesting a tendency to overestimate mortality at advanced ages in an insurance context.

Among the extrapolation methods considered, Makeham and Coale–Kisker produce closely aligned trajectories. The Coale–Kisker method is therefore retained as a conservative specification, as it captures the empirically documented deceleration in the growth of mortality at advanced ages, a feature commonly observed in insured and other selected populations (Coale and Kisker 1990; Pitacco 2016; Wilmoth and Horiuchi 1995).

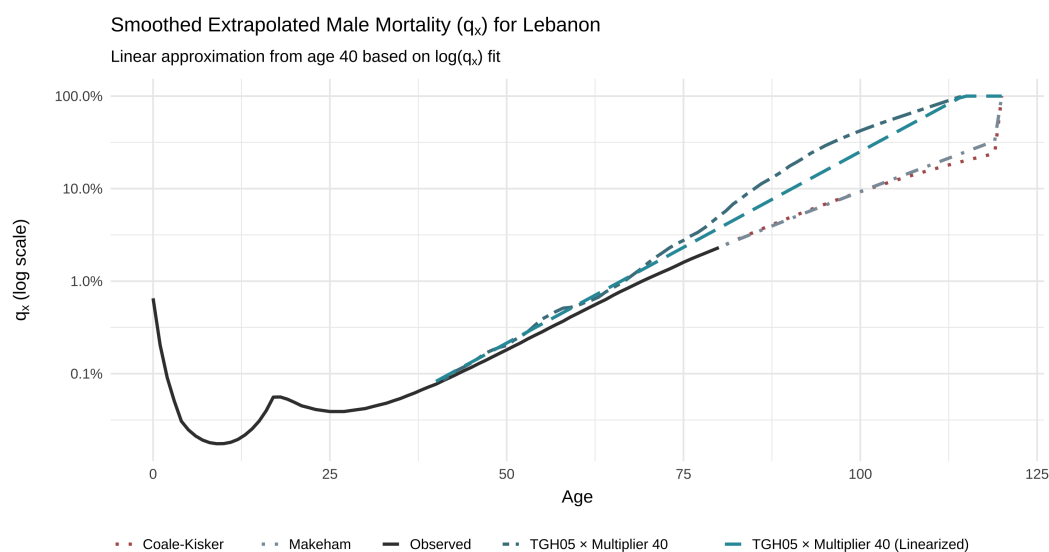


Figure 15. Extrapolated male mortality beyond age 80 using the Coale–Kisker method, Makeham’s law, and a level-adjusted TGH05 benchmark.

3.7. Female Mortality Construction and Extrapolation

Female mortality was constructed using the same methodological framework as for males. As in the male case, localized corrections and smoothing were applied at ages where mortality estimates are inherently unstable, particularly in early childhood and at advanced ages. Beyond age 80, the same extrapolation strategies as those used for males were considered, with the Coale–Kisker method ultimately retained for the final female mortality table.

Given the limited size and irregular age structure of the insured female portfolio in Lebanon, the direct construction of a standalone female mortality table is statistically fragile. To address this limitation, an indirect ratio-based strategy was adopted, deriving female mortality from the male mortality curve through empirically observed sex-specific differentials. This approach is well established in actuarial practice when female data are sparse and ensures internal coherence between male and female life tables (Cairns et al. 2006; Dickson et al. 2020; Pitacco et al. 2009).

Within this framework, the Lebanese female mortality curve was constructed using a hybrid ratio-based approach combining information from two international insured-life reference systems: the British AF80/AM80 tables and the French TGF05/TGH05 tables. These references reflect distinct historical periods and mortality regimes, separated by approximately twenty-five years, and capture different stages of longevity improvement, behavioral change, and epidemiological transition in insured populations.

The AF80/AM80 ratios, derived from an insured population in the early 1980s, are characterized by pronounced gender differentials at younger adult ages, with female mortality falling below 50% of male mortality during adolescence and early adulthood, before stabilizing around 60% at later adult ages. This pattern reflects strong excess male mortality largely driven by behavioral and external causes. By contrast, the more recent TGF05/TGH05 ratios correspond to a more advanced longevity regime, with smoother age profiles and narrower gender gaps, especially at older ages (Figure 16).

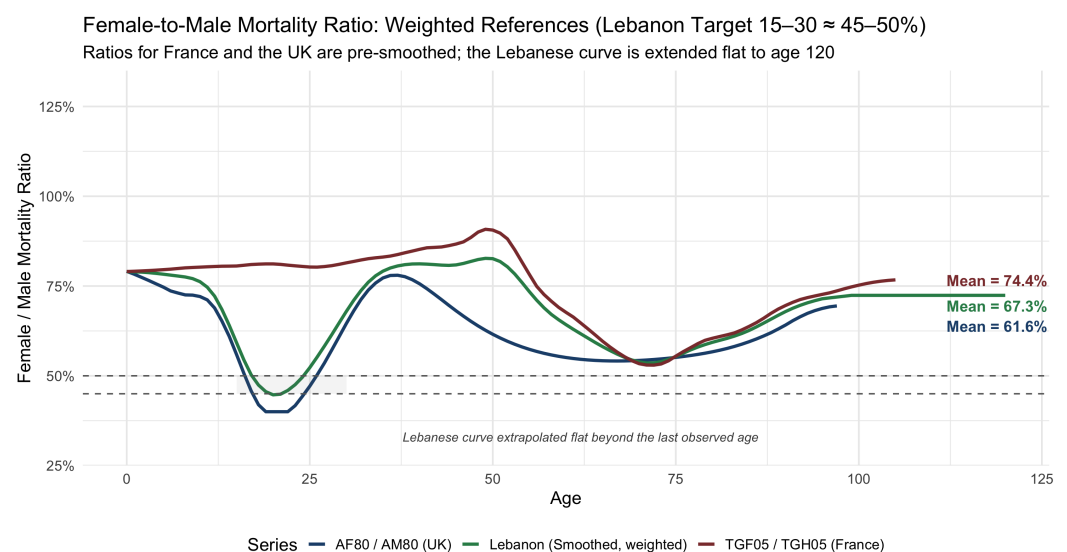


Figure 16. Weighted female-to-male mortality ratios combining UK (AF80 and AM80) and French (TGF05 and TGH05) references. Horizontal dashed lines indicate the target calibration range (approximately 45–50%) for the Lebanese female-to-male mortality ratio at ages 15–30.

Beyond cross-country differences, long-term demographic evidence highlights the importance of the period at which gender mortality ratios are observed. As shown in Figure 17, male and female mortality rates in France have declined substantially since 1960, but at different paces. Faster relative improvements among men have led to a progressive narrowing of the gender mortality gap over time (INSEE 2024; Preston and Wang 2006). This asymmetric evolution implies that female-to-male mortality ratios are inherently period-dependent. Consequently, the differences observed between AF80/AM80 and TGF05/TGH05 primarily reflect distinct stages of demographic, behavioral, and epidemiological transition rather than purely cross-country effects. A similar, though attenuated, pattern is observed in insured populations (Milliman 2019).

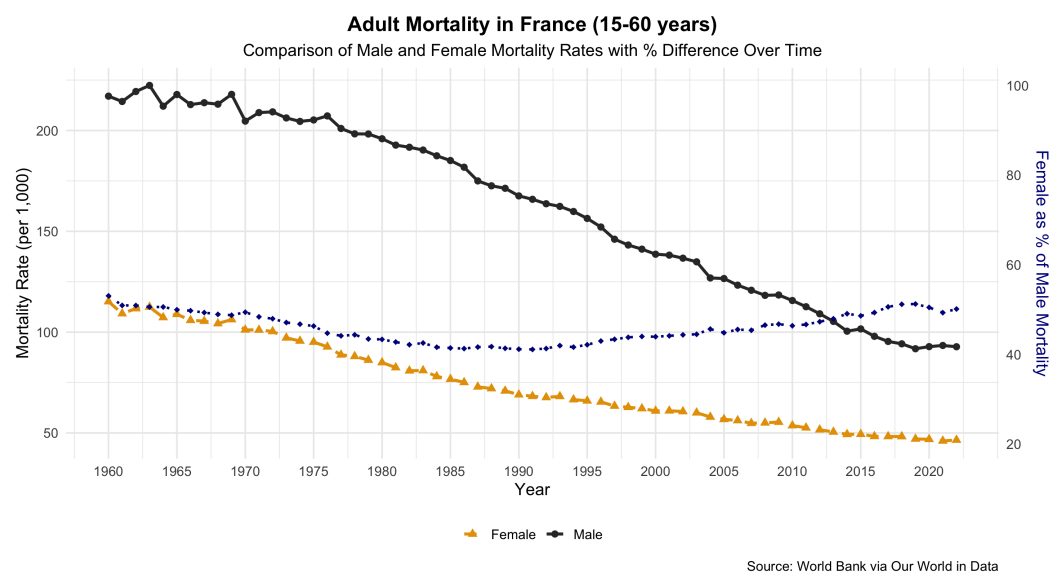


Figure 17. Adult mortality in France (ages 15 to 60): male and female mortality rates (left axis) and the corresponding female-to-male mortality ratio (blue line, right axis) (World Bank).

Crucially, local Lebanese evidence confirms that neither international reference can be applied uniformly across all ages. National mortality data analyzed by Naja et al. (Naja et al. 2025) for the period 2017–2022 show a pronounced excess of male mortality between ages 10 and 24, with men accounting for approximately 69% of all deaths compared to 31% among women. Given the near balance of the population by sex in this age group, these figures imply a female-to-male mortality ratio of approximately 45–50%, indicating that young men are about twice as likely to die as young women.

This pattern is epidemiologically coherent for Lebanon. National mortality statistics (Naja et al. 2025), together with the distribution of causes of death observed in the Lebanese insured population (Figure 8), indicate that external causes such as road traffic accidents, violence, and other injuries play a major role in early-adult mortality, particularly among men.

In contrast, published cause-of-death statistics for France reported in the World Health Organization Global Health Estimates show a substantially lower contribution of external causes to mortality at young adult ages, with deaths being predominantly driven by chronic and degenerative diseases (World Health Organization 2020). As a result, gender mortality differentials at young adult ages are structurally larger in Lebanon than those implied by the TGF05/TGH05 reference tables and are closer to the levels observed in the AF80/AM80 system.

At older ages, where mortality is increasingly driven by chronic and degenerative conditions, gender differentials are primarily shaped by longevity dynamics rather than external risks. In this age range, the French mortality profile becomes more representative, as the TGF05/TGH05 tables capture a mortality regime characterized by sustained longevity improvements and a progressive convergence between male and female mortality rates. This supports their relevance as a benchmark in later adulthood.

While age-specific patterns highlight the relevance of different reference systems at different stages of the life cycle, it is also informative to examine gender mortality differentials at an aggregate level. A broader international comparison further clarifies the empirical position of the commonly used 70% benchmark. As shown in Figure 18, female mortality in Lebanon has remained broadly between 60% and 70% of male mortality since 2000. A similarly stable range is observed in the United Kingdom over several decades, consistent with the AF80/AM80 calibration. In France, the female-to-male ratio in

the general population declined markedly between the 1960s and the early 1990s before stabilizing around 45–50%, reflecting faster longevity gains among men. By contrast, the insured-life TGF05/TGH05 tables imply a higher average ratio (approximately 74.5%), consistent with the healthier and more affluent composition of insured populations and stronger selection effects. These comparisons confirm that the 70% benchmark is empirically plausible in aggregate while remaining sensitive to population type and historical period.

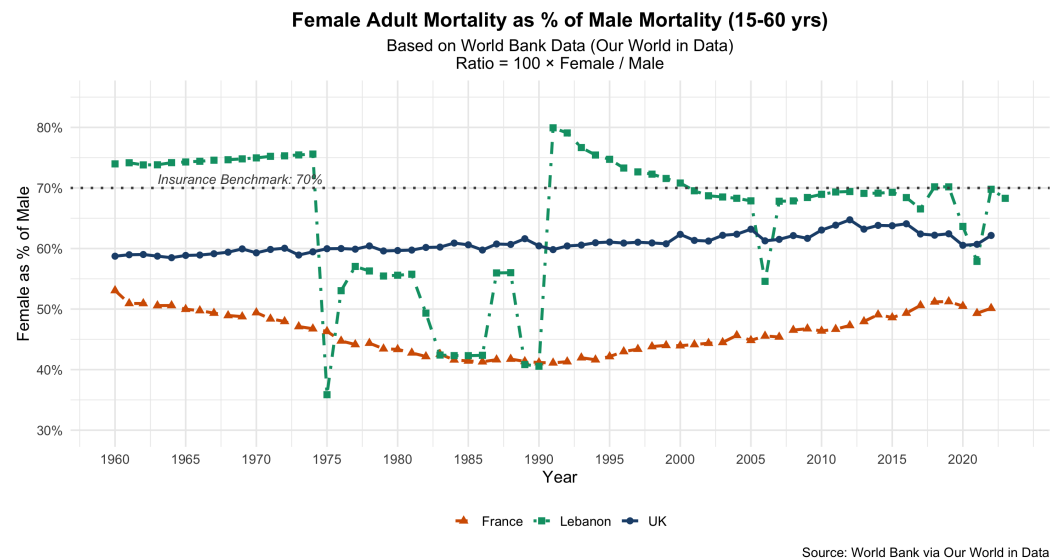


Figure 18. Female-to-male mortality ratio (ages 15 to 60) in Lebanon, the United Kingdom, and France, 1960 to 2022. The dotted line at 70% represents a benchmark commonly used in Lebanese insurance practice.

However, this age-specific relevance contrasts with current actuarial practice in Lebanon, where a constant female-to-male mortality ratio of 70% is commonly applied when female data are limited. While this benchmark is broadly consistent with the average magnitude of gender differentials observed in recent decades, it implicitly assumes that the ratio is stable across ages. Empirical evidence shows instead that gender differentials vary substantially over the life cycle, with pronounced excess male mortality at young adult ages and a gradual narrowing at older ages.

