

# **ACLR Final Project**

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# **Report**

## **Audience**

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Our final report's audience/stakeholders include physicians and other researchers evaluating the health of patients who have undergone ACL reconstruction surgery.

## **Problem Statement**

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After athletes tear their anterior cruciate ligament (ACL), many undergo ACL reconstruction (ACLR) surgery. However, physicians and other researchers are still evaluating the recovery and health of patients who have undergone ACLR. It is important to note that a majority of patients do not get reinjured - in this study, 83% had no reinjuries after ACLR surgery. There are many features that can affect reinjury rates after the surgery, such as the gender of the patient, the graft type used, and even their mental readiness. Specifically, our stakeholders are interested in all of these factors and what combination will lead to the lowest reinjury rates in patients after ACLR surgery is performed.

## **Analysis**

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[insert graph analyses]

## **Conclusion**

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[insert conclusion]

# 1 Data Cleaning

## 1.0.0.1 Choosing our Variables:

With the given dataset, we decided to focus on the variables we deemed to be most relevant to our hypothesis regarding recovery trends. Categorical variables such as `sex_dashboard`, `graft_dashboard2`, `reinjury`, and `tss_dashboard` were included along with numerical values such as `age`, `ikdc`, `acl_rsi`, and `bmi`.

Our categorical variables provide key insight into grouping individuals and focusing on patterns relevant to them, as well as stratifying the outcomes. For example, `sex_dashboard` allowed us to explore sex-based differences in recovery. Both `graft_dashboard2` and `reinjury` helped us determine whether certain graft types experienced reinjury more frequently with `tss_dashboard` establishing the time frame as to when individuals experienced their reinjury.

The numerical variables chosen are all continuous measures of both physical and psychological recovery factors that are key to affirming and establishing key numerical general descriptive statistics that provide a measure of evaluating outcome differences.

## 1.0.0.2 Cleaning Approach:

During our analysis, we took measures to address missing values, inconsistent data types, and outliers. For

For each variable, we assessed the proportion of missing values respective to the amount of observations. For our numerical columns, we decided to impute the missing values with the median, and for our categorical values decided to drop the records entirely

## 2 Exploratory Data Analysis

```
# setting up environment
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
# importing data as dataframe:
df = pd.read_csv('aclr data(in).csv')
```

```
# Including relevant variables into our dataframe and dropping the others:
df = df[['sex_dashboard', 'graft_dashboard2', 'reinjury', 'age', 'height_m', 'mass_kg', 'bmi',
df.head()
```

	sex_dashboard	graft_dashboard2	reinjury	age	height_m	mass_kg	bmi	ikdc	acl_rsi
0	Male	Other	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	NaN	NaN	No	21.7	1.9	87.4	24.210526	95.4	87.5
2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
3	Female	HS autograft	NaN	NaN	NaN	NaN	NaN	NaN	NaN
4	NaN	NaN	No	14.5	1.6	72.2	28.203125	79.3	8.3

```
# Filtering for numeric columns:
numeric_columns = df.select_dtypes(include=['int', 'float']).columns
# imputing missing values with the mean for each respective column
mean_values = df[numeric_columns].mean()
m_df = df.fillna(mean_values)
print(m_df.head(5))
```

```
sex_dashboard  graft_dashboard2  reinjury      age  height_m  mass_kg \
0            Male              Other     NaN  20.184761  1.725412  74.343033
1            NaN                NaN    No  21.700000  1.900000  87.400000
2            NaN                NaN     NaN  20.184761  1.725412  74.343033
3          Female        HS autograft     NaN  20.184761  1.725412  74.343033
```

4	NaN	NaN	No	14.500000	1.600000	72.200000	
	bmi	ikdc	acl_rsi	tegner_pre	tegner_now	lsi_ext_isok_60	\
0	25.201579	78.457377	64.929381	8.363162	5.838621	73.194083	
1	24.210526	95.400000	87.500000	9.000000	9.000000	87.860000	
2	25.201579	78.457377	64.929381	8.363162	5.838621	73.194083	
3	25.201579	78.457377	64.929381	8.363162	5.838621	73.194083	
4	28.203125	79.300000	8.300000	8.000000	5.000000	45.000000	
	lsi_flex_isok_60						
0		89.728019					
1		103.320000					
2		89.728019					
3		89.728019					
4		72.980000					

