RESEARCH BRIEF

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The Influence of Wage on Temporary Disability Duration—A Modeled View

Key Insights

The overall impact of wage on temporary disability (TD) duration is not a simple relationship. It is a result of intricate interactions with multiple factors, notably the injured worker age.

The average duration for high wage earners is the longest and that of low wage earners is the shortest.

The difference in duration among age groups is smallest for high wage earners.

The proportion of wage earners in the low and high wage earner groups varies by age.

The influence of wage on duration depends on claimant age. Keeping other factors constant,

- For workers age 29 years and younger, low wage earners have a meaningfully shorter duration.
- For workers in the age group 30 to 34, and those in the 64 and older age group, wage does not meaningfully influence duration.
- For workers in age groups between 35 to 64, high wage earners have a meaningfully shorter duration.

Introduction

In the previous duration research brief Temporary Disability Duration in Workers Compensation—A First Look, we shared descriptive statistics of the average temporary disability (TD) duration for four key factors—State, Age Group, Economic Sector, and Body System and Medical Condition.

This research brief incorporates a sophisticated inference model to further examine temporary disability duration. Additionally, we investigate the question, “Does wage influence temporary disability duration?”

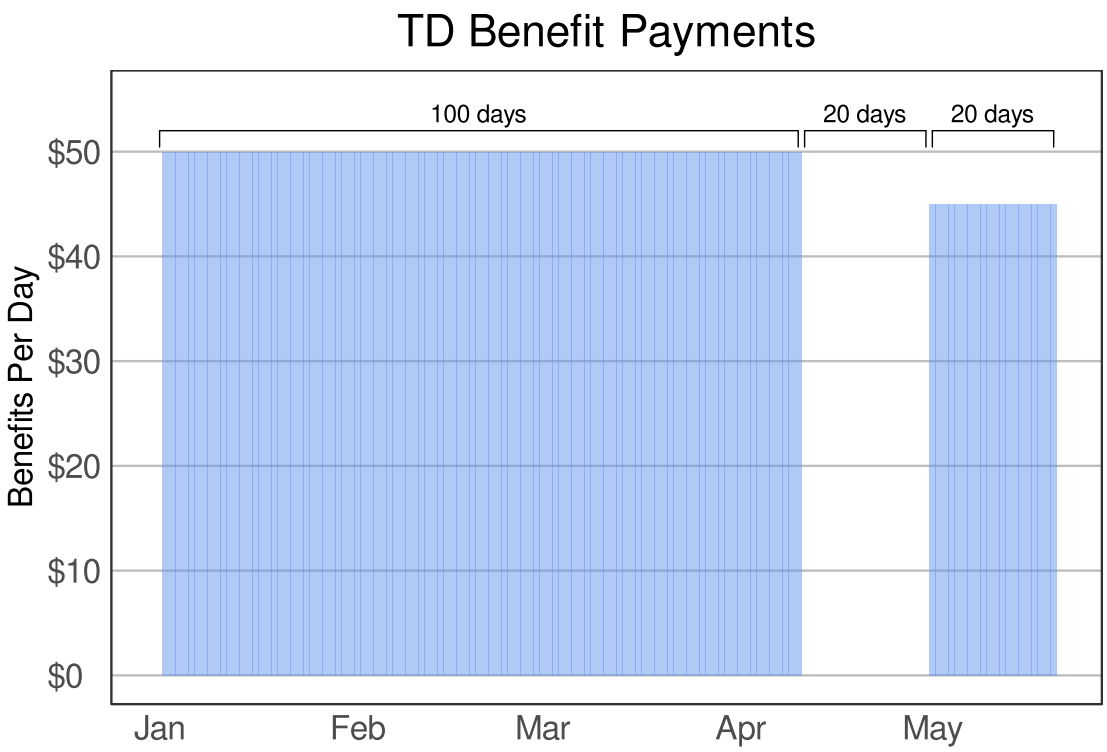
Duration Defined

We define TD **duration** as the number of days TD benefits were paid. This excludes any gaps in benefit payments. Exhibit 1 provides an illustration of an injured worker's TD benefit payments with a compensable accident on January 1. As of the 12-month maturity, the claimant received 120 days' worth of TD benefits over the following periods:

- $50 per day between January 2 and April 10 for a total of 100 days
- $45 per day between May 1 and May 20 for a total of 20 days

This claim was active for a total of 140 days. The injured worker received 120 days of TD benefit payments, the difference being the gap in payments from April 11 to April 30.

