EDA and Data Visualization for the Olympic Games

1. Import Libraries

In [70]:
```
import numpy as np
import pandas as pd
import seaborn as sns
from matplotlib import pyplot as plt

import os
print(os.listdir("../input"))
```

```
['noc_regions.csv', 'athlete_events.csv']
```

2. Read Data

In [71]:
```
data = pd.read_csv('../input/athlete_events.csv')
regions = pd.read_csv('../input/noc_regions.csv')
```

3. Collecting information about the two dataset

We are going to:

1. Review the first lines of the data;
2. Use the describe and info functions to collect statistical information, datatypes, column names and other information.

In [72]:
```
data.head(5)
```

Out[72]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal
0	1	A Dijiang	M	24.0	180.0	80.0	China	CHN	1992 Summer	1992	Summer	Barcelona	Basketball	Basketball Men's Basketball	NaN
1	2	A Lamusi	M	23.0	170.0	60.0	China	CHN	2012 Summer	2012	Summer	London	Judo	Judo Men's Extra-Lightweight	NaN
2	3	Gunnar Nielsen Aaby	M	24.0	NaN	NaN	Denmark	DEN	1920 Summer	1920	Summer	Antwerpen	Football	Football Men's Football	NaN
3	4	Edgar Lindenau Aabye	M	34.0	NaN	NaN	Denmark/Sweden	DEN	1900 Summer	1900	Summer	Paris	Tug-Of-War	Tug-Of-War Men's Tug-Of-War	Gold
4	5	Christine Jacoba Aaftink	F	21.0	185.0	82.0	Netherlands	NED	1988 Winter	1988	Winter	Calgary	Speed Skating	Speed Skating Women's 500 metres	NaN

In [73]:
```
data.describe()
```

Out[73]:

	ID	Age	Height	Weight	Year
count	271116.000000	261642.000000	210945.000000	208241.000000	271116.000000
mean	68248.954396	25.556898	175.338970	70.702393	1978.378480
std	39022.286345	6.393561	10.518462	14.348020	29.877632
min	1.000000	10.000000	127.000000	25.000000	1896.000000
25%	34643.000000	21.000000	168.000000	60.000000	1960.000000
50%	68205.000000	24.000000	175.000000	70.000000	1988.000000
75%	102097.250000	28.000000	183.000000	79.000000	2002.000000
max	135571.000000	97.000000	226.000000	214.000000	2016.000000