## 5. Descriptive Statistics & Distributions

Provide summaries of important variables:

```
# Summarizing categorical variables description stats:
print('\nCategorical Variable Descriptions:')
print('\n', df['sex_dashboard'].value_counts())
print('\n', df['graft_dashboard2'].value_counts())
print('\n', df['reinjury'].value_counts())
print('\n', pd.crosstab(df['sex_dashboard'], df['graft_dashboard2']))
```

Categorical Variable Descriptions:

```
sex_dashboard
Female      2399
Male        2323
Not Reported    15
Name: count, dtype: int64
```

```
graft_dashboard2
BTB autograft    1593
Other           1151
HS autograft     1030
QT autograft      805
Allograft         158
```

```
Name: count, dtype: int64
```

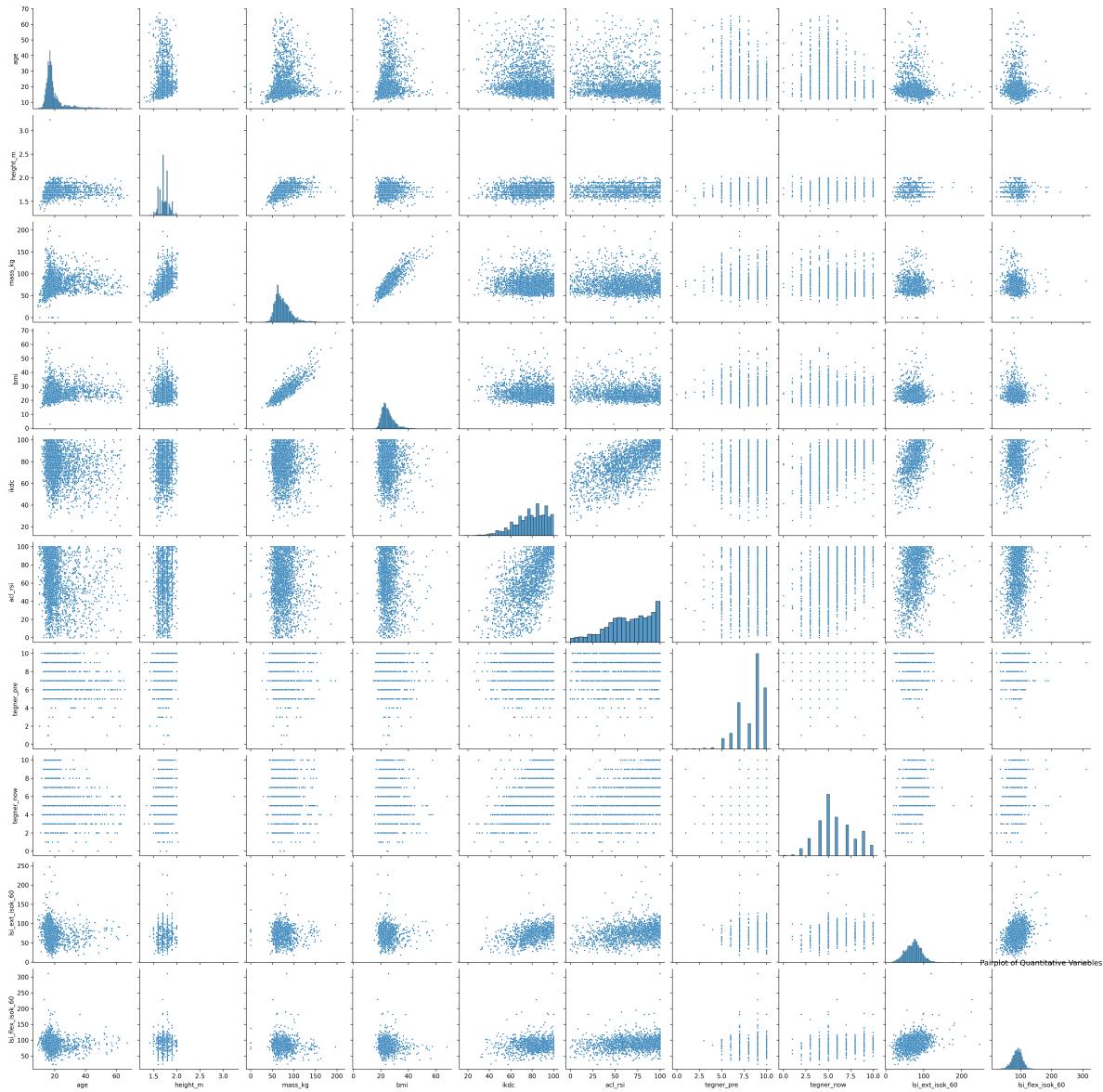
```
reinjury
BLANK      4273
No         789
Contralateral   61
Ipsilateral    51
Both          1
```

```
Name: count, dtype: int64
```