Exhibit 1: Illustration of Benefit Duration

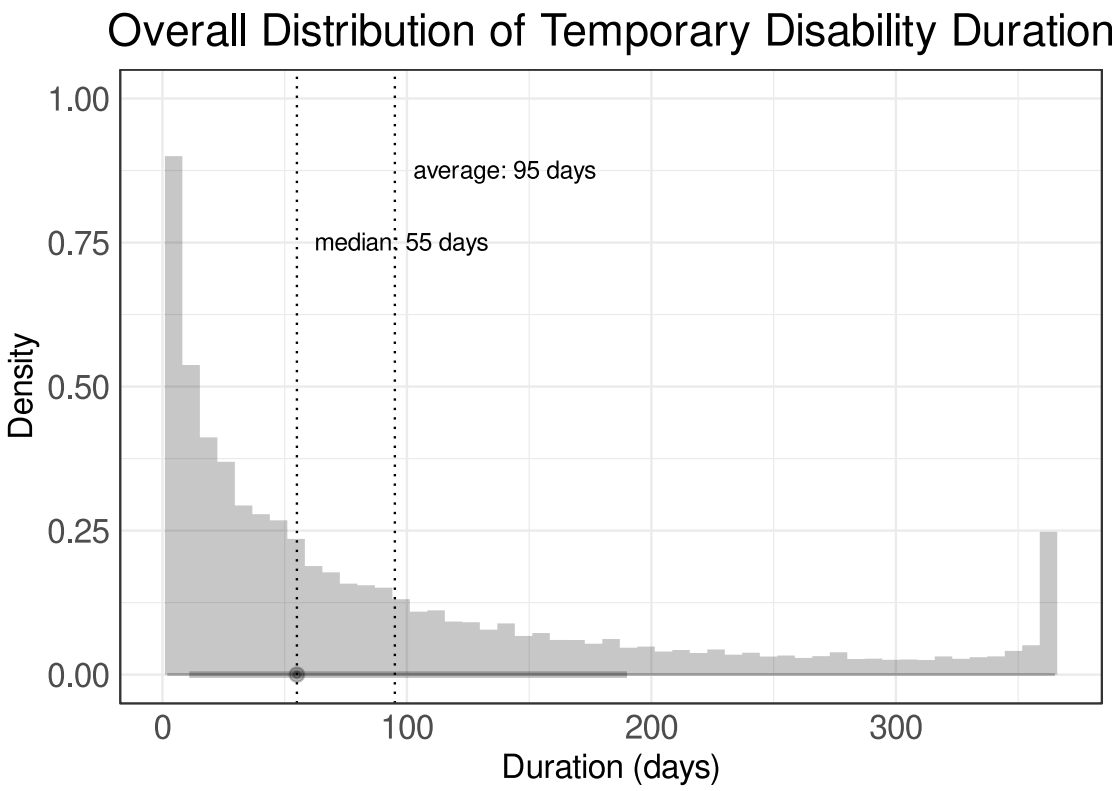


Duration Metrics

Exhibit 2 below demonstrates that, on average, injured workers experienced a TD duration of approximately 95 days. Half of all claims exceed a duration of 55 days.

The mass point at the tail of the distribution is due to the data being truncated at 365 days from the accident date. In the last week of the observation period, 13% of all claims are still receiving TD benefit payments.

Exhibit 2: Overall distribution of Temporary Disability Duration



Wage Groups

We determine wage groups based on the ratio of the injured worker wage to the State Average Weekly Wage (SAWW).

In this brief, we define three wage groups as follows:

- Low—Injured workers with pre-injury wage lower than 50% of the SAWW (green)
- Base—Injured workers with pre-injury wage between 50% and 150% of the SAWW (pink)
- High—Injured workers with pre-injury wage greater than 150% of the SAWW (blue)

A state agency publishes the SAWW anywhere from 6 to 23 months after the beginning of the measurement period. In periods of high wage inflation, the SAWW lag may result in a temporary situation where the percentage of high wage injured workers increases compared to historical norms. For more information on the impact of changes in the macro-economic conditions can impact the percentage of high wage or low wage workers, see NCCI's research brief, Why Wage Inflation Matters in Workers Compensation.

Exhibit 3.A illustrates a hypothetical relationship between an injured worker wage (as a percentage of the SAWW) and the payable benefit (as a percentage of the SAWW). Each solid black point represents a hypothetical worker's wage and payable benefit, assuming a 66.7% rate of compensation, a maximum weekly benefit of 100% the SAWW, and a minimum weekly benefit of 25% of the SAWW. Solid red vertical lines at 150% and 50% of the SAWW designate the separation between high wage vs base wage and base wage vs low wage earners, respectively.

Statutory minimum and maximum benefits vary by each state's unique workers compensation statutes. More information on TD benefit provisions by jurisdiction can be found in NCCI's ***Annual Statistical Bulletin,*** Exhibit 7.

Exhibit 3.A: Illustration of the relationship between wage and payable benefit

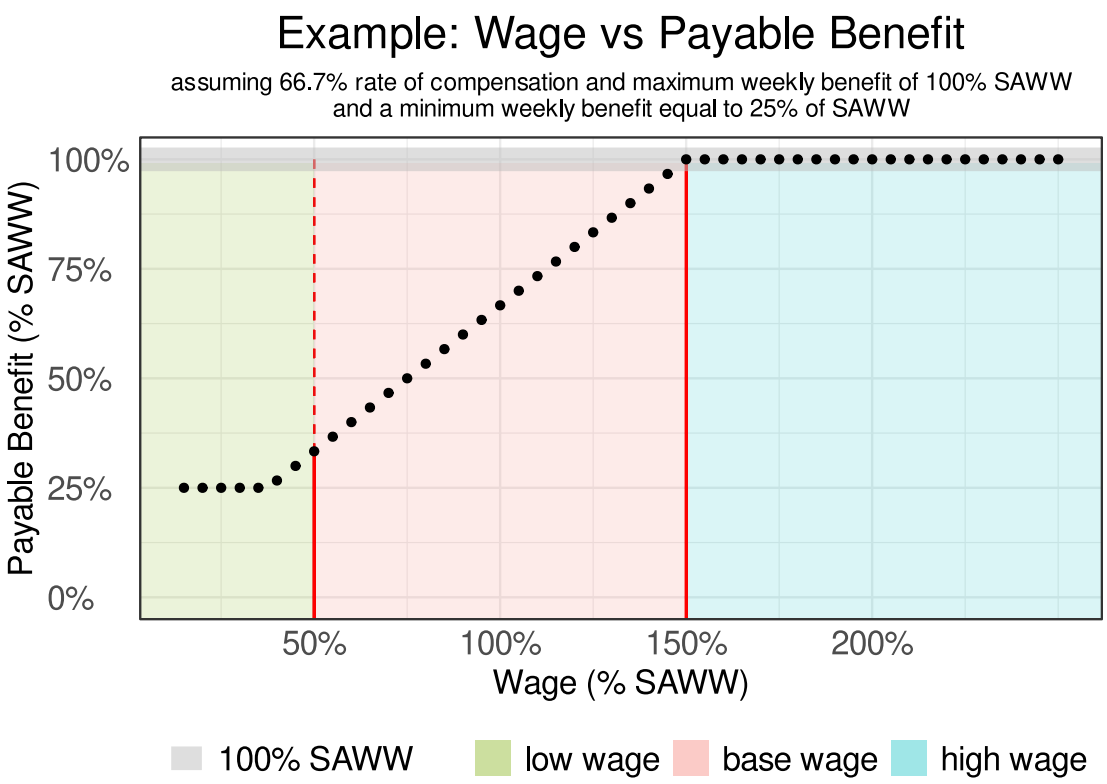


Exhibit 3.B shows the overall distribution of injured worker wages in this study, with conditional color based on the categorical groupings of low (green), base (pink), and high (blue) wage earners.

