

US Gymnastics Analysis

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Introduction

Context and Background

The Olympic Games are a highly anticipated world-renowned multi-sporting event that takes place every four years. Particularly the Summer Olympic Games tend to have a wider variety of 32 sports and more viewers than that of the Winter Olympics (Olympics, 2021). Athletes from all over the world can participate granted they meet the criteria established by their nation's Olympic committees and the international sports federations. With female qualifying gymnasts from the United States placing with medals in the team all-around, individual all-around, and each individual apparatus in the 2020 Tokyo Olympics game, there has been a surge in media attention on the United States gymnastics teams. (Olympics, 2020)

As the Paris 2024 Summer Olympic Games is approaching, the United States Olympic Men's and Women's Artistic Gymnastics aims to put together a team that best represents the country on the world's sporting stage by optimizing medal success amongst the team all-around, individual all-around, and individual apparatus events. This study aims to use the most recent Olympic Games and other world competitions' qualifying and final round results data to best assemble a team that is likely to produce optimal success in terms of medals within the Olympic qualifiers and final criteria. (UCSAS, 2023)

These are our main objectives for this study: (UCSAS, 2023)

- 1) Decide on whether to maximize total medal count, gold medal count, or a weighted medal count (e.g., 3 for gold, 2 for silver, 1 for bronze).
- 2) Decide on whether to value the medals of an event over others. For example, consider a team all-around medal to be more valuable than the individual all-around medals and/or consider the individual all-around medals to be more valuable than the individual apparatus medals.
- 3) Decide on whether Team USA should maximize its total medal count by selecting a team of five gymnasts who are all-around gymnasts, event specialists (gymnasts who focus on 1 or more apparatus but not all apparatus), or a combination of those. This should consider under what circumstances can Team USA maximize its total medal count by selecting a gymnast who only competes on 1 apparatus (e.g., Stephen Naderoscik, 2021 pommel horse World Champion).
- 4) Identify the group of five athletes who will most likely enable the Team USA Olympic Men's and Women's Artistic Gymnastics team to maximize medals won in the Paris 2024 Summer Olympics using an analytical model.

Addressing these objectives will assist the national Olympic Artistic Gymnastics teams in best approaching the Olympic gymnastics events in totality by offering recommended strategies to best approach team selection.

The Data

The UConn Sports Analytics Symposium provisioned a clean data set of the accumulation of results of teams worldwide that participated in the major domestic and international gymnastic qualifying and final competition events leading up to the 2024 Summer Olympic Games. These competitions took place in the 2022 and 2023 gymnastics seasons. The UConn Sports Analytics Symposium also provides a clean data set of the results of all the women’s artistic gymnastics teams that participated in the 2020 Tokyo Summer Olympics qualifying and final events. Both datasets are at the individual athlete, competition, apparatus, and round level. The data of the recorded results for each competition for both men and women gymnasts were collected and manually input from the official corresponding competitions’ website results after the judging of each competition.

The columns for both datasets include LastName, Firstname, Gender, Country, Data, Competition, Round (“TeamQual”: team all-around qualifiers, “TeamFinal”: team all-around finals, “AAQual”: individual all-around qualifiers, “AAfinal”: individual all-around finals, “qual”: individual apparatus qualifiers, “final”: individual apparatus finals), Location, Apparatus (“BB”: balance beam, “FX”: floor exercise, “HB”: high bar, “PB”: parallel bars, “PH”: pommel horse, “SR”: still rings, “UB”: uneven bars, “VT”: vault, “VT1” and “VT2”: 2 different vaults required in individual apparatus qualifications and finals), Rank, D_Score (difficulty score), E_Score (execution score), Penalty (score deduction for breaking event criteria), and Score (D_Score + E_Score - Penalty).

We decided to not proceed in using the data set of results from the 2020 Tokyo Summer Olympics since the data consisted only of female athletes and one competition (the Olympic Games). Also in the context of Olympic gymnastics, athletes of age 16 and older are eligible to compete but gymnastics is a sport in which most athletes retire in their early to mid-twenties. Specifically in the summer 2020 Tokyo Olympics only three female athletes aged 27 or older qualified to compete (Camenker, 2021). Furthermore, the average age for female gymnasts in the 2020 Olympics was approximately 22 years of age, meaning we assume that many of the competitors in the older data set will not be competing in the 2024 Paris Summer Olympics (Meyers, 2021).

EDA ...

Methodology

Simulations

Female Athletes’ Results

m_0	sig_0	k_0	v_0
14.0574616	0.5891628	0.6657795	79.5576545

Table 1: Women’s Floor Exercise Simulation Results

Athlete	Golds	Silvers	Bronzes	Total Medals
SimBIL_USA	211	99	47	357
RebAND_BRA	56	64	49	169
KalLIN_USA	31	33	32	96
JesGAD_GBR	26	27	42	95
FlaSAR_BRA	25	28	28	81
JorCHI_USA	22	27	27	76
JadCAR_USA	24	20	26	70
ShiJON_USA	14	28	19	61
JosROB_USA	16	24	18	58
MarMAG_ITA	13	21	13	47

m_0 sig_0 k_0 v_0
14.0574616 0.5891628 0.6657795 79.5576545

Table 2: Women’s Balance Beam Simulation Results

Athlete	Golds	Silvers	Bronzes	Total Medals
SimBIL_USA	24	11	10	45
YaqZHO_CHN	17	14	12	43
KonMCC_USA	13	9	11	33
YusOU_CHN	7	7	5	19
QinZHA_CHN	7	9	3	19
HuaLUO_CHN	2	3	5	10
LeaWON_USA	4	5	1	10
SunLEE_USA	2	2	6	10
SanWEV_NED	1	4	4	9
SkyBLA_USA	2	4	3	9

m_0 sig_0 k_0 v_0
14.0574616 0.5891628 0.6657795 79.5576545

Table 3: Women’s Vault Simulation Results

Athlete	Golds	Silvers	Bronzes	Total Medals
SimBIL_USA	32	20	14	66
RebAND_BRA	18	16	16	50
JadCAR_USA	13	9	8	30
ShiJON_USA	11	6	10	27
SkyBLA_USA	3	8	9	20
OndACH_GBR	4	7	9	20
KonMCC_USA	2	10	7	19
ShoMIY_JPN	4	9	5	18
JorCHI_USA	4	4	10	18
JosROB_USA	5	6	5	16

m_0 sig_0 k_0 v_0
14.0574616 0.5891628 0.6657795 79.5576545

Table 4: Women’s Uneven Bars Simulation Results

Athlete	Golds	Silvers	Bronzes	Total Medals
KayNEM_ALG	16	14	7	37
ShiJON_USA	10	8	9	27
QiyQIU_CHN	13	6	6	25
ZoeMIL_USA	6	8	8	22
RebAND_BRA	5	8	7	20
XijTAN_CHN	9	3	7	19
XiaWEI_CHN	4	8	3	15
AliD A_ITA	5	4	5	14
EliSEI_GER	2	7	4	13
YunLEE_KOR	4	3	4	11