These elements indicate that neither AF80/AM80 nor TGF05/TGH05 alone provides a fully adequate representation of gender mortality differentials for the Lebanese insured population. The British ratios are more informative at younger adult ages, where mortality is strongly influenced by behavioral and external causes, whereas the French ratios better reflect mortality patterns at older ages within a longevity-driven regime. This motivates the use of an age-dependent hybrid approach rather than a single reference or a constant ratio. The final Lebanese female mortality curve was therefore constructed using an age-dependent weighted combination of the two reference systems. Greater weight was assigned to the UK AF80/AM80 ratios at younger adult ages, while the influence of the French TGF05/TGH05 ratios increases progressively with age. The resulting Lebanese ratio was smoothed to ensure biological continuity and held constant beyond the highest observed age to ensure proper closure of the life table.

Final female mortality rates were obtained by applying the smoothed Lebanese ratio to the male mortality curve at each age,

$$q_x^{\text{female}} = q_x^{\text{male}} \times \text{Ratio}_{\text{Lebanon, smoothed}},$$

thereby ensuring full internal consistency between male and female life tables.

Figure 19 presents the reconstructed female mortality curve together with the male mortality curve and two alternative female estimates, all displayed on a logarithmic scale. The curve labeled 'Female (Observed, from data)' corresponds to the female mortality table constructed directly from the available insured female data using the same methodological framework as for males, including smoothing and extrapolation steps. The curve labeled 'Female (Constructed via weighted ratios)' represents the final ratio-based reconstruction, obtained by applying the age-dependent weighted female-to-male mortality ratios derived from the AF80/AM80 and TGF05/TGH05 reference systems to the male mortality curve.

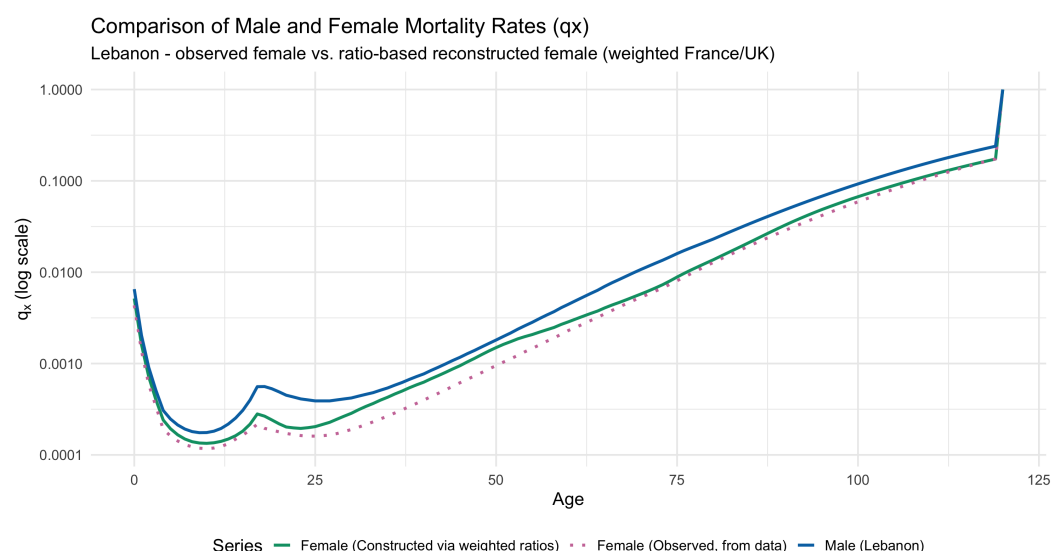


Figure 19. Comparison between the male mortality curve, the observed female data, and the ratio-based reconstructed female mortality rates (q_x).

Once age-specific insured mortality tables are constructed, population mortality is explored by recovering a realistic age pattern. This is achieved by applying age-specific insured-to-population mortality ratios observed in France. These ratios are used solely to transfer the age profile of mortality, while preserving the overall mortality level implied by the Lebanese insured data.

The resulting life expectancy at birth for the Lebanese male population ($e_0 = 79.12$ years) is very close to external estimates for Lebanon, which report values around 78 years over the period 2015–2019 (World Bank 2024b).

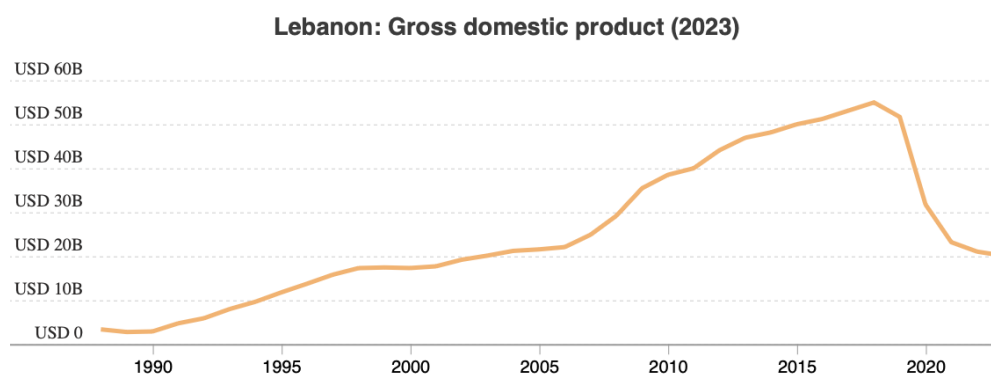
A complete presentation of the resulting insured and population-based life tables for both males and females is provided in Appendices A.1 and A.3.

4. Impact of the Economic and Health Crises on Mortality and Insurance Dynamics

Lebanon experienced a sequence of major shocks between 2019 and 2021, including a severe economic collapse, the COVID-19 pandemic, and the Beirut port explosion. Figure 20 summarizes the timing of these events, while Figure 21 illustrates the sharp macroeconomic contraction following 2019. These shocks profoundly altered both the demographic environment and the functioning of the insurance market.



Figure 20. Chronology of significant events in Lebanon (2000–2021).



Data from datacatalog.worldbank.org via Data Commons

Figure 21. Lebanon's nominal gross domestic product (1988–2023), showing steady expansion until 2018 followed by a sharp contraction after 2019. Source: ([World Bank 2024a](#)).

A central challenge when interpreting mortality indicators during this period is to disentangle genuine changes in mortality from mechanical effects induced by rapid contractions in insurance exposure. This section therefore examines portfolio dynamics, exposure evolution, and observed mortality jointly in order to provide a consistent actuarial interpretation of the crisis period.

4.1. Portfolio Disruptions, Exposure Dynamics, and Insurance Behaviour During the Crisis

Section 2 documents a decline in total insurance exposure prior to 2019, while annual death counts remained broadly stable, leading to rising insured mortality rates at the aggregate level. The present analysis refines this result by examining exposure dynamics by age interval in order to assess whether the change in risk profile observed for the portfolio as a whole is also reflected across age groups.

Figure 22 shows that exposure declined across all male age intervals, with markedly larger relative reductions among younger and middle-aged individuals (ages 2–26, 29–33, and 44–48), while older age groups (60–95) experienced more limited declines. This age-differentiated contraction is consistent with portfolio structure, where protection-type contracts are more prevalent and easier to discontinue at younger ages, whereas savings and mixed products exhibit greater persistence at older ages.

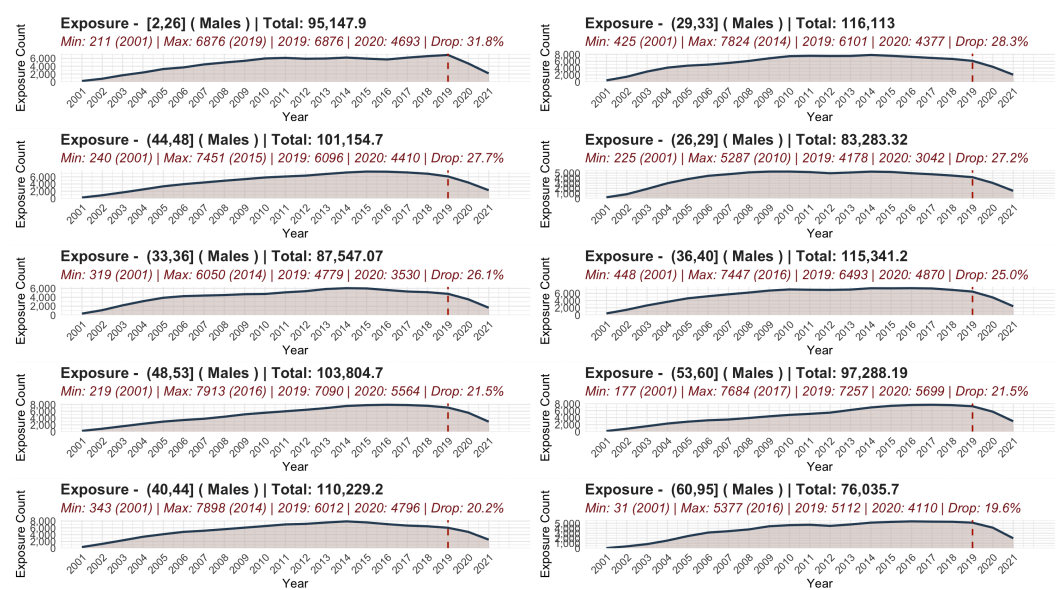


Figure 22. Evolution of male insurance exposure by age group, ordered by magnitude of decline during the crisis period.

Despite the sharp contraction in exposure across age intervals, the annual number of recorded deaths remained relatively stable, fluctuating between approximately 100 and 130 per year. The increase in observed mortality rates after 2020 therefore reflects primarily the combined effect of exposure contraction and age-specific portfolio reallocation.

To place these portfolio disruptions in a broader context, insurance exposure dynamics are examined over a longer time horizon. Figure 23 shows that insurance exposure expanded moderately until the mid-2010s, stagnated thereafter, and declined sharply after 2019. Exposure fell by approximately 25% in 2020 and by more than 50% in 2021.

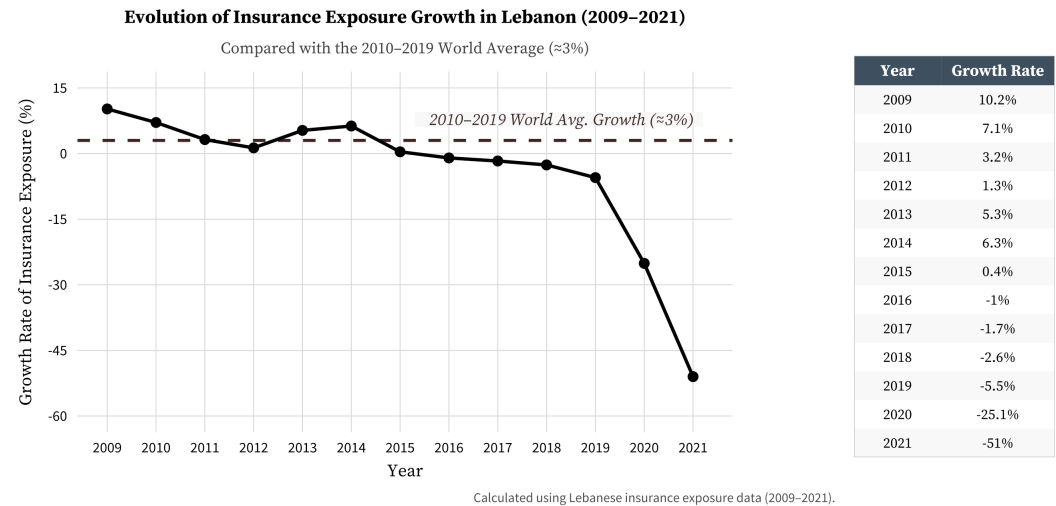


Figure 23. Evolution of insurance exposure growth in Lebanon (2009–2021), compared with the 2010–2019 world average of approximately 3%. Calculated using Lebanese insurance company data used in this study.

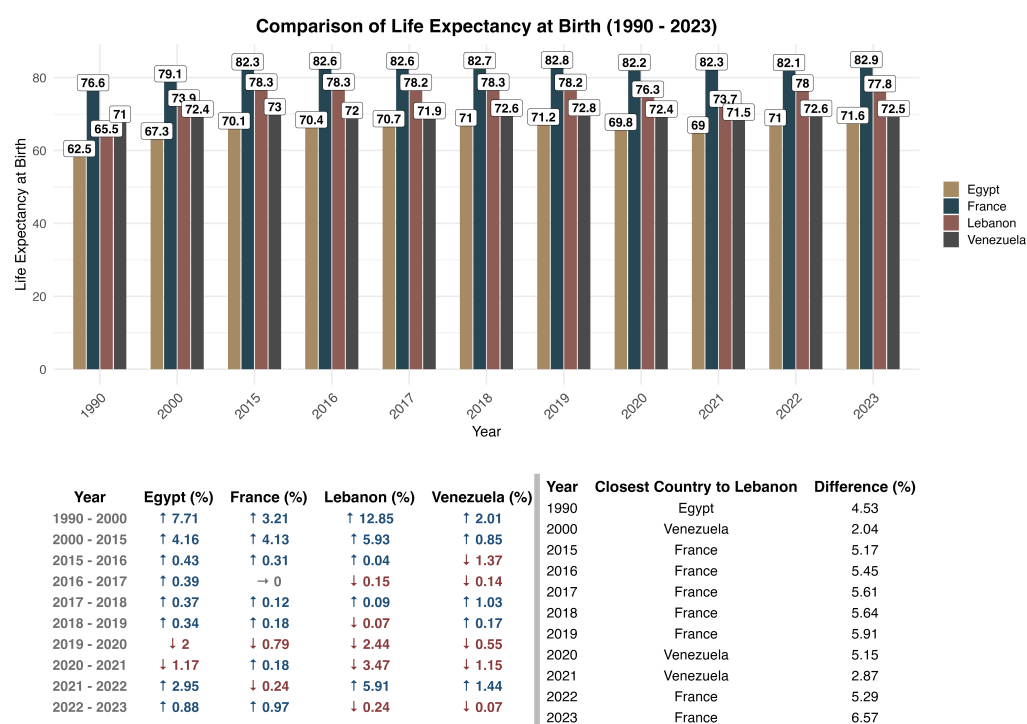
International evidence indicates that the contraction of insurance activity observed in 2020 was moderate at the global level. According to Swiss Re Institute data (Swiss Re Institute 2023), premium growth in 2020 declined by −1.8% in advanced markets and by −2.4% in emerging markets excluding China, while global premiums declined by −1.3%. Over the same year, emerging markets as a whole recorded a modest positive growth of 0.8%, driven primarily by China, where premium growth reached 3.6%. The magnitude of

the decline observed in the Lebanese insurance market therefore distinguishes it from the pandemic-related contractions recorded internationally.