In [74]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 271116 entries, 0 to 271115
Data columns (total 15 columns):
ID        271116 non-null int64
Name      271116 non-null object
Sex       271116 non-null object
Age       261642 non-null float64
Height    210945 non-null float64
Weight    208241 non-null float64
Team      271116 non-null object
NOC       271116 non-null object
Games     271116 non-null object
Year      271116 non-null int64
Season    271116 non-null object
City      271116 non-null object
Sport     271116 non-null object
Event     271116 non-null object
Medal     39783 non-null object
dtypes: float64(3), int64(2), object(10)
memory usage: 31.0+ MB
```

In [75]:
```
regions.head(5)
```

Out[75]:

	NOC	region	notes
0	AFG	Afghanistan	NaN
1	AHO	Curacao	Netherlands Antilles
2	ALB	Albania	NaN
3	ALG	Algeria	NaN
4	AND	Andorra	NaN

4. Joining the dataframes

We can now join the two dataframes using as key the NOC column with the Pandas 'Merge' function

In [76]:
```
merged = pd.merge(data, regions, on='NOC', how='left')
```

Let's see the result:

In [77]:
```
merged.head()
```

Out[77]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
0	1	A Dijiang	M	24.0	180.0	80.0	China	CHN	1992 Summer	1992	Summer	Barcelona	Basketball	Basketball Men's Basketball	NaN	China	NaN
1	2	A Lamusi	M	23.0	170.0	60.0	China	CHN	2012 Summer	2012	Summer	London	Judo	Judo Men's Extra-Lightweight	NaN	China	NaN
2	3	Gunnar Nielsen Aaby	M	24.0	NaN	NaN	Denmark	DEN	1920 Summer	1920	Summer	Antwerpen	Football	Football Men's Football	NaN	Denmark	NaN
3	4	Edgar Lindenau Aabye	M	34.0	NaN	NaN	Denmark/Sweden	DEN	1900 Summer	1900	Summer	Paris	Tug-Of-War	Tug-Of-War Men's Tug-Of-War	Gold	Denmark	NaN
4	5	Christine Jacoba Aaftink	F	21.0	185.0	82.0	Netherlands	NED	1988 Winter	1988	Winter	Calgary	Speed Skating	Speed Skating Women's 500 metres	NaN	Netherlands	NaN

5. Distribution of the age of gold medalists

Let's start creating a new dataframe including only gold medalists.

In [78]:
```
goldMedals = merged[(merged.Medal == 'Gold')]
goldMedals.head()
```

Out[78]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
3	4	Edgar Lindenau Aabye	M	34.0	NaN	NaN	Denmark/Sweden	DEN	1900 Summer	1900	Summer	Paris	Tug-Of-War	Tug-Of-War Men's Tug-Of-War	Gold	Denmark	NaN
42	17	Paavo Johannes Aaltonen	M	28.0	175.0	64.0	Finland	FIN	1948 Summer	1948	Summer	London	Gymnastics	Gymnastics Men's Team All-Around	Gold	Finland	NaN
44	17	Paavo Johannes Aaltonen	M	28.0	175.0	64.0	Finland	FIN	1948 Summer	1948	Summer	London	Gymnastics	Gymnastics Men's Horse Vault	Gold	Finland	NaN
48	17	Paavo Johannes Aaltonen	M	28.0	175.0	64.0	Finland	FIN	1948 Summer	1948	Summer	London	Gymnastics	Gymnastics Men's Pommelled Horse	Gold	Finland	NaN
60	20	Kjetil Andr Aamodt	M	20.0	176.0	85.0	Norway	NOR	1992 Winter	1992	Winter	Albertville	Alpine Skiing	Alpine Skiing Men's Super G	Gold	Norway	NaN

I would like to have a plot of the Age to see the distribution but I need to check first if the Age column contains NaN values..

In [79]:
```
goldMedals.isnull().any()
```

Out[79]:
```
ID        False
Name      False
Sex       False
Age        True
Height     True
Weight     True
Team      False
NOC       False
Games     False
Year      False
Season    False
City      False
Sport     False
Event     False
Medal     False
region     True
notes      True
dtype: bool
```

..and it does.

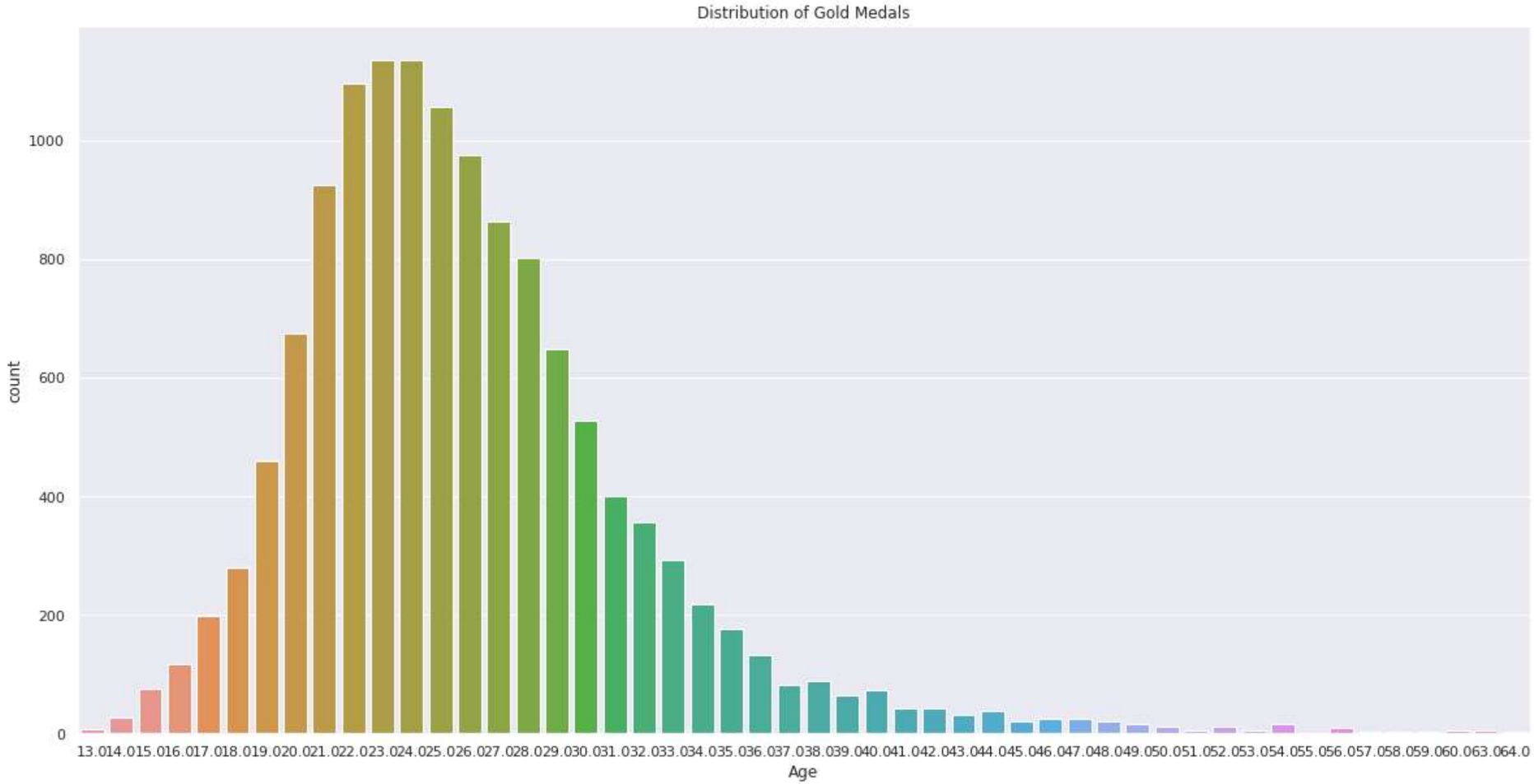
Let's take only the values that are different from NaN.

In [80]:
```
goldMedals = goldMedals[np.isfinite(goldMedals['Age'])]
```

We can now create a countplot to see the result of our work:

In [81]:
```
plt.figure(figsize=(20, 10))
plt.tight_layout()
sns.countplot(goldMedals['Age'])
plt.title('Distribution of Gold Medals')
```

Out[81]:
```
Text(0.5,1,'Distribution of Gold Medals')
```



It seems that we have people with Age greater that 50 with a gold medal: Let's know more about those people.

In [82]:
```
goldMedals['ID'][goldMedals['Age'] > 50].count()
```

Out[82]:
```
65
```

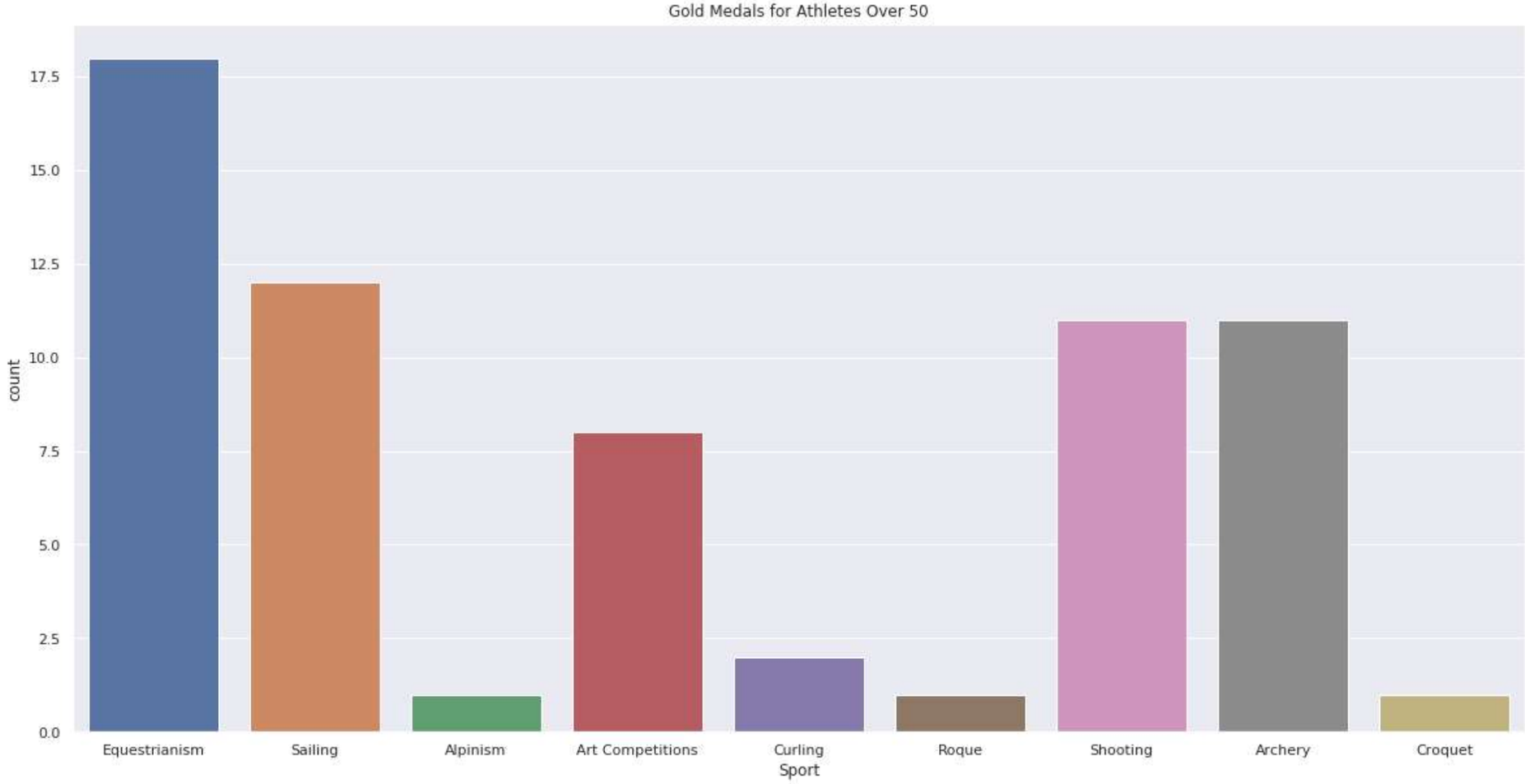
65 people: But which disciplines allows you to land a gold medal after your fifties?

We will now create a new dataframe called masterDisciplines in which we will insert this new set of people and then create a visualization with it.

In [83]:
```
masterDisciplines = goldMedals['Sport'][goldMedals['Age'] > 50]
```

In [84]:
```
plt.figure(figsize=(20, 10))
plt.tight_layout()
sns.countplot(masterDisciplines)
plt.title('Gold Medals for Athletes Over 50')
```

Out[84]:
```
Text(0.5,1,'Gold Medals for Athletes Over 50')
```



It seems that our senior gold medalists are shooters, archers, sailors and, above all, horse riders.

6. Women in Athletics

Studying the data we can try to understand how much medals we have only for women in the recent history of the Summer Games.

Let's create a filtered datased:

In [85]:
```
womenInOlympics = merged[(merged.Sex == 'F') & (merged.Season == 'Summer')]
```

Review our work:

In [86]:
```
womenInOlympics.head(10)
```

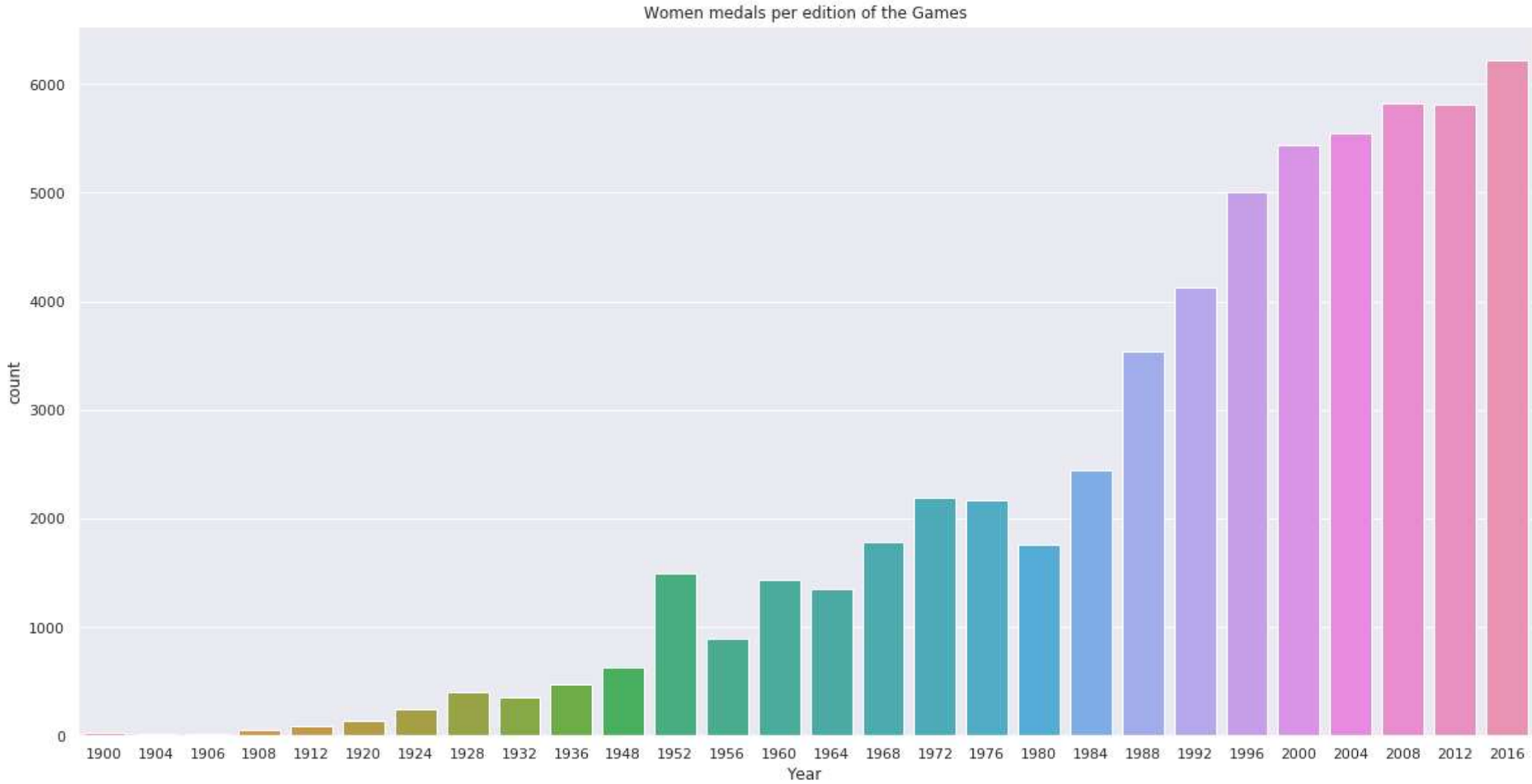
Out[86]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
26	8	Cornelia "Cor" Aalten (-Strannood)	F	18.0	168.0	NaN	Netherlands	NED	1932 Summer	1932	Summer	Los Angeles	Athletics	Athletics Women's 100 metres	NaN	Netherlands	NaN
27	8	Cornelia "Cor" Aalten (-Strannood)	F	18.0	168.0	NaN	Netherlands	NED	1932 Summer	1932	Summer	Los Angeles	Athletics	Athletics Women's 4 x 100 metres Relay	NaN	Netherlands	NaN
32	13	Minna Maarit Aalto	F	30.0	159.0	55.5	Finland	FIN	1996 Summer	1996	Summer	Atlanta	Sailing	Sailing Women's Windsurfer	NaN	Finland	NaN
33	13	Minna Maarit Aalto	F	34.0	159.0	55.5	Finland	FIN	2000 Summer	2000	Summer	Sydney	Sailing	Sailing Women's Windsurfer	NaN	Finland	NaN
79	21	Ragnhild Margrethe Aamodt	F	27.0	163.0	NaN	Norway	NOR	2008 Summer	2008	Summer	Beijing	Handball	Handball Women's Handball	Gold	Norway	NaN
80	22	Andreea Aanei	F	22.0	170.0	125.0	Romania	ROU	2016 Summer	2016	Summer	Rio de Janeiro	Weightlifting	Weightlifting Women's Super-Heavyweight	NaN	Romania	NaN
91	29	Willemien Aardenburg	F	22.0	NaN	NaN	Netherlands	NED	1988 Summer	1988	Summer	Seoul	Hockey	Hockey Women's Hockey	Bronze	Netherlands	NaN
105	37	Ann Kristin Aarnes	F	23.0	182.0	64.0	Norway	NOR	1996 Summer	1996	Summer	Atlanta	Football	Football Women's Football	Bronze	Norway	NaN
135	49	Moonika Aava	F	24.0	168.0	65.0	Estonia	EST	2004 Summer	2004	Summer	Athina	Athletics	Athletics Women's Javelin Throw	NaN	Estonia	NaN
136	49	Moonika Aava	F	28.0	168.0	65.0	Estonia	EST	2008 Summer	2008	Summer	Beijing	Athletics	Athletics Women's Javelin Throw	NaN	Estonia	NaN

To plot the curve over time, let's create a plot in which we put the year (on the x-axis) and count of the number of medals per edition of the games (consider that we will have more medals for the same athlete).

In [87]:
```
sns.set(style="darkgrid")
plt.figure(figsize=(20, 10))
sns.countplot(x='Year', data=womenInOlympics)
plt.title('Women medals per edition of the Games')
```

Out[87]:
```
Text(0.5,1,'Women medals per edition of the Games')
```



Usually I cross-check the data: below I tried to review only the medalists for the 1900 Summer edition to see if the visualization is correct.

In [88]:
```
womenInOlympics.loc[womenInOlympics['Year'] == 1900].head(10)
```

Out[88]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
283	150	Margaret Ives Abbott (-Dunne)	F	23.0	NaN	NaN	United States	USA	1900 Summer	1900	Summer	Paris	Golf	Golf Women's Individual	Gold	USA	NaN
284	151	Mary Perkins Ives Abbott (Perkins-)	F	42.0	NaN	NaN	United States	USA	1900 Summer	1900	Summer	Paris	Golf	Golf Women's Individual	NaN	USA	NaN
30535	15740	A. Brun	F	NaN	NaN	NaN	France	FRA	1900 Summer	1900	Summer	Paris	Golf	Golf Women's Individual	NaN	France	NaN
44448	22925	Charlotte Reinagle Cooper (-Sterry)	F	29.0	NaN	NaN	Great Britain	GBR	1900 Summer	1900	Summer	Paris	Tennis	Tennis Women's Singles	Gold	UK	NaN
44449	22925	Charlotte Reinagle Cooper (-Sterry)	F	29.0	NaN	NaN	Great Britain	GBR	1900 Summer	1900	Summer	Paris	Tennis	Tennis Mixed Doubles	Gold	UK	NaN
51667	26559	HIne de Pourtals (Barbey-)	F	32.0	NaN	NaN	Lerina	SUI	1900 Summer	1900	Summer	Paris	Sailing	Sailing Mixed Open	NaN	Switzerland	NaN
51668	26559	HIne de Pourtals (Barbey-)	F	32.0	NaN	NaN	Lerina	SUI	1900 Summer	1900	Summer	Paris	Sailing	Sailing Mixed 1-2 Ton	Gold	Switzerland	NaN
51669	26559	HIne de Pourtals (Barbey-)	F	32.0	NaN	NaN	Lerina	SUI	1900 Summer	1900	Summer	Paris	Sailing	Sailing Mixed 1-2 Ton	Silver	Switzerland	NaN
54280	27851	Mme. Desprs	F	NaN	NaN	NaN	France	FRA	1900 Summer	1900	Summer	Paris	Croquet	Croquet Mixed Singles, One Ball	NaN	France	NaN
54281	27851	Mme. Desprs	F	NaN	NaN	NaN	France	FRA	1900 Summer	1900	Summer	Paris	Croquet	Croquet Mixed Singles, Two Balls	NaN	France	NaN

Let's count the rows (same code as above adding the count() function and filtering only for ID).

In [89]:
```
womenInOlympics['ID'].loc[womenInOlympics['Year'] == 1900].count()
```

Out[89]:
```
33
```

So we have 33 records (with repetitions, for example 'Marion Jones (-Farquhar)' won a medal both for Tennis Women's Singles and Tennis Mixed Doubles).

7. Medals per country

Let's now review the top 5 gold medal countries:

In [90]:
```
goldMedals.region.value_counts().reset_index(name='Medal').head(5)
```

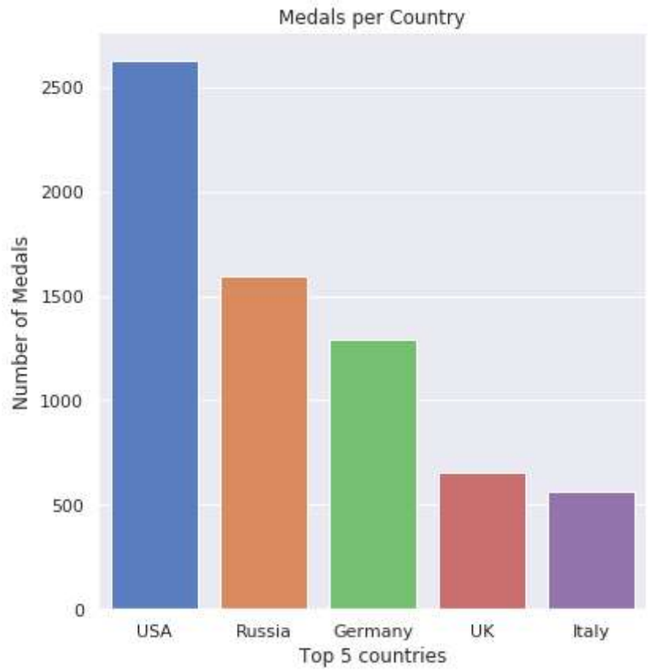
Out[90]:

	index	Medal
0	USA	2627
1	Russia	1599
2	Germany	1293
3	UK	657
4	Italy	567

Let's plot this:

In [91]:
```
totalGoldMedals = goldMedals.region.value_counts().reset_index(name='Medal').head(5)
g = sns.catplot(x="index", y="Medal", data=totalGoldMedals,
                height=6, kind="bar", palette="muted")
g.despine(left=True)
g.set_xlabels("Top 5 countries")
g.set_ylabels("Number of Medals")
plt.title('Medals per Country')
```

Out[91]: Text(0.5,1,'Medals per Country')



The USA seems to be the most winning country.

But which are the most awarded disciplines of American Athletes?

8. Disciplines with the greatest number of Gold Medals

Let's create a dataframe to filter the gold medals only for the USA.

In [92]:
```
goldMedalsUSA = goldMedals.loc[goldMedals['NOC'] == 'USA']
```

Now, we can count the medals per discipline:

In [93]:
```
goldMedalsUSA.Event.value_counts().reset_index(name='Medal').head(20)
```

Out[93]:

	index	Medal
0	Basketball Men's Basketball	186
1	Swimming Men's 4 x 200 metres Freestyle Relay	111
2	Swimming Men's 4 x 100 metres Medley Relay	108
3	Rowing Men's Coxed Eights	107
4	Basketball Women's Basketball	95
5	Athletics Men's 4 x 400 metres Relay	81
6	Swimming Women's 4 x 100 metres Medley Relay	79
7	Swimming Women's 4 x 100 metres Freestyle Relay	78
8	Football Women's Football	66
9	Athletics Men's 4 x 100 metres Relay	63
10	Swimming Men's 4 x 100 metres Freestyle Relay	58
11	Athletics Women's 4 x 100 metres Relay	50
12	Softball Women's Softball	45
13	Athletics Women's 4 x 400 metres Relay	38
14	Ice Hockey Men's Ice Hockey	36
15	Volleyball Men's Volleyball	36
16	Rugby Men's Rugby	36
17	Rowing Women's Coxed Eights	36
18	Swimming Women's 4 x 200 metres Freestyle Relay	33
19	Water Polo Women's Water Polo	25

Let's slice the dataframe using only the data of male athletes to better review it:

In [94]:
```
basketballGoldUSA = goldMedalsUSA.loc[(goldMedalsUSA['Sport'] == 'Basketball') & (goldMedalsUSA['Sex'] == 'M')].sort_values(['Year'])
```

In [95]:
```
basketballGoldUSA.head(15)
```

Out[95]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
109529	55375	Francis Lee Johnson	M	25.0	180.0	79.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
143383	71965	Frank John Lubin	M	26.0	200.0	113.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
161770	81220	Arthur Owen "Art" Mollner	M	23.0	183.0	73.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
