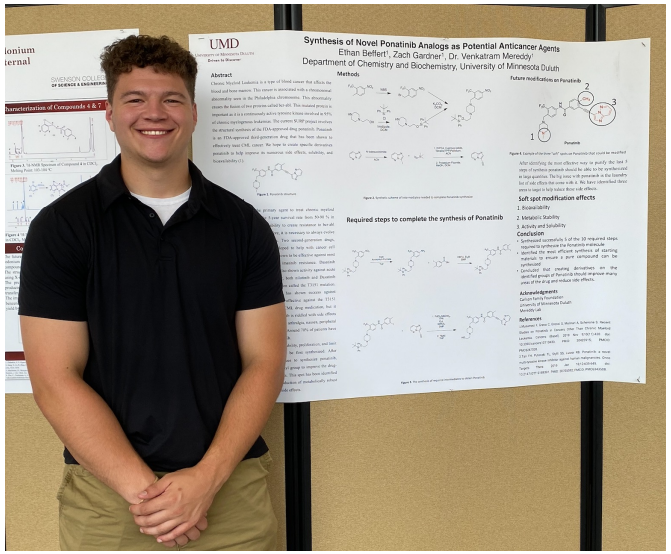
A Statistical Review of Tommy John Surgery

By Chad Fox and Ethan Beffert

Motivation's

- Chad
  - Plays Baseball at UMD
  - The issue directly affects my position

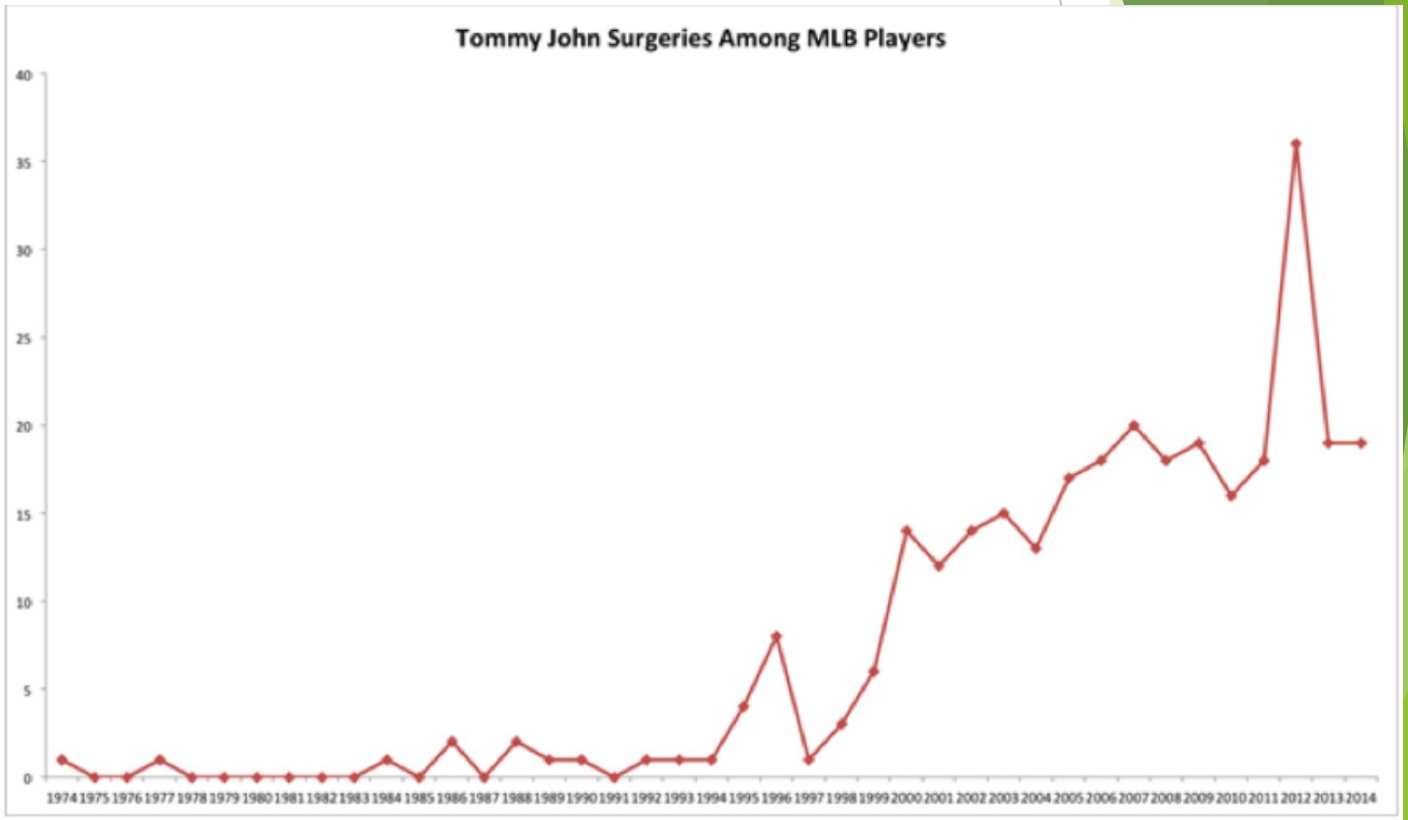


- Ethan
  - Played Football at UMD
  - I do research in the pharmacy school

Literature review- Motivation

- Tommy John's Surgery has increased in number greatly

- Possible Causes
  - Sports specialization
  - Increased Velocity
  - Youth sports coaches



What is Tommy John Surgery

- UCL Reconstruction Surgery
- UCL is a ligament on the inner side of the elbow
- Used a harvested tendon to repair the injury (hamstring or big toe)
- Could take a year or more typically to recover

Literature review- Combining the data

Rk.	Player	Year	BF	K%	BB%	Hard Hit %	New Adjusted EV	Whiff %	Swing %	4-Seam Avg MPH	4-Seam Avg Spin
1	Burnes, Corbin	2021	657	35.6	5.2	30.5	92.7	36.5	49.2	96.4	2607
2	Kershaw, Clayton	2016	544	31.6	2.0	27.3	92.4	31.0	51.7	93.6	2293
3	Bauer, Trevor	2020	278	36.0	6.1	38.0	93.7	30.2	46.4	93.5	2779
4	Kershaw, Clayton	2015	890	33.8	4.7	24.4	92.0	32.5	51.4	94.3	2215
5	Suárez, Ranger	2024	95	28.4	4.2	25.4	92.2	24.6	50.0	92.4	2072
6	Blanco, Ronel	2024	102	21.6	11.8	23.5	91.5	26.7	49.5	93.6	2196
