Age at Peak Performance: Comparing Mean Pro-Bowl Age Across NFL Positions

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Introduction

For our Stats Final Project, we came to the conclusion that focusing on a topic that had to do with sports would be fun and provide some interesting information on performance and other relevant data. Originally, we were thinking of staying local, focusing on Vassar sports, but eventually found an interesting topic that related to the NFL, which is relevant to the ongoing season. Throughout the many NFL teams, there is a range of different players of all ages. Most notably this season, there have been numerous quarterbacks who are on the older side and still performing at a very high level. This brought us to our most basic question of whether or not age matters in football. We narrowed this question down to asking whether or not age had a larger effect on performance, depending on the position the player plays. In order to answer this question, we had to find a mean age that corresponded with a relatively high level of performance in each position. We would then compare the different means throughout the eight chosen positions. With all the data that is available, we would then be able to answer the question, do certain positions for pro-bowl level NFL athletes have relatively similar career regressions in peak years and decline trends?

Data

In order to examine this question for this project, we conducted an observational study using data collected from Pro Football Reference, a thorough database that tracks detailed statistics for all NFL players throughout their careers. For each player, we collected their position (categorical), Pro Bowl year (categorical), award received (categorical), and the age at the time of Pro Bowl Selection (numerical, discrete). We focused primarily on players who achieved Pro Bowl recognition and received an award within the last ten years, as this criteria allowed us to center our analysis on elite NFL athletes across different positions. In total, we collected data across eight positions in the NFL: quarterback (QB), running back (RB), wide receiver (WR), tight end (TE), offensive line (OL), defensive line (DL), linebacker (LB), and defensive back (DB). These positions span offense and defense, with each facing different physical demands and performance expectations. This resulted in 4,000+ observations, which we narrowed down to 963 by choosing to just include pro bowl year and age. This approach allows us to analyze age distributions across positions and conduct statistical comparisons to determine whether certain positions showed significantly different age patterns.

Methods

Since we were working with a categorical and a numerical variable, we focused on comparing multiple means using multiple T-tests, specifically 25, comparing each position with each other. Given that our data was large enough, normal enough, and independent, using a mathematical model to hypothesis test was the best option. To visualize this data, we used a side-by-side box to show our position means and created histograms for each position to show a distribution of age and Pro Bowl appearances.
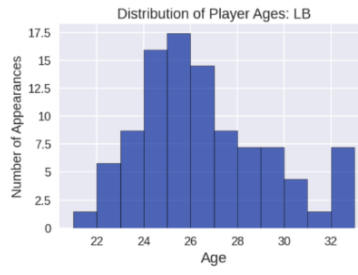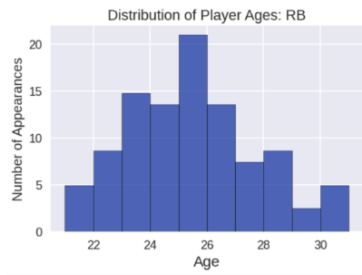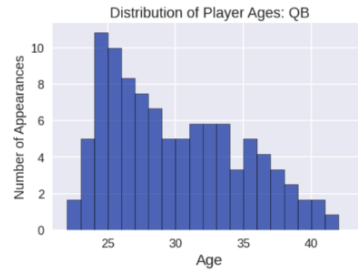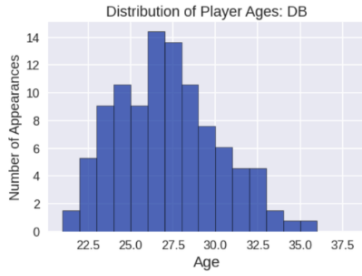
Results

To begin our analysis, we created visualizations for each of the eight positions to identify the distribution of player ages among Pro Bowl awarded players. These visualizations help us determine whether positions

show different age patterns among Pro Bowl players, providing preliminary evidence for or against our null hypothesis. Histogram set 1 and 2 displays the age distributions across all eight positions. Running backs show a distribution with low variance and a mode around 26 years old, with very few observations beyond age 30. Quarterbacks display a widely dispersed distribution, ranging from the early 20s to over 40; a right-skewed distribution indicating that some quarterbacks maintain Pro Bowl performance well into their 30s and early 40s. Defensive backs cluster tightly between ages 24 and 30, while linebackers show a roughly symmetric distribution centered about ages 25-27 years old. Wide receivers have a unimodal distribution peaking at about 25-26 years old with a moderate spread extending into the early 30s, and defensive linemen show a relatively uniform distribution across the mid to late 20s. As well, tight ends display a unimodal distribution with moderate spread spanning from the mid-20s into the early 30s, and offensive linemen show a roughly symmetric distribution, peaking around age 28 years old. Histogram set 1-2 summarizes mean ages across positions. Quarterbacks have the highest mean age at about 27.64 years, while running backs have the lowest at 24.935, a difference of 2.705 years. The remaining positions fall between these values. Figure 3 shows the side-by-side box plots for all eight positions. The medians vary noticeably across positions. Quarterbacks have the highest median at approximately 29 years, while running backs have the lowest median at about 25 years, a difference of 4 years. Quarterbacks also display the widest interquartile range, extending from about 25 to 33 years, with their distribution extending into their early 40s. Meanwhile, running backs have the narrowest interquartile range between 23 and 26 years, with two outliers in the early 30s. These patterns indicate that running backs have a narrow window for peak performance, while quarterbacks can maintain Pro Bowl-level performance well into their later years.
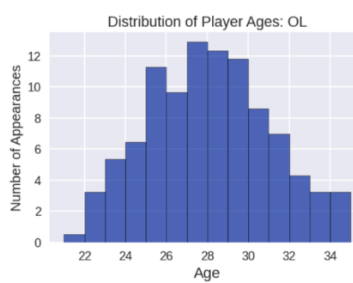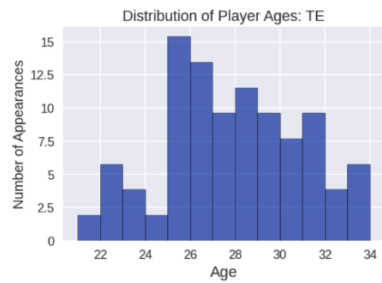
Mean Ages