79052	40143	John Haskell "Tex" Gibbons	M	28.0	185.0	79.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
189347	95095	Donald Arthur "Don" Piper	M	25.0	180.0	73.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
71407	36368	Joseph Cephis "Joe" Fortenberry	M	25.0	203.0	84.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
195790	98309	Jack Williamson Ragland	M	22.0	183.0	79.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
213368	107150	Willard Theodore Schmidt	M	26.0	205.0	86.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
219204	110112	Carl Leslie Shy	M	27.0	183.0	77.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
22390	11790	Ralph English Bishop	M	20.0	193.0	86.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
233437	117072	Duane Alexander Swanson	M	22.0	188.0	79.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
121770	61570	Carl Stanley Knowles	M	26.0	188.0	75.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
259515	129925	William John "Bill" Wheatley	M	27.0	188.0	79.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
13663	7396	Samuel J. "Sam" Balter, Jr.	M	26.0	178.0	68.0	United States	USA	1936 Summer	1936	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
201980	101443	Robert Lloyd Jackson "Jack" Robinson	M	21.0	183.0	82.0	United States	USA	1948 Summer	1948	Summer	London	Basketball	Basketball Men's Basketball	Gold	USA	NaN

What we supposed is true: the medals are not grouped by Edition/Team but we were counting the gold medals of each member of the team.

Let's proceed grouping by year the athletes - the idea is to create a new dataframe to make a pre-filter using only the first record for each member of the team.

In [96]:
```
groupedBasketUSA = basketballGoldUSA.groupby(['Year']).first()
groupedBasketUSA
```

Out[96]:

Year	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Season	City	Sport	Event	Medal	region	notes
1936	55375	Francis Lee Johnson	M	25.0	180.0	79.0	United States	USA	1936 Summer	Summer	Berlin	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1948	101443	Robert Lloyd Jackson "Jack" Robinson	M	21.0	183.0	82.0	United States	USA	1948 Summer	Summer	London	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1952	58738	Robert Earl "Bob" Kenney	M	21.0	188.0	84.0	United States	USA	1952 Summer	Summer	Helsinki	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1956	128271	James Patrick "Jim" Walsh	M	26.0	193.0	86.0	United States	USA	1956 Summer	Summer	Melbourne	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1960	13371	Robert Lewis "Bob" Boozer	M	23.0	203.0	99.0	United States	USA	1960 Summer	Summer	Roma	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1964	130843	George "Jiff" Wilson	M	22.0	203.0	95.0	United States	USA	1964 Summer	Summer	Tokyo	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1968	8104	Michael Thomas "Mike" Barrett	M	25.0	188.0	73.0	United States	USA	1968 Summer	Summer	Mexico City	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1976	65853	Thomas Joseph "Tom" LaGarde	M	21.0	208.0	97.0	United States	USA	1976 Summer	Summer	Montreal	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1984	120501	Wayman Lawrence Tisdale	M	20.0	205.0	118.0	United States	USA	1984 Summer	Summer	Los Angeles	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1992	33553	Patrick Aloysius Ewing	M	29.0	213.0	109.0	United States	USA	1992 Summer	Summer	Barcelona	Basketball	Basketball Men's Basketball	Gold	USA	NaN
1996	115325	John Houston Stockton	M	34.0	185.0	79.0	United States	USA	1996 Summer	Summer	Atlanta	Basketball	Basketball Men's Basketball	Gold	USA	NaN
2000	2863	Walter Ray Allen	M	25.0	192.0	93.0	United States	USA	2000 Summer	Summer	Sydney	Basketball	Basketball Men's Basketball	Gold	USA	NaN
2008	13739	Christopher Wesson "Chris" Bosh	M	24.0	208.0	104.0	United States	USA	2008 Summer	Summer	Beijing	Basketball	Basketball Men's Basketball	Gold	USA	NaN
2012	53494	LeBron Raymone James	M	27.0	203.0	114.0	United States	USA	2012 Summer	Summer	London	Basketball	Basketball Men's Basketball	Gold	USA	NaN
2016	55874	Hyland DeAndre Jordan, Jr.	M	28.0	211.0	120.0	United States	USA	2016 Summer	Summer	Rio de Janeiro	Basketball	Basketball Men's Basketball	Gold	USA	NaN

Let's count the records obtained:

In [97]:
```
groupedBasketUSA['ID'].count()
```

Out[97]:
```
15
```

So we have 15 records

9. What is the median height/weight of an Olympic medalist?

Let's try to plot a scatterplot of height vs weight to see the distribution of values (without grouping by discipline).

First of all, we have to take again the goldMedals dataframe

In [98]:
```
goldMedals.head()
```

Out[98]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
3	4	Edgar Lindenau Aabye	M	34.0	NaN	NaN	Denmark/Sweden	DEN	1900 Summer	1900	Summer	Paris	Tug-Of-War	Tug-Of-War Men's Tug-Of-War	Gold	Denmark	NaN
42	17	Paavo Johannes Aaltonen	M	28.0	175.0	64.0	Finland	FIN	1948 Summer	1948	Summer	London	Gymnastics	Gymnastics Men's Team All-Around	Gold	Finland	NaN
44	17	Paavo Johannes Aaltonen	M	28.0	175.0	64.0	Finland	FIN	1948 Summer	1948	Summer	London	Gymnastics	Gymnastics Men's Horse Vault	Gold	Finland	NaN
48	17	Paavo Johannes Aaltonen	M	28.0	175.0	64.0	Finland	FIN	1948 Summer	1948	Summer	London	Gymnastics	Gymnastics Men's Pommelled Horse	Gold	Finland	NaN
60	20	Kjetil Andr Aamodt	M	20.0	176.0	85.0	Norway	NOR	1992 Winter	1992	Winter	Albertville	Alpine Skiing	Alpine Skiing Men's Super G	Gold	Norway	NaN

We can see that we have NaN values both in height and weight columns.

At this point, we can act as follows:

1. Using only the rows that has a value in the Height and Weight columns;
2. Replace the value with the mean of the column.

Solution 2 in my opinion it is not the best way to go: we are talking about data of athletes of different ages and different disciplines (that have done different training).

Let's go with solution 1.

The first thing to do is to collect general information about the dataframe that we have to use: goldMedals.

In [99]:
```
goldMedals.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 13224 entries, 3 to 271076
Data columns (total 17 columns):
ID        13224 non-null int64
Name      13224 non-null object
Sex       13224 non-null object
Age       13224 non-null float64
Height    10532 non-null float64
Weight    10248 non-null float64
Team      13224 non-null object
NOC       13224 non-null object
Games     13224 non-null object
Year      13224 non-null int64
Season    13224 non-null object
City      13224 non-null object
Sport     13224 non-null object
Event     13224 non-null object
Medal     13224 non-null object
region    13223 non-null object
notes     171 non-null object
dtypes: float64(3), int64(2), object(12)
memory usage: 2.4+ MB
```

we have more than 13.000 rows.

We will now create a dataframe filtering only the rows that has the column Height and Weight populated.

In [100…
```
notNullMedals = goldMedals[(goldMedals['Height'].notnull()) & (goldMedals['Weight'].notnull())]
```

let's see the first rows of the dataset and the new information with the info function.

In [101…
```
notNullMedals.head()
```

Out[101]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
42	17	Paavo Johannes Aaltonen	M	28.0	175.0	64.0	Finland	FIN	1948 Summer	1948	Summer	London	Gymnastics	Gymnastics Men's Team All-Around	Gold	Finland	NaN
44	17	Paavo Johannes Aaltonen	M	28.0	175.0	64.0	Finland	FIN	1948 Summer	1948	Summer	London	Gymnastics	Gymnastics Men's Horse Vault	Gold	Finland	NaN
48	17	Paavo Johannes Aaltonen	M	28.0	175.0	64.0	Finland	FIN	1948 Summer	1948	Summer	London	Gymnastics	Gymnastics Men's Pommelled Horse	Gold	Finland	NaN
60	20	Kjetil Andr Aamodt	M	20.0	176.0	85.0	Norway	NOR	1992 Winter	1992	Winter	Albertville	Alpine Skiing	Alpine Skiing Men's Super G	Gold	Norway	NaN
73	20	Kjetil Andr Aamodt	M	30.0	176.0	85.0	Norway	NOR	2002 Winter	2002	Winter	Salt Lake City	Alpine Skiing	Alpine Skiing Men's Super G	Gold	Norway	NaN

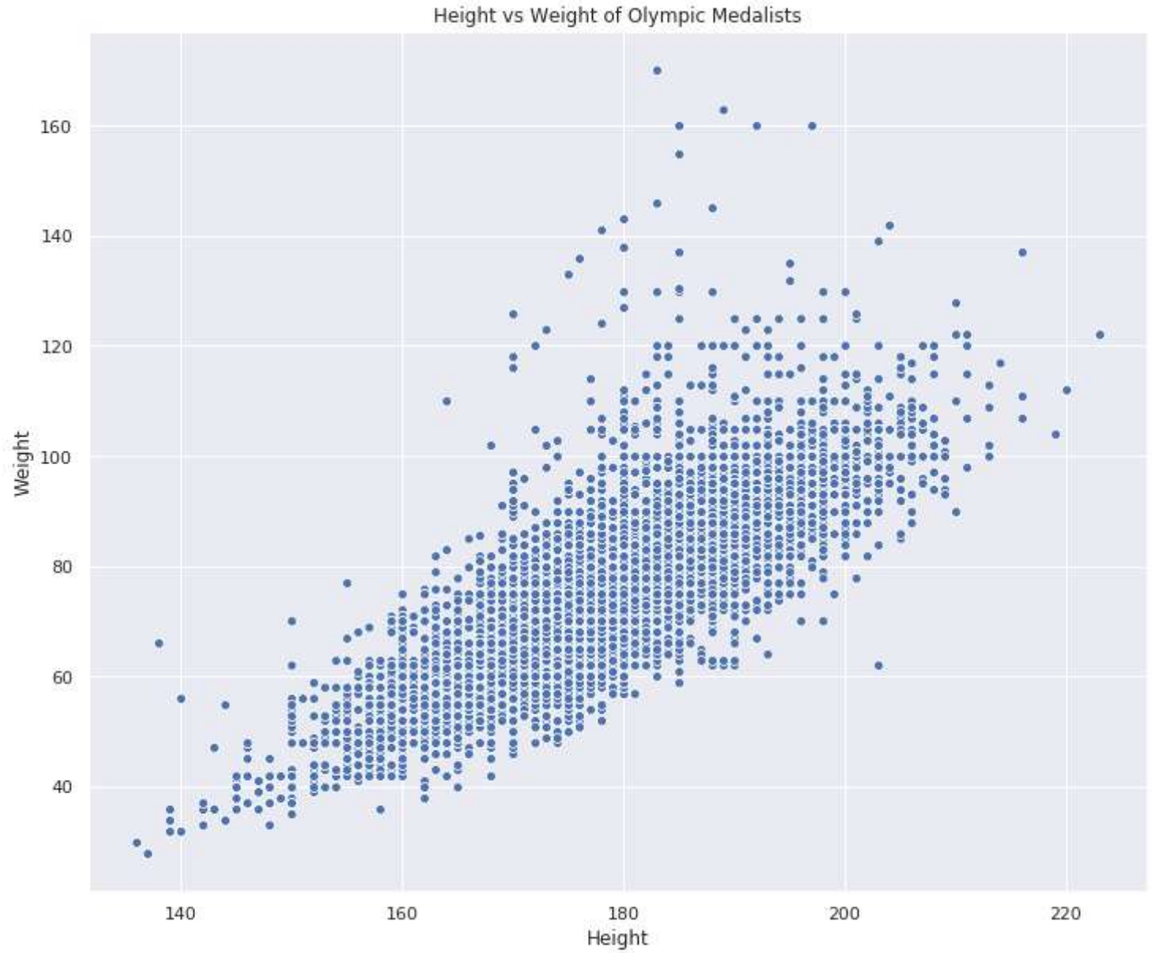
In [102…
```
notNullMedals.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 10167 entries, 42 to 271076
Data columns (total 17 columns):
ID        10167 non-null int64
Name      10167 non-null object
Sex       10167 non-null object
Age       10167 non-null float64
Height    10167 non-null float64
Weight    10167 non-null float64
Team      10167 non-null object
NOC       10167 non-null object
Games     10167 non-null object
Year      10167 non-null int64
Season    10167 non-null object
City      10167 non-null object
Sport     10167 non-null object
Event     10167 non-null object
Medal     10167 non-null object
region    10166 non-null object
notes     143 non-null object
dtypes: float64(3), int64(2), object(12)
memory usage: 1.4+ MB
```

we have 10.000 rows now, let's create the scatterplot:

In [103…
```
plt.figure(figsize=(12, 10))
ax = sns.scatterplot(x="Height", y="Weight", data=notNullMedals)
plt.title('Height vs Weight of Olympic Medalists')
```

Out[103]:
```
Text(0.5,1,'Height vs Weight of Olympic Medalists')
```



The vast majority of the samples show a linear relation between height and weight (the more the weight, the more the height).

We have exceptions.

For example, let's see which is the athlete that weighs more than 160 kilograms

In [104…
```
notNullMedals.loc[notNullMedals['Weight'] > 160]
```

Out[104]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
39181	20144	Andrey Ivanovich Chemerkin	M	24.0	183.0	170.0	Russia	RUS	1996 Summer	1996	Summer	Atlanta	Weightlifting	Weightlifting Men's Super-Heavyweight	Gold	Russia	NaN
268659	134407	Leonid Ivanovych Zhabotynskiy	M	26.0	189.0	163.0	Soviet Union	URS	1964 Summer	1964	Summer	Tokyo	Weightlifting	Weightlifting Men's Heavyweight	Gold	Russia	NaN
268660	134407	Leonid Ivanovych Zhabotynskiy	M	30.0	189.0	163.0	Soviet Union	URS	1968 Summer	1968	Summer	Mexico City	Weightlifting	Weightlifting Men's Heavyweight	Gold	Russia	NaN

10. Evolution of the Olympics over time

We will now try to answer the following questions:

- How the number of athletes/countries varied along time ?
- How the proportion of Men/Women varied with time ?
- How about mean age, weight and height along time ?

10.1 Variation of male/female athletes over time (Summer Games)

We will now create two dataframes dividing the population of our dataset using Sex and Season (we would like to review only the summer games)

In [105…
```
MenOverTime = merged[(merged.Sex == 'M') & (merged.Season == 'Summer')]
WomenOverTime = merged[(merged.Sex == 'F') & (merged.Season == 'Summer')]
```

let's check the head of one of the new dataframes to see the result:

In [106…
```
MenOverTime.head()
```

Out[106]:

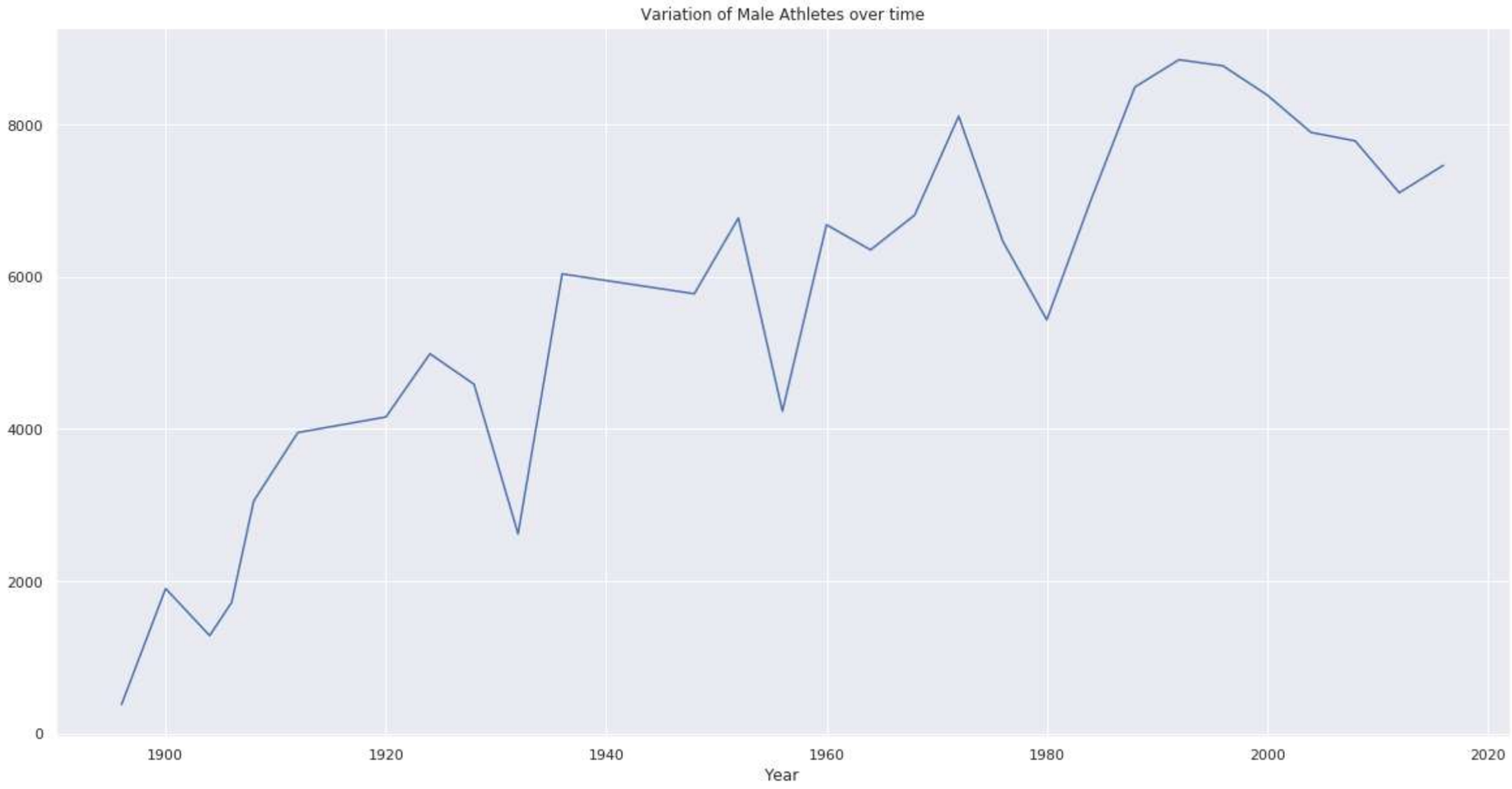
	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
0	1	A Dijiang	M	24.0	180.0	80.0	China	CHN	1992 Summer	1992	Summer	Barcelona	Basketball	Basketball Men's Basketball	NaN	China	NaN
1	2	A Lamusi	M	23.0	170.0	60.0	China	CHN	2012 Summer	2012	Summer	London	Judo	Judo Men's Extra-Lightweight	NaN	China	NaN
2	3	Gunnar Nielsen Aaby	M	24.0	NaN	NaN	Denmark	DEN	1920 Summer	1920	Summer	Antwerpen	Football	Football Men's Football	NaN	Denmark	NaN
3	4	Edgar Lindenau Aabye	M	34.0	NaN	NaN	Denmark/Sweden	DEN	1900 Summer	1900	Summer	Paris	Tug-Of-War	Tug-Of-War Men's Tug-Of-War	Gold	Denmark	NaN
29	10	Einar Ferdinand "Einari" Aalto	M	26.0	NaN	NaN	Finland	FIN	1952 Summer	1952	Summer	Helsinki	Swimming	Swimming Men's 400 metres Freestyle	NaN	Finland	NaN

At this time we are ready to create the plots.

The first one is for men, the second for women:

In [107…
```
part = MenOverTime.groupby('Year')['Sex'].value_counts()
plt.figure(figsize=(20, 10))
part.loc[:,'M'].plot()
plt.title('Variation of Male Athletes over time')
```

Out[107]:
```
Text(0.5,1,'Variation of Male Athletes over time')
```

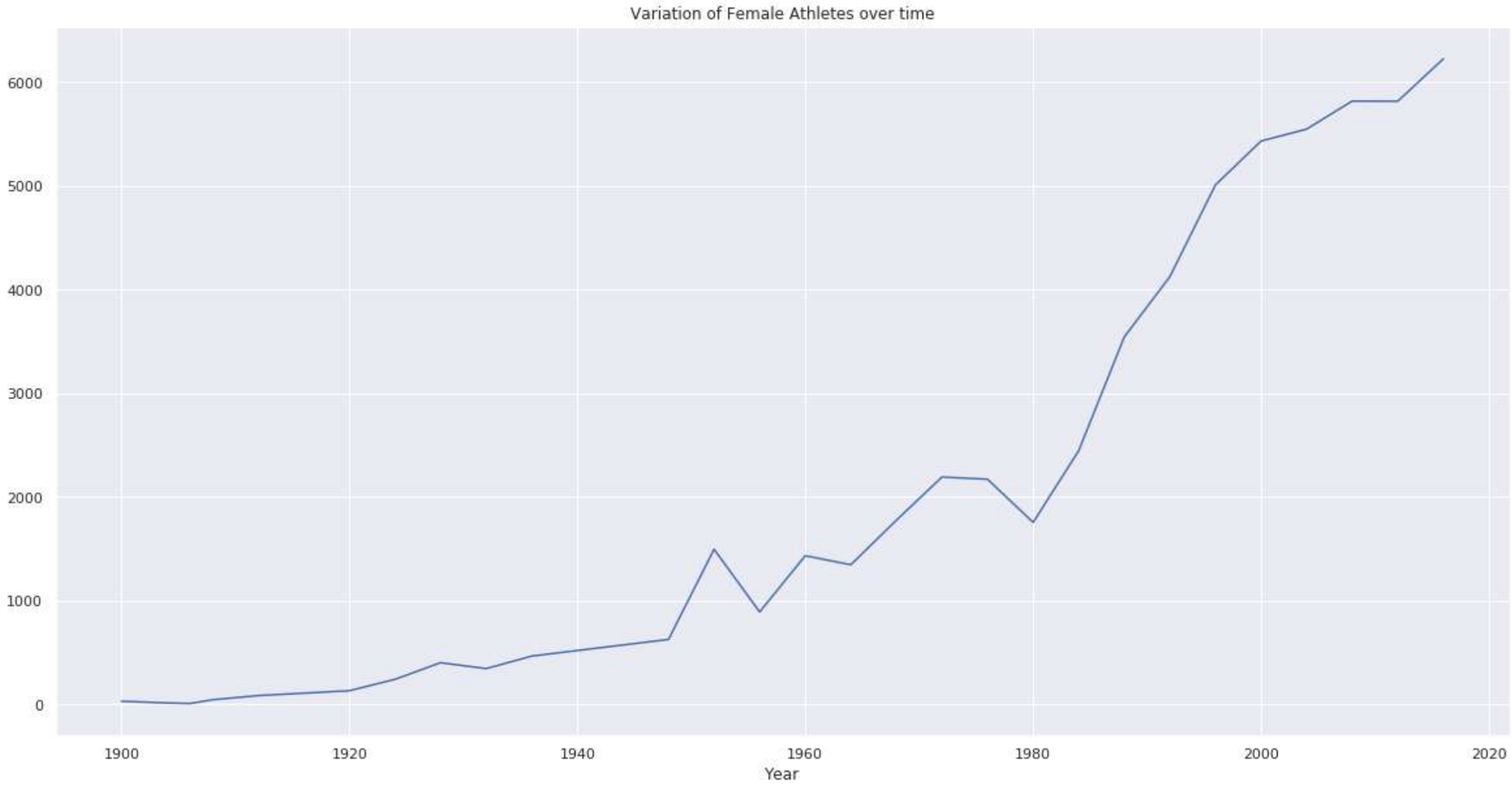


In [108…