7	Sale, Chris	2018	617	38.4	5.5	26.8	92.5	34.9	48.2	95.2	2357
8	Ryan, Joe	2024	93	32.3	3.2	32.2	93.2	27.1	53.3	93.5	2222

- Baseball Savant

2	Player	TJ Surgery Date	Team	Level	Position	Throws	Country	High School	College(s)	Age	Return Date (same level)	Recovery Time (months)	mlbamid	fgid	Surgeon(s)
3	Endy Rodriguez	12/12/2023	PIT	MLB	C	R	Dominican			23			682848	25332	
4	Johan Oviedo	12/1/2023	PIT	MLB	P	R	Cuba			25			670912	22487	
5	Jovani Moran	11/1/2023	MIN	AAA	P	L	Puerto Rico			26			663558	20422	
6	Taylor Broadway	10/18/2023	BOS	AA	P	R	United States	Texas	Mississippi	26			699479	sa3017205	
7	Felix Bautista	10/9/2023	BAL	MLB	P	R	Dominican			28			642585	20666	Dr. Keith Meister
8	Sandy Alcantara	10/6/2023	MIA	MLB	P	R	Dominican			27			645261	18684	Dr. Keith Meister
9	Angel Perdomo	10/6/2023	PIT	MLB	P	L	Dominican			29			622780	17759	
10	Riley Greene	9/20/2023	DET	MLB	OF	L*	United States	Florida		22			682985	25976	Dr. Keith Meister
11	Jasson Dominguez	9/20/2023	NYY	MLB	OF	R	Dominican			20			691176	28080	Dr. Keith Meister
12	Cole Waites	9/13/2023	SF	AAA	P	R	United States	Georgia	West Alabama	25			686972	25665	Dr. Keith Meister
13	Drey Jameson	9/1/2023	ARI	MLB	P	R	United States	Indiana	Ball State	25			686753	26260	