	graft_dashboard2	Allograft	BTB autograft	HS autograft	Other	QT autograft
sex_dashboard						
Female	75	834	516	565	409	
Male	83	757	513	574	396	
Not Reported	0	2	1	12	0	

```
# Pairplot of filtered variables:
```

```
sns.pairplot(df[['age', 'height_m', 'mass_kg', 'bmi', 'ikdc', 'acl_rsi', 'tegner_pre', 'tegner_post']])
plt.title('Pairplot of Quantitative Variables')
plt.show()
```



```
# Creating visualizations to illustrate distributions:
```

```
# SCATTERPLOT: Between height and mass_kg
plt.figure(figsize=(10,6))
sns.scatterplot(x='height_m', y='mass_kg', data=df)
# == SCAFFOLDING ==
plt.suptitle('Scatterplot of Height and Mass', weight = 'bold', fontsize = 16, x = 0.29)
# axis labels:
```

```

plt.xlabel('Height', weight = 'bold')
plt.ylabel('Mass (kg)', weight = 'bold')

# removing spines
plt.gca().spines['top'].set_visible(False)
plt.gca().spines['right'].set_visible(False)
plt.gca().spines['left'].set_visible(False)

plt.show()

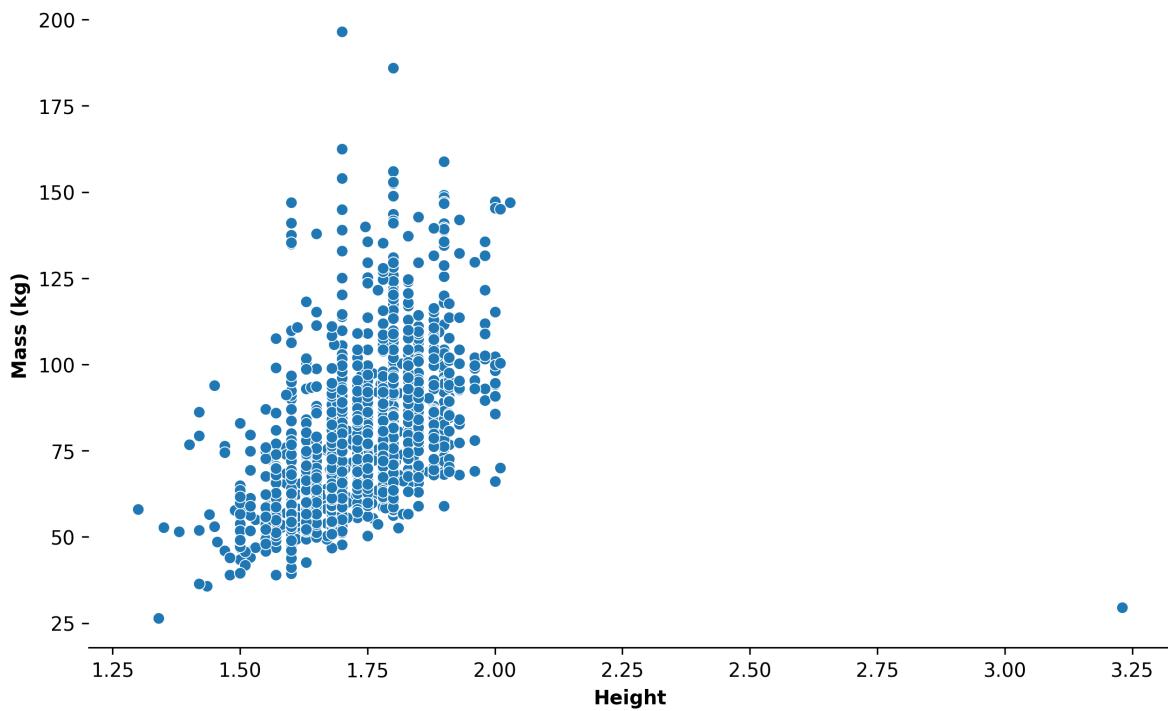
# Histogram for 'age':
plt.figure(figsize=(10,6))
df['age'].plot(kind='hist')
# == SCAFFOLDING ==
plt.suptitle('Histogram of Age', weight = 'bold', fontsize=16, x=0.20)
plt.title('Distribution of age values', fontsize=10, x=0.075)
plt.subplots_adjust(top = 0.91)

# axis labels:
plt.xlabel('Age', weight = 'bold')
plt.ylabel('Count', weight = 'bold')
# removing spines
plt.gca().spines['top'].set_visible(False)
plt.gca().spines['right'].set_visible(False)
plt.gca().spines['left'].set_visible(False)

plt.show()

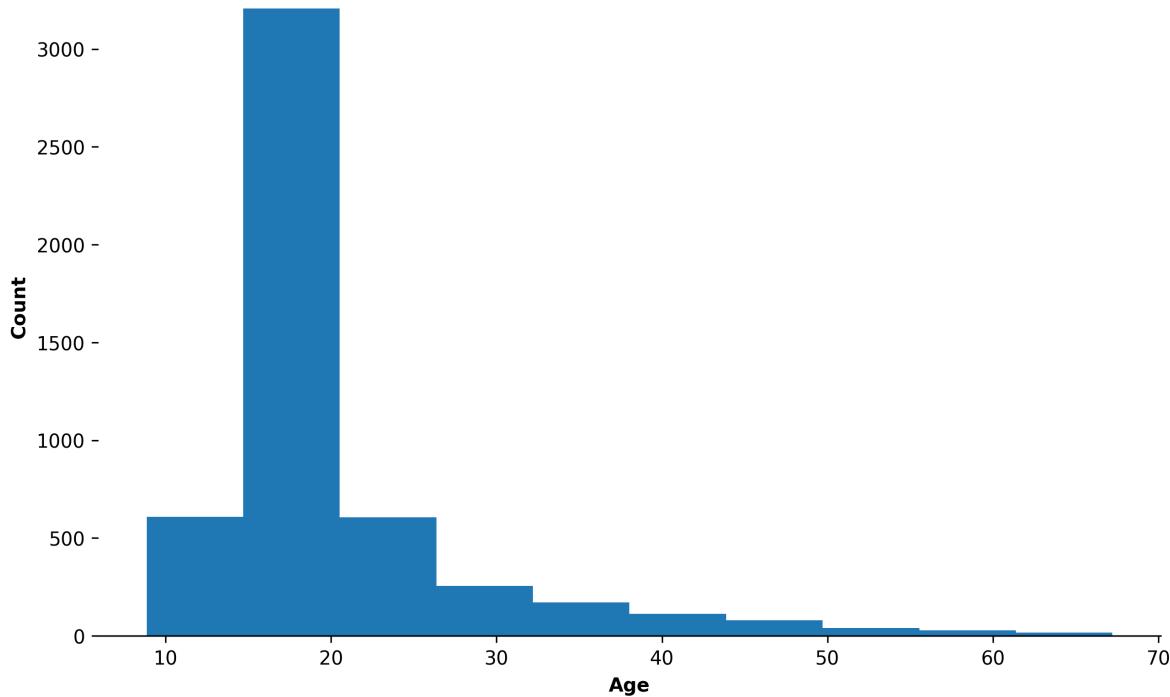
```