Male Athletes’ Results

m_0 sig_0 k_0 v_0
14.0574616 0.5891628 0.6657795 79.5576545

Table 5: Men’s Floor Exercise Simulation Results

Athlete	Gold	Silver	Bronze	Total Medals
CarYUL_PHI	12	11	4	27
ArtDOL_ISR	11	6	4	21
DaiHAS_JPN	4	5	8	17
RyoDOI_JPN	6	4	3	13
PauJUD_USA	3	6	3	12
ConMCC_USA	3	1	6	10
FreRIC_USA	2	4	4	10
NicBAR_ITA	6	3	0	9
ChiTAN_TPE	2	3	4	9
GiaREG_GBR	5	2	2	9

m_0 sig_0 k_0 v_0
14.0574616 0.5891628 0.6657795 79.5576545

Table 6: Men’s Vault Simulation Results

Athlete	Gold	Silver	Bronze	Total Medals
JakJAR_GBR	19	15	8	42
AshHON_USA	17	7	8	32
DaiHAS_JPN	8	12	10	30
KhoYOU_USA	7	11	11	29
BohZHA_CHN	10	11	7	28
DonWHI_USA	9	11	5	25
CurPHI_USA	5	7	9	21
TayBUR_USA	4	5	10	19
DalHAL_USA	5	6	7	18
KamNEL_USA	2	6	8	16

m_0 sig_0 k_0 v_0
14.0574616 0.5891628 0.6657795 79.5576545

Table 7: Men’s Pommel Horse Simulation Results

Athlete	Gold	Silver	Bronze	Total Medals
MaxWHI_GBR	13	11	12	36
ChiLEE_TPE	15	9	5	29
RhyMCC_IRL	8	8	7	23
NarKUR_KAZ	12	5	4	21
AhmSOU_JOR	4	8	8	20
Mc CLE_IRL	8	8	4	20
AhmABU_JOR	5	1	6	12
LorDE_NED	3	2	6	11
SteNED_USA	5	2	4	11
RhyMC_IRL	2	3	5	10

m_0 sig_0 k_0 v_0
14.0574616 0.5891628 0.6657795 79.5576545

Table 8: Men’s High Bar Simulation Results

Athlete	Golds	Silvers	Bronzes	Total Medals
DaiHAS_JPN	9	9	9	27
BohZHA_CHN	12	6	7	25
WeiSUN_CHN	8	5	6	19
ConSHI_CHN	9	3	3	15
YuyKAM_JPN	5	7	2	14
BroMAL_USA	4	4	4	12
ArtMAR_BRA	4	5	3	12
WeiSU_CHN	1	4	7	12
JoeFRA_GBR	3	5	3	11
ShoKAW_JPN	4	3	3	10

m_0 sig_0 k_0 v_0
14.0574616 0.5891628 0.6657795 79.5576545

Table 9: Men’s Still Rings Simulation Results

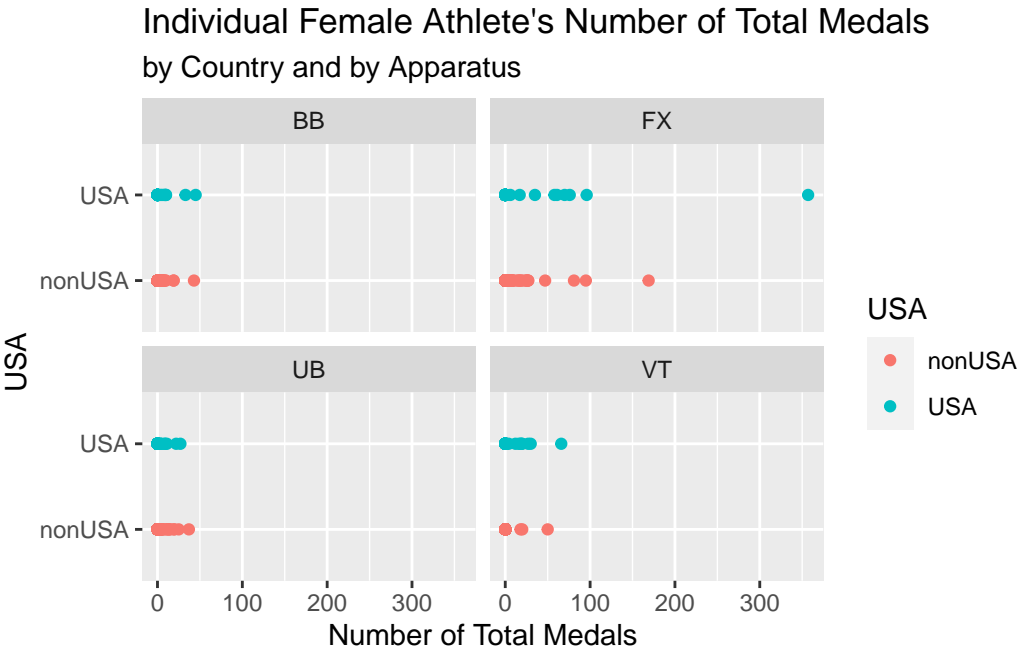
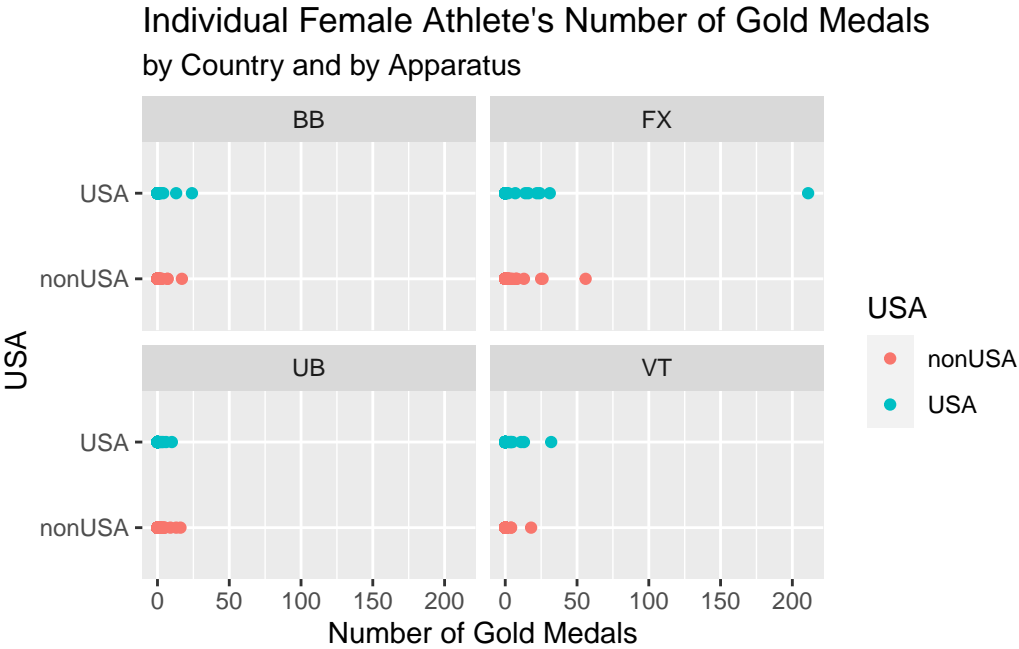
Athlete	Golds	Silvers	Bronzes	Total Medals
XinLAN_CHN	15	10	11	36
YanLIU_CHN	14	12	6	32
ElePET_GRE	15	8	6	29
JinZOU_CHN	5	7	9	21
HaoYOU_CHN	6	6	0	12
BohZHA_CHN	2	6	4	12
AdeASI_TUR	5	5	2	12
NikSIM_AZE	1	3	8	12
IbrCOL_TUR	4	2	4	10
SalMAR_ITA	4	4	2	10