- Low wage earners represent 29% of injured workers
- Base wage earners represent 64% of injured workers
- High wage earners represent 7% of injured workers

Exhibit 3.B: Distribution of worker wages

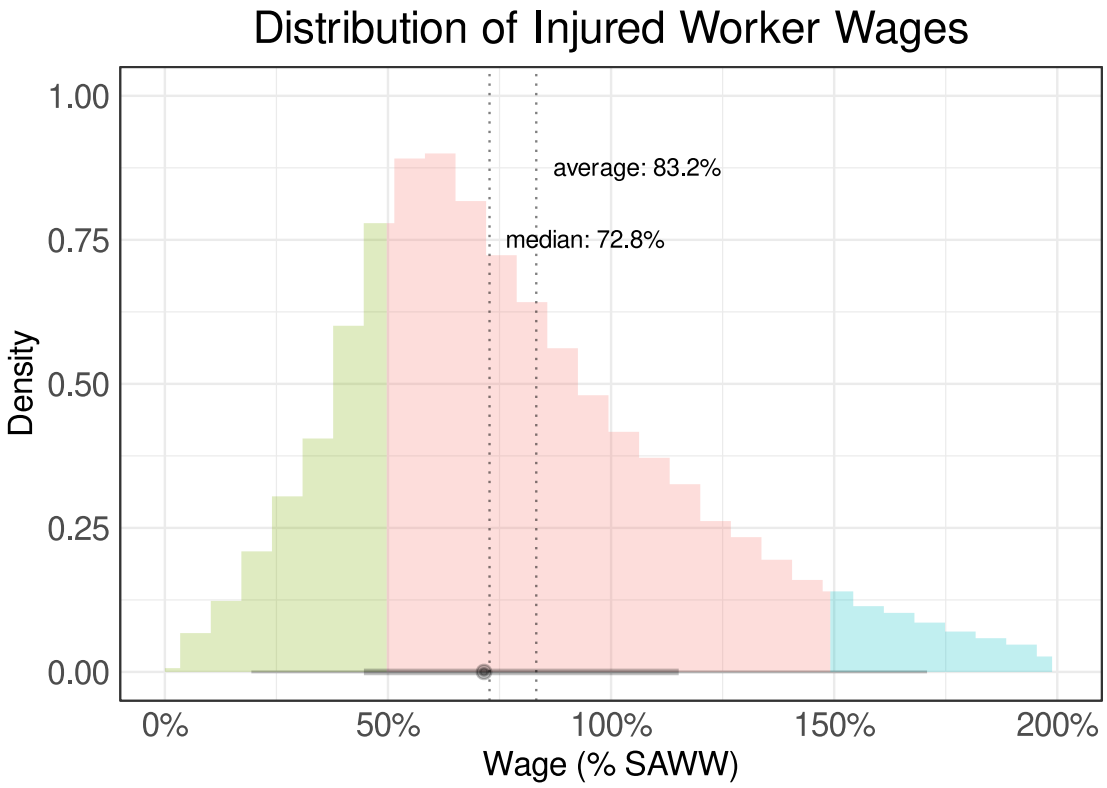
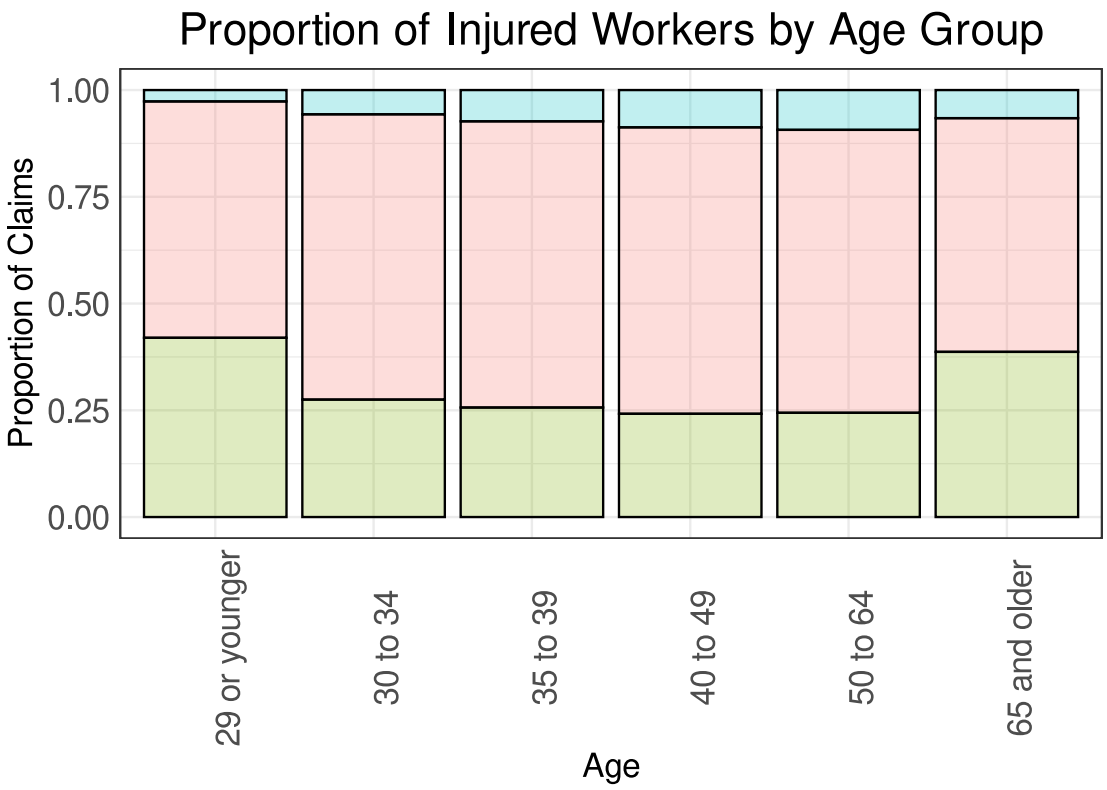


Exhibit 3.C shows the proportion of injured worker wages by age group, with conditional color based on the categorical groupings of low, base, and high wage earners. The green boxes represent the proportion of low wage earners by age group. The pink and blue boxes represent the base wage earners and high wage earners, respectively. Note that the youngest age group has the smallest proportion of high wage earners.