- Google sheet of players with Tommy John surgeries

Data Cleaning

- Merged data sets into one file
- Removed rows with missing data
- 35 total pitchers with TJ
  - 7 Dr. James Andrews
  - 11 Dr. Neal ElAttrache
  - 17 other doctors

```
DELETE FROM tommy_john
WHERE surgeon is null;

DELETE FROM tommy_john
WHERE recovery_time is null;

DELETE FROM tommy_john
WHERE level != 'MLB';

DELETE FROM tommy_john
WHERE position != 'P';
```

Baseball Statistics quick rundown

- K percentage (-)
- BB percentage (+)
- Average exit velocity (+)
- Hard hit percentage (+)
- Fastball Velocity (-)
- Fastball rpm (-)
- ERA (+)
- Whip (+)

Research Questions

- How does the performing surgeon in a Tommy John surgery impact the postoperative pitching statistics and outcomes of major league baseball pitchers?

- Is there a significant difference between the statistics of pitchers who have had Tommy John surgery and those who haven’t?

Proposed models

OLS Regression Results

Dep. Variable:	kpercent	R-squared:	0.081
Model:	OLS	Adj. R-squared:	0.024
Method:	Least Squares	F-statistic:	1.413
Date:	Mon, 15 Apr 2024	Prob (F-statistic):	0.258
Time:	22:35:12	Log-Likelihood:	-99.710
No. Observations:	35	AIC:	205.4
Df Residuals:	32	BIC:	210.1
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-2.8706	1.060	-2.709	0.011	-5.029	-0.712
andrews	2.8563	1.962	1.455	0.155	-1.141	6.854
neal	2.1706	1.691	1.284	0.208	-1.274	5.615

Omnibus:	0.204	Durbin-Watson:	1.826
Prob(Omnibus):	0.903	Jarque-Bera (JB):	0.410
Skew:	-0.047	Prob(JB):	0.815
Kurtosis:	2.478	Cond. No.	3.32

OLS Regression Results

Dep. Variable:	bbpercent	R-squared:	0.030
Model:	OLS	Adj. R-squared:	-0.030
Method:	Least Squares	F-statistic:	0.5024
Date:	Mon, 15 Apr 2024	Prob (F-statistic):	0.610
Time:	22:35:13	Log-Likelihood:	-91.857
No. Observations:	35	AIC:	189.7
Df Residuals:	32	BIC:	194.4
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.3412	0.847	0.403	0.690	-1.384	2.066
andrews	-1.5697	1.568	-1.001	0.324	-4.764	1.624
neal	-0.5230	1.351	-0.387	0.701	-3.275	2.229

Omnibus:	0.694	Durbin-Watson:	2.456
Prob(Omnibus):	0.707	Jarque-Bera (JB):	0.711
Skew:	0.072	Prob(JB):	0.701
Kurtosis:	2.317	Cond. No.	3.32

OLS Regression Results

Dep. Variable:	exitvelo	R-squared:	0.110
Model:	OLS	Adj. R-squared:	0.055
Method:	Least Squares	F-statistic:	1.984
Date:	Mon, 15 Apr 2024	Prob (F-statistic):	0.154
Time:	22:35:13	Log-Likelihood:	-65.797
No. Observations:	35	AIC:	137.6
Df Residuals:	32	BIC:	142.3
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.5471	0.402	1.360	0.183	-0.272	1.366
andrews	-1.1899	0.745	-1.598	0.120	-2.707	0.327
neal	-1.0652	0.642	-1.660	0.107	-2.372	0.242

Omnibus:	0.690	Durbin-Watson:	2.231
Prob(Omnibus):	0.708	Jarque-Bera (JB):	0.377
Skew:	-0.254	Prob(JB):	0.828
Kurtosis:	2.975	Cond. No.	3.32