m_0 sig_0 k_0 v_0
14.0574616 0.5891628 0.6657795 79.5576545

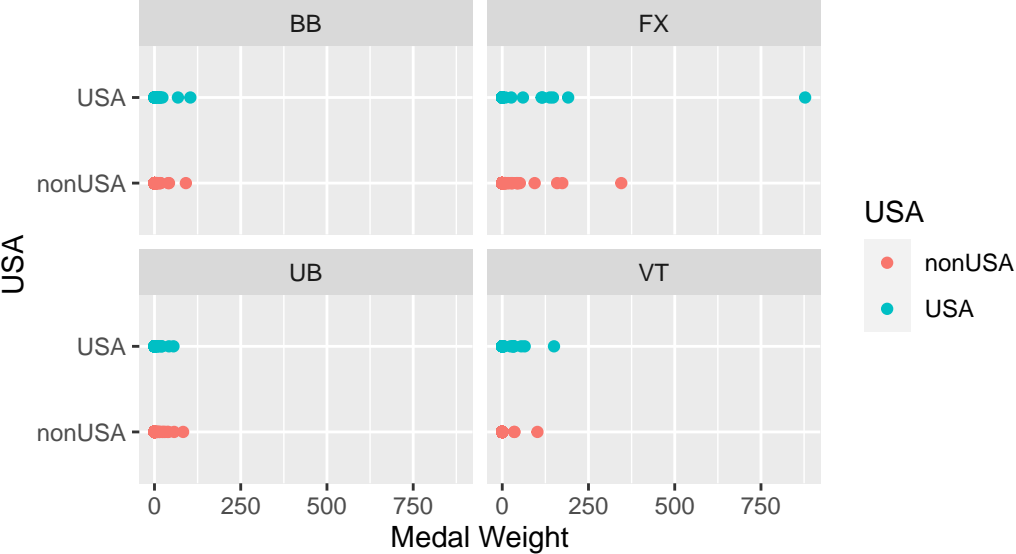
Table 10: Men’s Parallel Bars Simulation Results

Athlete	Golds	Silvers	Bronzes	Total Medals
JinZOU_CHN	32	17	11	60
LukDAU_GER	12	7	5	24
BohZHA_CHN	4	6	8	18
JoeFRA_GBR	4	6	6	16
IllKOV_UKR	3	4	9	16
CurPHI_USA	4	4	7	15
BlaSUN_USA	4	7	3	14
ColWAL_USA	6	2	5	13
CarYUL_PHI	2	7	2	11
ConSHI_CHN	4	2	3	9

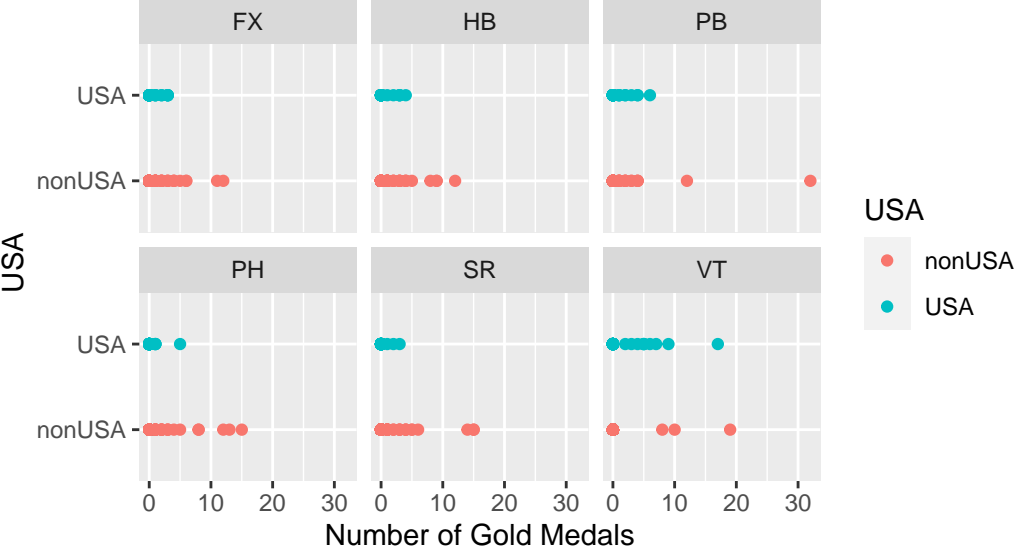
Objective 1: Choice of Medal Success Metric: Total Number of Gold Medals