Exhibit 3.C: Proportion of injured workers by age group



Descriptive Statistics

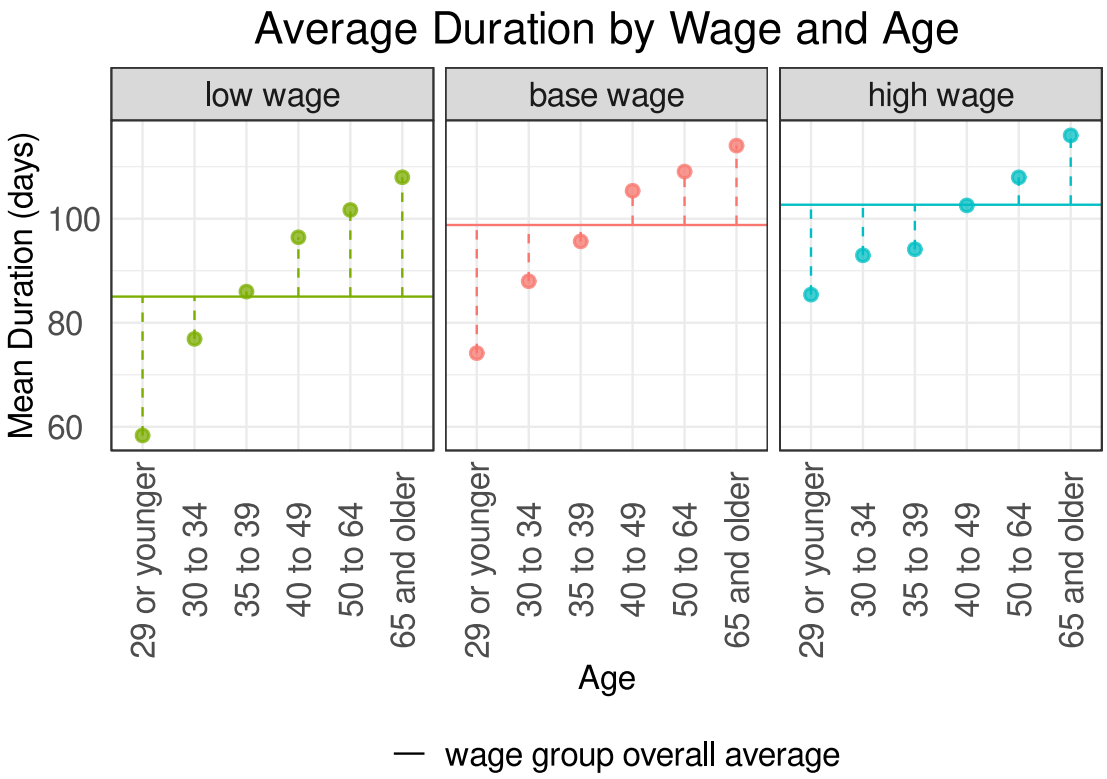
Previously, we documented that duration varies significantly by age, state, economic sector, body system, and medical condition (see Temporary Disability Duration in Workers Compensation—A First Look). We would expect TD duration to vary by wage, however, we anticipate that TD duration by wage group would be correlated to and interact with the aforementioned claim characteristics.

Exhibit 4 shows the average duration for each age within a wage group. Solid points represent age-specific averages, and the horizontal line in each plot represent the average for the wage group.

A few observations are clear:

- The difference in duration by wage group varies across age groups as indicated by the dots within each box.
- The range of the dots within each box is smallest for the high wage group. In other words, age matters less for the high wage group than for the others.
- We observe that for each age group the lowest wage earners have the shortest duration. The green dot is lower than the blue or pink dot when looking at any specific age group.

Exhibit 4: Average Duration by Wage Group, and Average Duration by Wage and Age Group



Modeled Results

The Model

To account for the interactions and confounding variables we examined the estimated marginal means (EMMs) from a generalized linear model (GLM). In simple terms, an estimated marginal mean is like the average value you get when you consider one specific group or condition while holding other factors constant. It helps explain what the typical outcome or result is for a particular group or situation, taking into account all the relevant factors that might affect it.

For information on the model specifications, see the Appendix A Why Modeling section.

What Was the Effect of Wage on Duration?

Recall that Exhibit 4 demonstrated that high wage earners have the longest duration, while low wage earners have the shortest duration on average. Exhibit 4 also indicated that low wage earners have the shortest duration for each of the age groups. Exhibit 3.C indicated that the proportion of low or high wage earners varies by age group.

We utilized the model to get the estimate marginal means, which represent an average modeled TD duration value for a specific group (e.g., low wage workers in the 29 or younger age group). Exhibit 5 illustrates the EMM of the TD duration for each level of wage and age. Each point and interval represents the mean and 95% confidence interval, respectively, for a given wage-age group. Notice in Exhibit 5 that the estimated marginal mean duration increases with age across all three wage groups.