4.2. Insured and Population Mortality Under Changing Conditions

Economic and institutional conditions affect both population mortality and the composition of insured portfolios. A first aggregate perspective on this interaction is provided by national life expectancy at birth, which summarizes overall mortality conditions and their evolution over time. Figure 24 presents the evolution of life expectancy in Lebanon relative to France, Venezuela, and Egypt.

From 2015 to 2019, life expectancy in Lebanon remains relatively close to that of France, with a stable gap reflecting persistent demographic and institutional differences. Following the onset of the economic collapse and the COVID-19 shock, this pattern changes markedly. Lebanese life expectancy declines and converges toward levels observed in Venezuela, whose life expectancy remains close to 73 years over the period considered. This convergence indicates a change in the mortality regime and motivates a closer examination of mortality dynamics using complementary indicators.



Source: World Bank - World Development Indicators (SP.DYN.LE00.IN)
<https://databank.worldbank.org/source/world-development-indicators/Series/SP.DYN.LE00.IN>

Figure 24. Life expectancy at birth in Lebanon, France, Venezuela, and Egypt (1990–2023). Upward and downward arrows indicate periods of increase and decline in life expectancy between successive observation periods. Source: World Bank, World Development Indicators (indicator SP.DYN.LE00.IN), available online: <https://databank.worldbank.org/source/world-development-indicators/Series/SP.DYN.LE00.IN>, accessed on 26 January 2026.

While life expectancy provides a synthetic view of long-term mortality conditions, annual mortality rates offer complementary information by capturing short-term fluctuations and shock periods, for which conventional life table measures may be misleading (Alho 2025; Goldstein and Lee 2020; Luy et al. 2020).

Figure 25 therefore compares male mortality rates between 2000 and 2023 across countries classified by income level.

Over the period 2000–2023, Lebanon exhibits the highest variability in annual male mortality, followed by Venezuela. During recent shock periods (2021), both countries reach comparable peaks of approximately eight deaths per 1000 individuals. This joint evidence complements the convergence observed in life expectancy and motivates further analysis of mortality patterns under crisis conditions.

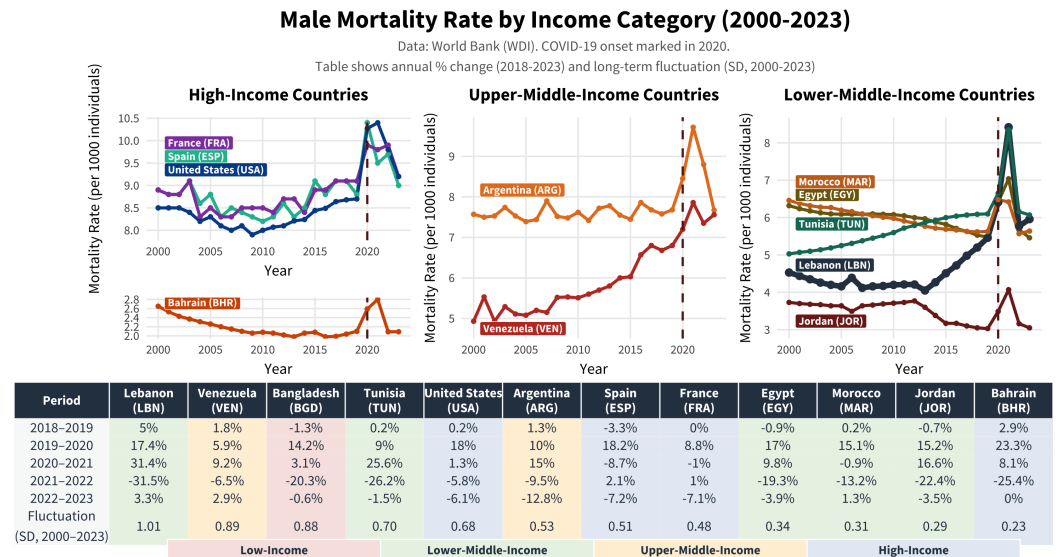


Figure 25. Male mortality rate (per 1000 individuals) between 2000 and 2023 by income category. Each panel corresponds to a World Bank income group (high-income, upper-middle-income, and lower-middle-income countries). Colored lines represent individual countries within each group, identified by their country codes shown on the curves. The vertical dashed line marks the year 2020, corresponding to the onset of the COVID-19 pandemic. Source: World Bank, *World Development Indicators*.

Insurance data provide detailed mortality information by age for insured individuals, whereas population mortality is more commonly available in aggregated age formats. Insured mortality is therefore analysed using abridged five-year age intervals. The analysis is restricted to men due to insufficient exposure in the insured female portfolio. Five-year life tables are constructed for the Lebanese insured male population in line with standard demographic and actuarial practice (Preston et al. 2001; United Nations 1983). Internal consistency between abridged mortality rates and five-year probabilities reconstructed from annual age-specific q_x estimates is confirmed by a low root mean squared error (RMSE = 0.095), indicating close agreement between the two representations.

To examine how insured and population mortality evolve relative to one another over time, age-independent multipliers are derived from yearly ratios between Lebanese insured mortality and World Bank population mortality over the period 2009 to 2021. Ratios are computed over ages 15 to 59, where both insured exposure and population mortality data are considered statistically reliable. Figure 26 illustrates the temporal variability of these ratios.

Three multiplier scenarios are retained to characterize the range of observed insured-to-population alignment conditions. The minimum scenario corresponds to crisis periods. The maximum scenario reflects earlier periods dominated by stronger selection effects. The average scenario represents an intermediate and deliberately conservative case. The median multiplier (55.1) is very close to the arithmetic mean (53.98) and does not provide additional information. Time-weighted approaches are not retained, as weighting recent or earlier years leads to values close to the minimum or maximum scenarios, respectively.

Applying these multipliers to interval-based insured mortality defines population mortality scenarios that are compared with international benchmarks (Figure 27). The

crisis-related minimum scenario places Lebanese age-specific mortality at levels comparable to those observed in Venezuela, consistent with the convergence identified in life expectancy. The average scenario is associated with higher mortality levels, reflecting differences in insured-to-population alignment across economic regimes.

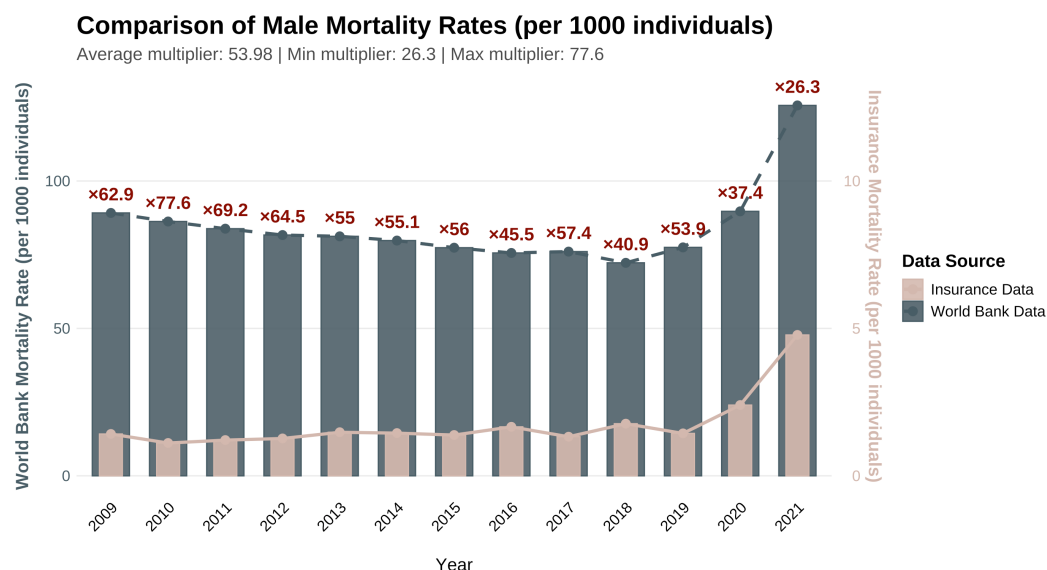


Figure 26. Yearly ratios between Lebanese population mortality (World Bank) and insured mortality (company data), 2009 to 2021.

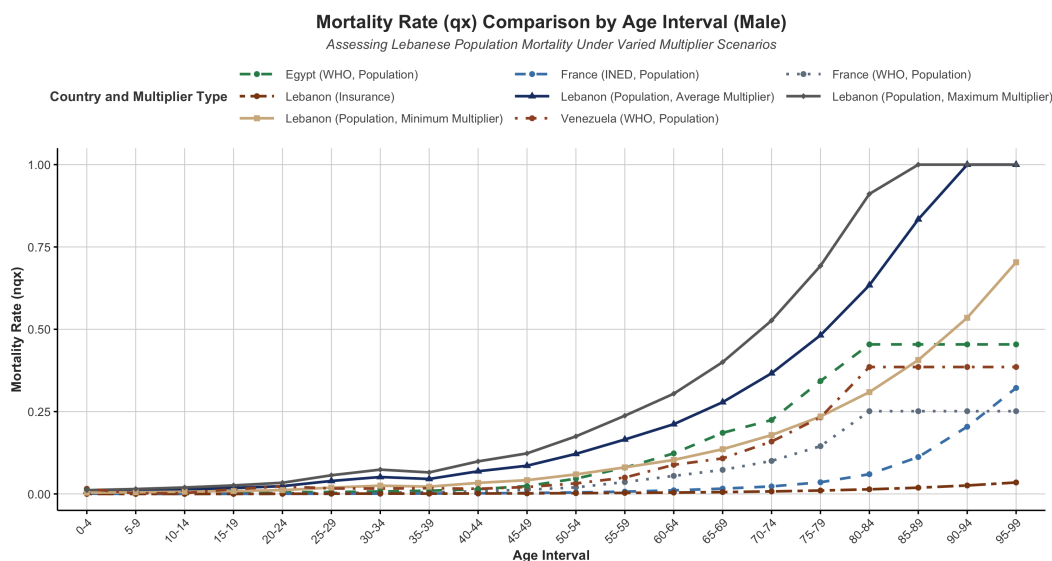


Figure 27. Lebanese male mortality under multiplier scenarios compared with population references.

The validity of transposing yearly insured-to-population mortality ratios to age-specific mortality rates depends on the age structure and risk composition of the insured portfolio. In non-crisis periods, insured portfolios are predominantly composed of younger and lower-risk individuals, as documented in Section 2. Aggregate yearly ratios are therefore strongly influenced by portfolio composition and may distort mortality at older ages when applied uniformly.

During crisis periods, portfolio composition changes, with a relative increase in older and higher-risk insured individuals. In this context, annual insured mortality moves closer to population mortality, and the resulting ratios more closely reflect age-specific mortality patterns. For adult and older ages, the transposition becomes substantially more reliable.

Economic and institutional shocks substantially alter both population mortality and the composition of insured portfolios. In the Lebanese case, mortality dynamics exhibit pronounced volatility at the population level and are further amplified within insurance data through rapid changes in coverage, selection, and exposure. Variations in the insured risk profile therefore translate into marked changes in observed mortality and in the insured-to-population relationship.

This sensitivity is particularly pronounced in Lebanon, where insurance participation responds sharply to economic stress. During crisis periods, portfolio composition shifts toward older and higher-risk insured individuals, leading insured mortality to converge toward population mortality. As a result, transposition mechanisms that may appear stable in non-crisis contexts become highly dependent on prevailing socioeconomic conditions.

These findings underline that mortality estimation based on insurance data cannot be interpreted independently of portfolio dynamics and institutional context. In countries exposed to repeated economic shocks, such as Lebanon, mortality levels and trends are especially susceptible to abrupt and structurally significant fluctuations.

4.3. Scenario Testing and Actuarial Validation Under Crisis Conditions

To assess the actuarial implications of abrupt shifts in mortality dynamics observed within the Lebanese insured portfolio, the mortality table constructed in this study is evaluated through a multi-scenario sensitivity analysis. The objective is to quantify the impact of adverse mortality deviations on insurance valuations and to benchmark the resulting outcomes against commonly used international mortality references applied in the Lebanese market.

Four mortality scenarios are considered. The first scenario applies the TGH05 table (France, insured population, diagonal 2005) as a high-income insured reference. The second relies on the AM80 table (United Kingdom, insured lives, Duration 2+), which remains widely used in actuarial practice in Lebanon. The third scenario corresponds to the Lebanese mortality table developed in this study. The fourth scenario introduces a uniform mortality stress designed to reflect excess mortality observed during periods of severe economic and health disruption (Figure 28).

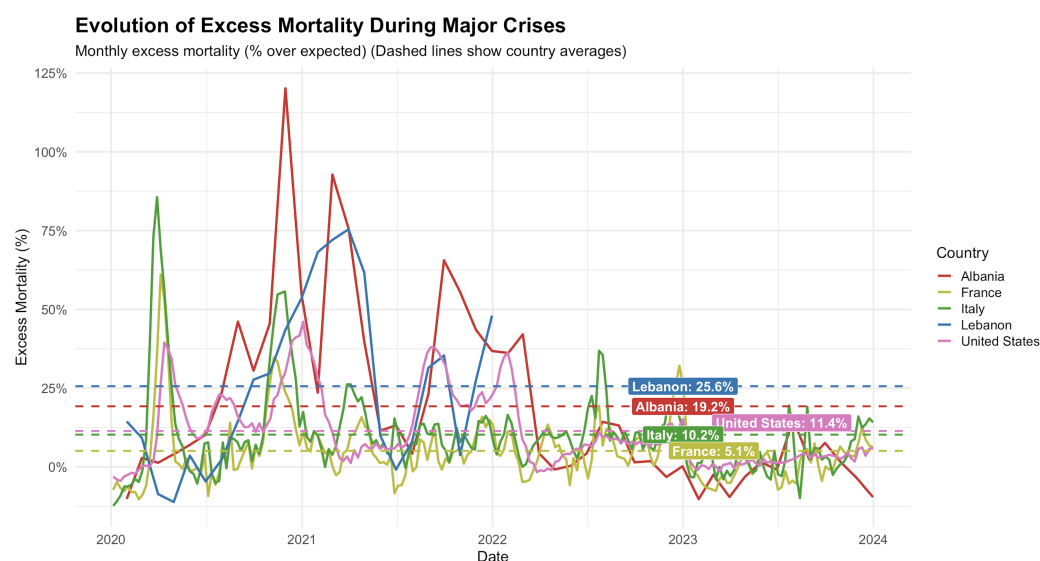


Figure 28. Evolution of excess loss ratios during crisis periods in Lebanon. Source: Our World in Data, *Excess Mortality during COVID-19*, available online: <https://ourworldindata.org/excess-mortality-covid>, accessed on 22 May 2025.