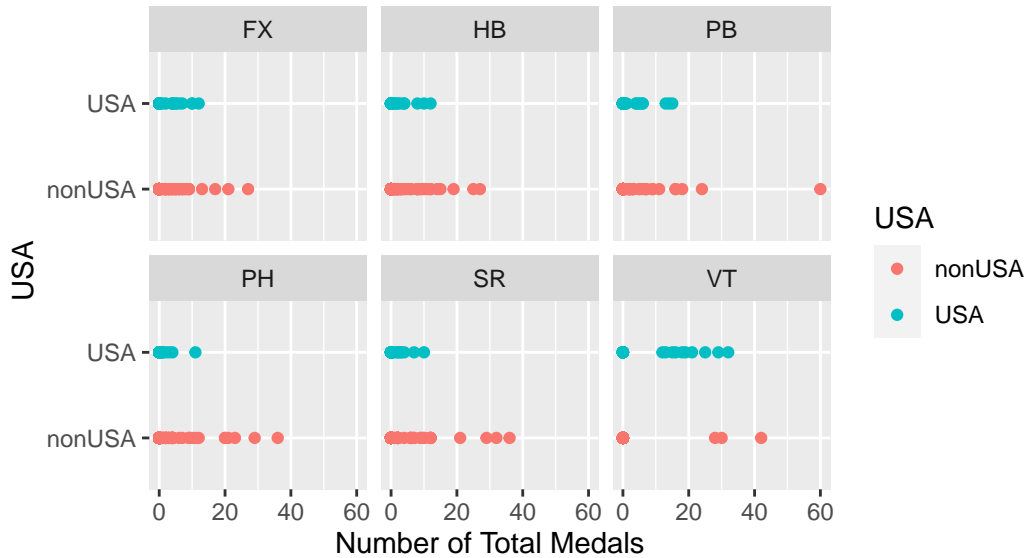
Individual Female Athlete's Medal Weight
by Country and by Apparatus



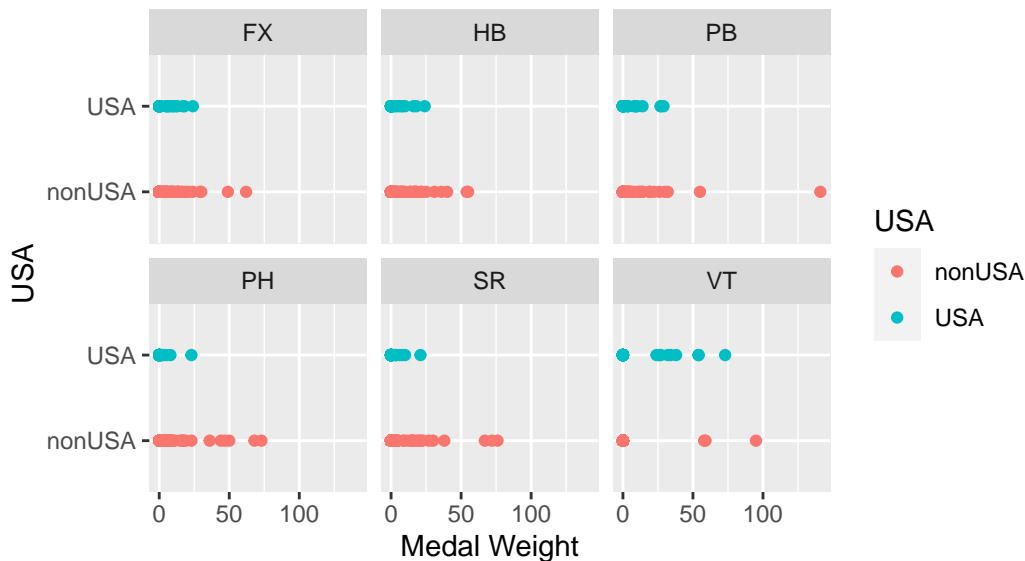
Individual Male Athlete's Number of Gold Medals
by Country and by Apparatus



Individual Male Athlete's Number of Total Medals by Country and by Apparatus



Individual Male Athlete's Medal Weight by Country and by Apparatus



From the visualizations of the women's simulation of the three considered success metrics (gold medal count, total medal count, and weighted medal count) for each apparatus by USA and non-USA teams, there looks to be at least one USA athlete that places higher than of all non-USA athletes in each medal metric for each apparatus except uneven bars. The women's USA team makes up 58% of the total women's gold medals in the simulation which is a higher proportion than the 49% of the total medal count and 52% of the weighted medals (Appendix: Image 5). From the visualizations of the men's simulation of the three considered success metrics, for each apparatus by USA and non-USA teams, there are non-USA athletes for each apparatus that exceed the USA in each medal success metric. The men's USA team makes up 25% of the total medal count in the simulation which is a higher proportion than the 23% of the total gold medal count and 24% of the weighted medals. (Appendix: Image 6) When viewing the top 5 most successful female athletes (top 5 most decorated by that medal metric) in each apparatus for each medal success metric, the USA makes a good portion of these athletes. There tend to be 2-4 USA athletes in the top 5 depending on the success metric and apparatus (Appendix: Image 5). When viewing the top 5 most successful male athletes in each apparatus for each medal

success metric, there tends to be 0-3 (mostly 0) male athletes present (Appendix: Image 6). Considering that female USA athletes tend to represent a much higher proportion of medal successes (no matter the success metric) than male USA athletes, it is best to prioritize the success metric that the female team performs the best in. Therefore, the success metric that we aim to maximize to best ensure the USA team’s success is the total number of gold medals.