Exhibit 5: Estimated Marginal Mean Duration by Wage and Age Group

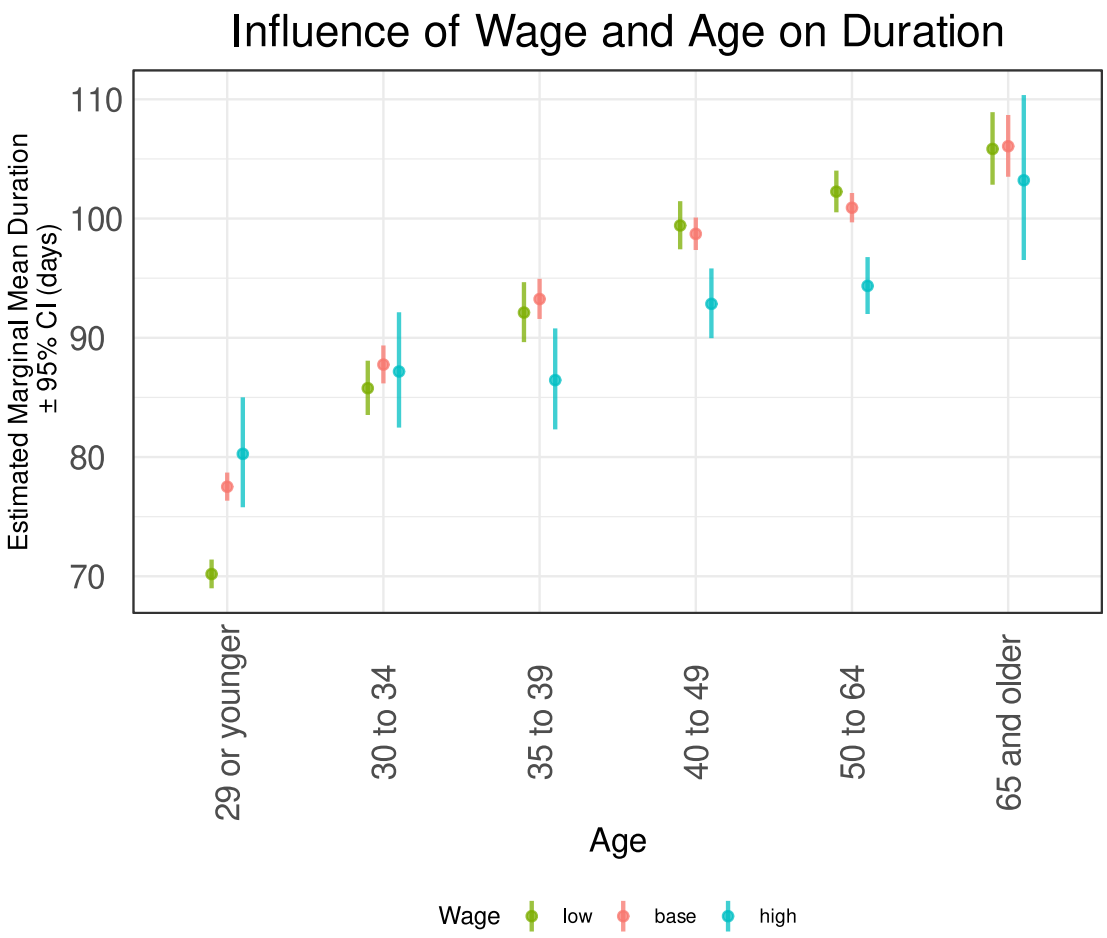
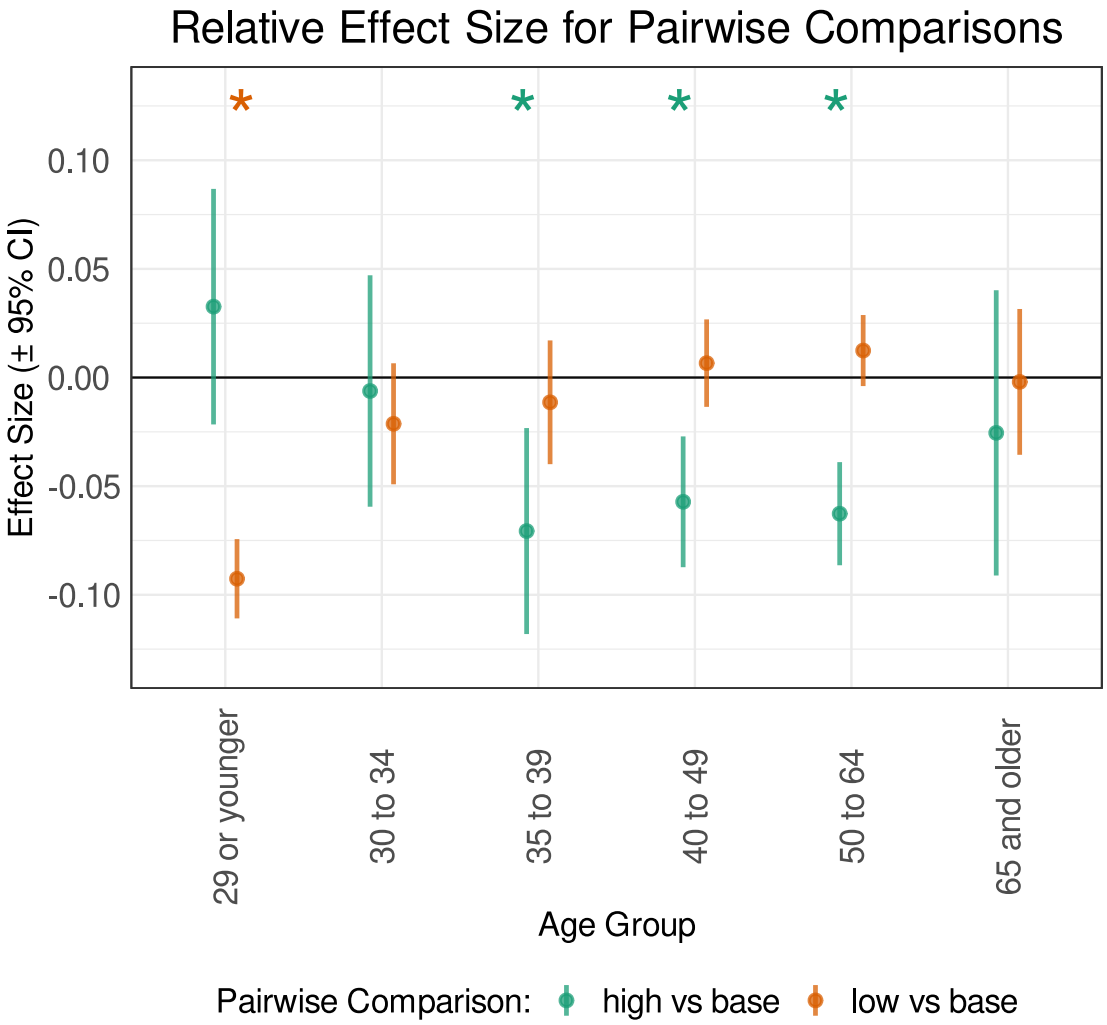


Exhibit 6 displays the pairwise differences of the EMMs for the low and high wage earners in comparison to the base wage earners. Each point and interval calculates the effect size and 95% confidence interval around the effect size for a specific pairwise comparison. We compare the difference in the EMMs for high wage and low wage earners to base wage earners within each age group. Then, we calculated an effect size with a 95% confidence interval. If the 95% confidence interval around the effect size is greater or less than 0, we consider this difference to be meaningful. A negative effect size indicates that the EMM for high/low wage earners is significantly shorter than the base wage group, while a positive effect size suggests that the EMM for high/low wage earners is significantly longer than the base wage group.

We observe that within the youngest age group (29 and younger), low wage workers had a significantly shorter duration than both base and high wage workers. There were no meaningful differences across the wage groups among workers aged 30 to 34 or 65 and older. For injured workers aged 35 to 64, high-paid workers had the shortest TD duration. It's important to note that there is no meaningful difference between any of the age groups for the 30 to 34 age group. This may seem contradictory to the findings in Exhibit 4, which showed that low wage earners have a shorter duration for the 30 to 34 age group. These seemingly contradictory findings emphasize the necessity of using a more sophisticated approach that considers interactions and unbalanced wage group sample sizes across age groups, as opposed to the descriptive statistics in Exhibit 3.C.

Exhibit 6: Pairwise Comparisons between Low, Base, and High Wage Workers



Note: a * indicates that the effect size (± 95% CI) exceeds 0

How did the other fixed effects influence duration?