```
part = WomenOverTime.groupby('Year')['Sex'].value_counts()
plt.figure(figsize=(20, 10))
part.loc[:,'F'].plot()
plt.title('Variation of Female Athletes over time')
```

Out[108]:

```
Text(0.5,1,'Variation of Female Athletes over time')
```



What I immediately saw is that for women:

1. We have a steep increase in the population;
2. The grow is constant.

On the other hand, the grow for men seems less strong:

1. After the 1990 we can see a relevant decrease in the number of male athletes at the summer games;
2. The growth has slowly restarted recently.

10.2 Variation of age along time

Another really interesting question can be: "How the age of the athletes has changed over time?"

Let's use a box plot: In descriptive statistics, a box plot or boxplot is a method for graphically depicting groups of numerical data through their quartiles.

Box plots may also have lines extending vertically from the boxes (whiskers) indicating variability outside the upper and lower quartiles, hence the terms box-and-whisker plot and box-and-whisker diagram.

Outliers may be plotted as individual points. Box plots are non-parametric: they display variation in samples of a statistical population without making any assumptions of the underlying statistical distribution.

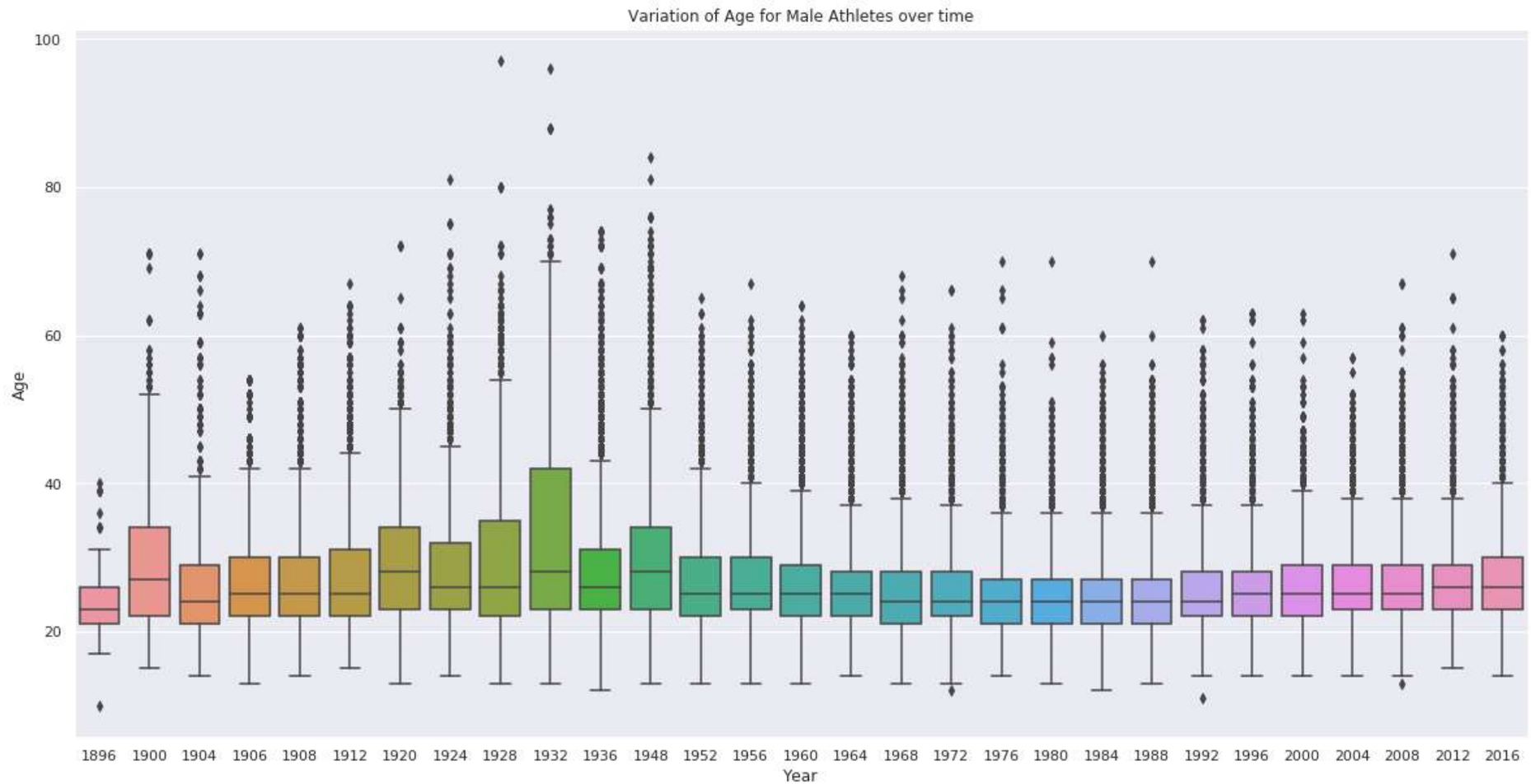
The spacings between the different parts of the box indicate the degree of dispersion (spread) and skewness in the data, and show outliers.

In addition to the points themselves, they allow one to visually estimate various L-estimators, notably the interquartile range, midhinge, range, mid-range, and trimean.

Box plots can be drawn either horizontally or vertically. Box plots received their name from the box in the middle.

In [109…
```
plt.figure(figsize=(20, 10))
sns.boxplot('Year', 'Age', data=MenOverTime)
plt.title('Variation of Age for Male Athletes over time')
```

Out[109]:
```
Text(0.5,1,'Variation of Age for Male Athletes over time')
```



What is strange for me is the age of some athletes in the games between the 1924 and the 1948: let's check all the people with age greater than 80.

In [110…
```
MenOverTime.loc[MenOverTime['Age'] > 80].head(10)
```

Out[110]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
9371	5146	George Denholm Armour	M	84.0	NaN	NaN	Great Britain	GBR	1948 Summer	1948	Summer	London	Art Competitions	Art Competitions Mixed Painting, Unknown Event	NaN	UK	NaN
60861	31173	Thomas Cowperthwait Eakins	M	88.0	NaN	NaN	United States	USA	1932 Summer	1932	Summer	Los Angeles	Art Competitions	Art Competitions Mixed Painting, Unknown Event	NaN	USA	NaN
60862	31173	Thomas Cowperthwait Eakins	M	88.0	NaN	NaN	United States	USA	1932 Summer	1932	Summer	Los Angeles	Art Competitions	Art Competitions Mixed Painting, Unknown Event	NaN	USA	NaN
60863	31173	Thomas Cowperthwait Eakins	M	88.0	NaN	NaN	United States	USA	1932 Summer	1932	Summer	Los Angeles	Art Competitions	Art Competitions Mixed Painting, Unknown Event	NaN	USA	NaN
98118	49663	Winslow Homer	M	96.0	NaN	NaN	United States	USA	1932 Summer	1932	Summer	Los Angeles	Art Competitions	Art Competitions Mixed Painting, Unknown Event	NaN	USA	NaN
154855	77710	Robert Tait McKenzie	M	81.0	NaN	NaN	Canada	CAN	1948 Summer	1948	Summer	London	Art Competitions	Art Competitions Mixed Sculpturing, Unknown Event	NaN	Canada	NaN
236912	118789	Louis Tauzin	M	81.0	NaN	NaN	France	FRA	1924 Summer	1924	Summer	Paris	Art Competitions	Art Competitions Mixed Sculpturing	NaN	France	NaN
257054	128719	John Quincy Adams Ward	M	97.0	NaN	NaN	United States	USA	1928 Summer	1928	Summer	Amsterdam	Art Competitions	Art Competitions Mixed Sculpturing, Statues	NaN	USA	NaN

Art competitions formed part of the modern Olympic Games during its early years, from 1912 to 1948. The competitions were part of the original intention of the Olympic Movement's founder, Pierre de Frédy, Baron de Coubertin. Medals were awarded for works of art inspired by sport, divided into five categories: architecture, literature, music, painting, and sculpture.

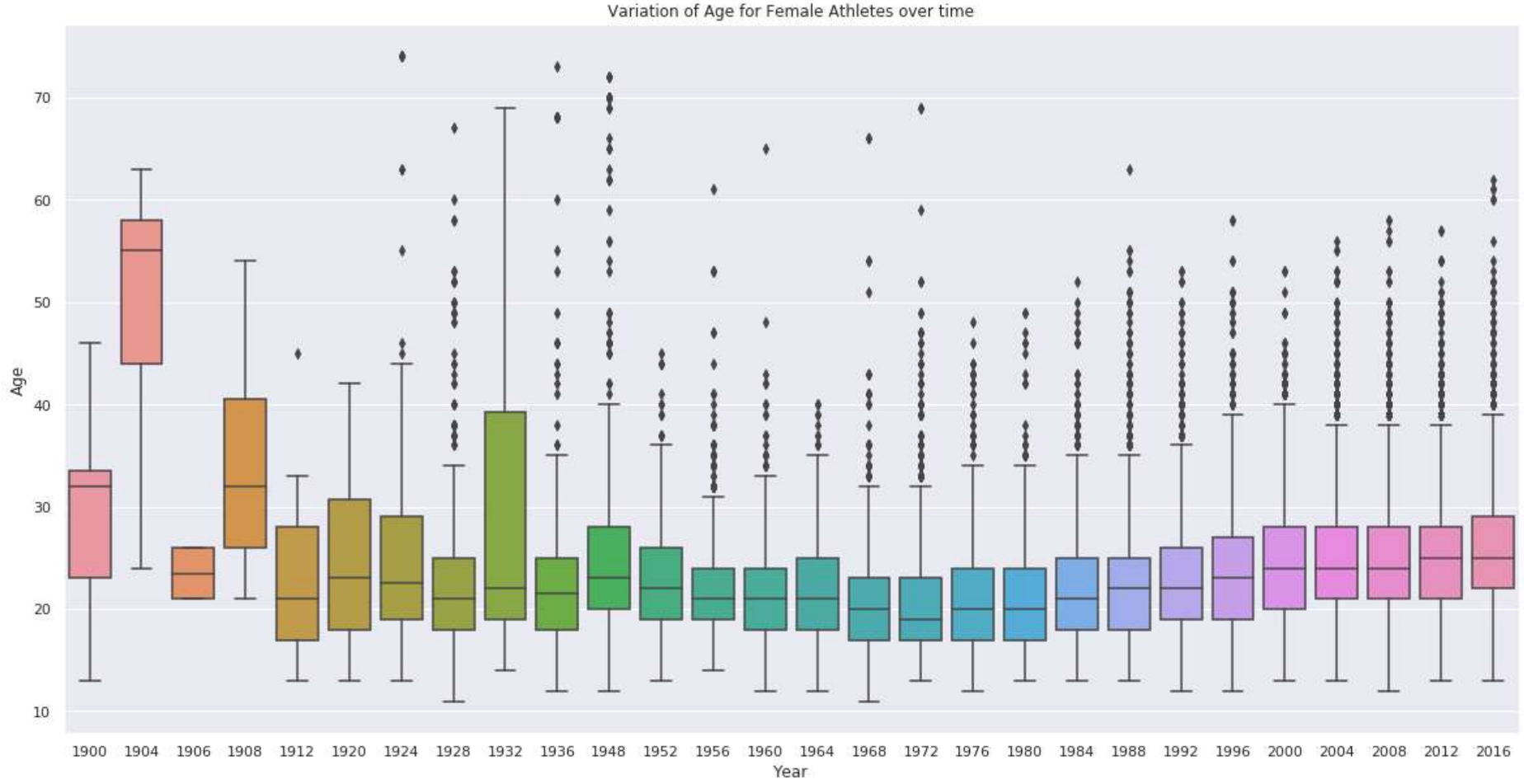
After this brief parenthesis we can do the same graph for women:

In [111…

```
plt.figure(figsize=(20, 10))
sns.boxplot('Year', 'Age', data=WomenOverTime)
plt.title('Variation of Age for Female Athletes over time')
```

Out[111]:

```
Text(0.5,1,'Variation of Age for Female Athletes over time')
```



Interesting points for me:

- the age distribution starts has a lower minimum and a lower maximum;
- In 1904 the age distribution is strongly different from the other Olympics: let's know more about this point:

In [112…

```
WomenOverTime.loc[WomenOverTime['Year'] == 1904]
```

Out[112]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
44365	22877	Emma C. Cooke	F	55.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double Columbia Round	Silver	USA	NaN
44366	22877	Emma C. Cooke	F	55.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double National Round	Silver	USA	NaN
99506	50366	Matilda "Lida" Howell (Scott-)	F	44.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double Columbia Round	Gold	USA	NaN
99507	50366	Matilda "Lida" Howell (Scott-)	F	44.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double National Round	Gold	USA	NaN
99508	50366	Matilda "Lida" Howell (Scott-)	F	44.0	NaN	NaN	Cincinnati Archers	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Team Round	Gold	USA	NaN
190950	95906	Lida Peyton "Eliza" Pollock (McMillen-)	F	63.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double Columbia Round	Bronze	USA	NaN
190951	95906	Lida Peyton "Eliza" Pollock (McMillen-)	F	63.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double National Round	Bronze	USA	NaN
190952	95906	Lida Peyton "Eliza" Pollock (McMillen-)	F	63.0	NaN	NaN	Cincinnati Archers	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Team Round	Gold	USA	NaN
237131	118921	Leonora Josephine "Leonie" Taylor	F	NaN	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double Columbia Round	NaN	USA	NaN
237132	118921	Leonora Josephine "Leonie" Taylor	F	NaN	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double National Round	NaN	USA	NaN
237133	118921	Leonora Josephine "Leonie" Taylor	F	NaN	NaN	NaN	Cincinnati Archers	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Team Round	Gold	USA	NaN
237134	118922	Mabel Caroline Taylor (-Brummel)	F	24.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double Columbia Round	NaN	USA	NaN
237135	118922	Mabel Caroline Taylor (-Brummel)	F	24.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double National Round	NaN	USA	NaN
262863	131533	Emily Woodruff (Smiley-)	F	58.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double Columbia Round	NaN	USA	NaN
262864	131533	Emily Woodruff (Smiley-)	F	58.0	NaN	NaN	United States	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Double National Round	NaN	USA	NaN
262865	131533	Emily Woodruff (Smiley-)	F	58.0	NaN	NaN	Cincinnati Archers	USA	1904 Summer	1904	Summer	St. Louis	Archery	Archery Women's Team Round	Gold	USA	NaN

10.3 Variation of weight along time

We will now try using a pointplot to visualize the variation in weight over athletes.

The first graph will show data for men, the second for women:

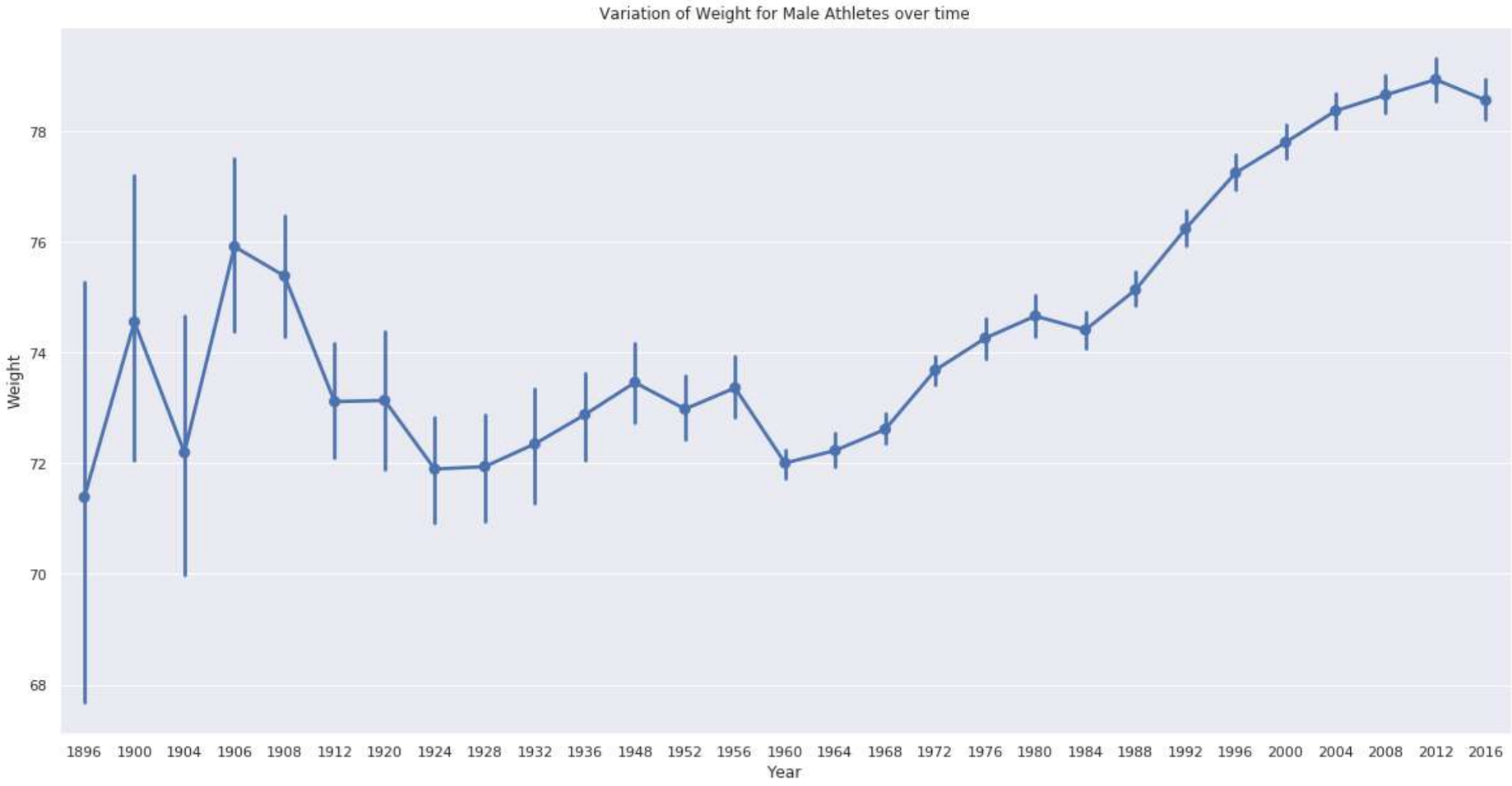
In [113…