To translate observed crisis dynamics into an actuarial stress scenario, a uniform mortality increase of +20% is applied to the constructed Lebanese mortality table. As shown in Figure 28, excess mortality in Lebanon averaged approximately 25.6% over the crisis period, a value partly driven by short-lived peaks associated with extreme events. From an international perspective, a 20% stress corresponds to the upper range of excess mortality observed over prolonged crisis periods across the countries considered in this study and therefore represents a severe yet actuarially plausible adverse scenario.

For each mortality scenario, expected present values (EPVs) are computed for four standard life insurance products: pure endowment, term insurance, whole life insurance, and endowment insurance. All valuations are performed assuming a constant annual interest rate of 2%.

Adverse mortality conditions increase EPVs for products whose benefits are primarily triggered by death events, namely term insurance and whole life insurance, as higher mortality raises the expected frequency of benefit payments. Conversely, adverse mortality reduces EPVs for survival-oriented contracts such as pure endowment insurance, where benefits are paid only if the insured survives to maturity. Endowment insurance, which combines death and survival components, exhibits an intermediate response reflecting these opposing effects.

Figure 29 shows that across all products and entry ages, EPVs derived from the Lebanese mortality table remain close to those obtained under TGH05 and substantially less extreme than those implied by AM80. Even under the uniform crisis stress of +20%, valuation outcomes remain markedly closer to realistic actuarial benchmarks than to the values generated by legacy imported tables.

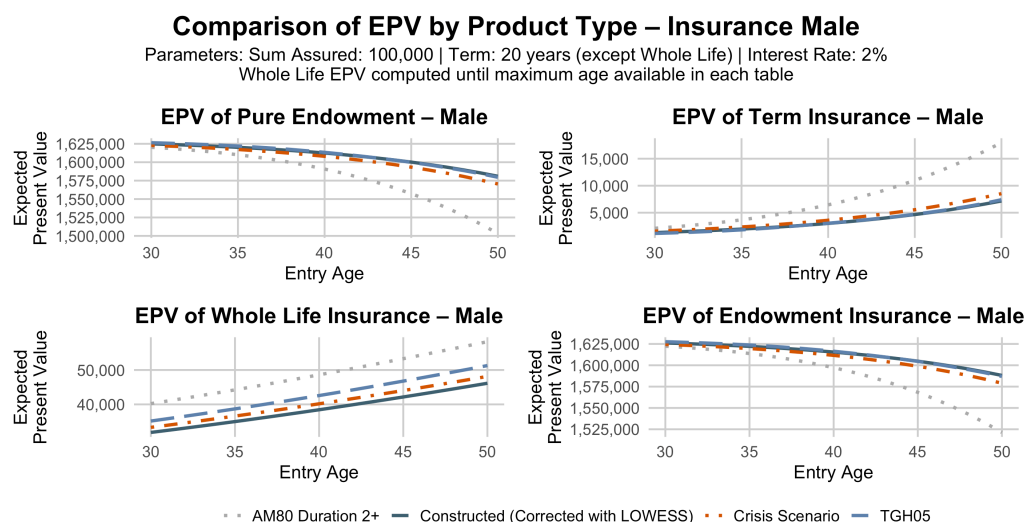


Figure 29. Comparison of expected present values by entry age and mortality table for four insurance products (male).

Age-specific comparisons further highlight structural discrepancies between imported mortality tables and the locally constructed Lebanese tables. Relative differences between AM80/AF80 and Lebanese mortality rates frequently exceed 20–30% at older ages (Figures 30 and 31). These differences indicate that simple proportional adjustments applied to legacy tables fail to capture the true age profile of mortality in the Lebanese context.

Overall, the scenario analysis confirms that even under adverse crisis assumptions, the locally constructed Lebanese mortality table yields more realistic valuation patterns and smaller actuarial distortions than imported legacy references. This validates its suitability as a context-appropriate actuarial basis for pricing, reserving, and solvency assessment in an economy exposed to recurrent shocks.

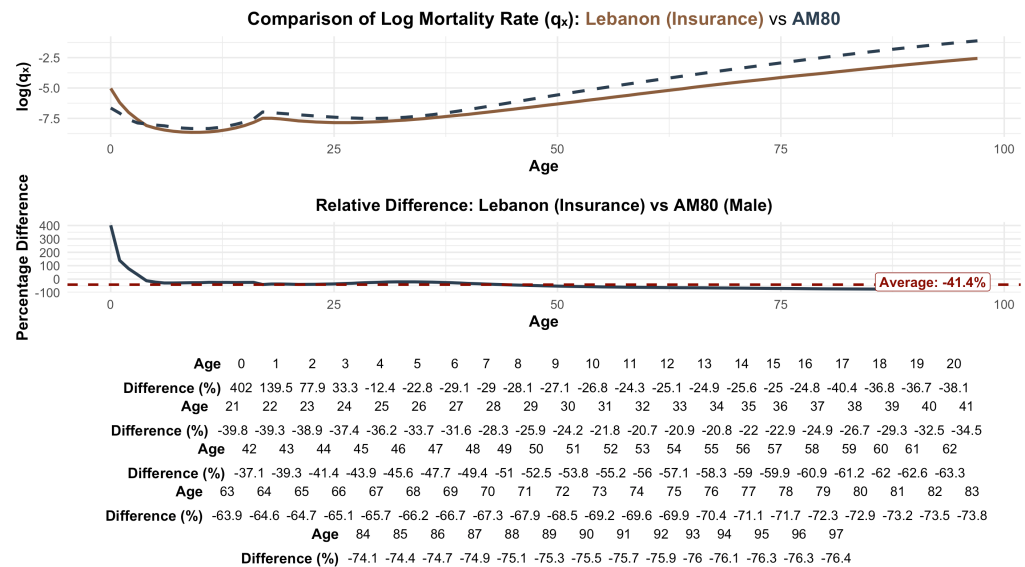


Figure 30. Comparison of logarithmic mortality rates and relative differences between AM80 and Lebanese male mortality rates. **Upper panel:** the grey dotted curve corresponds to the AM80 reference mortality table used as a benchmark. **Lower panel:** the grey dotted horizontal line represents the average relative difference (in percentage) between Lebanese insured mortality and the AM80 reference across all ages.

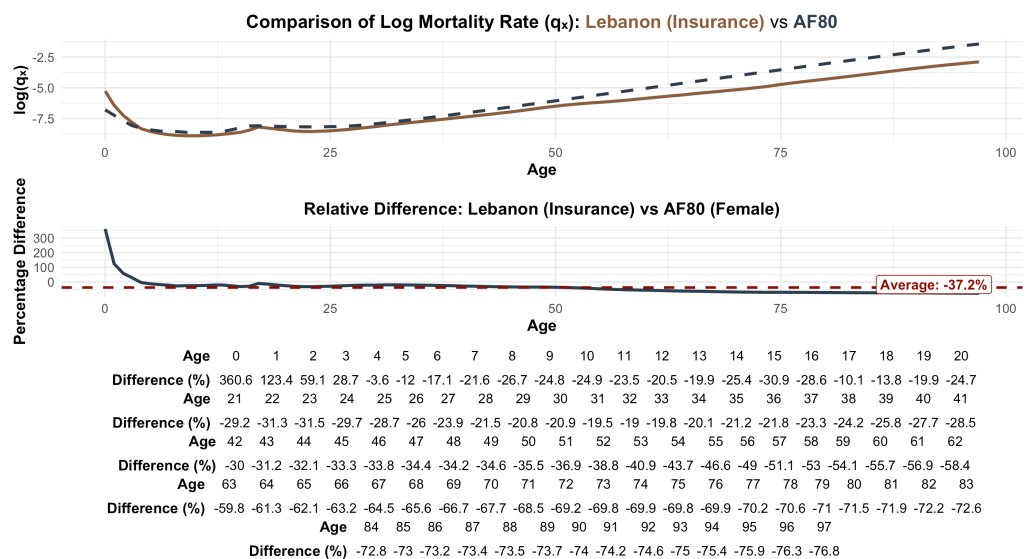


Figure 31. Comparison of logarithmic mortality rates and relative differences between AF80 and Lebanese female mortality rates. **Upper panel:** the grey dotted curve corresponds to the AF80 reference mortality table used as a benchmark. **Lower panel:** the grey dotted horizontal line represents the average relative difference (in percentage) between Lebanese insured mortality and the AF80 reference across all ages.

5. Conclusions

This study addresses a structural gap in Lebanon: the absence of a locally constructed mortality table adapted to the country's demographic, institutional, and data environment. This gap stems from the structural constraints faced by a small country with limited statistical infrastructure, including the absence of a recent census, incomplete vital registration systems, and fragmented mortality data.

In this setting, actuarial practice in Lebanon has traditionally relied on imported mortality references, such as the AM80 table developed in the United Kingdom in 1980 for insured populations with markedly different demographic, epidemiological, and institu-

tional characteristics. While such tables provide a convenient benchmark, their application in the Lebanese context may lead to distortions in pricing, reserving, and long-term financial planning when population structure and mortality dynamics differ substantially.

As emphasized in the literature, accurate mortality measurement is not a marginal technical adjustment but a central component of fair premium calculation, sustainable pension systems, and informed public health and social policy (Murray and Lopez 1997). In this light, the development of a Lebanon-specific mortality reference represents a necessary step toward strengthening the robustness and coherence of actuarial and demographic analyses in the country.

Against this background, harmonized insurance data constitute one of the few available sources of longitudinal and internally consistent mortality information in Lebanon. By mobilizing more than two decades of insured-life data, this study constructs an actuarially coherent mortality reference designed to operate under conditions of data scarcity, sparse exposure, and strong selection effects. The objective of the construction phase is to establish a stable and methodologically sound baseline reflecting observed insured experience.

A key contribution of this work lies in the development of an estimation framework capable of producing reliable age-specific mortality rates despite these structural limitations. The Sample Weighted Average (SWA) approach combines complementary smoothing techniques and adapts locally to exposure density while ensuring demographic coherence across ages. Old-age mortality is extrapolated using the Coale–Kisker method, and early-age mortality is corrected through external calibration to preserve biological and epidemiological plausibility. Female mortality is reconstructed using an age-dependent ratio-based approach reflecting empirically observed gender differentials.

The resulting insured life tables form a coherent actuarial reference that is internally consistent, demographically plausible, and suitable for pricing, reserving, and solvency analysis. Their construction relies on observed insured experience corrected for known data limitations and selection mechanisms, and provides a stable baseline for actuarial applications.

Building on this baseline, the analysis then examines how economic and health shocks affect mortality measurement through their impact on insurance portfolio composition. The economic collapse and the COVID-19 pandemic are analyzed as stress episodes that reveal the sensitivity of insured mortality to abrupt changes in coverage, selection, and exposure.

During such periods, insurance participation contracts sharply and portfolio composition shifts toward older and higher-risk insured individuals. As a result, insured mortality rates become highly volatile and move closer to population mortality, even when absolute death counts remain relatively stable. These dynamics indicate that changes in observed insured mortality may be driven primarily by portfolio effects rather than by underlying demographic shifts alone.

Population mortality is therefore explored through scenario-based approaches designed to assess how insured-to-population alignment varies across economic and institutional regimes. Multiplier scenarios and age-specific adjustments provide interpretable representations of population mortality under different conditions, while preserving coherence with observed Lebanese insured experience.

From an actuarial perspective, the results highlight the central role of risk-profile composition in mortality modeling. Variations in underwriting practices, coverage persistence, and socioeconomic selection translate directly into changes in observed insured mortality levels. In environments exposed to recurrent instability, such as Lebanon, these effects are amplified, which makes the use of locally constructed and regularly calibrated mortality references for insured populations essential.

Beyond the Lebanese case, this study offers methodological insights for mortality modeling in small countries characterized by incomplete statistical systems. It provides a structured framework for constructing actuarially sound mortality tables from insured experience when comprehensive population mortality data are unavailable, provided that data limitations and selection effects are explicitly addressed.

The analysis further highlights that crisis effects on mortality operate through two distinct but interacting channels. First, economic stress directly affects insurance participation, leading to sharp contractions in exposure and changes in portfolio composition that amplify selection effects and mortality volatility. Second, concurrent pressures on the health system may affect population health outcomes, reinforcing observed mortality dynamics. From an actuarial perspective, this dual mechanism underscores the importance of stress-testing premiums, reserves, and long-term liabilities under adverse scenarios, using locally constructed mortality tables as a stable reference.

This work establishes a robust and actuarially coherent mortality baseline for the Lebanese insured population. Building on this foundation, a first consistent estimation of population mortality is obtained by combining insured experience with external insured-to-population ratios derived from French references. The resulting tables provide a durable reference for actuarial practice, demographic analysis, and policy evaluation in a country exposed to recurrent economic and institutional shocks.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Final Life Tables by Gender and Population Type

This appendix presents the final Lebanese life tables, disaggregated by gender and population type (insured versus general population). Mortality rates were corrected, smoothed, and extrapolated following the actuarial framework described in the previous sections. The insured tables are derived from aggregated insurance company data, while population-level tables are obtained through demographic adjustments designed to ensure coherence with external mortality benchmarks. All tables follow standard actuarial notation and report age-specific mortality, survival, exposure, and life expectancy functions.

The insured mortality tables constructed in this study are based on data pooled across multiple insurance companies operating in Lebanon. They therefore reflect the average mortality experience and socioeconomic composition of the Lebanese insured market as a whole, rather than that of any single insurer.