## Scatterplot of Height and Mass



## Histogram of Age

Distribution of age values

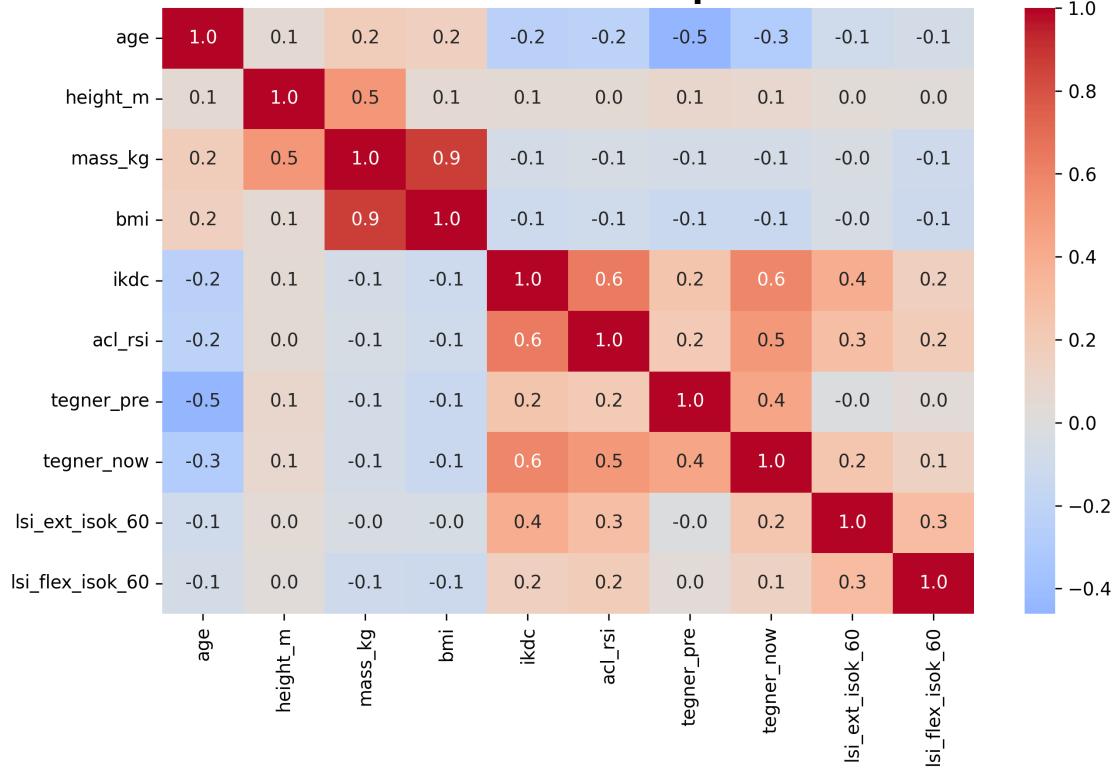


## 6. Examine Correlations (if relevant)

Interpret findings: What variables appear related?

```
# setting filtered_df to be the relevant columns:  
filtered_df = df[['sex_dashboard', 'graft_dashboard2', 'reinjury', 'age', 'height_m', 'mass_kg',  
# dropping categorical columns:  
num_fil_df = filtered_df.drop(['sex_dashboard', 'graft_dashboard2', 'reinjury'], axis=1)  
# creating correlation matrix of our filtered numerical columns  
corr_matrix = num_fil_df.corr()  
  
# plotting correlation heatmap:  
plt.figure(figsize=(10,6))  
sns.heatmap(corr_matrix, fmt=".1f", annot=True, cmap="coolwarm", center=0)  
plt.title("Cleaned Dataframe: Correlation Heatmap", weight = 'bold', fontsize = 18, x=0.21)  
plt.show()
```

## Cleaned Dataframe: Correlation Heatmap



Positively correlated variables seem to include: - ikdc and acl\_rsi - bmi and mass\_kg - tegner\_now and ikdc - tegner\_now and acl\_rsi

Negatively correlated variables seem to include: - tegner\_pre and age - tegner\_now and age