The purpose of the GLM model is to comprehend how a worker wage-age interaction term influences duration while controlling for a state-specific term for claimant attorney representation, medical condition, and economic sector. To gain a better understanding of these fixed effects, we computed their estimated marginal means.

Exhibits 7, 8, and 9 illustrate the EMM for the TD duration for the modeled confounding factors. Each point shows the EMM and the line shows the 95% confidence interval of the EMM.

Exhibit 7 illustrates the EMMs for claims with and without claimant attorney representation for each state. In each state, claims with claimant attorney representation experience significantly longer TD duration than those without representation. The average EMM of TD duration without claimant attorney representation ranges from 60 days to 110 days. The average EMM of TD duration with claimant attorney representation ranges from 106 days to 254 days.

Furthermore, we incorporated the state-attorney interaction term since the effect of claimant attorney representation varies among states. The differences range from a low value of 46 days to a high value of 157 days.

Exhibit 7: State-Attorney Estimated Marginal Means

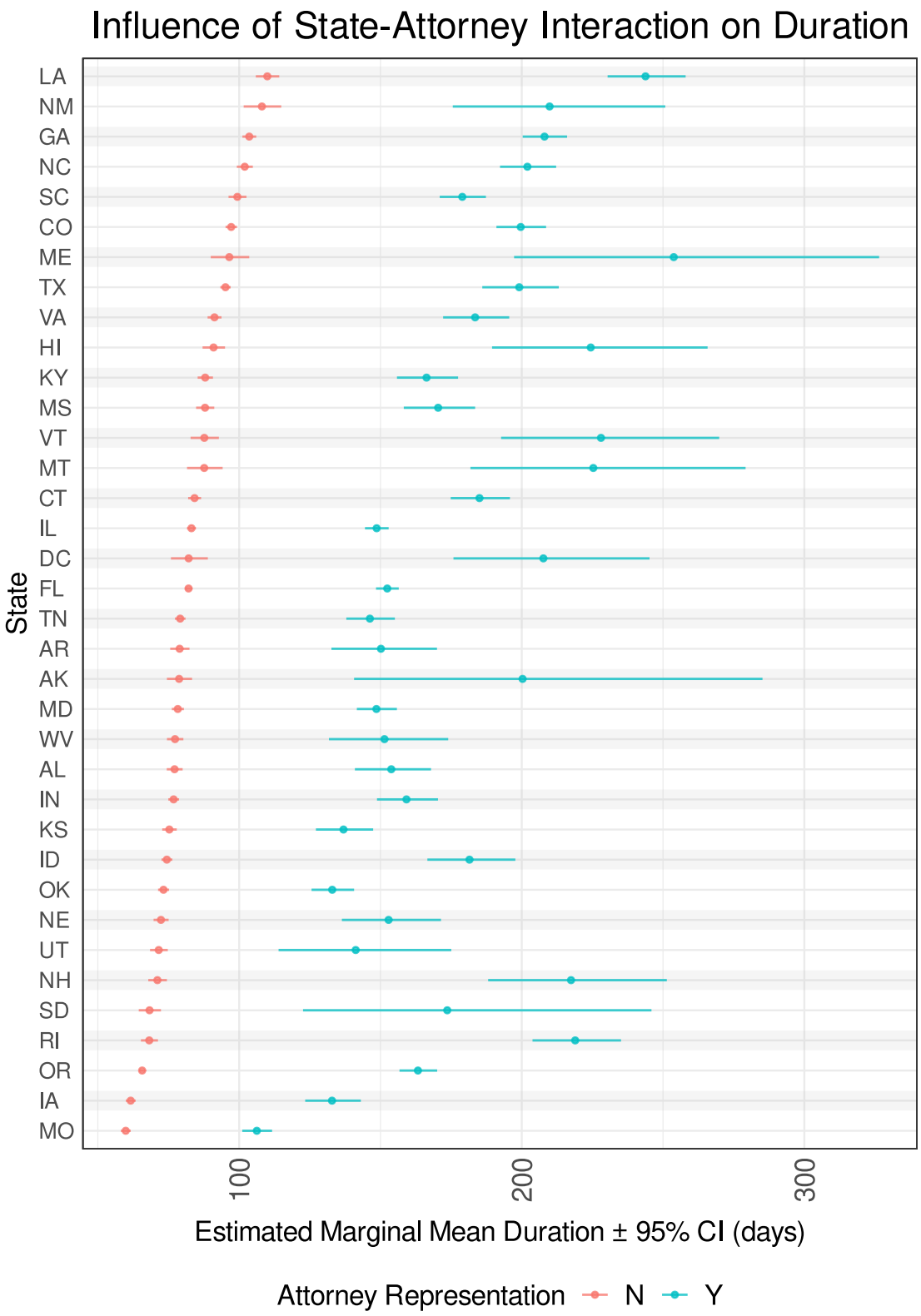


Exhibit 8 shows the EMM for each medical condition. Spinal cord injuries demonstrated the longest duration, followed by femur fractures.