In actuarial applications, mortality tables serve as reference bases whose use requires calibration to the characteristics of the insurer's own portfolio, including underwriting standards and socioeconomic composition. Empirical evidence shows that mortality levels and age profiles vary systematically across insured portfolios due to selection and socioeconomic effects. [Villegas and Haberman \(2014\)](#) demonstrate that incorporating socioeconomic and geodemographic information improves mortality modelling for insured lives, while [Ridsdale and Gallop \(2010\)](#) document a persistent socioeconomic gradient in mortality. [Richards \(2008b\)](#) further highlight the material impact of portfolio characteristics on observed mortality experience. Portfolio-specific calibration prior to operational use thus follows standard actuarial practice.

Appendix A.1. Insurance-Based Life Tables

Table A1. Final life table—Lebanese male insured population.

Life Table—Lebanese Male Insured Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
0	0.0065	0.9935	100,000	652.59	99,673.71	8,834,162.19	88.34
1	0.0020	0.9980	99,347	202.22	99,246.31	8,734,488.48	87.92
2	0.0009	0.9991	99,145	89.96	99,100.22	8,635,242.17	87.10
3	0.0005	0.9995	99,055	50.18	99,030.14	8,536,141.95	86.18
4	0.0003	0.9997	99,005	30.35	98,989.88	8,437,111.81	85.22
5	0.0002	0.9998	98,975	24.46	98,962.47	8,338,121.93	84.24
6	0.0002	0.9998	98,950	21.04	98,939.71	8,239,159.47	83.27
7	0.0002	0.9998	98,929	18.96	98,919.72	8,140,219.75	82.28
8	0.0002	0.9998	98,910	17.78	98,901.34	8,041,300.04	81.30
9	0.0002	0.9998	98,892	17.31	98,883.80	7,942,398.69	80.31
10	0.0002	0.9998	98,875	17.36	98,866.46	7,843,514.89	79.33
11	0.0002	0.9998	98,858	17.96	98,848.80	7,744,648.43	78.34
12	0.0002	0.9998	98,840	19.25	98,830.20	7,645,799.63	77.36
13	0.0002	0.9998	98,821	21.53	98,809.81	7,546,969.43	76.37
14	0.0003	0.9997	98,799	24.99	98,786.55	7,448,159.62	75.39
15	0.0003	0.9997	98,774	30.39	98,758.86	7,349,373.07	74.41
16	0.0004	0.9996	98,744	39.37	98,723.98	7,250,614.21	73.43
17	0.0006	0.9994	98,704	55.08	98,676.76	7,151,890.22	72.46
18	0.0006	0.9994	98,649	55.24	98,621.60	7,053,213.46	71.50
19	0.0005	0.9995	98,594	52.25	98,567.85	6,954,591.86	70.54
20	0.0005	0.9995	98,542	48.29	98,517.58	6,856,024.01	69.57
21	0.0005	0.9996	98,493	44.32	98,471.28	6,757,506.43	68.61
22	0.0004	0.9996	98,449	42.33	98,427.95	6,659,035.15	67.64
23	0.0004	0.9996	98,407	40.35	98,386.61	6,560,607.20	66.67
24	0.0004	0.9996	98,366	39.35	98,346.76	6,462,220.59	65.70
25	0.0004	0.9996	98,327	38.35	98,307.92	6,363,873.83	64.72
26	0.0004	0.9996	98,289	38.33	98,269.58	6,265,565.92	63.75
27	0.0004	0.9996	98,250	38.32	98,231.25	6,167,296.34	62.77
28	0.0004	0.9996	98,212	39.28	98,192.45	6,069,065.09	61.80
29	0.0004	0.9996	98,173	40.25	98,152.68	5,970,872.64	60.82
30	0.0004	0.9996	98,133	41.22	98,111.95	5,872,719.96	59.84

Table A1. Cont.

Life Table—Lebanese Male Insured Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
31	0.0004	0.9996	98,091	43.16	98,069.76	5,774,608.01	58.87
32	0.0005	0.9995	98,048	45.10	98,025.63	5,676,538.25	57.90
33	0.0005	0.9995	98,003	47.04	97,979.56	5,578,512.63	56.92
34	0.0005	0.9995	97,956	49.96	97,931.06	5,480,533.07	55.95
35	0.0005	0.9995	97,906	52.87	97,879.64	5,382,602.01	54.98
36	0.0006	0.9994	97,853	56.75	97,824.83	5,284,722.37	54.01
37	0.0006	0.9994	97,796	60.63	97,766.14	5,186,897.53	53.04
38	0.0007	0.9993	97,736	65.48	97,703.08	5,089,131.40	52.07
39	0.0007	0.9993	97,670	70.32	97,635.18	4,991,428.32	51.10
40	0.0008	0.9992	97,600	75.15	97,562.44	4,893,793.14	50.14
41	0.0008	0.9992	97,525	81.92	97,483.90	4,796,230.70	49.18
42	0.0009	0.9991	97,443	88.67	97,398.61	4,698,746.80	48.22
43	0.0010	0.9990	97,354	96.38	97,306.08	4,601,348.19	47.26
44	0.0011	0.9989	97,258	105.04	97,205.37	4,504,042.12	46.31
45	0.0012	0.9988	97,153	113.67	97,096.02	4,406,836.75	45.36
46	0.0013	0.9987	97,039	124.21	96,977.08	4,309,740.73	44.41
47	0.0014	0.9986	96,915	134.71	96,847.61	4,212,763.66	43.47
48	0.0015	0.9985	96,780	147.11	96,706.71	4,115,916.04	42.53
49	0.0017	0.9983	96,633	160.41	96,552.95	4,019,209.33	41.59
50	0.0018	0.9982	96,473	174.62	96,385.43	3,922,656.39	40.66
51	0.0020	0.9980	96,298	190.67	96,202.79	3,826,270.95	39.73
52	0.0022	0.9978	96,107	207.59	96,003.66	3,730,068.16	38.81
53	0.0024	0.9976	95,900	228.24	95,785.74	3,634,064.50	37.89
54	0.0026	0.9974	95,672	248.75	95,547.25	3,538,278.76	36.98
55	0.0028	0.9972	95,423	270.05	95,287.85	3,442,731.51	36.08
56	0.0031	0.9969	95,153	295.93	95,004.87	3,347,443.66	35.18
57	0.0034	0.9966	94,857	322.51	94,695.65	3,252,438.79	34.29
58	0.0037	0.9963	94,534	349.78	94,359.50	3,157,743.14	33.40
59	0.0041	0.9959	94,185	385.22	93,992.01	3,063,383.64	32.53
60	0.0045	0.9955	93,799	418.35	93,590.23	2,969,391.64	31.66
61	0.0049	0.9951	93,381	455.70	93,153.20	2,875,801.41	30.80
62	0.0053	0.9947	92,925	495.29	92,677.71	2,782,648.21	29.94
63	0.0058	0.9942	92,430	537.94	92,161.09	2,689,970.50	29.10
64	0.0063	0.9937	91,892	581.68	91,601.28	2,597,809.41	28.27
65	0.0070	0.9930	91,310	638.56	90,991.16	2,506,208.13	27.45
66	0.0077	0.9923	90,672	694.24	90,324.75	2,415,216.97	26.64
67	0.0083	0.9917	89,978	748.61	89,603.33	2,324,892.22	25.84
68	0.0091	0.9909	89,229	808.41	88,824.81	2,235,288.89	25.05
69	0.0099	0.9901	88,421	872.71	87,984.25	2,146,464.08	24.28
70	0.0107	0.9893	87,548	937.64	87,079.07	2,058,479.83	23.51
71	0.0116	0.9884	86,610	1003.81	86,108.35	1,971,400.76	22.76
72	0.0125	0.9875	85,606	1072.65	85,070.12	1,885,292.41	22.02
73	0.0135	0.9865	84,534	1142.90	83,962.34	1,800,222.29	21.30
74	0.0147	0.9853	83,391	1224.18	82,778.81	1,716,259.95	20.58
75	0.0160	0.9840	82,167	1313.57	81,509.93	1,633,481.14	19.88

Table A1. Cont.

Life Table—Lebanese Male Insured Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
76	0.0173	0.9827	80,853	1398.22	80,154.04	1,551,971.21	19.19
77	0.0186	0.9814	79,455	1477.86	78,715.99	1,471,817.18	18.52
78	0.0200	0.9800	77,977	1557.20	77,198.46	1,393,101.18	17.87
79	0.0215	0.9786	76,420	1639.21	75,600.26	1,315,902.72	17.22
80	0.0231	0.9770	74,781	1723.69	73,918.81	1,240,302.46	16.59
81	0.0249	0.9751	73,057	1822.42	72,145.75	1,166,383.65	15.97
82	0.0270	0.9730	71,235	1921.13	70,273.98	1,094,237.90	15.36
83	0.0291	0.9709	69,313	2018.98	68,303.92	1,023,963.92	14.77
84	0.0314	0.9686	67,294	2114.98	66,236.94	955,660.00	14.20
85	0.0339	0.9661	65,179	2208.08	64,075.42	889,423.06	13.65
86	0.0365	0.9635	62,971	2297.16	61,822.79	825,347.64	13.11
87	0.0392	0.9608	60,674	2381.01	59,483.71	763,524.85	12.58
88	0.0422	0.9578	58,293	2458.39	57,064.00	704,041.14	12.08
89	0.0453	0.9547	55,835	2528.01	54,570.80	646,977.14	11.59
90	0.0486	0.9514	53,307	2588.59	52,012.50	592,406.33	11.11
91	0.0520	0.9480	50,718	2638.86	49,398.77	540,393.83	10.65
92	0.0557	0.9443	48,079	2677.62	46,740.53	490,995.06	10.21
93	0.0596	0.9404	45,402	2703.75	44,049.84	444,254.53	9.78
94	0.0636	0.9364	42,698	2716.26	41,339.83	400,204.69	9.37
95	0.0679	0.9321	39,982	2714.32	38,624.54	358,864.85	8.98
96	0.0724	0.9276	37,267	2697.30	35,918.74	320,240.31	8.59
97	0.0771	0.9229	34,570	2664.82	33,237.68	284,321.57	8.22
98	0.0820	0.9180	31,905	2616.75	30,596.89	251,083.89	7.87
99	0.0872	0.9128	29,289	2553.26	28,011.89	220,487.00	7.53
100	0.0926	0.9074	26,735	2474.83	25,497.85	192,475.11	7.20
101	0.0982	0.9018	24,260	2382.26	23,069.30	166,977.26	6.88
102	0.1041	0.8959	21,878	2276.65	20,739.85	143,907.95	6.58
103	0.1102	0.8898	19,602	2159.42	18,521.82	123,168.11	6.28
104	0.1165	0.8835	17,442	2032.23	16,426.00	104,646.29	6.00
105	0.1231	0.8769	15,410	1896.99	14,461.39	88,220.30	5.72
106	0.1299	0.8701	13,513	1755.79	12,635.00	73,758.91	5.46
107	0.1370	0.8630	11,757	1610.82	10,951.70	61,123.90	5.20
108	0.1443	0.8557	10,146	1464.34	9414.12	50,172.20	4.94
109	0.1519	0.8481	8682	1318.58	8022.65	40,758.09	4.69
110	0.1597	0.8403	7363	1175.68	6775.52	32,735.43	4.45
111	0.1677	0.8323	6188	1037.59	5668.89	25,959.91	4.20
112	0.1759	0.8241	5150	906.08	4697.05	20,291.02	3.94
113	0.1844	0.8156	4244	782.61	3852.71	15,593.97	3.67
114	0.1931	0.8069	3461	668.35	3127.23	11,741.26	3.39
115	0.2020	0.7980	2793	564.13	2510.99	8614.03	3.08
116	0.2111	0.7889	2229	470.45	1993.70	6103.04	2.74
117	0.2203	0.7797	1758	387.47	1564.74	4109.35	2.34
118	0.2298	0.7702	1371	315.05	1213.48	2544.60	1.86
119	0.2394	0.7606	1056	252.81	929.55	1331.12	1.26
120	1.0000	0.0000	803	803.14	401.57	401.57	0.50

Table A2. Final life table—Lebanese female insured population.