### 7. Explore Relationships (if relevant)

Dig into potential causal or descriptive relationships Use visualizations and statistical summaries.

```
# Records were mismatched so we shifted row values by 1
# (for every graft_type recorded, reinjury was blank so shifted by 1 to match)
df['reinjury_shifted'] = df['reinjury'].shift(-1)
df_cleaned = df[df['graft_dashboard2'].notna()][['graft_dashboard2', 'reinjury_shifted']]
df_cleaned.columns = ['graft_dashboard2', 'reinjury']
print(df_cleaned.head()) # previewing cleaned dataset

df_cleaned = df_cleaned[
    (df_cleaned['reinjury'].str.upper() != 'BLANK') &
    (df_cleaned['graft_dashboard2'].str.upper() != 'BLANK')]
```

```

grouped_counts = (
    df_cleaned.groupby(['graft_dashboard2', 'reinjury'])
    .size()
    .reset_index(name='count')
)

# #graft_order = ['HS allograft', 'BTB allograft', 'QT autograft', 'Allograft', 'Other']
# # Convert 'graft_dashboard2' to a categorical type w order
# #grouped_counts['graft_dashboard2'] = pd.Categorical(
# #    grouped_counts['graft_dashboard2'],
# #    categories=graft_order,
# #    ordered=True
# #)
# sort the DataFrame by this order for plotting
#grouped_counts = grouped_counts.sort_values('graft_dashboard2')

# plotting stacked bar chart:
plt.figure(figsize=(10, 6))
sns.barplot(
    data=grouped_counts,
    x='graft_dashboard2',
    y='count',
    hue='reinjury',
    palette='Set2'
)
# == SCAFFOLDING ==
plt.xlabel('Graft Type')
plt.ylabel('Count', weight = 'bold')
plt.title('Reinjury Types by Graft Type', weight = 'bold', fontsize = 16, x = 0.2)
plt.legend(title='Reinjury Type')
# removing spines
plt.gca().spines['top'].set_visible(False)
plt.gca().spines['right'].set_visible(False)
plt.gca().spines['left'].set_visible(False)

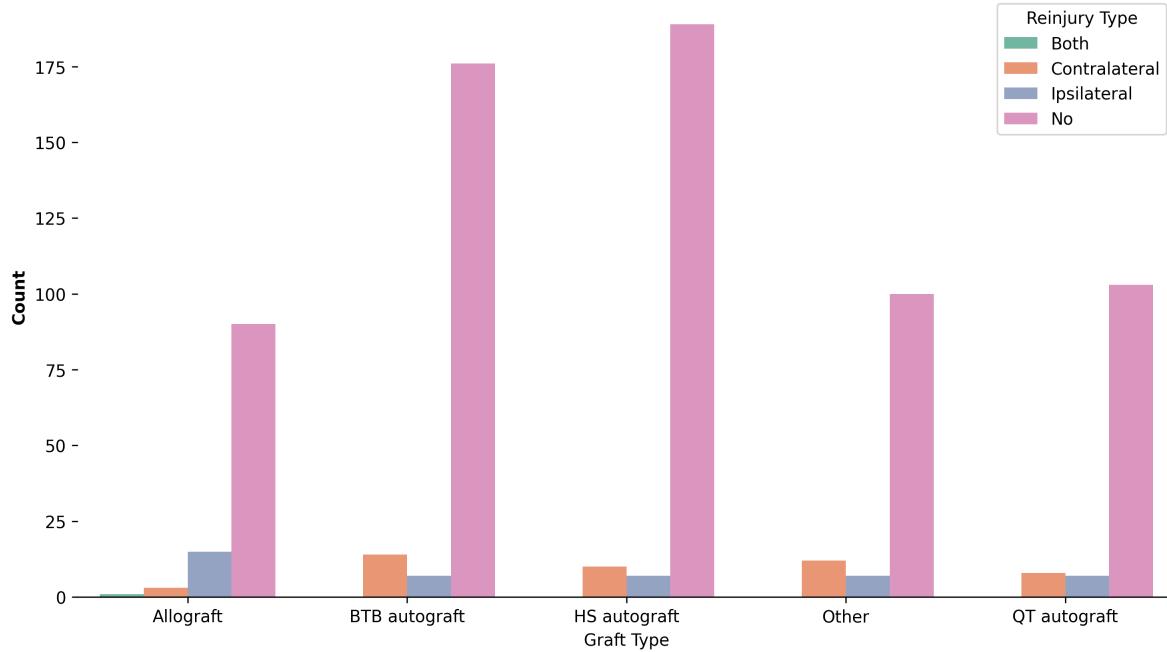
plt.tight_layout()
plt.show()