Exhibit 8: Medical Condition Estimated Marginal Means

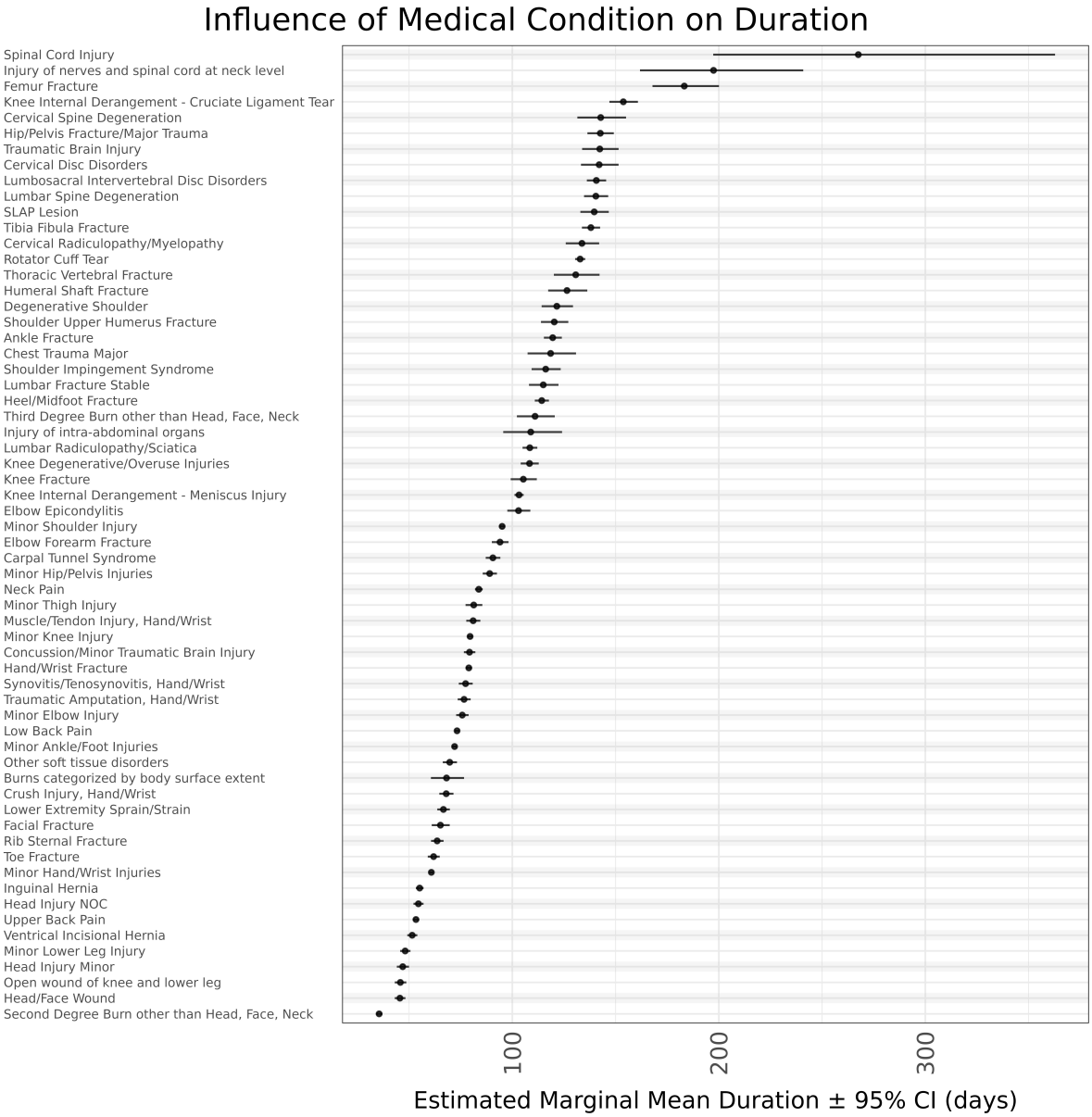
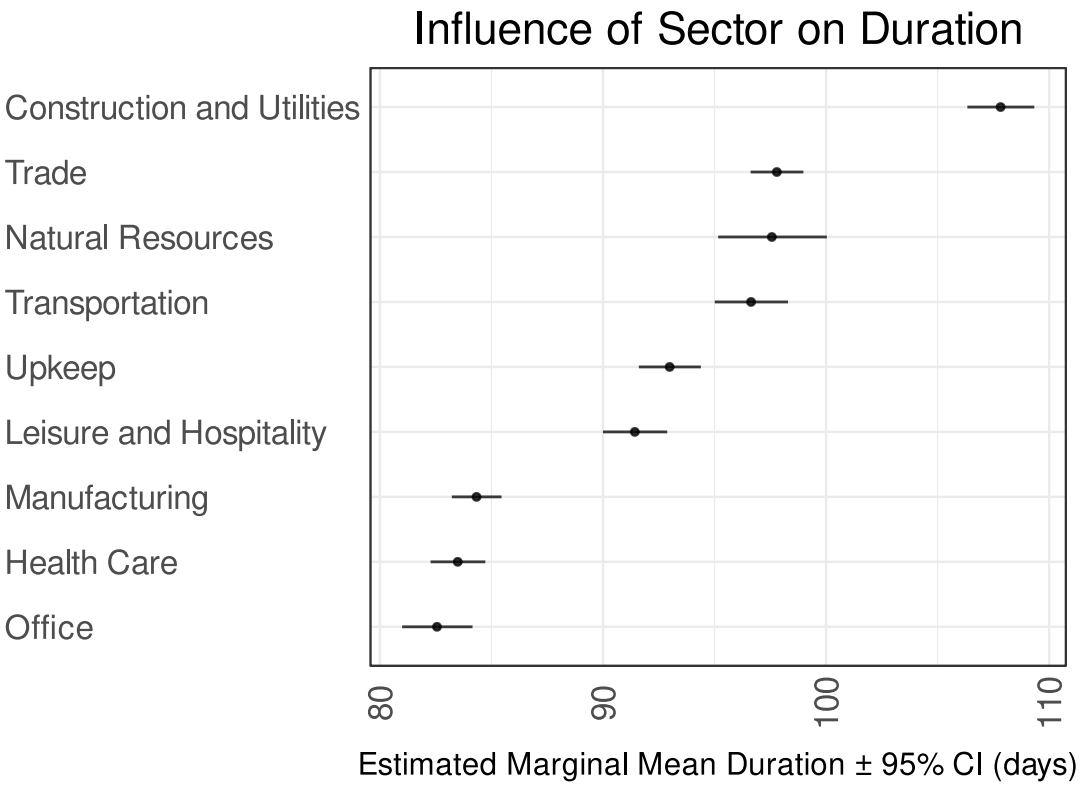


Exhibit 9 shows the EMM by economic sector. The EMM for construction and utilities is greater than the EMM in other sectors.

Exhibit 9: Economic Sector Estimated Marginal Means



Conclusion

We have shown that answering the question—"Do wages influence temporary disability duration?"—is not a simple one. It requires subject matter expertise. Looking solely at the average duration for each age group, a descriptive statistic, one may conclude that as wages increase TD duration increases. However, the goal was not to find what wage group has the longest duration; rather it was to determine how wages influence duration.

We showed how using a GLM model and the EMMs from the model can assist in determining influence. EMMs are incorporated to fade out the effects of other factors providing a clear picture of the influence of the factor of interest. We expected that high wage earners would be incentivized to return to work sooner, leading to shorter duration. Overall, we found that high wage earners have longer durations and low wage earners have shorter duration. However, the influence of wage on duration depends on the age of the worker.

Often these complex interactions can never truly be known since data and computing power are finite, at least as of 2024. This is why having subject matter experts is so important and cannot be replaced by models, at least not yet.

Appendix A

Why Modeling?