Life Table—Lebanese Female Insured Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
0	0.0052	0.9948	100,000	515.83	99,742.09	9,420,321.09	94.20
1	0.0016	0.9984	99,484	159.99	99,404.18	9,320,579.00	93.69
2	0.0007	0.9993	99,324	71.13	99,288.62	9,221,174.82	92.84
3	0.0004	0.9996	99,253	39.61	99,233.25	9,121,886.20	91.91
4	0.0002	0.9998	99,213	23.90	99,201.49	9,022,652.95	90.94
5	0.0002	0.9998	99,190	19.21	99,179.94	8,923,451.45	89.96
6	0.0002	0.9998	99,170	16.45	99,162.11	8,824,271.51	88.98
7	0.0001	0.9999	99,154	14.78	99,146.50	8,725,109.40	88.00
8	0.0001	0.9999	99,139	13.81	99,132.20	8,625,962.90	87.01
9	0.0001	0.9999	99,125	13.41	99,118.59	8,526,830.70	86.02
10	0.0001	0.9999	99,112	13.40	99,105.18	8,427,712.11	85.03
11	0.0001	0.9999	99,098	13.64	99,091.67	8,328,606.93	84.04
12	0.0001	0.9999	99,085	14.19	99,077.75	8,229,515.26	83.06
13	0.0002	0.9998	99,071	15.07	99,063.13	8,130,437.51	82.07
14	0.0002	0.9998	99,056	16.26	99,047.46	8,031,374.38	81.08
15	0.0002	0.9998	99,039	17.79	99,030.43	7,932,326.93	80.09
16	0.0002	0.9998	99,022	21.20	99,010.93	7,833,296.50	79.11
17	0.0003	0.9997	99,000	27.24	98,986.71	7,734,285.56	78.12
18	0.0003	0.9997	98,973	25.41	98,960.38	7,635,298.85	77.15
19	0.0002	0.9998	98,948	23.14	98,936.11	7,536,338.47	76.16
20	0.0002	0.9998	98,925	21.38	98,913.85	7,437,402.36	75.18
21	0.0002	0.9998	98,903	19.81	98,893.25	7,338,488.51	74.20
22	0.0002	0.9998	98,883	19.09	98,873.80	7,239,595.26	73.21
23	0.0002	0.9998	98,864	18.95	98,854.78	7,140,721.46	72.23
24	0.0002	0.9998	98,845	19.52	98,835.55	7,041,866.67	71.24
25	0.0002	0.9998	98,826	20.07	98,815.75	6,943,031.13	70.26
26	0.0002	0.9998	98,806	21.21	98,795.11	6,844,215.37	69.27
27	0.0002	0.9998	98,785	22.39	98,773.31	6,745,420.26	68.28
28	0.0002	0.9998	98,762	24.25	98,749.99	6,646,646.95	67.30
29	0.0003	0.9997	98,738	26.19	98,724.77	6,547,896.96	66.32
30	0.0003	0.9997	98,712	28.17	98,697.59	6,449,172.18	65.33
31	0.0003	0.9997	98,684	30.99	98,668.01	6,350,474.59	64.35
32	0.0003	0.9997	98,653	33.73	98,635.65	6,251,806.58	63.37
33	0.0004	0.9996	98,619	36.30	98,600.63	6,153,170.93	62.39
34	0.0004	0.9996	98,582	39.40	98,562.78	6,054,570.30	61.42
35	0.0004	0.9996	98,543	42.35	98,521.91	5,956,007.52	60.44
36	0.0005	0.9995	98,501	45.89	98,477.79	5,857,485.61	59.47
37	0.0005	0.9995	98,455	49.30	98,430.20	5,759,007.82	58.49
38	0.0005	0.9995	98,406	53.45	98,378.82	5,660,577.62	57.52
39	0.0006	0.9994	98,352	57.52	98,323.34	5,562,198.80	56.55
40	0.0006	0.9994	98,295	61.59	98,263.78	5,463,875.46	55.59
41	0.0007	0.9993	98,233	67.05	98,199.45	5,365,611.69	54.62
42	0.0007	0.9993	98,166	72.31	98,129.77	5,267,412.23	53.66
43	0.0008	0.9992	98,094	78.34	98,054.45	5,169,282.46	52.70
44	0.0009	0.9991	98,015	85.31	97,972.62	5,071,228.01	51.74
45	0.0009	0.9991	97,930	92.40	97,883.76	4,973,255.39	50.78

Table A2. Cont.

Life Table—Lebanese Female Insured Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
46	0.0010	0.9990	97,838	101.30	97,786.91	4,875,371.63	49.83
47	0.0011	0.9989	97,736	110.90	97,680.81	4,777,584.72	48.88
48	0.0013	0.9987	97,625	122.73	97,563.99	4,679,903.91	47.94
49	0.0014	0.9986	97,503	134.91	97,435.17	4,582,339.92	47.00
50	0.0015	0.9985	97,368	146.85	97,294.29	4,484,904.75	46.06
51	0.0016	0.9984	97,221	158.86	97,141.43	4,387,610.46	45.13
52	0.0018	0.9982	97,062	170.19	96,976.91	4,290,469.03	44.20
53	0.0019	0.9981	96,892	181.59	96,801.02	4,193,492.12	43.28
54	0.0020	0.9980	96,710	191.16	96,614.65	4,096,691.10	42.36
55	0.0021	0.9979	96,519	200.29	96,418.92	4,000,076.46	41.44
56	0.0022	0.9978	96,319	211.21	96,213.18	3,903,657.53	40.53
57	0.0023	0.9977	96,108	223.89	95,995.63	3,807,444.36	39.62
58	0.0025	0.9975	95,884	237.28	95,765.04	3,711,448.73	38.71
59	0.0027	0.9973	95,646	255.83	95,518.48	3,615,683.69	37.80
60	0.0029	0.9971	95,391	273.05	95,254.04	3,520,165.20	36.90
61	0.0031	0.9969	95,118	292.65	94,971.19	3,424,911.16	36.01
62	0.0033	0.9967	94,825	311.96	94,668.88	3,329,939.97	35.12
63	0.0035	0.9965	94,513	332.36	94,346.72	3,235,271.09	34.23
64	0.0037	0.9963	94,181	353.00	94,004.05	3,140,924.37	33.35
65	0.0041	0.9959	93,828	380.88	93,637.10	3,046,920.32	32.47
66	0.0044	0.9956	93,447	407.60	93,242.86	2,953,283.21	31.60
67	0.0047	0.9953	93,039	433.10	92,822.51	2,860,040.35	30.74
68	0.0050	0.9950	92,606	461.70	92,375.11	2,767,217.85	29.88
69	0.0054	0.9947	92,144	492.97	91,897.78	2,674,842.74	29.03
70	0.0057	0.9943	91,651	525.79	91,388.39	2,582,944.96	28.18
71	0.0062	0.9938	91,125	562.72	90,844.14	2,491,556.56	27.34
72	0.0067	0.9933	90,563	604.38	90,260.58	2,400,712.43	26.51
73	0.0072	0.9928	89,958	651.32	89,632.74	2,310,451.84	25.68
74	0.0080	0.9920	89,307	711.96	88,951.10	2,220,819.11	24.87
75	0.0089	0.9911	88,595	784.40	88,202.92	2,131,868.01	24.06
76	0.0097	0.9903	87,811	855.61	87,382.91	2,043,665.09	23.27
77	0.0106	0.9894	86,955	925.51	86,492.36	1,956,282.18	22.50
78	0.0116	0.9884	86,030	998.58	85,530.31	1,869,789.82	21.73
79	0.0126	0.9874	85,031	1074.22	84,493.91	1,784,259.51	20.98
80	0.0137	0.9863	83,957	1149.54	83,382.04	1,699,765.60	20.25
81	0.0149	0.9851	82,807	1236.68	82,188.92	1,616,383.56	19.52
82	0.0163	0.9837	81,571	1327.50	80,906.83	1,534,194.64	18.81
83	0.0177	0.9823	80,243	1422.81	79,531.68	1,453,287.81	18.11
84	0.0194	0.9806	78,820	1526.90	78,056.82	1,373,756.13	17.43
85	0.0212	0.9788	77,293	1637.10	76,474.82	1,295,699.31	16.76
86	0.0232	0.9768	75,656	1752.16	74,780.19	1,219,224.49	16.12
87	0.0254	0.9747	73,904	1873.44	72,967.39	1,144,444.30	15.49
88	0.0278	0.9722	72,031	1999.29	71,031.03	1,071,476.91	14.88
89	0.0303	0.9697	70,031	2123.28	68,969.75	1,000,445.88	14.29
90	0.0330	0.9670	67,908	2241.66	66,787.28	931,476.14	13.72

Table A2. Cont.

Life Table—Lebanese Female Insured Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
91	0.0359	0.9641	65,666	2355.99	64,488.45	864,688.86	13.17
92	0.0389	0.9611	63,310	2461.17	62,079.87	800,200.41	12.64
93	0.0420	0.9580	60,849	2553.17	59,572.70	738,120.54	12.13
94	0.0452	0.9548	58,296	2632.89	56,979.67	678,547.83	11.64
95	0.0485	0.9515	55,663	2700.82	54,312.82	621,568.16	11.17
96	0.0521	0.9479	52,962	2756.96	51,583.92	567,255.34	10.71
97	0.0558	0.9442	50,205	2802.12	48,804.38	515,671.42	10.27
98	0.0592	0.9408	47,403	2805.60	46,000.52	466,867.04	9.85
99	0.0631	0.9369	44,598	2815.00	43,190.22	420,866.52	9.44
100	0.0670	0.9330	41,783	2800.44	40,382.49	377,676.30	9.04
101	0.0711	0.9289	38,982	2771.57	37,596.49	337,293.81	8.65
102	0.0753	0.9247	36,211	2728.30	34,846.55	299,697.32	8.28
103	0.0798	0.9202	33,482	2670.74	32,147.03	264,850.77	7.91
104	0.0844	0.9156	30,812	2599.30	29,512.01	232,703.74	7.55
105	0.0891	0.9109	28,212	2514.63	26,955.04	203,191.73	7.20
106	0.0941	0.9059	25,698	2417.61	24,488.92	176,236.69	6.86
107	0.0992	0.9008	23,280	2309.41	22,125.41	151,747.76	6.52
108	0.1045	0.8955	20,971	2191.38	19,875.02	129,622.35	6.18
109	0.1100	0.8900	18,779	2065.10	17,746.78	109,747.33	5.84
110	0.1156	0.8844	16,714	1932.27	15,748.10	92,000.55	5.50
111	0.1214	0.8786	14,782	1794.73	13,884.60	76,252.46	5.16
112	0.1274	0.8726	12,987	1654.38	12,160.04	62,367.86	4.80
113	0.1335	0.8665	11,333	1513.13	10,576.28	50,207.82	4.43
114	0.1398	0.8602	9820	1372.84	9133.30	39,631.53	4.04
115	0.1462	0.8538	8447	1235.28	7829.24	30,498.23	3.61
116	0.1528	0.8472	7212	1102.09	6660.55	22,669.00	3.14
117	0.1595	0.8405	6110	974.70	5622.16	16,008.45	2.62
118	0.1664	0.8336	5135	854.35	4707.63	10,386.29	2.02
119	0.1734	0.8267	4280	742.02	3909.44	5678.66	1.33
120	1.0000	0.0000	3538	3538.44	1769.22	1769.22	0.50

Table A3. Abridged life table—Lebanese male insured population (2009–2021). Constructed using insurance-based data, grouped by five-year age intervals, and closed at age 100+.

Insured Life Table—Lebanese Male Insured Population (2009–2021, Five-Year Groups)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_{x+5} = l_x p_x$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = \frac{5}{2}(l_x + l_{x+5})$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
0–4	0.00000	1.00000	100,000	0	500,000	9,792,947	97.93
5–9	0.00000	1.00000	100,000	0	500,000	9,292,947	92.93
10–14	0.00000	1.00000	100,000	0	500,000	8,792,947	87.93
15–19	0.00001	0.99999	100,000	1	499,998	8,292,947	82.93
20–24	0.00036	0.99964	99,999	36	499,905	7,792,950	77.93
25–29	0.00073	0.99927	99,963	73	499,633	7,293,045	72.96
30–34	0.00095	0.99905	99,890	95	499,213	6,793,412	68.01
35–39	0.00084	0.99916	99,795	84	498,766	6,294,199	63.07
40–44	0.00127	0.99873	99,711	127	498,240	5,795,433	58.12
45–49	0.00159	0.99841	99,585	158	497,528	5,297,193	53.19
50–54	0.00225	0.99775	99,426	224	496,572	4,799,666	48.27
55–59	0.00306	0.99694	99,203	304	495,254	4,303,093	43.38

Table A3. Cont.

Insured Life Table—Lebanese Male Insured Population (2009–2021, Five-Year Groups)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_{x+5} = l_x p_x$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = \frac{5}{2}(l_x + l_{x+5})$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x / l_x$
60–64	0.00415	0.99585	98,899	410	493,469	3,807,839	38.50
65–69	0.00562	0.99438	98,489	554	491,059	3,314,370	33.65
70–74	0.00761	0.99239	97,935	745	487,812	2,823,310	28.83
75–79	0.01031	0.98969	97,190	1002	483,444	2,335,498	24.03
80–84	0.01397	0.98603	96,188	1344	477,580	1,852,054	19.25
85–89	0.01892	0.98108	94,844	1794	469,734	1,374,474	14.49
90–94	0.02563	0.97437	93,050	2385	459,286	904,740	9.72
95–99	0.03472	0.96528	90,665	3148	445,454	445,454	4.91
100+	1.00000	0.00000	87,517	87,517	0	0	0.00

Appendix A.2. Population-Based Life Tables (Adjusted with Multipliers)

Population-level mortality scenarios are obtained by applying three multipliers to insured mortality. These abridged life tables are constructed for sensitivity analysis purposes, in order to assess how population mortality patterns may respond to crisis-related changes in insured-population alignment. They are not intended as definitive national life tables, but as bounded scenarios reflecting observed structural shifts during periods of economic and institutional stress.

Table A4. Abridged life table—Lebanese male population (minimum multiplier scenario, 2009–2021). Constructed using the minimum multiplier between deaths observed in insurance company data and those recorded for the Lebanese population (Our World in Data), based on annual observations from 2009 to 2021.

Population Life Table—Minimum Multiplier Scenario (Male, 2009–2021, Five-Year Groups)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_{x+5} = l_x p_x$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = \frac{5}{2}(l_x + l_{x+5})$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x / l_x$
0–4	0.00385	0.99615	100,000	385	499,038	6,942,415	69.42
5–9	0.00507	0.99493	99,615	505	496,812	6,443,377	64.68
10–14	0.00666	0.99334	99,110	660	493,900	5,946,565	60.00
15–19	0.00876	0.99124	98,450	862	490,093	5,452,665	55.39
20–24	0.01153	0.98847	97,587	1125	485,124	4,962,572	50.85
25–29	0.01923	0.98077	96,462	1855	477,674	4,477,448	46.42
30–34	0.02504	0.97496	94,607	2369	467,114	3,999,774	42.28
35–39	0.02216	0.97784	92,238	2044	456,082	3,532,660	38.30
40–44	0.03354	0.96646	90,194	3025	443,409	3,076,578	34.11
45–49	0.04178	0.95822	87,169	3642	426,741	2,633,169	30.21
50–54	0.05932	0.94068	83,527	4955	405,249	2,206,428	26.42
55–59	0.08061	0.91939	78,572	6334	377,028	1,801,178	22.92
60–64	0.10328	0.89672	72,239	7461	342,542	1,424,150	19.71
65–69	0.13585	0.86415	64,778	8800	301,889	1,081,609	16.70
70–74	0.17869	0.82131	55,978	10,003	254,882	779,720	13.93
75–79	0.23504	0.76496	45,975	10,806	202,861	524,837	11.42
80–84	0.30915	0.69085	35,169	10,873	148,664	321,976	9.16
85–89	0.40664	0.59336	24,297	9880	96,783	173,312	7.13
90–94	0.53486	0.46514	14,417	7711	52,806	76,529	5.31
95–99	0.70352	0.29648	6706	4718	21,735	23,723	3.54
100+	1.00000	0.00000	1988	1988	1988	1988	1.00

Table A5. Abridged life table—Lebanese male population (average multiplier scenario, 2009–2021). Constructed using the average multiplier between deaths observed in insurance company data and those recorded for the Lebanese population (Our World in Data), based on annual observations from 2009 to 2021.