```
plt.figure(figsize=(20, 10))
sns.pointplot('Year', 'Weight', data=MenOverTime)
plt.title('Variation of Weight for Male Athletes over time')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[113]:

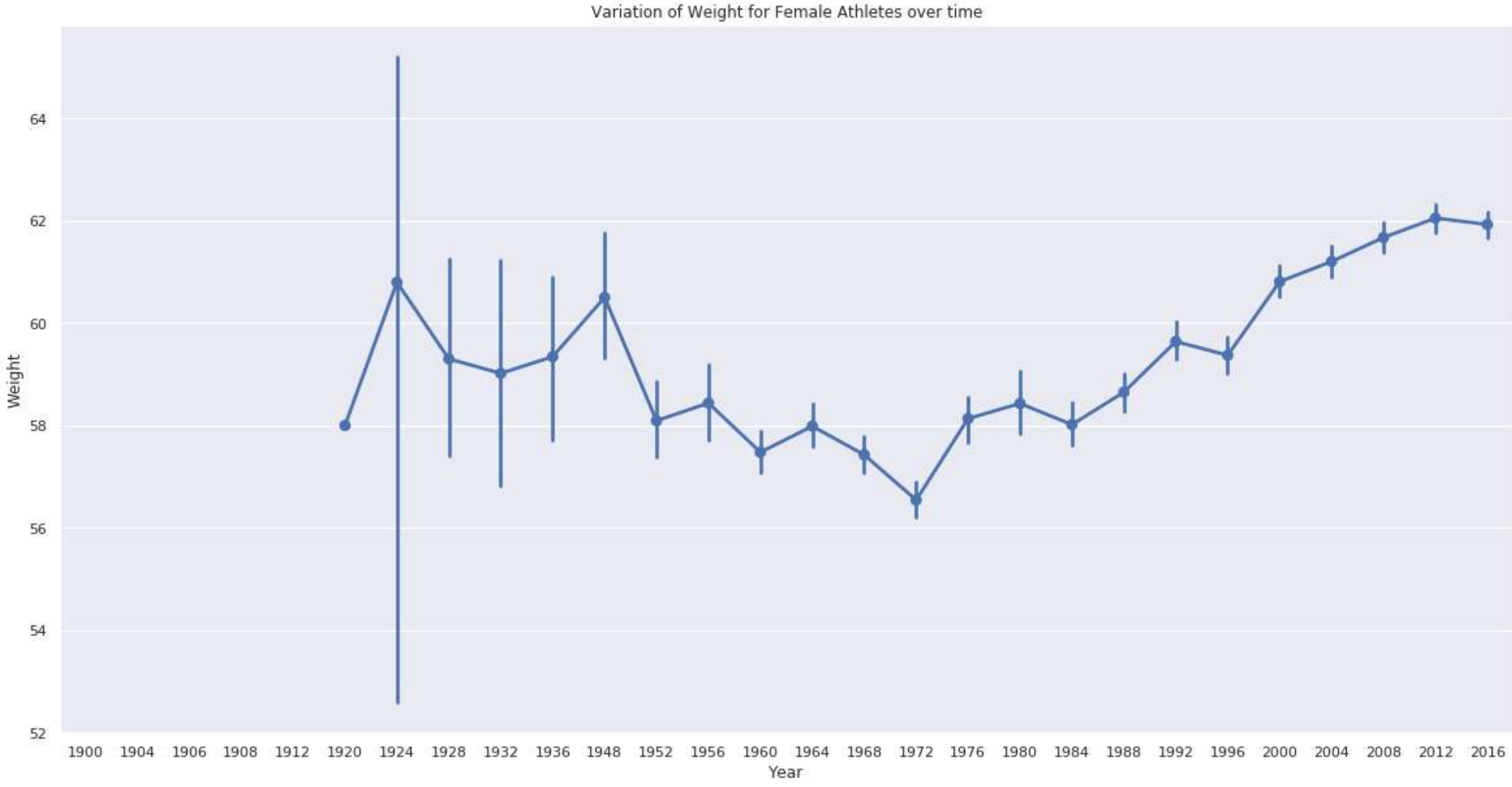
```
Text(0.5,1,'Variation of Weight for Male Athletes over time')
```



In [114…
```
plt.figure(figsize=(20, 10))
sns.pointplot('Year', 'Weight', data=WomenOverTime)
plt.title('Variation of Weight for Female Athletes over time')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[114]:
```
Text(0.5,1,'Variation of Weight for Female Athletes over time')
```



What we can see is that it seems that we do not have data for women before 1924.

Let's try filtering all the women athletes for that period to review this point:

In [115…

```
womenInOlympics.loc[womenInOlympics['Year'] < 1924].head(20)
```

Out[115]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
283	150	Margaret Ives Abbott (-Dunne)	F	23.0	NaN	NaN	United States	USA	1900 Summer	1900	Summer	Paris	Golf	Golf Women's Individual	Gold	USA	NaN
284	151	Mary Perkins Ives Abbott (Perkins-)	F	42.0	NaN	NaN	United States	USA	1900 Summer	1900	Summer	Paris	Golf	Golf Women's Individual	NaN	USA	NaN
1738	968	Margarete "Grete" Adler	F	16.0	NaN	NaN	Austria	AUT	1912 Summer	1912	Summer	Stockholm	Swimming	Swimming Women's 100 metres Freestyle	NaN	Austria	NaN
1739	968	Margarete "Grete" Adler	F	16.0	NaN	NaN	Austria	AUT	1912 Summer	1912	Summer	Stockholm	Swimming	Swimming Women's 4 x 100 metres Freestyle Relay	Bronze	Austria	NaN
1756	975	Anna Mrtha Vilhelmina Adlerstrhle (von Oelreich-)	F	39.0	NaN	NaN	Sweden	SWE	1908 Summer	1908	Summer	London	Tennis	Tennis Women's Singles, Covered Courts	Bronze	Sweden	NaN
1768	978	Mrta Elvira Adlerz (-Hermansson)	F	15.0	NaN	NaN	Sweden	SWE	1912 Summer	1912	Summer	Stockholm	Diving	Diving Women's Plain High	NaN	Sweden	NaN
1769	978	Mrta Elvira Adlerz (-Hermansson)	F	23.0	NaN	NaN	Sweden	SWE	1920 Summer	1920	Summer	Antwerpen	Diving	Diving Women's Plain High	NaN	Sweden	NaN
2749	1531	Frances Helen Aitchison (-Leisk)	F	30.0	NaN	NaN	Great Britain-1	GBR	1912 Summer	1912	Summer	Stockholm	Tennis	Tennis Mixed Doubles, Covered Courts	Silver	UK	NaN
2750	1531	Frances Helen Aitchison (-Leisk)	F	30.0	NaN	NaN	Great Britain	GBR	1912 Summer	1912	Summer	Stockholm	Tennis	Tennis Women's Singles, Covered Courts	NaN	UK	NaN
4963	2830	Mary Aileen Allen (Conquest-)	F	31.0	157.0	NaN	United States	USA	1920 Summer	1920	Summer	Antwerpen	Diving	Diving Women's Springboard	NaN	USA	NaN
6958	3907	Elsa Helena Andersson (-Cordes)	F	17.0	NaN	NaN	Sweden	SWE	1912 Summer	1912	Summer	Stockholm	Diving	Diving Women's Plain High	NaN	Sweden	NaN
7129	3985	Selma Augusta Maria Andersson	F	17.0	NaN	NaN	Sweden	SWE	1912 Summer	1912	Summer	Stockholm	Diving	Diving Women's Plain High	NaN	Sweden	NaN
7130	3985	Selma Augusta Maria Andersson	F	25.0	NaN	NaN	Sweden	SWE	1920 Summer	1920	Summer	Antwerpen	Diving	Diving Women's Plain High	NaN	Sweden	NaN
8630	4739	Gertrude Appleyard (Tuppen-)	F	43.0	NaN	NaN	Great Britain	GBR	1908 Summer	1908	Summer	London	Archery	Archery Women's Double National Round	NaN	UK	NaN
9048	4981	Fernande Arendt (-Jamar)	F	NaN	NaN	NaN	Belgium	BEL	1920 Summer	1920	Summer	Antwerpen	Tennis	Tennis Women's Singles	NaN	Belgium	NaN
9049	4981	Fernande Arendt (-Jamar)	F	NaN	NaN	NaN	Belgium	BEL	1920 Summer	1920	Summer	Antwerpen	Tennis	Tennis Women's Doubles	NaN	Belgium	NaN
9355	5142	Ethel Isabel Armitage (MacLaren-)	F	34.0	NaN	NaN	Great Britain	GBR	1908 Summer	1908	Summer	London	Archery	Archery Women's Double National Round	NaN	UK	NaN
9400	5160	Beatrice Eileen Armstrong (-Purdy)	F	26.0	NaN	NaN	Great Britain	GBR	1920 Summer	1920	Summer	Antwerpen	Diving	Diving Women's Plain High	Silver	UK	NaN
9502	5213	Edith Arnheim (Lasch-)	F	28.0	NaN	NaN	Sweden	SWE	1912 Summer	1912	Summer	Stockholm	Tennis	Tennis Women's Singles	NaN	Sweden	NaN
9503	5213	Edith Arnheim (Lasch-)	F	28.0	NaN	NaN	Sweden-3	SWE	1912 Summer	1912	Summer	Stockholm	Tennis	Tennis Mixed Doubles	NaN	Sweden	NaN

the first values seems all NaN (Not a number) so the information is correct.

10.4 Variation of height along time

Using the same pointplot (with a different palette) we can plot the weight change along time.

The first graph will show the information for men, the second for women:

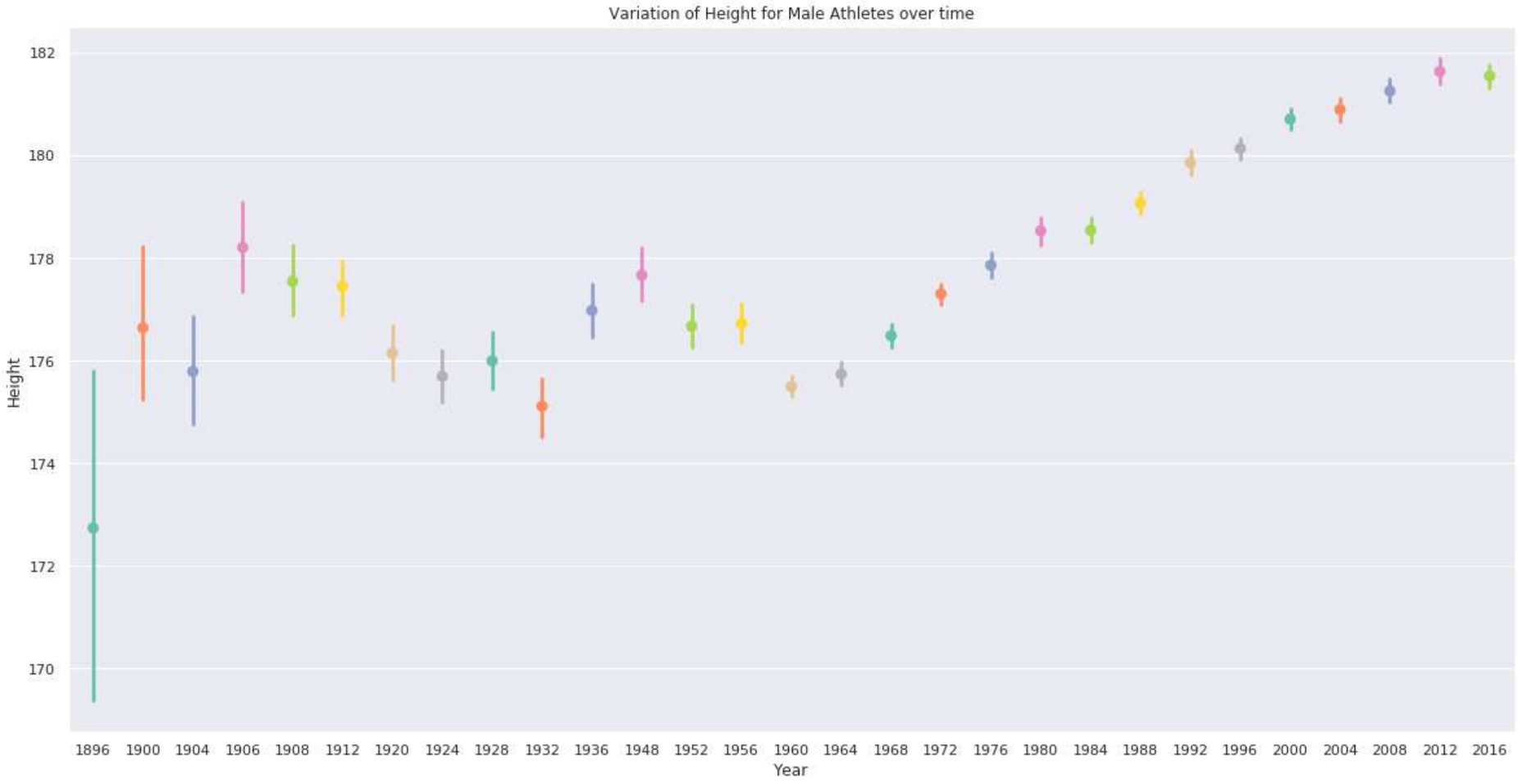
In [116…

```
plt.figure(figsize=(20, 10))
sns.pointplot('Year', 'Height', data=MenOverTime, palette='Set2')
plt.title('Variation of Height for Male Athletes over time')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[116]:

```
Text(0.5,1,'Variation of Height for Male Athletes over time')
```



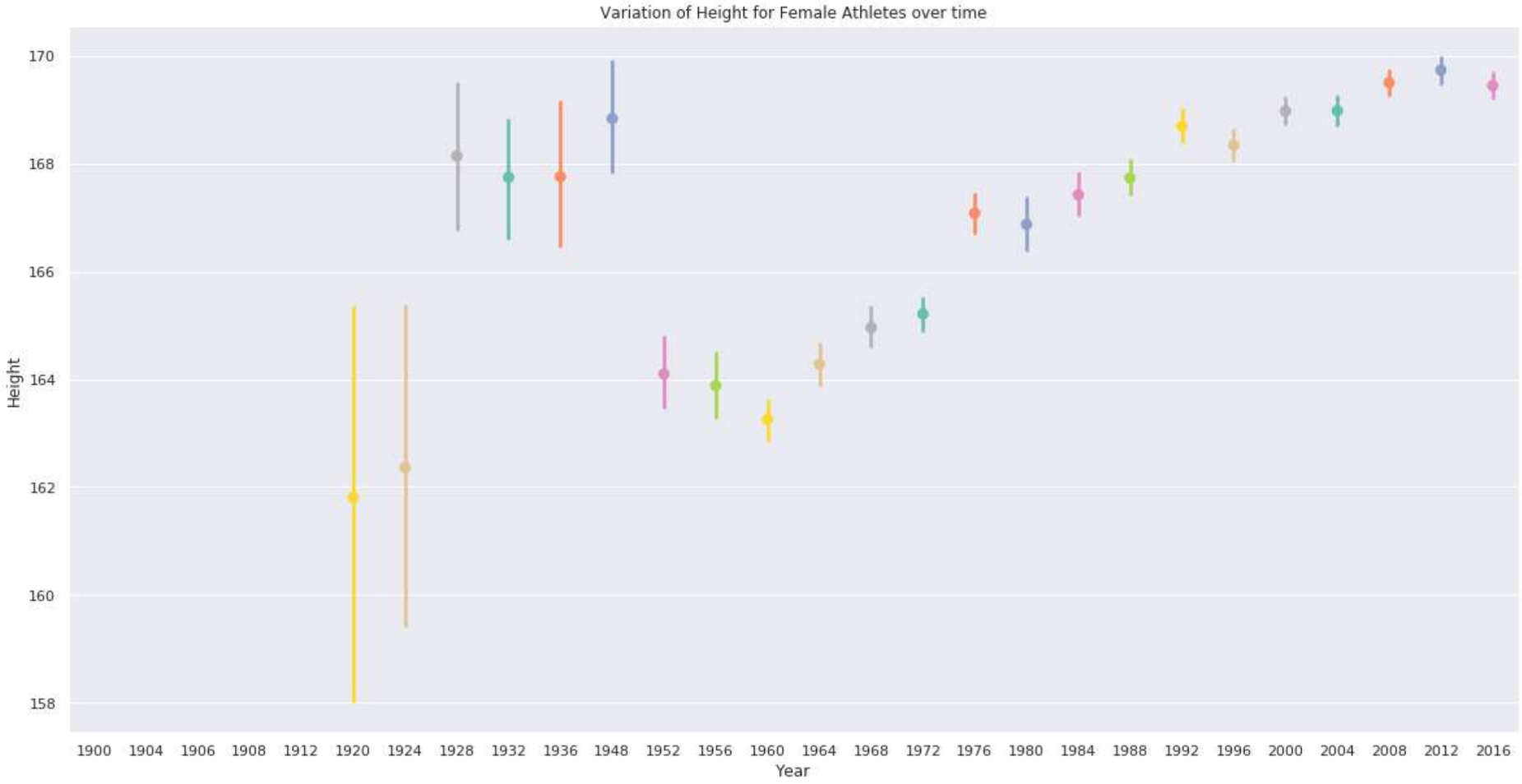
In [117…

```
plt.figure(figsize=(20, 10))
sns.pointplot('Year', 'Height', data=WomenOverTime, palette='Set2')
plt.title('Variation of Height for Female Athletes over time')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[117]:

```
Text(0.5,1,'Variation of Height for Female Athletes over time')
```



What we may see:

- For both men and women, the height is incrementing over time but it is decreasing between the 2012 and the 2016.
- For women we have a peak between 1928 and 1948, let's deepen this point:

In [118…

```
WomenOverTime.loc[(WomenOverTime['Year'] > 1924) & (WomenOverTime['Year'] < 1952)].head(10)
```

Out[118]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
26	8	Cornelia "Cor" Aalten (-Strannood)	F	18.0	168.0	NaN	Netherlands	NED	1932 Summer	1932	Summer	Los Angeles	Athletics	Athletics Women's 100 metres	NaN	Netherlands	NaN
27	8	Cornelia "Cor" Aalten (-Strannood)	F	18.0	168.0	NaN	Netherlands	NED	1932 Summer	1932	Summer	Los Angeles	Athletics	Athletics Women's 4 x 100 metres Relay	NaN	Netherlands	NaN
731	419	Majken berg	F	30.0	170.0	60.0	Sweden	SWE	1948 Summer	1948	Summer	London	Athletics	Athletics Women's Discus Throw	NaN	Sweden	NaN
1301	733	Ilona cs (-Zimmermann)	F	16.0	NaN	NaN	Hungary	HUN	1936 Summer	1936	Summer	Berlin	Swimming	Swimming Women's 100 metres Freestyle	NaN	Hungary	NaN
1302	733	Ilona cs (-Zimmermann)	F	16.0	NaN	NaN	Hungary	HUN	1936 Summer	1936	Summer	Berlin	Swimming	Swimming Women's 4 x 100 metres Freestyle Relay	NaN	Hungary	NaN
1484	825	Lynda Riley Adams (-Hunt)	F	16.0	NaN	NaN	Canada	CAN	1936 Summer	1936	Summer	Berlin	Diving	Diving Women's Springboard	NaN	Canada	NaN
1485	825	Lynda Riley Adams (-Hunt)	F	16.0	NaN	NaN	Canada	CAN	1936 Summer	1936	Summer	Berlin	Diving	Diving Women's Platform	NaN	Canada	NaN
1525	845	Birgitta Ann-Agnes "Bride" Adams-Ray	F	21.0	NaN	NaN	Sweden	SWE	1928 Summer	1928	Summer	Amsterdam	Athletics	Athletics Women's High Jump	NaN	Sweden	NaN
1567	874	Edith Addams de Habbelinck (-Lutjens, -Taylor,...	F	20.0	NaN	NaN	Belgium	BEL	1928 Summer	1928	Summer	Amsterdam	Fencing	Fencing Women's Foil, Individual	NaN	Belgium	NaN
1568	875	Jenny Marie Beatrice Addams	F	19.0	NaN	NaN	Belgium	BEL	1928 Summer	1928	Summer	Amsterdam	Fencing	Fencing Women's Foil, Individual	NaN	Belgium	NaN

The list is full of NaN values (that is why the data for the period deviates from what expected).

10.5 Variation of age for Italian athletes

Let's see the age over time for Italian athletes.

I will start reviewing the dataset MenOverTime to refresh the columns:

In [119…
```
MenOverTime.head(5)
```

Out[119]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
0	1	A Dijiang	M	24.0	180.0	80.0	China	CHN	1992 Summer	1992	Summer	Barcelona	Basketball	Basketball Men's Basketball	NaN	China	NaN
1	2	A Lamusi	M	23.0	170.0	60.0	China	CHN	2012 Summer	2012	Summer	London	Judo	Judo Men's Extra-Lightweight	NaN	China	NaN
2	3	Gunnar Nielsen Aaby	M	24.0	NaN	NaN	Denmark	DEN	1920 Summer	1920	Summer	Antwerpen	Football	Football Men's Football	NaN	Denmark	NaN
3	4	Edgar Lindenau Aabye	M	34.0	NaN	NaN	Denmark/Sweden	DEN	1900 Summer	1900	Summer	Paris	Tug-Of-War	Tug-Of-War Men's Tug-Of-War	Gold	Denmark	NaN
29	10	Einar Ferdinand "Einari" Aalto	M	26.0	NaN	NaN	Finland	FIN	1952 Summer	1952	Summer	Helsinki	Swimming	Swimming Men's 400 metres Freestyle	NaN	Finland	NaN

Let's create a sliced dataframe including only male athletes from Italy

In [120…
```
itMenOverTime = MenOverTime.loc[MenOverTime['region'] == 'Italy']
```

Let's review the first rows:

In [121…
```
itMenOverTime.head(5)
```

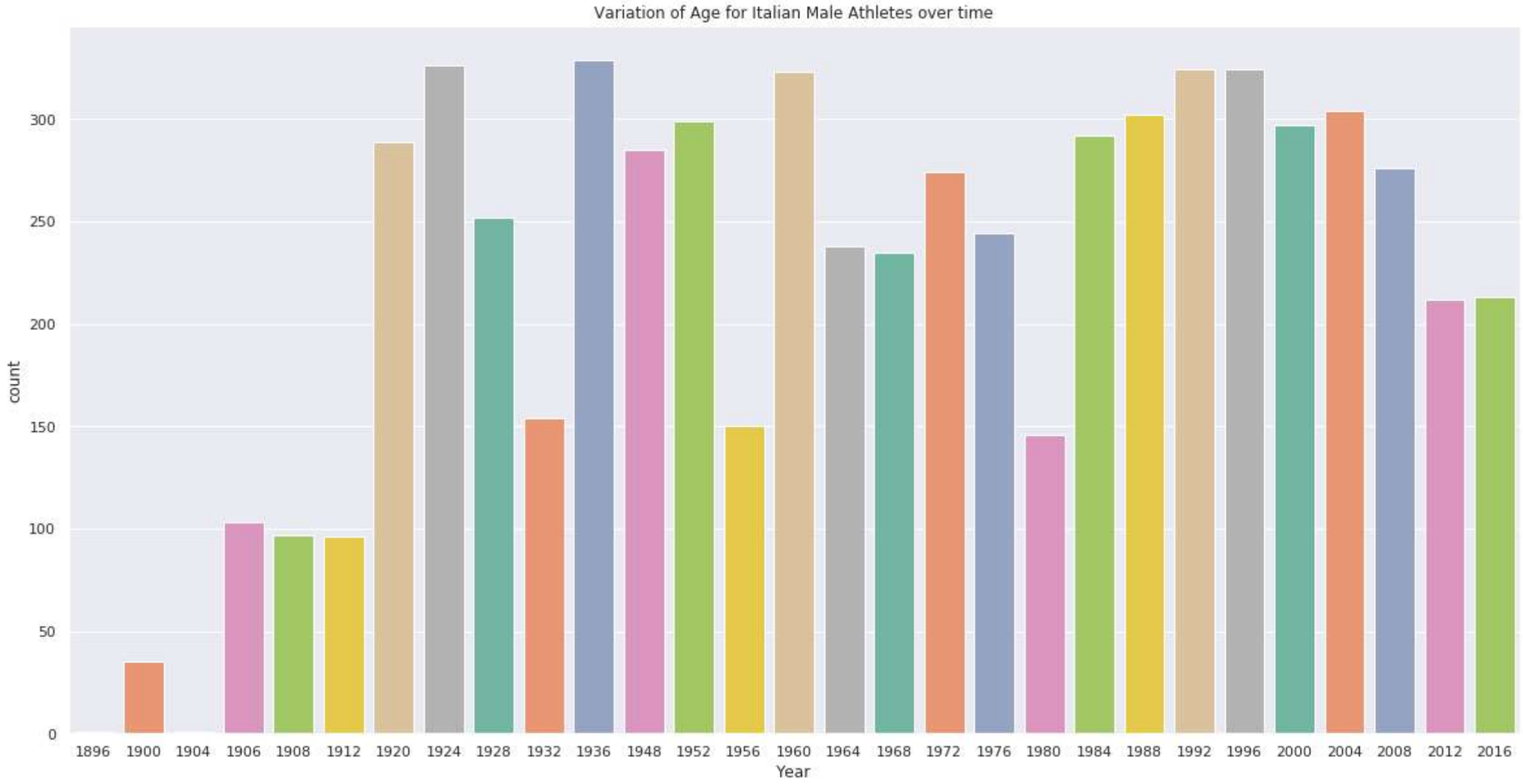
Out[121]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
158	62	Giovanni Abagnale	M	21.0	198.0	90.0	Italy	ITA	2016 Summer	2016	Summer	Rio de Janeiro	Rowing	Rowing Men's Coxless Pairs	Bronze	Italy	NaN
197	91	Emanuele Abate	M	27.0	190.0	80.0	Italy	ITA	2012 Summer	2012	Summer	London	Athletics	Athletics Men's 110 metres Hurdles	NaN	Italy	NaN
198	92	Ignazio Abate	M	21.0	180.0	73.0	Italy	ITA	2008 Summer	2008	Summer	Beijing	Football	Football Men's Football	NaN	Italy	NaN
214	103	Silvano Abba	M	25.0	NaN	NaN	Italy	ITA	1936 Summer	1936	Summer	Berlin	Modern Pentathlon	Modern Pentathlon Men's Individual	Bronze	Italy	NaN
218	106	Agostino Abbagnale	M	22.0	188.0	96.0	Italy	ITA	1988 Summer	1988	Summer	Seoul	Rowing	Rowing Men's Quadruple Sculls	Gold	Italy	NaN

now we can plot the change over time:

In [122…
```
sns.set(style="darkgrid")
plt.figure(figsize=(20, 10))
sns.countplot(x='Year', data=itMenOverTime, palette='Set2')
plt.title('Variation of Age for Italian Male Athletes over time')
```

Out[122]:
```
Text(0.5,1,'Variation of Age for Italian Male Athletes over time')
```

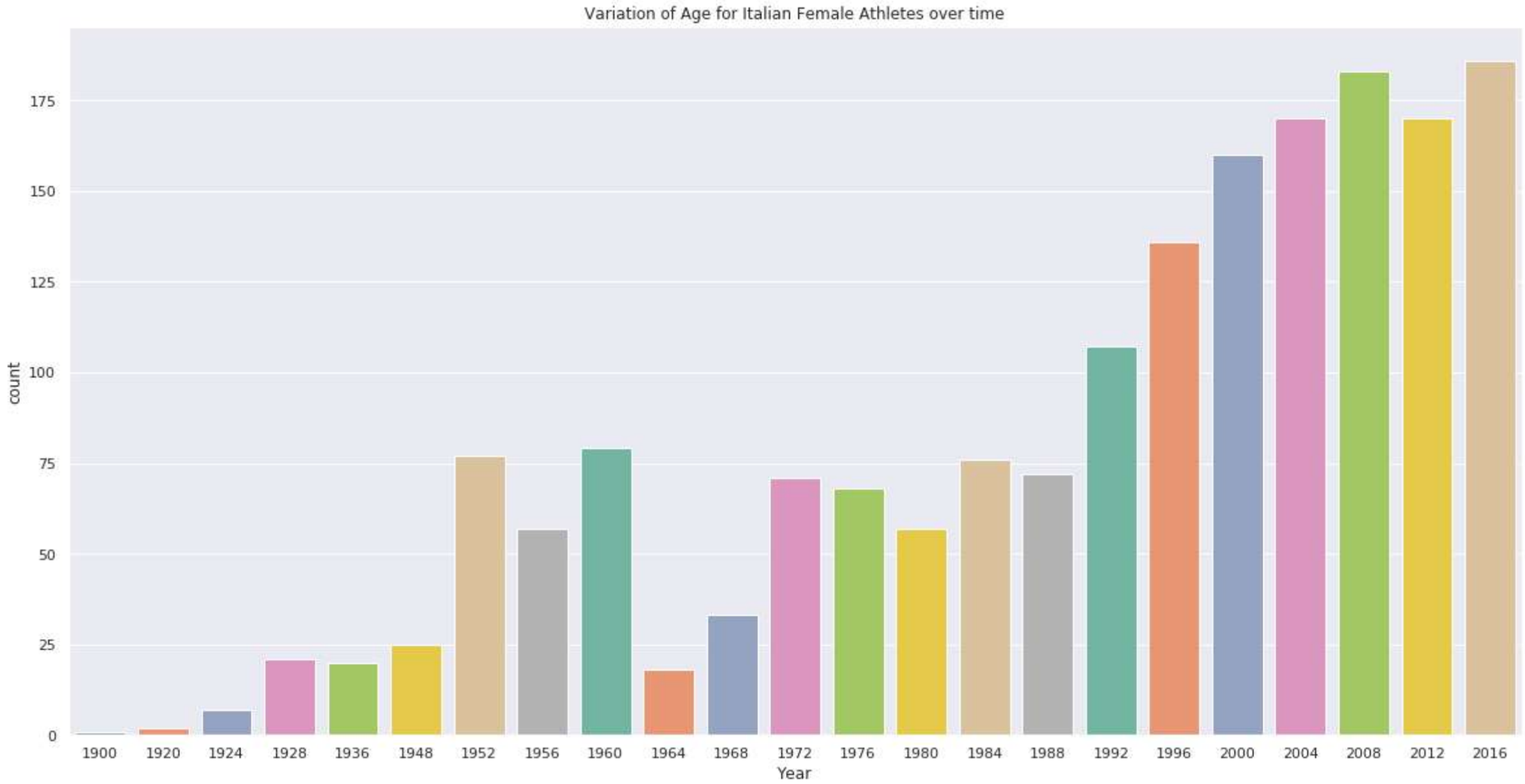


we can quickly do the same operation for women:

In [123…
```
itWomenOverTime = WomenOverTime.loc[WomenOverTime['region'] == 'Italy']
```

In [124…
```
sns.set(style="darkgrid")
plt.figure(figsize=(20, 10))
sns.countplot(x='Year', data=itWomenOverTime, palette='Set2')
plt.title('Variation of Age for Italian Female Athletes over time')
```

Out[124]:
```
Text(0.5,1,'Variation of Age for Italian Female Athletes over time')
```



What we see is that the Italian women participation is increasing, while the men participation is decreasing starting from the 2008 games.

10.6 Variation of height/weight along time for particular disciplines

10.6.1 Gymnastic

Let's see the trend of height/weight for Gymnasts, starting from men and then women following the usual approach:

In [125…
```
MenOverTime.head(5)
```

Out[125]:

	ID	Name	Sex	Age	Height	Weight	Team	NOC	Games	Year	Season	City	Sport	Event	Medal	region	notes
0	1	A Dijiang	M	24.0	180.0	80.0	China	CHN	1992 Summer	1992	Summer	Barcelona	Basketball	Basketball Men's Basketball	NaN	China	NaN
1	2	A Lamusi	M	23.0	170.0	60.0	China	CHN	2012 Summer	2012	Summer	London	Judo	Judo Men's Extra-Lightweight	NaN	China	NaN
2	3	Gunnar Nielsen Aaby	M	24.0	NaN	NaN	Denmark	DEN	1920 Summer	1920	Summer	Antwerpen	Football	Football Men's Football	NaN	Denmark	NaN
3	4	Edgar Lindenau Aabye	M	34.0	NaN	NaN	Denmark/Sweden	DEN	1900 Summer	1900	Summer	Paris	Tug-Of-War	Tug-Of-War Men's Tug-Of-War	Gold	Denmark	NaN
29	10	Einar Ferdinand "Einari" Aalto	M	26.0	NaN	NaN	Finland	FIN	1952 Summer	1952	Summer	Helsinki	Swimming	Swimming Men's 400 metres Freestyle	NaN	Finland	NaN

Let's first of all isolate all the discipline of the Olympics dataframe.

My idea is to see if Gymnastics is called differently or if there is any typo.

In [126…