Dep. Variable:	hardhit	R-squared:	0.091
Model:	OLS	Adj. R-squared:	0.034
Method:	Least Squares	F-statistic:	1.599
Date:	Mon, 15 Apr 2024	Prob (F-statistic):	0.218
Time:	22:35:13	Log-Likelihood:	-112.40
No. Observations:	35	AIC:	230.8
Df Residuals:	32	BIC:	235.5
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.3294	1.523	0.216	0.830	-2.773	3.432
andrews	-4.5008	2.820	-1.596	0.120	-10.245	1.244
neal	-3.1567	2.430	-1.299	0.203	-8.106	1.793

Omnibus:	4.872	Durbin-Watson:	1.906
Prob(Omnibus):	0.088	Jarque-Bera (JB):	3.450
Skew:	-0.567	Prob(JB):	0.178
Kurtosis:	4.038	Cond. No.	3.32

Dep. Variable:	fastvelo	R-squared:	0.077
Model:	OLS	Adj. R-squared:	0.020
Method:	Least Squares	F-statistic:	1.344
Date:	Mon, 15 Apr 2024	Prob (F-statistic):	0.275
Time:	22:35:13	Log-Likelihood:	-73.038
No. Observations:	35	AIC:	152.1
Df Residuals:	32	BIC:	156.7
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.2471	0.495	0.499	0.621	-0.760	1.255
andrews	1.0815	0.916	1.181	0.246	-0.784	2.947
neal	-0.5289	0.789	-0.670	0.508	-2.136	1.079

Omnibus:	17.133	Durbin-Watson:	1.344
Prob(Omnibus):	0.000	Jarque-Bera (JB):	24.807
Skew:	-1.263	Prob(JB):	4.10e-06
Kurtosis:	6.260	Cond. No.	3.32

Dep. Variable:	fastrpm	R-squared:	0.023
Model:	OLS	Adj. R-squared:	-0.039
Method:	Least Squares	F-statistic:	0.3697
Date:	Mon, 15 Apr 2024	Prob (F-statistic):	0.694
Time:	22:35:13	Log-Likelihood:	-220.00
No. Observations:	35	AIC:	446.0
Df Residuals:	32	BIC:	450.7
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-3.4118	32.952	-0.104	0.918	-70.532	63.709
andrews	43.4118	61.015	0.711	0.482	-80.871	167.695
neal	-11.2246	52.573	-0.214	0.832	-118.312	95.863

Omnibus:	19.493	Durbin-Watson:	1.720
Prob(Omnibus):	0.000	Jarque-Bera (JB):	44.455
Skew:	-1.146	Prob(JB):	2.22e-10
Kurtosis:	8.023	Cond. No.	3.32

- Recovery time vs K percentage
  - P value 0.258
- Recovery time vs BB percentage
  - P value 0.5024
- Recovery time vs Average Exit Velocity
  - P value 0.154
- Recovery time vs Hard Hit percentage
  - P value 0.218
- Recovery time vs Average fastball velocity
  - P value 0.275
- Recovery time vs Fastball rpm
  - P value 0.694

OLS Regression Results

Dep. Variable:	whip	R-squared:	0.131
Model:	OLS	Adj. R-squared:	0.077
Method:	Least Squares	F-statistic:	2.422
Date:	Mon, 15 Apr 2024	Prob (F-statistic):	0.105
Time:	22:35:13	Log-Likelihood:	-3.0036
No. Observations:	35	AIC:	12.01
Df Residuals:	32	BIC:	16.67
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.1494	0.067	2.234	0.033	0.013	0.286
andrews	-0.2351	0.124	-1.899	0.067	-0.487	0.017
neal	-0.1803	0.107	-1.690	0.101	-0.398	0.037

Omnibus:	4.066	Durbin-Watson:	2.236
Prob(Omnibus):	0.131	Jarque-Bera (JB):	2.672
Skew:	0.595	Prob(JB):	0.263
Kurtosis:	3.643	Cond. No.	3.32