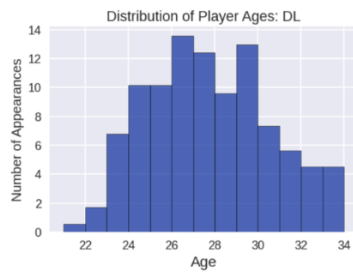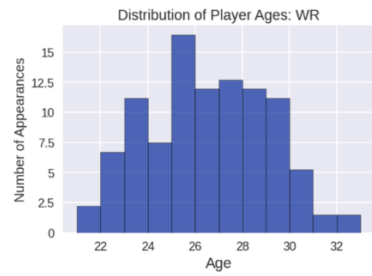| position	mean age
Quarter Back	27.643
Offensive Lineman	27.474
Defensive Lineman	26.913
Defensive Back	26.287
Tight End	26.267
Linebacker	26.260
Wide Receiver	25.688
Running Back	24.935

Histograms (Set 1)

Distribution of Player Ages: DB

Distribution of Player Ages: QB

Distribution of Player Ages: RB

Distribution of Player Ages: LB

Histograms (Set 2)

Distribution of Player Ages: WR

Distribution of Player Ages: DL

Distribution of Player Ages: TE

Distribution of Player Ages: OL
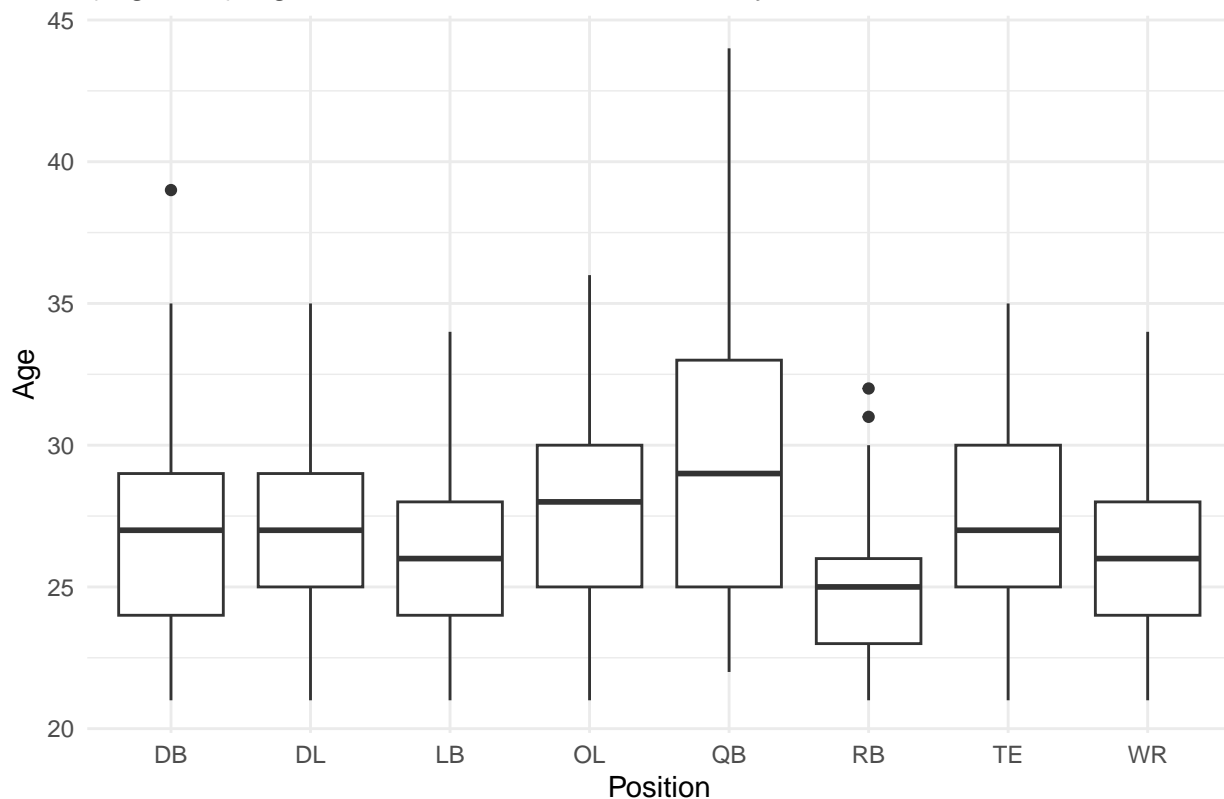
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(Figure 3) Age Distribution of Pro Bowlers by Position