```

	graft_dashboard2	reinjury
0	Other	No

3	HS autograft	No
8	HS autograft	BLANK
10	HS autograft	No
15	HS autograft	No

### Reinjury Types by Graft Type



HS Autograft has the highest proportion of no reinjuries, while the BTB autograft seems to have the highest recorded count of Contralateral reinjuries.

```
# Bar Chart: Focusing on Tegner as a metric since it assesses overall functionality

# calculating mean and std for both Tegner values:
mean_val = [filtered_df['tegner_pre'].mean(), filtered_df['tegner_now'].mean()]
std_val = [filtered_df['tegner_pre'].std(), filtered_df['tegner_now'].std()]

# == PLOTTING ==
plt.figure(figsize=(10,6))
plt.bar(['Pre', 'Now'], mean_val, yerr=std_val, capsize=5, color=['#7aa095', '#bf8b85'], alpha=0.8)

# SCAFFOLDING:
plt.suptitle('Tegner Performance Decreases after ACL Reconstruction ', weight='bold', fontsize=16)
plt.title('Comparing Tegner scores before surgery to scores recorded post-surgery', fontsize=14)
```

```

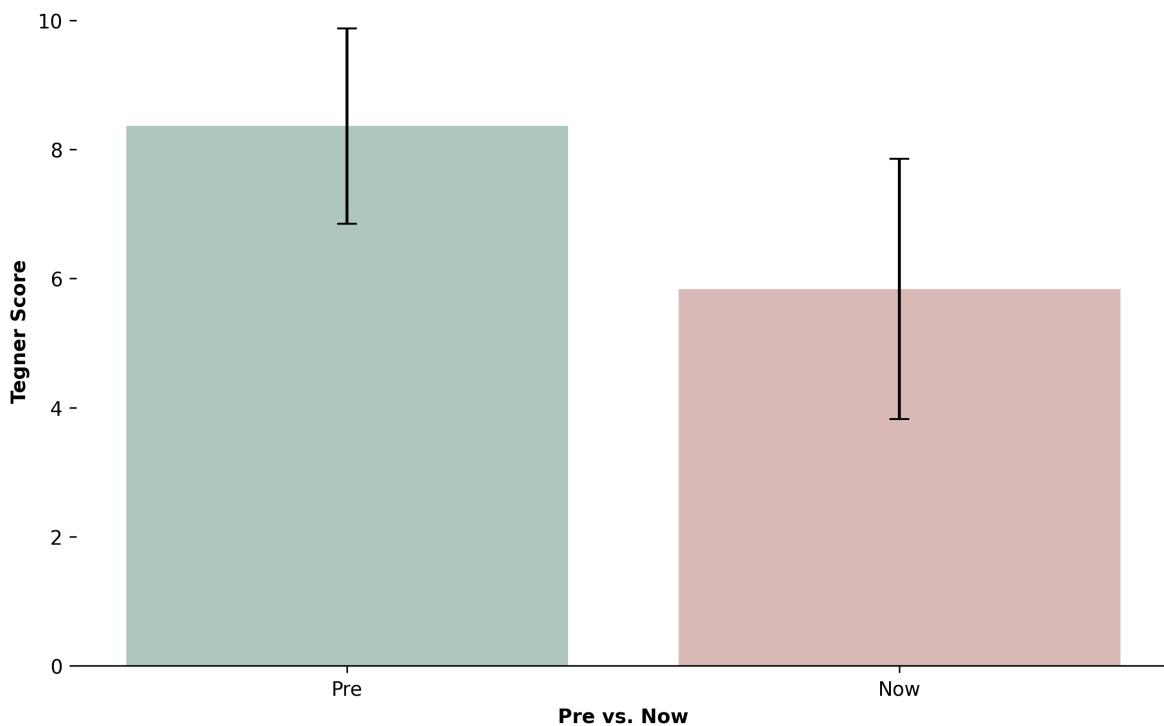
plt.subplots_adjust(top = 0.90) # adjusting space between the super title and the title
plt.ylabel('Tegner Score', weight='bold')
plt.xlabel('Pre vs. Now', weight='bold')

# removing spines
plt.gca().spines['top'].set_visible(False)
plt.gca().spines['right'].set_visible(False)
plt.gca().spines['left'].set_visible(False)
plt.show()