Population Life Table—Average Multiplier Scenario (Male, 2009–2021, Five-Year Groups)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_{x+5} = l_x p_x$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = \frac{5}{2}(l_x + l_{x+5})$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x / l_x$
0–4	0.00790	0.99210	100,000	790	498,025	5,707,683	57.08
5–9	0.01039	0.98961	99,210	1031	493,473	5,209,658	52.51
10–14	0.01366	0.98634	98,179	1341	487,543	4,716,185	48.04
15–19	0.01797	0.98203	96,838	1740	479,840	4,228,642	43.67
20–24	0.02364	0.97636	95,098	2248	469,869	3,748,802	39.42
25–29	0.03943	0.96057	92,850	3661	455,096	3,278,933	35.31
30–34	0.05135	0.94865	89,189	4580	434,494	2,823,837	31.66
35–39	0.04545	0.95455	84,609	3845	413,431	2,389,343	28.24
40–44	0.06877	0.93123	80,763	5554	389,932	1,975,912	24.47
45–49	0.08566	0.91434	75,209	6442	359,940	1,585,980	21.09
50–54	0.12164	0.87836	68,767	8365	322,922	1,226,040	17.83
55–59	0.16528	0.83472	60,402	9983	277,052	903,117	14.95
60–64	0.21179	0.78821	50,419	10,678	225,399	626,065	12.42
65–69	0.27857	0.72143	39,741	11,071	171,027	400,667	10.08
70–74	0.36641	0.63359	28,670	10,505	117,088	229,640	8.01
75–79	0.48195	0.51805	18,165	8755	68,939	112,552	6.20
80–84	0.63392	0.36608	9410	5965	32,138	43,613	4.63
85–89	0.83382	0.16618	3445	2872	10,044	11,475	3.33
90–94	1.00000	0.00000	572	572	1431	1431	2.50
95–99	1.00000	0.00000	0	0	0	0	0.00
100+	1.00000	0.00000	0	0	0	0	0.00

Table A6. Abridged life table—Lebanese male population (maximum multiplier scenario, 2009–2021). Constructed using the maximum multiplier between deaths observed in insurance company data and those recorded for the Lebanese population (Our World in Data), based on annual observations from 2009 to 2021.

Population Life Table—Maximum Multiplier Scenario (Male, 2009–2021, Five-Year Groups)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_{x+5} = l_x p_x$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = \frac{5}{2}(l_x + l_{x+5})$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x / l_x$
0–4	0.01135	0.98865	100,000	1135	497,162	5,099,461	50.99
5–9	0.01493	0.98507	98,865	1476	490,635	4,602,298	46.55
10–14	0.01964	0.98036	97,389	1913	482,163	4,111,663	42.22
15–19	0.02583	0.97417	95,476	2466	471,216	3,629,501	38.01
20–24	0.03397	0.96603	93,010	3160	457,151	3,158,285	33.96
25–29	0.05666	0.94334	89,851	5091	436,525	2,701,133	30.06
30–34	0.07379	0.92621	84,760	6254	408,162	2,264,608	26.72
35–39	0.06531	0.93469	78,505	5127	379,708	1,856,446	23.65
40–44	0.09883	0.90117	73,378	7252	348,760	1,476,738	20.13
45–49	0.12311	0.87689	66,126	8141	310,278	1,127,978	17.06

Table A6. *Cont.*

Population Life Table—Maximum Multiplier Scenario (Male, 2009–2021, Five-Year Groups)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_{x+5} = l_x p_x$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = \frac{5}{2}(l_x + l_{x+5})$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
50–54	0.17481	0.82519	57,985	10,136	264,585	817,700	14.10
55–59	0.23753	0.76247	47,849	11,366	210,831	553,114	11.56
60–64	0.30436	0.69564	36,483	11,104	154,656	342,284	9.38
65–69	0.40034	0.59966	25,379	10,160	101,495	187,627	7.39
70–74	0.52657	0.47343	15,219	8014	56,060	86,132	5.66
75–79	0.69262	0.30738	7205	4990	23,550	30,072	4.17
80–84	0.91102	0.08898	2215	2018	6029	6522	2.94
85–89	1.00000	0.00000	197	197	493	493	2.50
90–94	1.00000	0.00000	0	0	0	0	
95–99	1.00000	0.00000	0	0	0	0	
100+	1.00000	0.00000	0	0	0	0	

Appendix A.3. Population-Based Life Tables (Adjusted Using Age-Specific Ratios Between the French Insured Tables TGH05/TGF05 and the French General Population Table INED 2005)

The following tables present population-based life tables for Lebanese women and men (Tables A7 and A8). These tables were derived from the extrapolated insurance-based mortality rates, adjusted using age-specific ratios between the French insured population (TGH05/TGF05) and the French general population (INED, 2005). For ages older than 80 years, the last observed ratio was kept constant, so the extrapolated behavior was inherited directly from the Coale–Kisker extension. The mortality rates of the female population were obtained from the mortality rates of the female insurance.

Table A7. Population-based life table—Lebanese male population (derived from insurance-based rates using TGH05/INED France ratios).

Life Table—Lebanese Male Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1} p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2} d_x$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
0	0.0087	0.9913	100,000	870.11	99,564.94	7,912,456.96	79.12
1	0.0008	0.9992	99,130	74.93	99,092.42	7,812,892.02	78.81
2	0.0005	0.9995	99,055	48.64	99,030.64	7,713,799.59	77.87
3	0.0004	0.9996	99,006	36.47	98,988.09	7,614,768.95	76.91
4	0.0003	0.9997	98,970	26.63	98,956.54	7,515,780.86	75.94
5	0.0002	0.9998	98,943	24.32	98,931.06	7,416,824.33	74.96
6	0.0002	0.9998	98,919	22.65	98,907.57	7,317,893.27	73.98
7	0.0002	0.9998	98,896	18.84	98,886.83	7,218,985.70	73.00
8	0.0002	0.9998	98,877	16.06	98,869.38	7,120,098.87	72.01
9	0.0002	0.9998	98,861	17.19	98,852.76	7,021,229.49	71.02
10	0.0002	0.9998	98,844	19.03	98,834.65	6,922,376.73	70.03
11	0.0002	0.9998	98,825	21.51	98,814.38	6,823,542.08	69.05
12	0.0002	0.9998	98,804	22.71	98,792.27	6,724,727.70	68.06
13	0.0003	0.9997	98,781	26.87	98,767.48	6,625,935.43	67.08
14	0.0004	0.9996	98,754	37.43	98,735.33	6,527,167.95	66.10
15	0.0006	0.9994	98,717	54.98	98,689.13	6,428,432.62	65.12

Table A7. Cont.

Life Table—Lebanese Male Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
16	0.0009	0.9991	98,662	85.12	98,619.08	6,329,743.49	64.16
17	0.0014	0.9986	98,577	134.85	98,509.09	6,231,124.42	63.21
18	0.0016	0.9984	98,442	156.35	98,363.49	6,132,615.33	62.30
19	0.0015	0.9985	98,285	143.48	98,213.58	6,034,251.84	61.40
20	0.0015	0.9985	98,142	144.02	98,069.83	5,936,038.26	60.48
21	0.0013	0.9987	97,998	127.78	97,933.93	5,837,968.42	59.57
22	0.0013	0.9987	97,870	125.98	97,807.05	5,740,034.49	58.65
23	0.0013	0.9987	97,744	122.52	97,682.81	5,642,227.44	57.72
24	0.0011	0.9989	97,622	111.82	97,565.64	5,544,544.63	56.80
25	0.0011	0.9989	97,510	110.10	97,454.67	5,446,978.99	55.86
26	0.0012	0.9988	97,400	113.63	97,342.81	5,349,524.32	54.92
27	0.0011	0.9989	97,286	107.57	97,232.21	5,252,181.51	53.99
28	0.0011	0.9989	97,178	108.03	97,124.40	5,154,949.31	53.05
29	0.0011	0.9989	97,070	109.69	97,015.54	5,057,824.90	52.10
30	0.0013	0.9987	96,961	121.78	96,899.81	4,960,809.36	51.16
31	0.0013	0.9987	96,839	127.41	96,775.21	4,863,909.55	50.23
32	0.0014	0.9986	96,712	135.42	96,643.80	4,767,134.33	49.29
33	0.0014	0.9986	96,576	138.60	96,506.78	4,670,490.54	48.36
34	0.0016	0.9984	96,437	153.02	96,360.97	4,573,983.76	47.43
35	0.0017	0.9983	96,284	160.24	96,204.34	4,477,622.78	46.50
36	0.0019	0.9981	96,124	183.54	96,032.45	4,381,418.44	45.58
37	0.0020	0.9980	95,941	189.86	95,845.75	4,285,385.99	44.67
38	0.0022	0.9978	95,751	212.18	95,644.73	4,189,540.24	43.75
39	0.0023	0.9977	95,539	224.39	95,426.45	4,093,895.51	42.85
40	0.0026	0.9974	95,314	245.86	95,191.32	3,998,469.07	41.95
41	0.0027	0.9973	95,068	253.18	94,941.80	3,903,277.75	41.06
42	0.0029	0.9971	94,815	277.32	94,676.55	3,808,335.95	40.17
43	0.0031	0.9969	94,538	289.67	94,393.05	3,713,659.40	39.28
44	0.0036	0.9964	94,248	335.83	94,080.30	3,619,266.35	38.40
45	0.0038	0.9962	93,912	355.98	93,734.40	3,525,186.04	37.54
46	0.0042	0.9958	93,556	389.30	93,361.75	3,431,451.65	36.68
47	0.0045	0.9955	93,167	418.40	92,957.91	3,338,089.89	35.83
48	0.0049	0.9951	92,749	455.22	92,521.10	3,245,131.99	34.99
49	0.0055	0.9945	92,293	509.10	92,038.94	3,152,610.89	34.16
50	0.0063	0.9937	91,784	576.00	91,496.39	3,060,571.94	33.35
51	0.0064	0.9936	91,208	585.06	90,915.86	2,969,075.55	32.55
52	0.0066	0.9934	90,623	600.11	90,323.27	2,878,159.69	31.76
53	0.0070	0.9930	90,023	631.51	89,707.46	2,787,836.42	30.97
54	0.0069	0.9931	89,392	618.24	89,082.59	2,698,128.96	30.18
55	0.0069	0.9931	88,773	611.29	88,467.83	2,609,046.37	29.39
56	0.0074	0.9926	88,162	653.38	87,835.49	2,520,578.55	28.59
57	0.0080	0.9920	87,509	696.84	87,160.38	2,432,743.05	27.80
58	0.0086	0.9914	86,812	743.99	86,439.96	2,345,582.67	27.02
59	0.0099	0.9901	86,068	852.30	85,641.82	2,259,142.71	26.25
60	0.0109	0.9891	85,216	932.93	84,749.20	2,173,500.90	25.51
61	0.0117	0.9883	84,283	987.42	83,789.03	2,088,751.69	24.78
62	0.0130	0.9870	83,295	1084.65	82,752.99	2,004,962.66	24.07
63	0.0143	0.9857	82,211	1171.89	81,624.72	1,922,209.67	23.38
64	0.0144	0.9856	81,039	1165.11	80,456.22	1,840,584.95	22.71
65	0.0158	0.9842	79,874	1258.68	79,244.33	1,760,128.72	22.04
66	0.0167	0.9833	78,615	1313.90	77,958.04	1,680,884.39	21.38
67	0.0173	0.9827	77,301	1335.50	76,633.35	1,602,926.35	20.74
68	0.0184	0.9816	75,966	1396.09	75,267.55	1,526,293.00	20.09
69	0.0191	0.9809	74,570	1426.24	73,856.38	1,451,025.45	19.46
70	0.0195	0.9805	73,143	1424.04	72,431.25	1,377,169.07	18.83
71	0.0206	0.9794	71,719	1474.97	70,981.74	1,304,737.82	18.19
72	0.0217	0.9783	70,244	1521.14	69,483.68	1,233,756.08	17.56
73	0.0226	0.9774	68,723	1550.84	67,947.69	1,164,272.39	16.94
74	0.0246	0.9754	67,172	1649.25	66,347.65	1,096,324.70	16.32
75	0.0269	0.9731	65,523	1761.52	64,642.26	1,029,977.05	15.72

Table A7. Cont.