"All models are wrong, but some are useful." is a well-known saying in the field of modeling and statistics, often attributed to the statistician George Box.

Statistical Modeling

Statistical inference is an organized approach to yield estimates and confidence intervals about a prediction or parameter of interest. It allows us to learn from imperfect data. When attempting to understand a system with complex interactions, it is ideal to try and understand those influences simultaneously. In this study, we expect wage to influence duration, but we must first disentangle the influences of multiple other factors like age, medical condition, and economic sector. Simply put, we have a hypothesis (High wage earners experience shorter duration.) to test while controlling for other important factors. Hypothesis testing is a branch of statistical inference used for assessing the strength of statistical evidence supporting a hypothesis. In this study, we aim to leverage statistical inference to understand differences in duration that can be attributed to a worker's wage. Specifically, we used a statistical model to examine whether this data supports our hypothesis (High wage earners experience shorter duration.).

In this study, duration is the response variable and wage is the primary explanatory factor of interest. Because the response variable, duration in days, is a count (i.e., non-negative integer), we needed the flexibility of a generalized linear model (GLM) to model non-normal errors. We chose a negative binomial (NB) GLM to analyze an over-dispersed count response variable (duration). Wage shares an interaction with age (as show in Exhibit 4), so we decided to use a Wage:Age interaction term. Through experimentation, we decided to also control for the effects of claimant attorney representation (interacted with state), medical condition, and economic sector. We used this model to understand the influence of a worker Wage:Age interaction term on duration, while controlling for a state-specific term for attorney representation, medical condition, and economic sector (see formula below):

\[Duration \sim \beta_0 + \beta_1 * Wage:Age + \beta_2 * Attorney:State + \beta_3 * MedicalCondition + \beta_4 * Sector\]

Raw ordinary means can be rendered unreliable if the data is unbalanced and/or contains spurious interactions. In large observational datasets like this one, the analysis will need to control for the unbalanced sample sizes and confounding factors. Estimated Marginal Means (EMMs) represent the average value of the response variable (in this case duration) for each level of explanatory variable (i.e., Wage:Age interaction). EMMs are essentially estimates of what the means would be if all groups had the same sample size and/or the same mean value on a covariate/factor. Using our negative binomial model, we calculated the EMMs along with asymptotic 95% confidence intervals for each Wage:Age group. We then used the EMMs (which were proportionally weighted and averaged across the other explanatory factors) and their associated 95% confidence intervals, to make pairwise comparisons between wage groups (i.e., high vs base, low vs base), within a given age group.

Very large sample sizes will often lead to overly small p-values (p-value: the probability of obtaining data as extreme, or more extreme, as those observed, if the null hypothesis is true). In fact, the sample size can be large enough that a non-null statistical comparison will *always* show a statistically significant result. In cases like this, appropriate interpretation is paramount. Effect sizes help supplement statistical significance because they quantify the magnitude of differences between two groups relative to the pooled uncertainty between two groups. This study has a very large sample (>230,000 observations), so we calculated effect sizes (± 95% confidence interval) around each pairwise comparison. We evaluated whether pairwise comparison effect sizes (± 95% confidence interval) were not equal to 0, and used that to determine whether a difference was *meaningful* or not.

Statistical analyses were conducted in R (R Development Core Team, 2007) and figures were produced using the **ggplot2** package (Wickham, 2016). The negative binomial GLM was fit using the **MASS** package (Venables & Ripley, 2002) and estimated marginal means were calculated using the **emmeans** package (Lenth, 2024).

Appendix B

Data

Based on data reported in NCCI's Unit Statistical Data, Indemnity Data Call (IDC) and Medical Data Call (MDC). Includes claim data from the following jurisdictions: AK, AL, AR, AZ, CO, CT, DC, FL, GA, HI, IA, ID, IL, IN, KS, KY, LA, MD, ME, MO, MS, MT, NC, NE, NH, NM, NV, OK, OR, RI, SC, SD, TN, TX, UT, VA, VT, and WV. Statistics are for data reported as of 12 months from the accident date for claims occurring between 4/1/2020 and 3/31/2022. COVID-19 claims are excluded from this analysis.

A total of 237,999 claims were observed. The data consists of claims where NCCI was able to join the Unit Statistical Data, IDC, and MDC.

Body System and Medical Condition

For the assignment of each claim's medical condition and body system, an algorithm was implemented that prioritizes injury-related diagnoses (e.g., rotator cuff tear) over comorbidity-related diagnoses (e.g., nicotine addiction). "Injury-related" diagnoses are defined as all ICD-10 codes beginning with M, S, T, U, K40, K42, K43, G82, G56.2, G56.3, or G56.0. Oftentimes, an individual claim will have multiple medical conditions which can impact several body systems. To account for this, a single primary medical condition is assigned according to medical payments over the study period. The body system is then derived from the primary medical condition.

Economic Sector

The nine economic sectors presented in this brief are derived by mapping NCCI class codes at the individual claim level into groupings similar to North American Industry Classification System (NAICS) supersectors, with some modifications to make these groupings more relevant to workers compensation data. The groupings are chosen to ensure that each sector is aligned with the established class code descriptions and contains a sufficient amount of data. The nine sectors are as follows:

- The Natural Resources, Construction and Utilities, Manufacturing, Health Care, and Leisure and Hospitality economic sectors are closely analogous to the NAICS sectors or supersectors of the same name, noting that we combine the Construction and Utilities NAICS sectors.
- The Trade economic sector aligns with the Retail and Wholesale Trade NAICS sectors, along with some Other Services businesses that provide in-person services to customers.
- The Transportation economic sector aligns with the Transportation and Warehousing NAICS sector, which includes trucking operations and warehousing and storage for goods.
- The Office economic sector includes office-based businesses in the Information, Financial Activities, and Professional and Business Services NAICS supersectors, as well as the Educational Services sector.
- The Upkeep economic sector aligns with businesses in the Real Estate and Rental and Leasing, Administrative and Support, Waste Management and Remediation Services, and Other Services NAICS sectors that are related to property management, building cleaning and maintenance services, landscaping, and repair and maintenance of machinery and equipment.

Duration Footnote

Duration was calculated as the total number of benefit payment days as reported in the IDC for benefit types 5 (Temporary Total) and 11 (Temporary Partial). Lump sum transactions that spanned at least two days were included in this total.

Previous Studies

Why Wage Inflation Matters in Workers Compensation

Temporary Disability Duration in Workers Compensation—A First Look