```

## Tegner Performance Decreases after ACL Reconstruction

Comparing Tegner scores before surgery to scores recorded post-surgery



```

# Creating a violin plot to compare the tegner_pre and tegner_now by age:
# PLOT
plt.figure(figsize=(12, 6))
sns.violinplot(data=filtered_df[['tegner_pre', 'tegner_now']], inner='quartile')

# SCAFFOLDING:
plt.suptitle('Tegner Scores are Lower After ACL Reconstruction', weight='bold', fontsize=16,

```

```

plt.title('Comparing values from the pre_tegner to the current tegner values', fontsize=12, weight='bold')

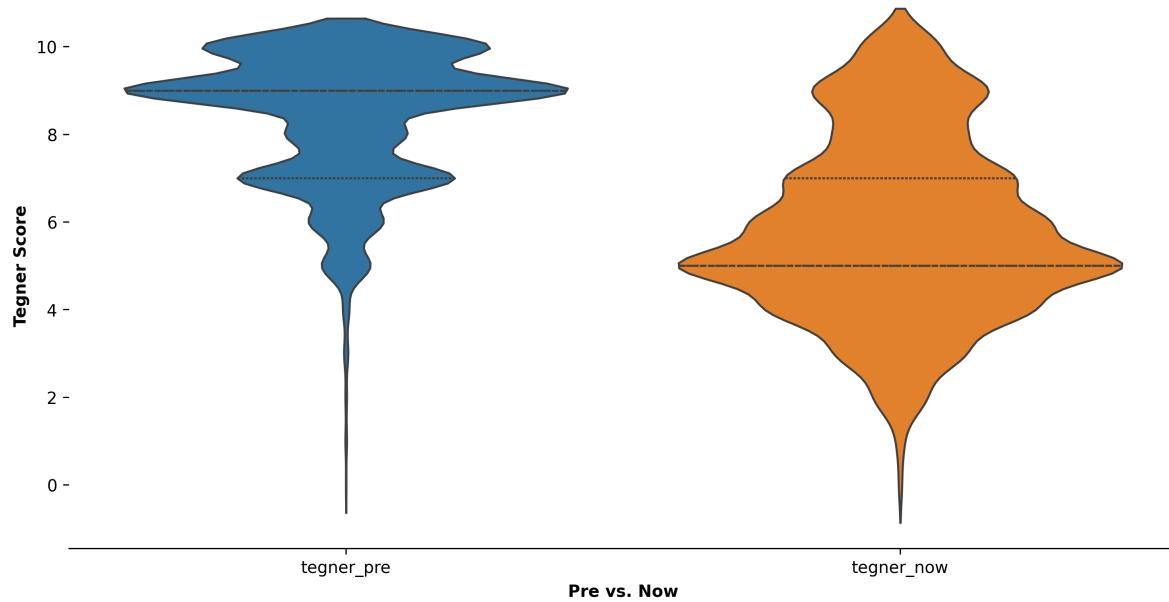
plt.subplots_adjust(top = 0.90) # adjusting space between the super title and the title
plt.ylabel('Tegner Score', weight='bold')
plt.xlabel('Pre vs. Now', weight='bold')

plt.gca().spines['top'].set_visible(False)
plt.gca().spines['right'].set_visible(False)
plt.gca().spines['left'].set_visible(False)
plt.show()

```

### Tegner Scores are Lower After ACL Reconstruction

Comparing values from the pre\_tegner to the current tegner values



# **3 Data Visualization**

insert visualizations

## 4 Data Dictionary

Here are the relevant variables we used to complete our analysis with their meanings.

Variable	Description
acl_rsi	The return-to-sport-after-injury score is self-reported by the patient.
age	The age at which the patient received surgery.
bmi	Body mass index of the patient.
graft_dashboard2	The types of grafts used in surgery are allograft, QT autograft, HS autograft, BTB autograft, and others.
height_m	The height of the patient in meters.
ikdc	A patient-reported outcome measure used to assess knee function and symptoms.
mass_kg	The weight of the patient in kilograms.
reinjury	The different types of reinjuries: contralateral, ipsilateral, and both.
sex_dashboard	The gender of the patient: male or female.
tss_dashboard	Categorizes the months post-surgery into subsets.