[1] Standard Errors assume that the covariance matrix of the errors is correctly

OLS Regression Results

Dep. Variable:	era	R-squared:	0.149
Model:	OLS	Adj. R-squared:	0.096
Method:	Least Squares	F-statistic:	2.795
Date:	Mon, 15 Apr 2024	Prob (F-statistic):	0.0761
Time:	22:35:13	Log-Likelihood:	-64.252
No. Observations:	35	AIC:	134.5
Df Residuals:	32	BIC:	139.2
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.7553	0.385	1.963	0.058	-0.029	1.539
andrews	-0.9696	0.713	-1.361	0.183	-2.421	0.482
neal	-1.3998	0.614	-2.280	0.029	-2.650	-0.149

Omnibus:	0.243	Durbin-Watson:	2.203
Prob(Omnibus):	0.886	Jarque-Bera (JB):	0.435
Skew:	0.110	Prob(JB):	0.804
Kurtosis:	2.500	Cond. No.	3.32

OLS Regression Results

Dep. Variable:	recov	R-squared:	0.194
Model:	OLS	Adj. R-squared:	0.144
Method:	Least Squares	F-statistic:	3.854
Date:	Mon, 15 Apr 2024	Prob (F-statistic):	0.0316
Time:	22:35:12	Log-Likelihood:	-127.31
No. Observations:	35	AIC:	260.6
Df Residuals:	32	BIC:	265.3
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	20.0588	2.332	8.601	0.000	15.308	24.809
andrews	9.3697	4.318	2.170	0.038	0.574	18.166
neal	-3.3316	3.721	-0.895	0.377	-10.911	4.248

Omnibus:	14.669	Durbin-Watson:	1.845
Prob(Omnibus):	0.001	Jarque-Bera (JB):	18.040
Skew:	1.174	Prob(JB):	0.000121
Kurtosis:	5.619	Cond. No.	3.32

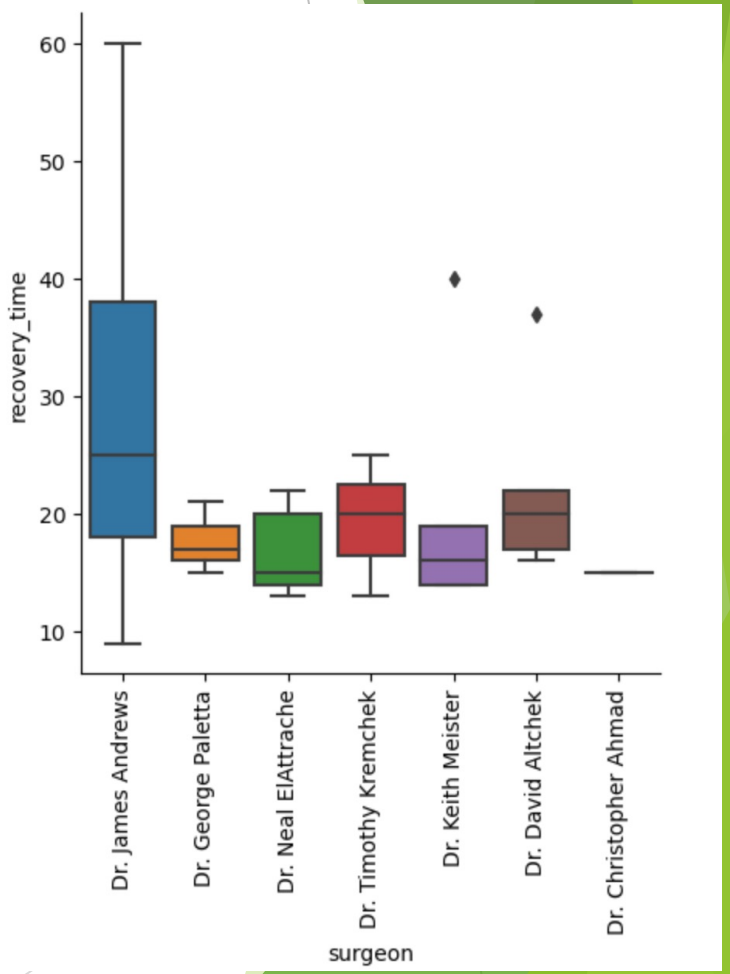
Proposed Models

- Recovery time vs Era
  - 0.0761
- Recovery time vs WHIP
  - 0.105
- Recovery time vs Surgeon
  - P value 0.0316