Objective 2: Value of Medals for Each Event Type

Discussion

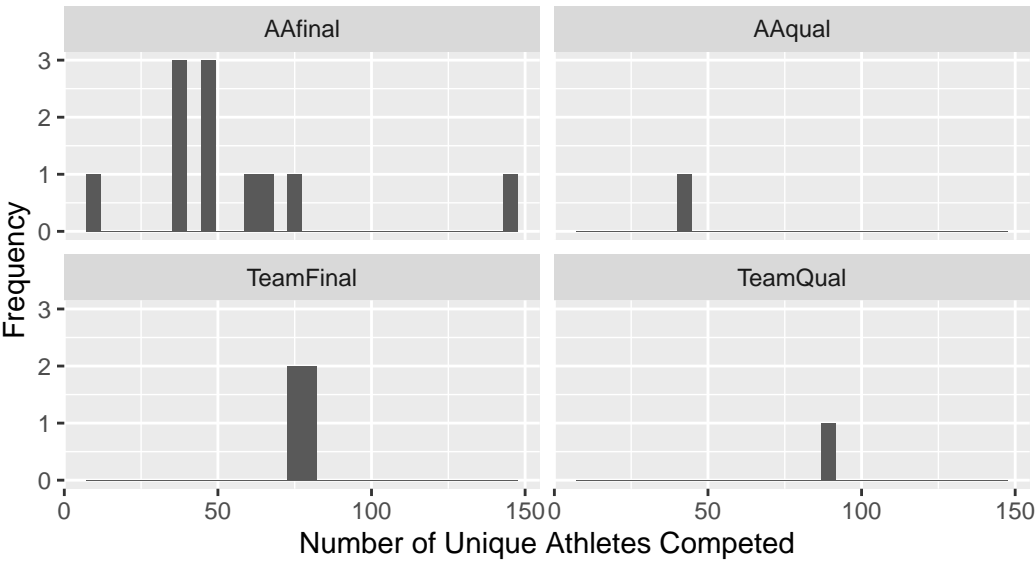
Appendix

Work Cited

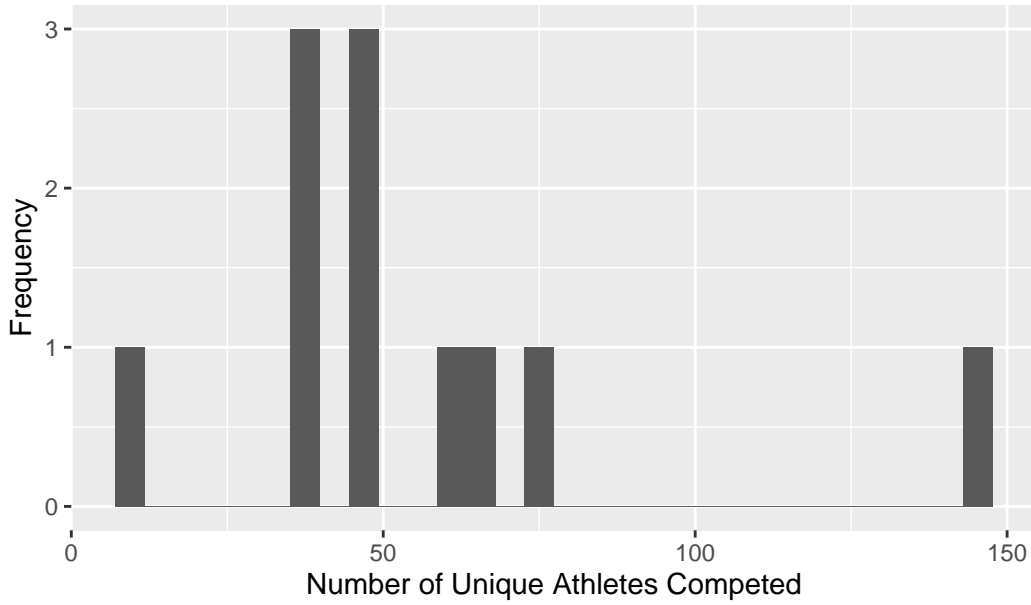
- “Paris 2024 Olympic Games: How Do Athletes Qualify?” Olympics, 8 Aug. 2021, olympics.com/en/news/paris-2024-olympic-games-how-do-athletes-qualify. Accessed 20 Nov. 2023.
- “Tokyo 2020 Artistic Gymnastics - Olympic Results by Discipline.” Olympics, olympics.com/en/olympic-games/tokyo-2020/results/artistic-gymnastics. Accessed 20 Nov. 2023.
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- Camenker, Jacob. “How Old Is Simone Biles? Why Elite Olympic Gymnasts Typically Retire at a Young Age.” Sporting News, 18 Sept. 2021, www.sportingnews.com/us/athletics/news/simone-biles-retire-age-olympics/1laom4i4u4wh1thcgta4nun2x. Accessed 20 Nov. 2023.
- Meyers, Dvora. “Time for the End of the Teen Gymnast.” FiveThirtyEight, 27 July 2021, fivethirtyeight.com/features/gymnasts-age-olympics/. Accessed 20 Nov. 2023.