```
MenOverTime['Sport'].unique().tolist()
```

Out[126]:
```
['Basketball',
 'Judo',
 'Football',
 'Tug-Of-War',
 'Swimming',
 'Badminton',
 'Gymnastics',
 'Athletics',
 'Art Competitions',
 'Wrestling',
 'Water Polo',
 'Sailing',
 'Rowing',
 'Fencing',
 'Equestrianism',
 'Shooting',
 'Boxing',
 'Taekwondo',
 'Cycling',
 'Weightlifting',
 'Diving',
 'Canoeing',
 'Handball',
 'Tennis',
 'Modern Pentathlon',
 'Hockey',
 'Volleyball',
 'Baseball',
 'Table Tennis',
 'Archery',
 'Trampolining',
 'Beach Volleyball',
 'Golf',
 'Rugby Sevens',
 'Triathlon',
 'Rugby',
 'Lacrosse',
 'Polo',
 'Cricket',
 'Ice Hockey',
 'Racquets',
 'Motorboating',
 'Croquet',
 'Figure Skating',
 'Jeu De Paume',
 'Roque',
 'Basque Pelota',
 'Alpinism',
 'Aeronautics']
```

the string to use to filter is 'Gymnastics': let's create two new dataframes for men and women.

In [127…
```
gymMenOverTime = MenOverTime.loc[MenOverTime['Sport'] == 'Gymnastics']
gymWomenOverTime = WomenOverTime.loc[WomenOverTime['Sport'] == 'Gymnastics']
```

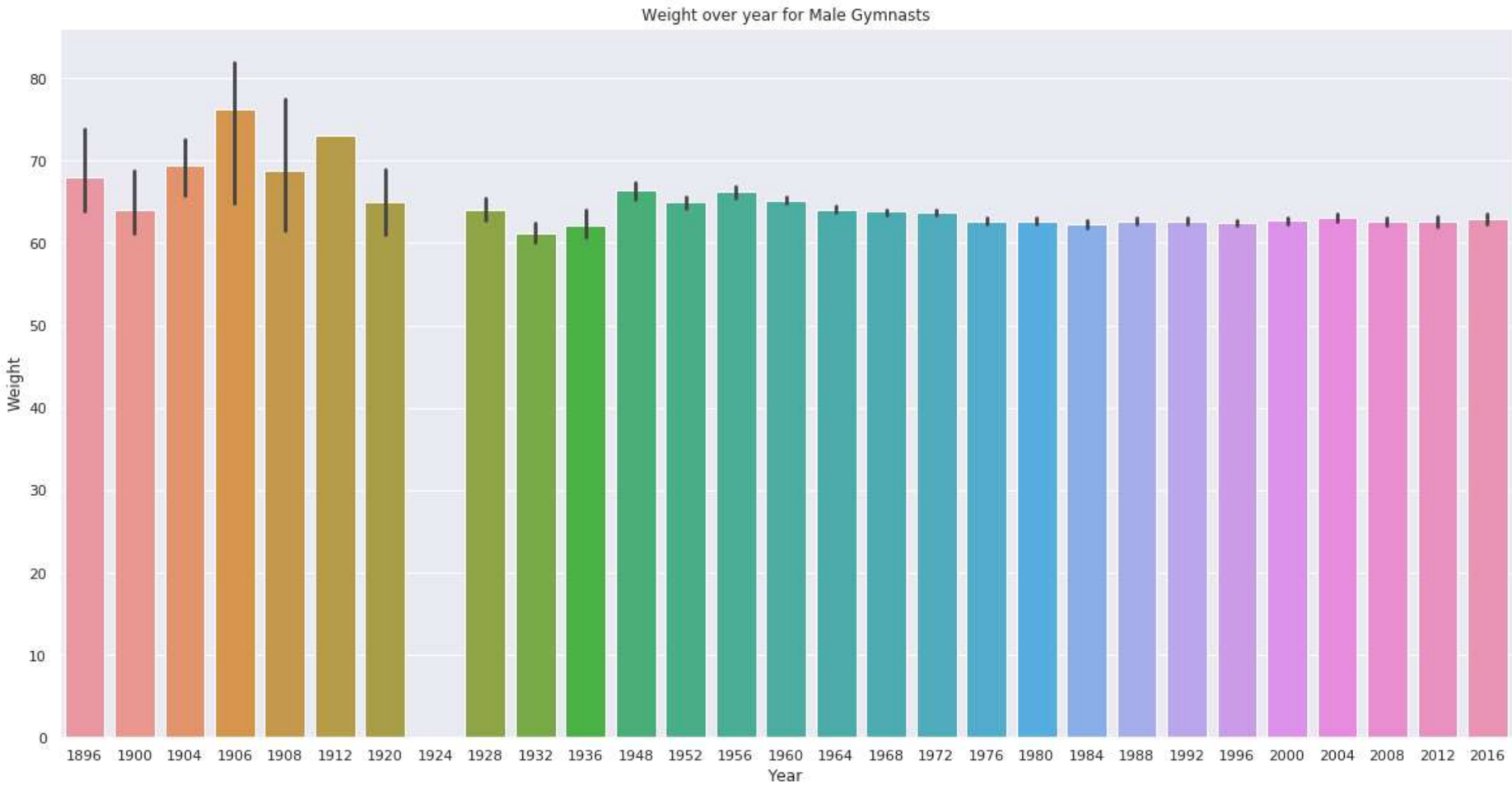
let's now create our plot for male and female athletes and then we can make our observations

In [128…
```
plt.figure(figsize=(20, 10))
sns.barplot('Year', 'Weight', data=gymMenOverTime)
```

```
plt.title('Weight over year for Male Gymnasts')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

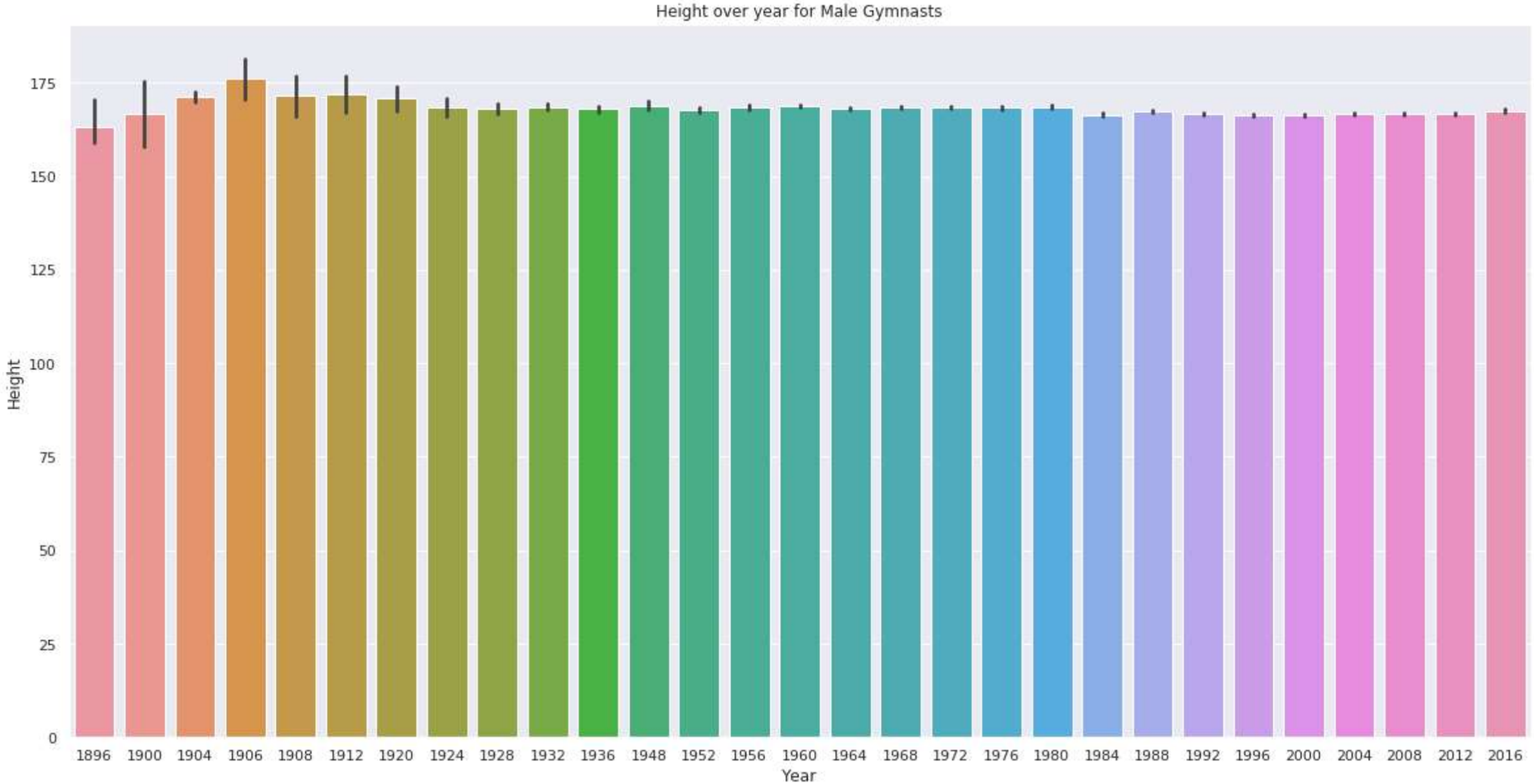
Out[128]:
```
Text(0.5,1,'Weight over year for Male Gymnasts')
```



In [129…
```
plt.figure(figsize=(20, 10))
sns.barplot('Year', 'Height', data=gymMenOverTime)
plt.title('Height over year for Male Gymnasts')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

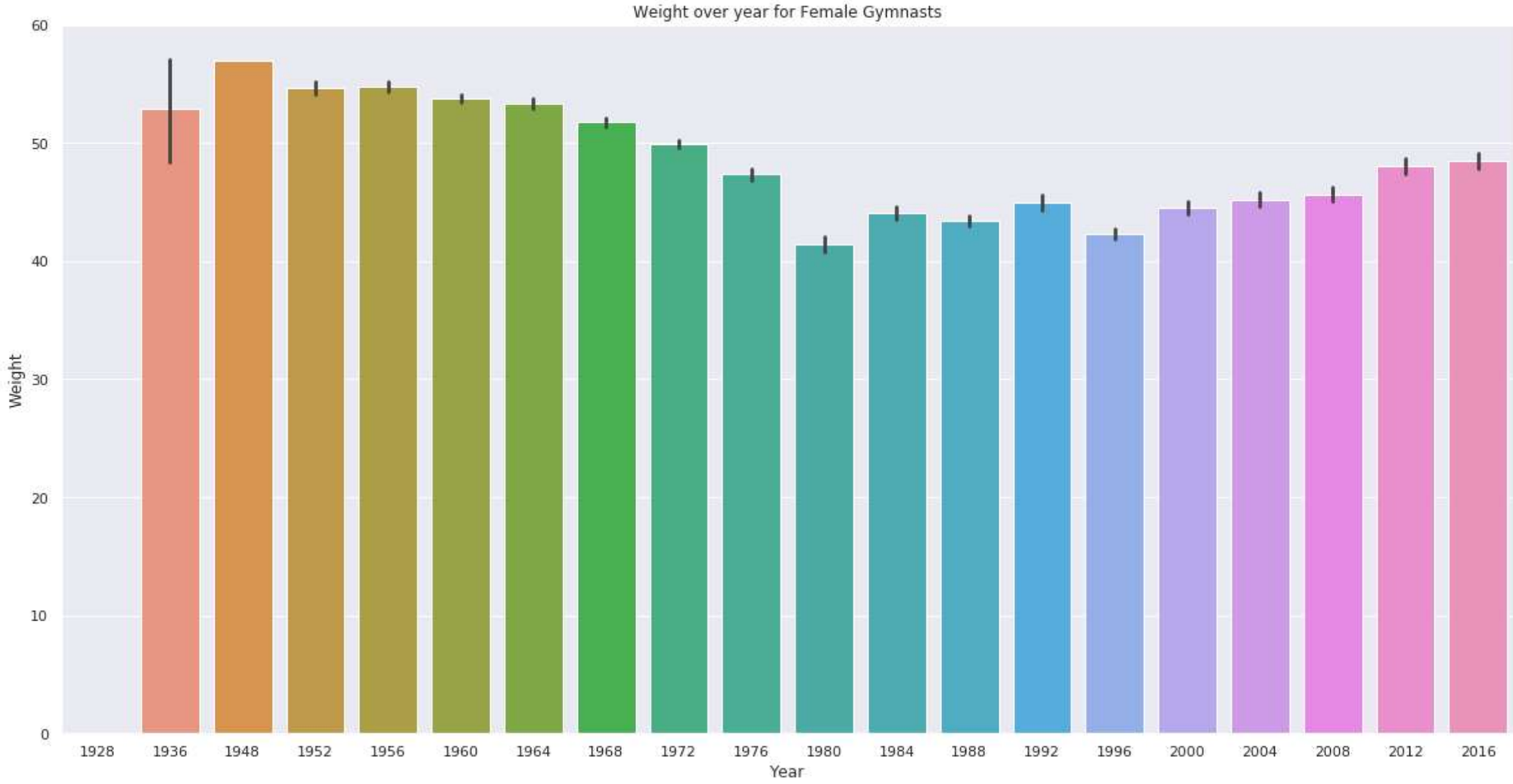
Out[129]:
```
Text(0.5,1,'Height over year for Male Gymnasts')
```



In [130…
```
plt.figure(figsize=(20, 10))
sns.barplot('Year', 'Weight', data=gymWomenOverTime)
plt.title('Weight over year for Female Gymnasts')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

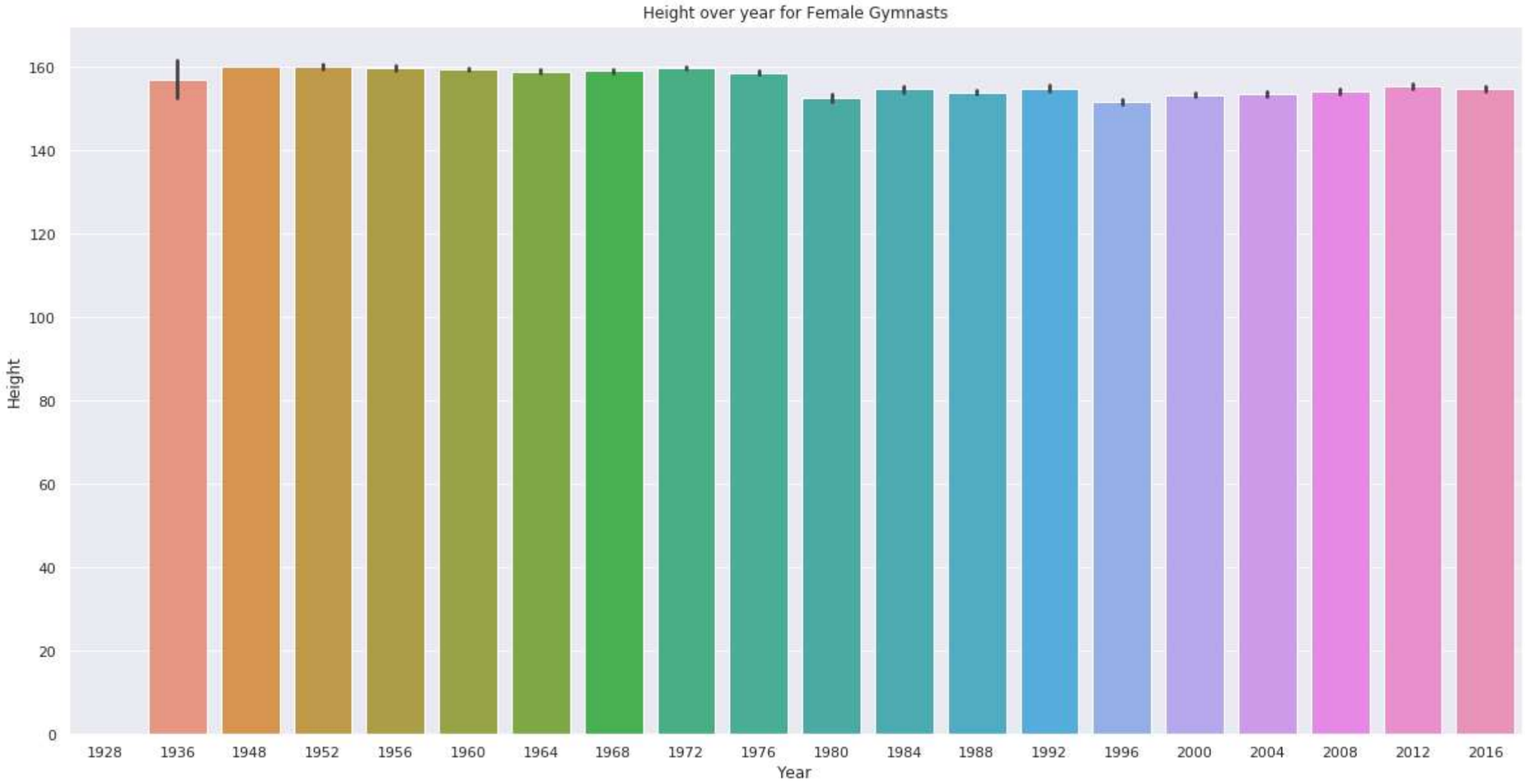
Out[130]:
```
Text(0.5,1,'Weight over year for Female Gymnasts')
```