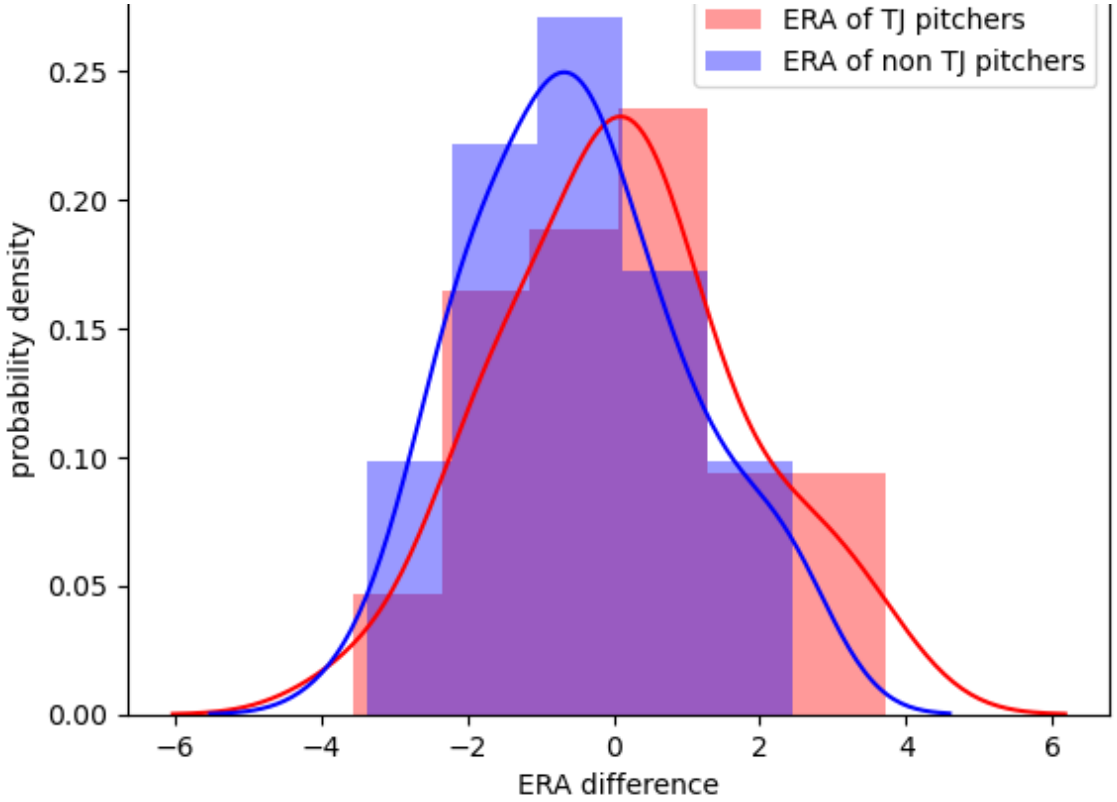
The relationship between surgeon and recovery time

[12]:

surgeon	count	mean	std	min	25%	50%	75%	max
Dr. Christopher Ahmad	1.0	15.000000	NaN	15.0	15.0	15.0	15.0	15.0
Dr. David Altchek	5.0	22.400000	8.502941	16.0	17.0	20.0	22.0	37.0
Dr. George Paletta	3.0	17.666667	3.055050	15.0	16.0	17.0	19.0	21.0
Dr. James Andrews	7.0	29.428571	17.775049	9.0	18.0	25.0	38.0	60.0
Dr. Keith Meister	5.0	20.600000	11.036304	14.0	14.0	16.0	19.0	40.0
Dr. Neal ElAttrache	11.0	16.727273	3.495452	13.0	14.0	15.0	20.0	22.0
Dr. Timothy Kremchek	3.0	19.333333	6.027714	13.0	16.5	20.0	22.5	25.0