1) Distribution of Athletes Competed at Competition Rounds

All Around or Team All Arouns

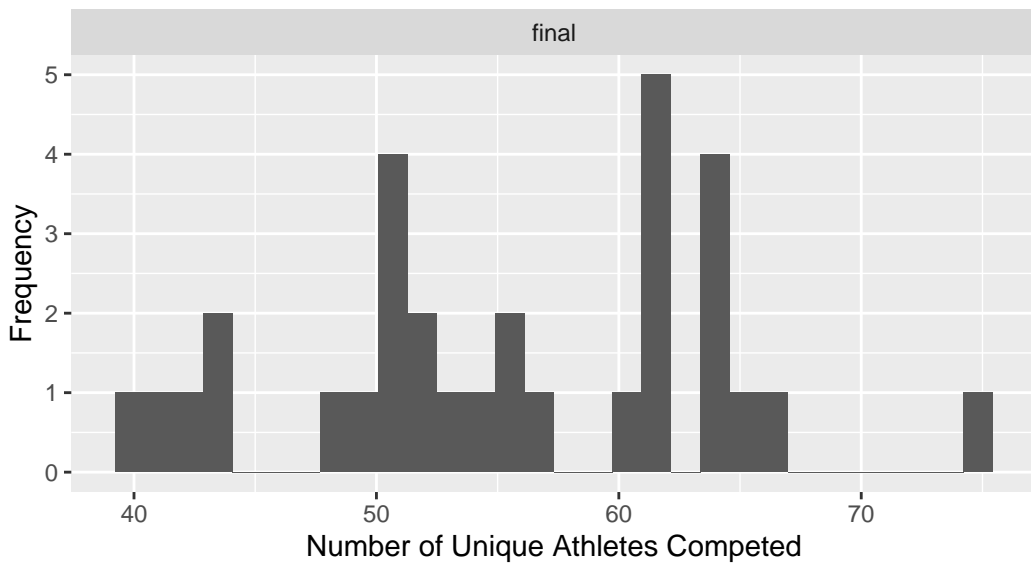


2) Distribution of Athletes Competed at AA Finals

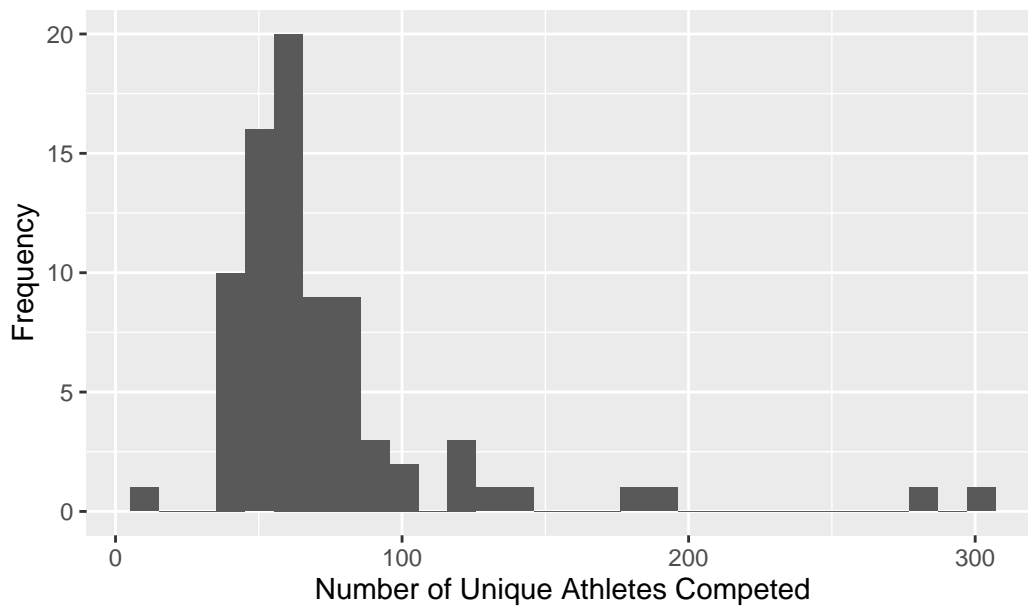


3) Distribution of Athletes Competed at Final Rounds

Individual Apparatuses

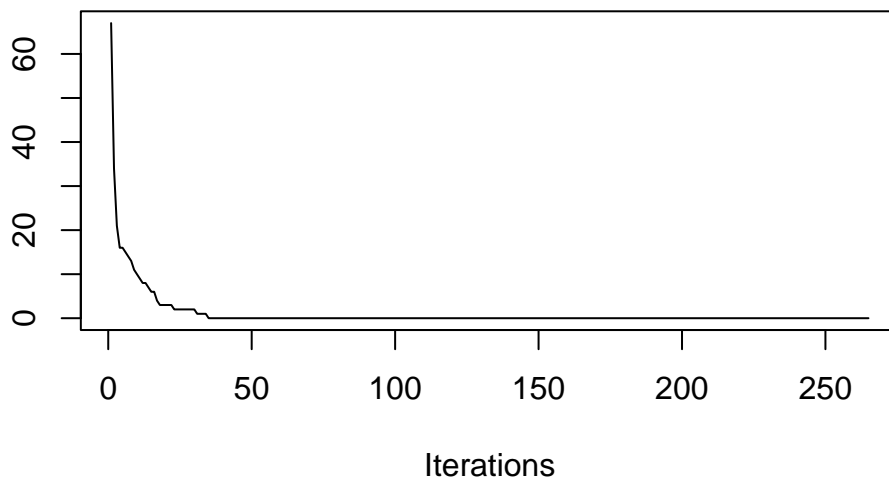


4) Distribution of Athletes Competed at Competitions

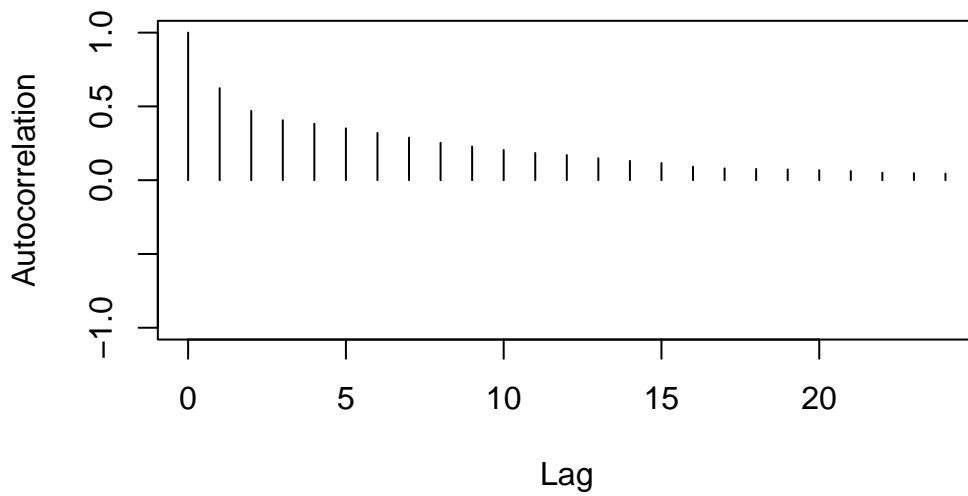


Diagnostics

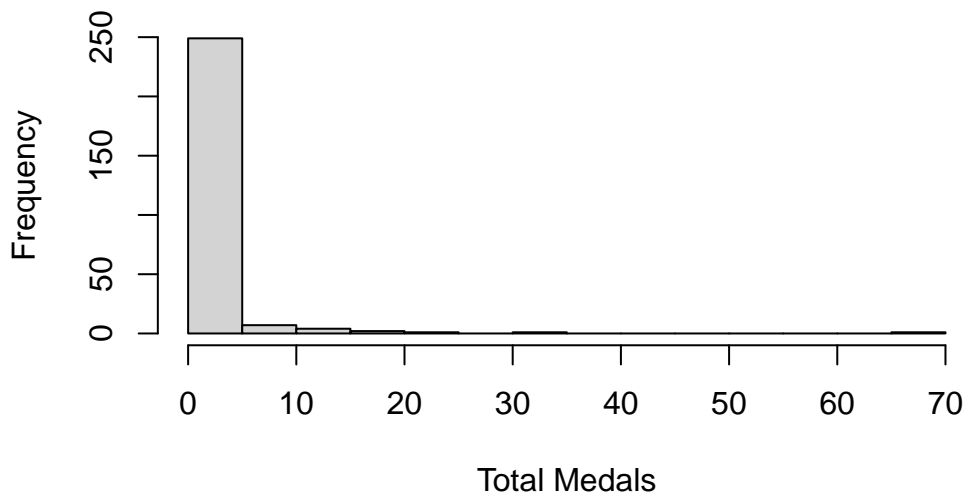
Trace Plot of Total Medals



var1
29.54697



Histogram of Total Medals



Iterations = 1:1060
 Thinning interval = 1
 Number of chains = 1
 Sample size per chain = 1060

1. Empirical mean and standard deviation for each variable,
 plus standard error of the mean:

Mean	SD	Naive SE	Time-series SE
2.2642	14.5906	0.4481	1.3603

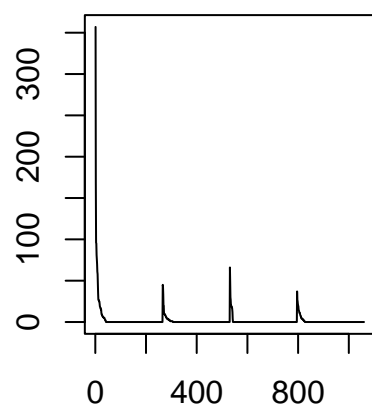
2. Quantiles for each variable:

2.5%	25%	50%	75%	97.5%
0	0	0	0	22

```
var1
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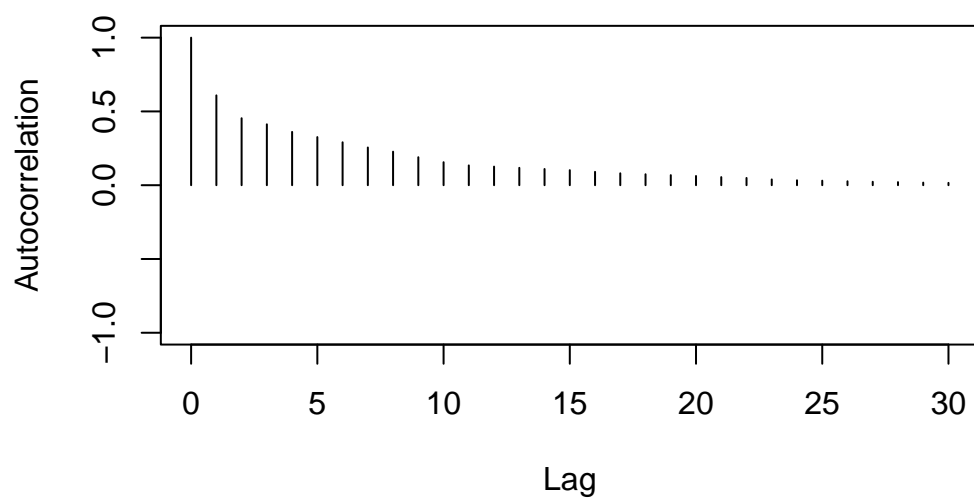
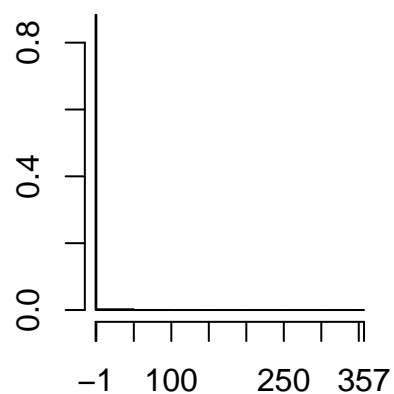
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var1
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Trace of var1



Iterations

Density of var1



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Thinning interval = 1
Number of chains = 1
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Sample size per chain = 1590

1. Empirical mean and standard deviation for each variable,
plus standard error of the mean:

Mean	SD	Naive SE	Time-series SE
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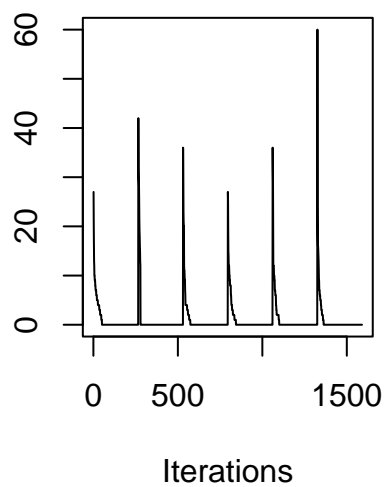
2. Quantiles for each variable:

2.5%	25%	50%	75%	97.5%
0	0	0	0	12

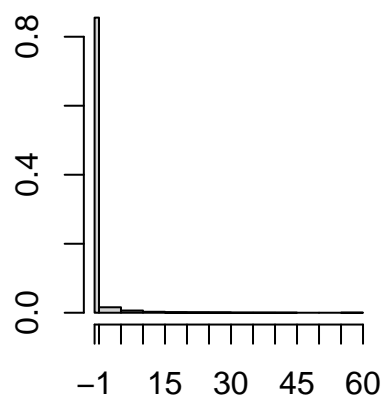
var1
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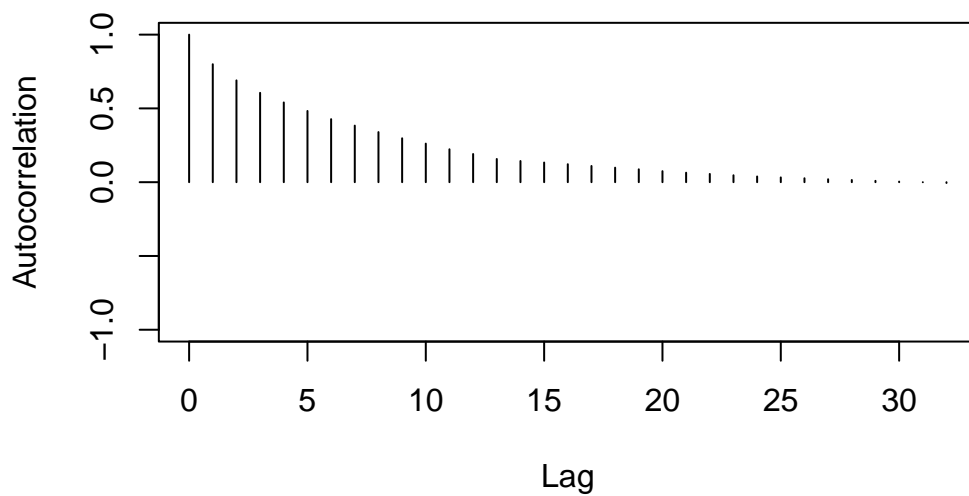
var1
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Trace of var1



Density of var1





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1 SimBIL_USA    24     11     10         45 USA         104 BB
2 YaqZHO_CHN    17     14     12         43 CHN          91 BB
3 KonMCC_USA    13      9     11         33 USA          68 BB
4 YusOU__CHN     7      7      5         19 CHN          40 BB
5 QinZHA_CHN     7      9      3         19 CHN          42 BB
6 SimBIL_USA   211    99     47        357 USA        878 FX
7 RebAND_BRA    56     64     49        169 BRA        345 FX
8 KallIN_USA    31     33     32         96 USA        191 FX
9 JesGAD_GBR    26     27     42         95 GBR        174 FX
10 FlaSAR_BRA   25     28     28         81 BRA        159 FX
11 KayNEM_ALG   16     14      7         37 ALG         83 UB
12 QiyQIU_CHN   13      6      6         25 CHN         57 UB
13 ShiJON_USA   10      8      9         27 USA         55 UB
14 XijTAN_CHN    9      3      7         19 CHN         40 UB
15 ZoeMIL_USA    6      8      8         22 USA         42 UB
16 SimBIL_USA   32     20     14         66 USA        150 VT
17 RebAND_BRA   18     16     16         50 BRA        102 VT
18 JadCAR_USA   13      9      8         30 USA         65 VT
19 ShiJON_USA   11      6     10         27 USA         55 VT
20 JosROB_USA    5      6      5         16 USA         32 VT
# i 1 more variable: USA <fct>
```

```
# A tibble: 21 x 9
# Groups:   Apparatus [4]
  unique_id  Golds Silvers Bronzes Total_Medals Country Medal_Weight Apparatus
```

```

  <chr>      <dbl>  <dbl>  <dbl>      <dbl> <fct>      <dbl> <chr>
1 SimBIL_USA    24    11    10          45 USA        104 BB
2 YaqZHO_CHN   17    14    12          43 CHN         91 BB
3 KonMCC_USA   13     9    11          33 USA         68 BB
4 YusOU__CHN    7     7     5          19 CHN         40 BB
5 QinZHA_CHN    7     9     3          19 CHN         42 BB
6 SimBIL_USA  211    99    47         357 USA        878 FX
7 RebAND_BRA   56    64    49         169 BRA        345 FX
8 KallIN_USA   31    33    32          96 USA        191 FX
9 JesGAD_GBR   26    27    42          95 GBR        174 FX
10 FlaSAR_BRA  25    28    28          81 BRA        159 FX
# i 11 more rows
# i 1 more variable: USA <fct>

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1 SimBIL_USA    24    11    10          45 USA        104 BB
2 YaqZHO_CHN   17    14    12          43 CHN         91 BB
3 KonMCC_USA   13     9    11          33 USA         68 BB
4 QinZHA_CHN    7     9     3          19 CHN         42 BB
5 YusOU__CHN    7     7     5          19 CHN         40 BB
6 SimBIL_USA  211    99    47         357 USA        878 FX
7 RebAND_BRA   56    64    49         169 BRA        345 FX
8 KallIN_USA   31    33    32          96 USA        191 FX
9 JesGAD_GBR   26    27    42          95 GBR        174 FX
10 FlaSAR_BRA  25    28    28          81 BRA        159 FX
# i 11 more rows
# i 1 more variable: USA <fct>

# A tibble: 2 x 2
  USA    sumGolds
  <fct>    <dbl>
1 nonUSA    324
2 USA       476

# A tibble: 2 x 2
  USA    sumTot
  <fct>    <dbl>
1 nonUSA  1195
2 USA     1205

# A tibble: 2 x 2
  USA    sumWeighted
  <fct>    <dbl>
1 nonUSA  2250
2 USA     2550