In [131…
```
plt.figure(figsize=(20, 10))
sns.barplot('Year', 'Height', data=gymWomenOverTime)
plt.title('Height over year for Female Gymnasts')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[131]:
```
Text(0.5,1,'Height over year for Female Gymnasts')
```



A few things I noticed:

- The weight for female Gymnasts has go down for 60 to 50 kilograms on average;
- The weight for men has been more or less stable since 1964;
- The height is more stable for both men and women.

Also, men weight data from 1924 seems missing: let's check.

In [132…
```
gymMenOverTime['Weight'].loc[gymMenOverTime['Year'] == 1924].isnull().all()
```

Out[132]:
```
True
```

It seems that we do not have any information about the athletes in 1924.

10.6.2 Weightlifting

Let's work on an analysis similar to what we have done for Gymnastics also for the Lifters.

We can start creating a new, dedicated dataframe.

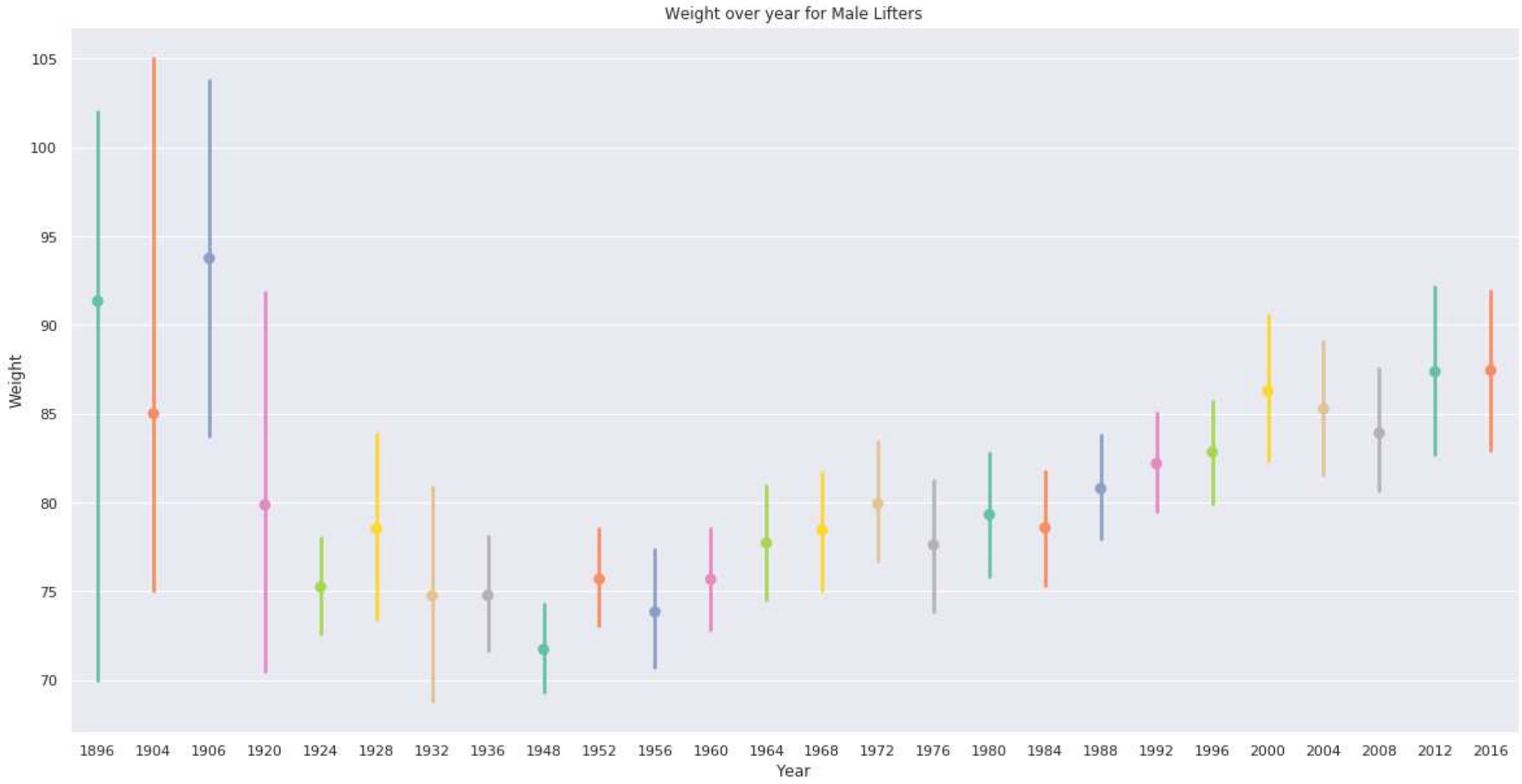
In [133…
```
wlMenOverTime = MenOverTime.loc[MenOverTime['Sport'] == 'Weightlifting']
wlWomenOverTime = WomenOverTime.loc[WomenOverTime['Sport'] == 'Weightlifting']
```

let's now create our plot for male and female athletes and then we can make our observations

In [134…
```
plt.figure(figsize=(20, 10))
sns.pointplot('Year', 'Weight', data=wlMenOverTime, palette='Set2')
plt.title('Weight over year for Male Lifters')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

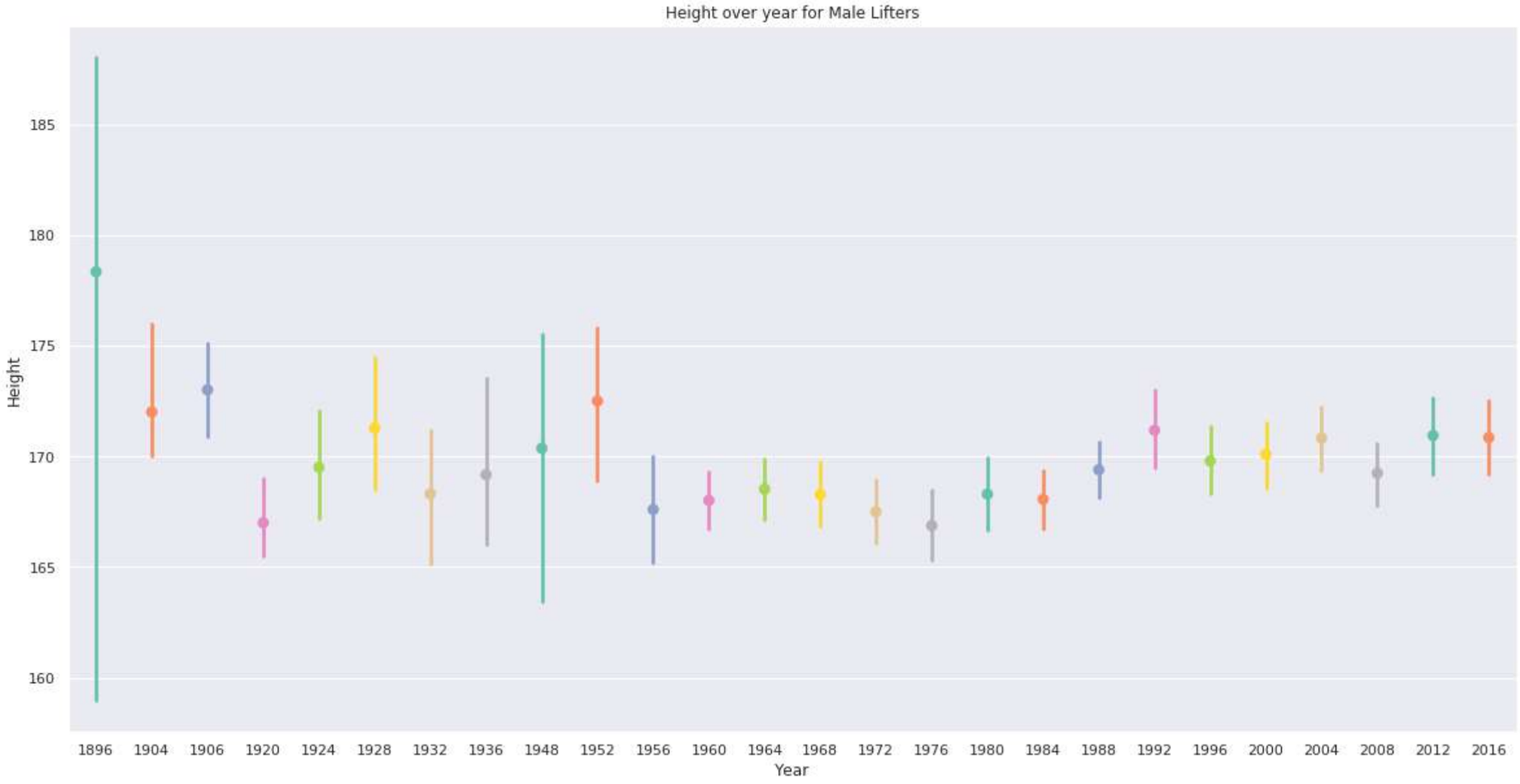
Out[134]:
```
Text(0.5,1,'Weight over year for Male Lifters')
```



In [135…
```
plt.figure(figsize=(20, 10))
sns.pointplot('Year', 'Height', data=wlMenOverTime, palette='Set2')
plt.title('Height over year for Male Lifters')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

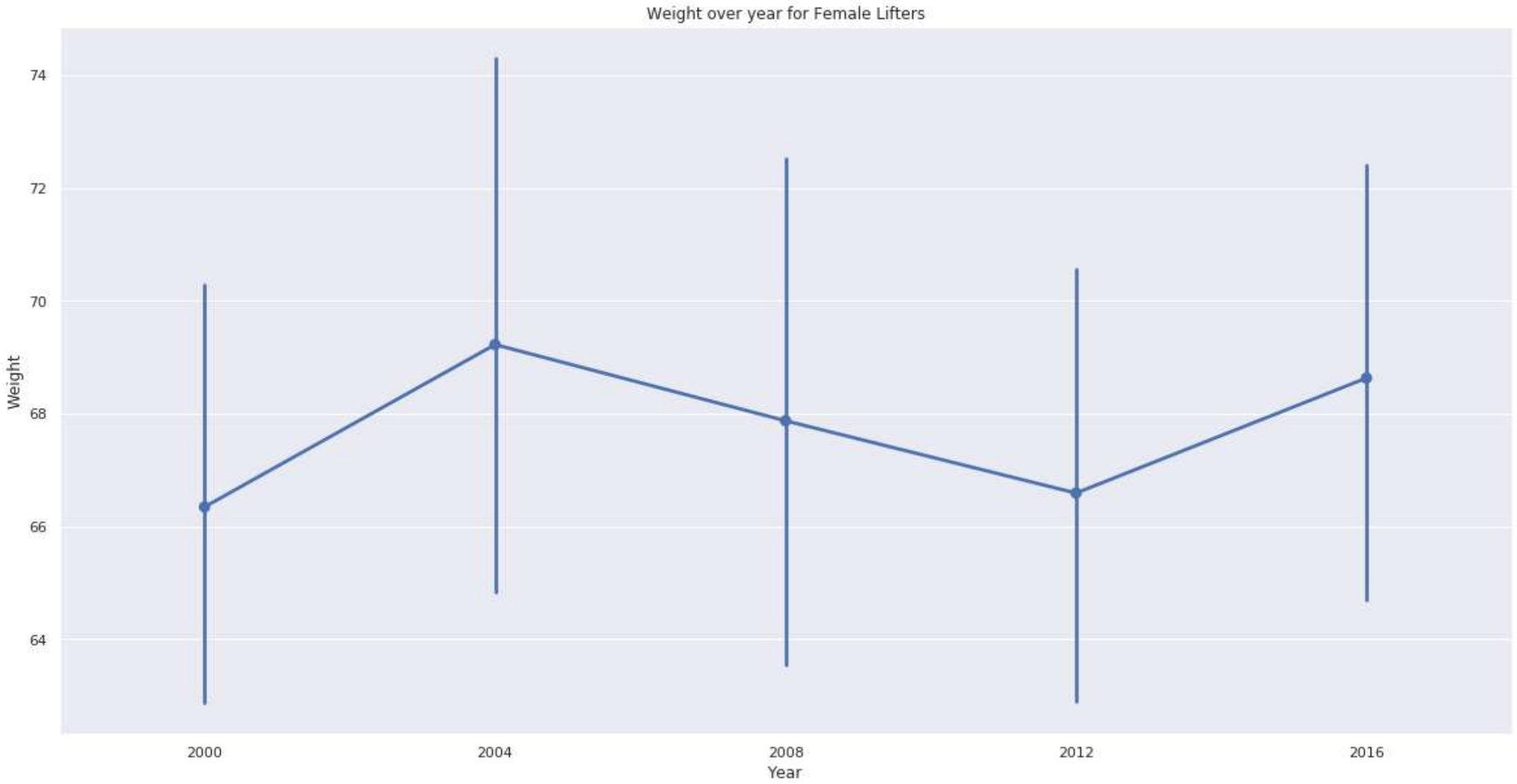
Out[135]:
```
Text(0.5,1,'Height over year for Male Lifters')
```



In [136…
```
plt.figure(figsize=(20, 10))
sns.pointplot('Year', 'Weight', data=wlWomenOverTime)
plt.title('Weight over year for Female Lifters')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

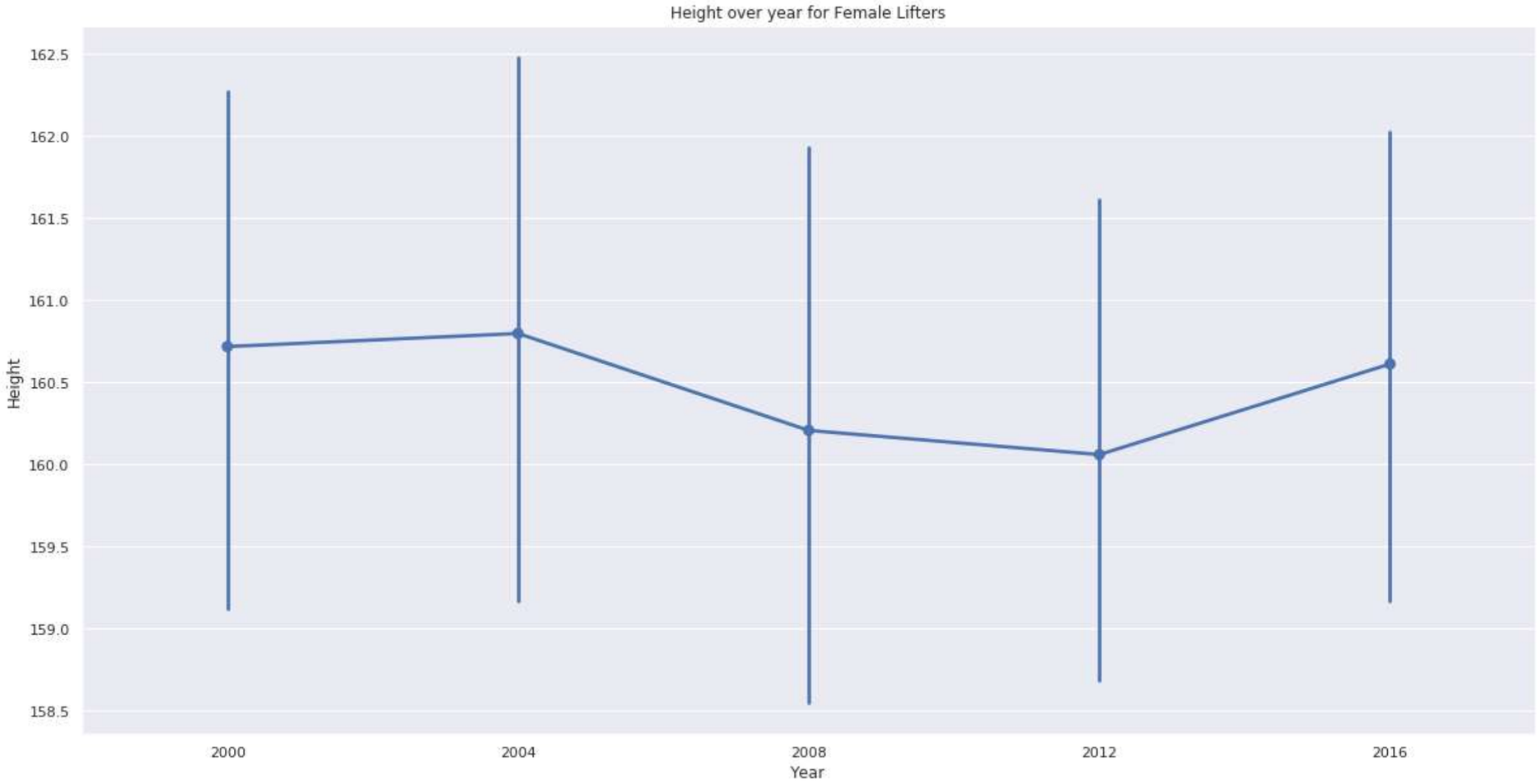
Out[136]:
```
Text(0.5,1,'Weight over year for Female Lifters')
```



In [137…
```
plt.figure(figsize=(20, 10))
sns.pointplot('Year', 'Height', data=wlWomenOverTime)
plt.title('Height over year for Female Lifters')
```

```
/opt/conda/lib/python3.6/site-packages/scipy/stats/stats.py:1713: FutureWarning: Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`, which will result either in an error or a different result.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
```

Out[137]:
```
Text(0.5,1,'Height over year for Female Lifters')
```



It seems that we do not have data for female athletes before the 2000 Games.

Let's check this point.

In [138…
```
wlWomenOverTime['Weight'].loc[wlWomenOverTime['Year'] < 2000].isnull().all()
```

Out[138]:
```
True
```

Our observation seems correct.