Inferential Analysis:

To determine whether the observed differences in mean ages across positions were statistically significant, we conducted a pairwise two-sample t-test comparing each position against every other position, resulting in 25 total comparisons with a significance level of aplha = 0.05. The results revealed significant differences in mean ages for most position pairs. Looking at our data, we found that there were 8 combinations of positions, WR vs. LB, WR vs. DB, TE vs. OL, TE vs. DL, TE vs. LB, TE vs. DB, DL vs. DB, LB vs. DB that all had p-values > 0.05. For the remaining 17 combinations, our T-test concluded that the p-values were all less then 0.05. This shows that our data was significant enough to say that our means were not equal to each other. When creating our T-tests in R, we also were given CI's for each position that gave us extra data telling us whether or not our Null value of 0 was with in the CI or not. Several of our tests were close to including 0 but off by a few decimal points, backing up our overall conclusion. Below there are 3 of the 25 T-tests included for reference.

```r
t.test(Age ~ Pos, data = subset(Probowlers, Pos %in% c("QB", "RB")))
```

```
##
##  Welch Two Sample t-test
##
## data:  Age by Pos
## t = 8.4746, df = 184.61, p-value = 7.342e-15
## alternative hypothesis: true difference in means between group QB and group RB is not equal to 0
## 95 percent confidence interval:
##  3.431437 5.513937
## sample estimates:
## mean in group QB mean in group RB
##         29.57025         25.09756
```

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```r
t.test(Age ~ Pos, data = subset(Probowlers, Pos %in% c("WR", "LB")))
```

```
##
##  Welch Two Sample t-test
##
## data:  Age by Pos
## t = 0.77813, df = 122.03, p-value = 0.438
## alternative hypothesis: true difference in means between group LB and group WR is not equal to 0
## 95 percent confidence interval:
##  -0.5361219  1.2305663
## sample estimates:
## mean in group LB mean in group WR
##          26.45833          26.11111
```

```r
t.test(Age ~ Pos, data = subset(Probowlers, Pos %in% c("LB", "RB")))
```

```
##
##  Welch Two Sample t-test
##
## data:  Age by Pos
## t = 2.9103, df = 129.93, p-value = 0.00425
## alternative hypothesis: true difference in means between group LB and group RB is not equal to 0
## 95 percent confidence interval:
##  0.4357228 2.2858220
## sample estimates:
## mean in group LB mean in group RB
##          26.45833          25.09756
```

Discussion

The purpose of this study was to examine the differences in peak performance and regression curves between positional groups in the NFL through means of pro bowl selections. The exploratory and inferential analysis demonstrates that age-related performance trends do, in fact, differ between positions. Our results suggest that positions that demand frequent high impact collisions and require athletic output for success, particularly running back and defensive backs, tend to have younger peak ages and narrower performance windows as their mean age and spread of pro bowl appearances is lower and tapered. In contrast, quarterbacks, a notably "protected" position that demands more mental processing rather than raw explosiveness, can still deliver elite years well into their 30s and even 40s. Other positions, such as wide receivers, linebackers, tight ends, and defensive linemen, fall between these extremes with moderate peak ages with some variability, reflecting the balance between experience and physical ability required at these positions. Offensive linemen showed a slightly older mean age with a normal distribution of pro bowl appearances. Other than being consistent with the necessary qualifications of blocking technique and strength, this can be explained by pro bowl voter trends. Offensive line is the least understood positional group by casual fans and analysts with their lack of statistics to determine success, so being a pro bowl selection is much more determined by reputation in offensive linemen compared to other positional groups, explaining the trend that their peak ages are assumed to be marginally older. These findings together display the differences in peak performance and regression curves across positions in football can be explained through the physical load placed on the players' bodies and how this relates to the requirements to be successful at their respected positions.

Conclusion

This analysis provides insight not only into player age patterns but also to the broader discussions of resource allocation for player development and contract negotiations that NFL executives discuss every year when constructing their rosters for the upcoming season. Future research could extend this work by incorporating additional performance metrics, controlling for injury history, or examining trends over longer time spans.

Overall, through using observational data from Pro Football Reference and analyzing eight distinct positional groups, we found clear and meaningful differences in age distributions and average peak ages. Therefore, we reject the null hypothesis in favor of the alternative, determining that the mean age of pro bowl appearances differs between positions in the NFL.