Life Table—Lebanese Male Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived (Cumulative) $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
76	0.0290	0.9710	63,762	1850.00	62,836.50	965,334.79	15.14
77	0.0312	0.9688	61,912	1931.45	60,945.78	902,498.28	14.58
78	0.0328	0.9672	59,980	1968.64	58,995.74	841,552.50	14.03
79	0.0340	0.9660	58,011	1969.54	57,026.65	782,556.77	13.49
80	0.0352	0.9648	56,042	1971.98	55,055.89	725,530.12	12.95
81	0.0381	0.9619	54,070	2059.02	53,040.40	670,474.23	12.40
82	0.0412	0.9588	52,011	2141.31	50,940.23	617,433.83	11.87
83	0.0445	0.9555	49,870	2217.52	48,760.82	566,493.60	11.36
84	0.0480	0.9520	47,652	2286.26	46,508.93	517,732.78	10.86
85	0.0517	0.9483	45,366	2346.12	44,192.73	471,223.85	10.39
86	0.0557	0.9443	43,020	2395.71	41,821.82	427,031.12	9.93
87	0.0599	0.9401	40,624	2433.65	39,407.14	385,209.30	9.48
88	0.0644	0.9356	38,190	2458.69	36,960.97	345,802.16	9.05
89	0.0691	0.9309	35,732	2469.70	34,496.77	308,841.20	8.64
90	0.0741	0.9259	33,262	2465.73	32,029.05	274,344.43	8.25
91	0.0794	0.9206	30,796	2446.07	29,573.15	242,315.38	7.87
92	0.0850	0.9150	28,350	2410.26	27,144.99	212,742.23	7.50
93	0.0909	0.9091	25,940	2358.20	24,760.76	185,597.24	7.15
94	0.0971	0.9029	23,582	2290.11	22,436.60	160,836.48	6.82
95	0.1036	0.8964	21,292	2206.61	20,188.24	138,399.88	6.50
96	0.1105	0.8895	19,085	2108.67	18,030.60	118,211.64	6.19
97	0.1177	0.8823	16,976	1997.69	15,977.42	100,181.03	5.90
98	0.1252	0.8748	14,979	1875.37	14,040.89	84,203.61	5.62
99	0.1331	0.8669	13,103	1743.78	12,231.31	70,162.72	5.35
100	0.1413	0.8587	11,359	1605.22	10,556.81	57,931.40	5.10
101	0.1499	0.8501	9754	1462.18	9023.11	47,374.59	4.86
102	0.1589	0.8411	8292	1317.24	7633.40	38,351.48	4.63
103	0.1682	0.8318	6975	1172.99	6388.29	30,718.08	4.40
104	0.1779	0.8221	5802	1031.94	5285.82	24,329.79	4.19
105	0.1879	0.8121	4770	896.37	4321.67	19,043.97	3.99
106	0.1984	0.8016	3873	768.32	3489.32	14,722.30	3.80
107	0.2092	0.7908	3105	649.45	2780.43	11,232.98	3.62
108	0.2203	0.7797	2456	541.04	2185.19	8452.55	3.44
109	0.2319	0.7681	1915	443.92	1692.71	6267.36	3.27
110	0.2437	0.7563	1471	358.48	1291.51	4574.65	3.11
111	0.2560	0.7440	1112	284.72	969.90	3283.15	2.95
112	0.2686	0.7314	828	222.26	716.41	2313.24	2.80
113	0.2815	0.7185	605	170.39	520.09	1596.83	2.64
114	0.2948	0.7052	435	128.19	370.80	1076.74	2.48
115	0.3083	0.6917	307	94.57	259.42	705.95	2.30
116	0.3222	0.6778	212	68.35	177.96	446.53	2.10
117	0.3364	0.6636	144	48.36	119.60	268.57	1.87
118	0.3508	0.6492	95	33.47	78.68	148.96	1.56
119	0.3655	0.6345	62	22.64	50.63	70.28	1.13
120	1.0000	0.0000	39	39.31	19.65	19.65	0.50

Ratios based on TGH05/INED France Male.

Table A8. Population-based life table—Lebanese female population (derived from insurance-based rates using TGF05/INED France ratios).

Life Table—Lebanese Female Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
0	0.0069	0.9931	100,000	693.14	99,653.43	8,946,118.78	89.46
1	0.0006	0.9994	99,307	58.28	99,277.72	8,846,465.35	89.08
2	0.0004	0.9996	99,249	37.38	99,229.89	8,747,187.63	88.13
3	0.0003	0.9997	99,211	28.18	99,197.11	8,647,957.74	87.17
4	0.0002	0.9998	99,183	20.40	99,172.82	8,548,760.63	86.19
5	0.0002	0.9998	99,163	17.38	99,153.93	8,449,587.81	85.21

Table A8. Cont.

Life Table—Lebanese Female Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
6	0.0002	0.9998	99,145	18.19	99,136.14	8,350,433.89	84.22
7	0.0001	0.9999	99,127	13.07	99,120.50	8,251,297.75	83.24
8	0.0002	0.9998	99,114	15.28	99,106.33	8,152,177.25	82.25
9	0.0001	0.9999	99,099	11.68	99,092.85	8,053,070.92	81.26
10	0.0001	0.9999	99,087	11.70	99,081.16	7,953,978.07	80.27
11	0.0001	0.9999	99,075	13.62	99,068.50	7,854,896.91	79.28
12	0.0001	0.9999	99,062	14.17	99,054.61	7,755,828.41	78.29
13	0.0002	0.9998	99,048	16.56	99,039.25	7,656,773.80	77.30
14	0.0002	0.9998	99,031	17.72	99,022.11	7,557,734.55	76.32
15	0.0002	0.9998	99,013	20.73	99,002.88	7,458,712.44	75.33
16	0.0003	0.9997	98,993	28.24	98,978.39	7,359,709.57	74.35
17	0.0003	0.9997	98,964	33.25	98,947.65	7,260,731.18	73.37
18	0.0003	0.9997	98,931	31.42	98,915.31	7,161,783.53	72.39
19	0.0003	0.9997	98,900	29.12	98,885.04	7,062,868.22	71.41
20	0.0003	0.9997	98,870	25.61	98,857.67	6,963,983.18	70.44
21	0.0003	0.9997	98,845	24.71	98,832.51	6,865,125.51	69.45
22	0.0002	0.9998	98,820	21.33	98,809.48	6,766,293.01	68.47
23	0.0002	0.9998	98,799	22.69	98,787.47	6,667,483.53	67.49
24	0.0002	0.9998	98,776	20.24	98,766.01	6,568,696.05	66.50
25	0.0002	0.9998	98,756	21.62	98,745.07	6,469,930.05	65.51
26	0.0003	0.9997	98,734	28.76	98,719.88	6,371,184.97	64.53
27	0.0003	0.9997	98,706	27.47	98,691.77	6,272,465.09	63.55
28	0.0003	0.9997	98,678	30.69	98,662.69	6,173,773.32	62.56
29	0.0003	0.9997	98,647	33.56	98,630.56	6,075,110.63	61.58
30	0.0004	0.9996	98,614	40.11	98,593.72	5,976,480.07	60.60
31	0.0004	0.9996	98,574	42.21	98,552.56	5,877,886.35	59.63
32	0.0005	0.9995	98,531	52.04	98,505.44	5,779,333.79	58.65
33	0.0006	0.9994	98,479	58.76	98,450.04	5,680,828.35	57.69
34	0.0007	0.9993	98,421	64.63	98,388.35	5,582,378.31	56.72
35	0.0008	0.9992	98,356	74.94	98,318.56	5,483,989.96	55.76
36	0.0008	0.9992	98,281	80.50	98,240.84	5,385,671.40	54.80
37	0.0009	0.9991	98,201	88.50	98,156.33	5,287,430.56	53.84
38	0.0010	0.9990	98,112	102.64	98,060.76	5,189,274.23	52.89
39	0.0011	0.9989	98,009	111.94	97,953.47	5,091,213.46	51.95
40	0.0012	0.9988	97,898	116.62	97,839.19	4,993,259.99	51.00
41	0.0013	0.9987	97,781	124.14	97,718.82	4,895,420.80	50.07
42	0.0014	0.9986	97,657	133.82	97,589.83	4,797,701.98	49.13
43	0.0014	0.9986	97,523	138.62	97,453.61	4,700,112.15	48.19
44	0.0016	0.9984	97,384	156.37	97,306.12	4,602,658.53	47.26
45	0.0017	0.9983	97,228	163.88	97,146.00	4,505,352.41	46.34
46	0.0019	0.9981	97,064	181.22	96,973.45	4,408,206.42	45.42
47	0.0020	0.9980	96,883	197.98	96,783.85	4,311,232.97	44.50
48	0.0022	0.9978	96,685	211.20	96,579.27	4,214,449.11	43.59
49	0.0021	0.9979	96,474	206.70	96,370.32	4,117,869.85	42.68
50	0.0022	0.9978	96,267	214.15	96,159.89	4,021,499.53	41.77
51	0.0025	0.9975	96,053	239.66	95,932.99	3,925,339.64	40.87
52	0.0025	0.9975	95,813	239.68	95,693.32	3,829,406.65	39.97
53	0.0027	0.9973	95,573	254.32	95,446.32	3,733,713.32	39.07
54	0.0029	0.9971	95,319	279.22	95,179.55	3,638,267.00	38.17
55	0.0031	0.9969	95,040	294.56	94,892.66	3,543,087.46	37.28
56	0.0031	0.9969	94,745	290.50	94,600.13	3,448,194.80	36.39
57	0.0032	0.9968	94,455	303.64	94,303.05	3,353,594.68	35.50
58	0.0034	0.9966	94,151	322.74	93,989.86	3,259,291.62	34.62
59	0.0038	0.9962	93,828	357.00	93,649.99	3,165,301.76	33.73
60	0.0042	0.9958	93,471	395.10	93,273.94	3,071,651.76	32.86
61	0.0046	0.9954	93,076	430.60	92,861.09	2,978,377.82	32.00
62	0.0053	0.9947	92,646	488.41	92,401.59	2,885,516.73	31.15
63	0.0058	0.9942	92,157	538.22	91,888.28	2,793,115.14	30.31
64	0.0060	0.9940	91,619	552.23	91,343.05	2,701,226.87	29.48
65	0.0065	0.9935	91,067	589.37	90,772.25	2,609,883.81	28.66

Table A8. Cont.

Life Table—Lebanese Female Population (Annual Intervals)							
Age Group	Mortality Rate q_x	Survival Probability $p_x = 1 - q_x$	Survivors $l_x = l_{x-1}p_{x-1}$	Deaths $d_x = l_x q_x$	Person-Years Lived $L_x = l_x - \frac{1}{2}d_x$	Total Person-Years Lived $T_x = \sum_{y \geq x} L_y$	Life Expectancy $e_x = T_x/l_x$
66	0.0069	0.9931	90,478	620.01	90,167.56	2,519,111.57	27.84
67	0.0071	0.9929	89,858	640.69	89,537.22	2,428,944.00	27.03
68	0.0077	0.9923	89,217	689.48	88,872.13	2,339,406.79	26.22
69	0.0083	0.9917	88,527	734.98	88,159.90	2,250,534.66	25.42
70	0.0087	0.9913	87,792	761.11	87,411.85	2,162,374.75	24.63
71	0.0094	0.9906	87,031	814.06	86,624.27	2,074,962.90	23.84
72	0.0102	0.9898	86,217	882.51	85,775.98	1,988,338.63	23.06
73	0.0106	0.9894	85,335	908.25	84,880.60	1,902,562.65	22.30
74	0.0116	0.9884	84,426	980.93	83,936.01	1,817,682.05	21.53
75	0.0127	0.9873	83,446	1061.46	82,914.82	1,733,746.03	20.78
76	0.0139	0.9861	82,384	1147.76	81,810.21	1,650,831.21	20.04
77	0.0148	0.9852	81,236	1205.15	80,633.76	1,569,021.00	19.31
78	0.0163	0.9837	80,031	1301.41	79,380.48	1,488,387.24	18.60
79	0.0177	0.9823	78,730	1392.34	78,033.61	1,409,006.76	17.90
80	0.0189	0.9811	77,337	1463.13	76,605.87	1,330,973.16	17.21
81	0.0206	0.9794	75,874	1565.71	75,091.45	1,254,367.29	16.53
82	0.0225	0.9775	74,309	1670.96	73,473.11	1,179,275.84	15.87
83	0.0245	0.9755	72,638	1779.62	71,747.82	1,105,802.73	15.22
84	0.0268	0.9732	70,858	1896.66	69,909.68	1,034,054.90	14.59
85	0.0293	0.9707	68,961	2018.21	67,952.25	964,145.22	13.98
86	0.0320	0.9680	66,943	2142.20	65,872.04	896,192.97	13.39
87	0.0350	0.9650	64,801	2269.75	63,666.07	830,320.92	12.81
88	0.0384	0.9616	62,531	2398.17	61,332.10	766,654.86	12.26
89	0.0419	0.9581	60,133	2519.15	58,873.44	705,322.76	11.73
90	0.0456	0.9544	57,614	2627.86	56,299.94	646,449.31	11.22
91	0.0496	0.9504	54,986	2725.89	53,623.07	590,149.37	10.73
92	0.0537	0.9463	52,260	2807.13	50,856.56	536,526.31	10.27
93	0.0580	0.9420	49,453	2867.10	48,019.44	485,669.75	9.82
94	0.0624	0.9376	46,586	2907.19	45,132.29	437,650.31	9.39
95	0.0670	0.9330	43,679	2928.35	42,214.52	392,518.02	8.99
96	0.0719	0.9281	40,750	2931.03	39,284.82	350,303.51	8.60
97	0.0771	0.9229	37,819	2916.59	36,361.01	311,018.68	8.22
98	0.0818	0.9182	34,903	2854.32	33,475.55	274,657.67	7.87
99	0.0872	0.9128	32,048	2795.11	30,650.83	241,182.13	7.53
100	0.0926	0.9074	29,253	2709.14	27,898.71	210,531.29	7.20
101	0.0982	0.9018	26,544	2607.68	25,240.30	182,632.58	6.88
102	0.1041	0.8959	23,936	2491.96	22,690.48	157,392.28	6.58
103	0.1102	0.8898	21,445	2363.51	20,262.74	134,701.80	6.28
104	0.1166	0.8834	19,081	2224.18	17,968.90	114,439.06	6.00
105	0.1232	0.8768	16,857	2076.04	15,818.79	96,470.16	5.72
106	0.1300	0.8700	14,781	1921.39	13,820.08	80,651.37	5.46
107	0.1371	0.8629	12,859	1762.63	11,978.06	66,831.29	5.20
108	0.1444	0.8556	11,097	1602.24	10,295.63	54,853.23	4.94
109	0.1519	0.8481	9495	1442.64	8773.19	44,557.60	4.69
110	0.1597	0.8403	8052	1286.19	7408.77	35,784.41	4.44
111	0.1678	0.8322	6766	1135.02	6198.17	28,375.64	4.19
112	0.1760	0.8240	5631	991.07	5135.12	22,177.47	3.94
113	0.1845	0.8155	4640	855.94	4211.61	17,042.35	3.67
114	0.1932	0.8068	3784	730.90	3418.20	12,830.74	3.39
115	0.2021	0.7979	3053	616.86	2744.31	9412.54	3.08
116	0.2112	0.7888	2436	514.36	2178.70	6668.23	2.74
117	0.2204	0.7796	1922	423.58	1709.73	4489.52	2.34
118	0.2299	0.7701	1498	344.38	1325.75	2779.79	1.86
119	0.2395	0.7605	1154	276.31	1015.41	1454.04	1.26
120	1.0000	0.0000	877	877.26	438.63	438.63	0.50

Ratios based on TGF05/INED France Female.

These tables provide essential input for the modeling of mortality, the estimation of premiums, and the calculation of technical reserves. They also form a reliable basis for directly comparing the mortality characteristics of insured individuals with those of the wider Lebanese population.

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