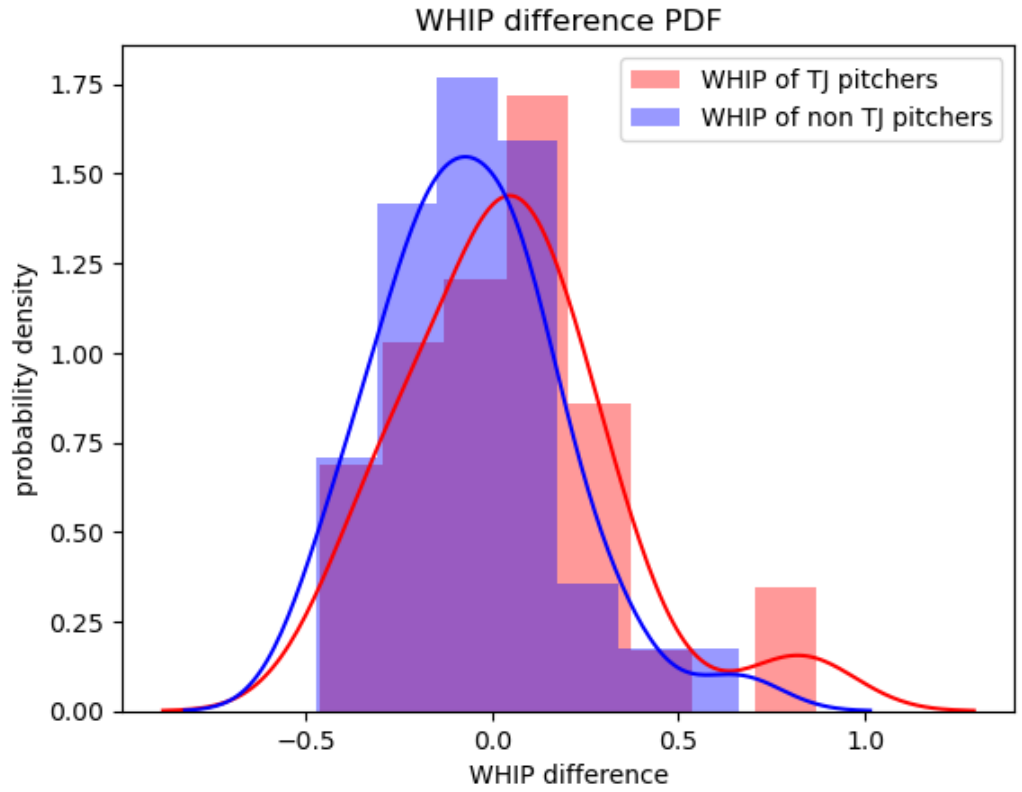


T-Test TJ vs no TJ ERA



- ttestERA=ttest_ind(era,earNOTJ)
- TtestResult(statistic=1.591418198901537
- pvalue=0.116154031301848 27

T-Test TJ vs no TJ WHIP



- ttestWHIP=ttest_ind(whip,whipNOTJ)
- TtestResult(statistic=1.6424610891642755
- pvalue=0.10511137950195451, df=68.0)

Conclusions

- How does the performing surgeon in a Tommy John surgery impact the postoperative pitching statistics and outcomes of major league baseball pitchers?
  - No pitching statistics are impacted significantly based on the performing surgeon. However, there is a relationship between recovery time and the performing surgeon. Statistically, we would recommend Dr. Neal for the shortest recovery
- Is there a significant difference between the statistics of pitchers who have had Tommy John surgery and those who haven't?
  - It appears that the overall statistical performance of the ERA and WHIP metrics is not statistically significant between Tommy John and non-Tommy John pitchers. However, it is interesting that pitchers post-Tommy John appear to be improving in performance more than pitchers without the surgery.

Future Ideas

- Look at how Tommy John surgery affects different types of pitchers (reliever, closer, starter)
- Look at if there are any predictors for someone to be more prone to UCL injury (innings pitched, velocity, months taken off after the season)
- Potentially create a model to predict statistical output after Tommy John Surgery

Questions ???

References

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