```

Image 5) For the women's simulation when looking at the top 5 athletes by:

Gold Medal Count for each apparatus there are 11 out of 20 from the US: balance beam (BB): 2, floor exercise (FX): 3, uneven bars (UB): 2, and vault (VT): 4

USA makes up 58% of the total women's gold medals in the simulation.

Total Medal Count for each apparatus there are 10 out of 20 from the US: balance beam (BB): 2, floor exercise (FX): 2, uneven bars (UB): 2, vault (VT): 4

USA makes up 49% of the total women's medals in the simulation.

Weighted Medal Count for each apparatus there are 9 out of 20 from the US: balance beam (BB): 2, floor exercise (FX): 2, uneven bars (UB): 2, vault (VT): 3

USA makes up 52% of the weight of women's medals in the simulation.

```
# A tibble: 34 x 9
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# Groups:   Apparatus [6]
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	unique_id	Gold	Silver	Bronze	Total_Medals	Country	Medal_Weight	Apparatus
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1	CarYUL_PHI	12	11	4	27	PHI	62	FX
2	ArtDOL_ISR	11	6	4	21	ISR	49	FX
3	RyoDOI_JPN	6	4	3	13	JPN	29	FX
4	NicBAR_ITA	6	3	0	9	ITA	24	FX
5	GiaREG_GBR	5	2	2	9	GBR	21	FX
6	BohZHA_CHN	12	6	7	25	CHN	55	HB
7	DaiHAS_JPN	9	9	9	27	JPN	54	HB
8	ConSHI_CHN	9	3	3	15	CHN	36	HB
9	WeiSUN_CHN	8	5	6	19	CHN	40	HB
10	YuyKAM_JPN	5	7	2	14	JPN	31	HB

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# i 24 more rows
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```

```
# A tibble: 34 x 9
```

```
# Groups:   Apparatus [6]
```

	unique_id	Gold	Silver	Bronze	Total_Medals	Country	Medal_Weight	Apparatus
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<fct>	<dbl>	<chr>
1	CarYUL_PHI	12	11	4	27	PHI	62	FX
2	ArtDOL_ISR	11	6	4	21	ISR	49	FX
3	DaiHAS_JPN	4	5	8	17	JPN	30	FX
4	RyoDOI_JPN	6	4	3	13	JPN	29	FX
5	PauJUD_USA	3	6	3	12	USA	24	FX
6	DaiHAS_JPN	9	9	9	27	JPN	54	HB
7	BohZHA_CHN	12	6	7	25	CHN	55	HB
8	WeiSUN_CHN	8	5	6	19	CHN	40	HB
9	ConSHI_CHN	9	3	3	15	CHN	36	HB
10	YuyKAM_JPN	5	7	2	14	JPN	31	HB

```
# i 24 more rows
```

```
# i 1 more variable: USA <fct>
```

```
# A tibble: 32 x 9
```

```
# Groups:   Apparatus [6]
```

	unique_id	Gold	Silver	Bronze	Total_Medals	Country	Medal_Weight	Apparatus
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<fct>	<dbl>	<chr>

```

1 CarYUL_PHI    12      11      4      27 PHI        62 FX
2 ArtDOL_ISR    11       6      4      21 ISR        49 FX
3 DaiHAS_JPN     4       5      8      17 JPN        30 FX
4 RyoDOI_JPN     6       4      3      13 JPN        29 FX
5 PauJUD_USA     3       6      3      12 USA        24 FX
6 NicBAR_ITA     6       3      0       9 ITA        24 FX
7 BohZHA_CHN    12       6      7      25 CHN        55 HB
8 DaiHAS_JPN     9       9      9      27 JPN        54 HB
9 WeiSUN_CHN     8       5      6      19 CHN        40 HB
10 ConSHI_CHN    9       3      3      15 CHN        36 HB
# i 22 more rows
# i 1 more variable: USA <fct>

```

```

# A tibble: 2 x 2
  USA      sumGolds
  <fct>      <dbl>
1 nonUSA    464
2 USA       136

```

```

# A tibble: 2 x 2
  USA      sumTot
  <fct>      <dbl>
1 nonUSA  1350
2 USA     450

```

```

# A tibble: 2 x 2
  USA      sumWeighted
  <fct>      <dbl>
1 nonUSA   2738
2 USA     862

```

Image 6) For the men's simulation when looking at the top 5 athletes by:

Gold Medal Count for each apparatus there are 5 out of 30 from the US: floor exercise (FX): 0, high bar (HB): 0, parallel bars (PB): 3 pommel horse (PH): 0, still rings (SR): 0, vault (VT): 2

USA makes up 23% of the total men's gold medals in the simulation.

Total Medal Count for each apparatus there are 3 out of 30 from the US: floor exercise (FX): 1, high bar (HB): 0, parallel bars (PB): 0, pommel horse (PH): 0, still rings (SR): 0, vault (VT): 2

USA makes up 25% of the total men's medals in the simulation.

Weighted Medal Count for each apparatus there are 5 out of 30 from the US: floor exercise (FX): 1, high bar (HB): 0, parallel bars (PB): 1, pommel horse (PH): 0, still rings (SR): 0, vault (VT): 3

USA makes up 24% of the weight of men's medals in the simulation.