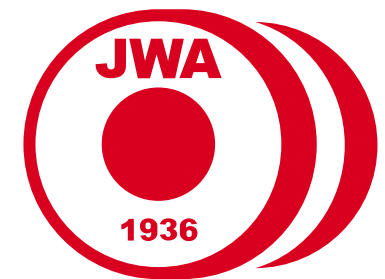


Kinematic characteristics of the snatch techniques of the top weightlifters in 2019 IWF Junior World Championships

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1. Introduction

We analyzed the biomechanical activity observed while performing the snatch technique during the International Weightlifting Federation (IWF) 2019 Junior World Championships in Suva, FIJI. This study reports one of the outcomes of our research and provides the kinematic characteristics of the snatch techniques of world class top lifters in junior category.

The purpose of this report was to clarify the characteristics of superior lifter of snatch based on barbell trajectory among elite male

This report compares the characteristics of the top 30% and the bottom 30% barbell trajectories in each weight class.

2. Methods

2.1 Procedures

Snatch attempts were recorded using a digital video camera(ILCE-7M3, SONY, Japan) operating at 50 Hz with a shutter speed of 1/500 sec. To obtain the real-space two-dimensional position coordinates of the barbell trajectory in the sagittal plane, the left end of the barbell was digitized to obtain the position coordinates in the camera space. The Speedede-Up Robust Features method was used for automatic digitizing. The barbell plate diameter (0.45 m) was used as the reference to calibrate the barbell's real-space position coordinates from the camera-space position coordinates.

2. Methods

2.2 Subject

We analyzed Top of 30% and bottom of 30% lifters' barbell trajectory in each weight class. The data were divided into six groups as shown in follow.

Men light weight: M55, M61, M67

Men medium weight: M73, M81, M89

Men heavy weight: M96, M102, M109

Woman light weight: W45, W49, W55

Woman medium weight: W59, W64, W71

Woman heavy weight: W76, W81, W87

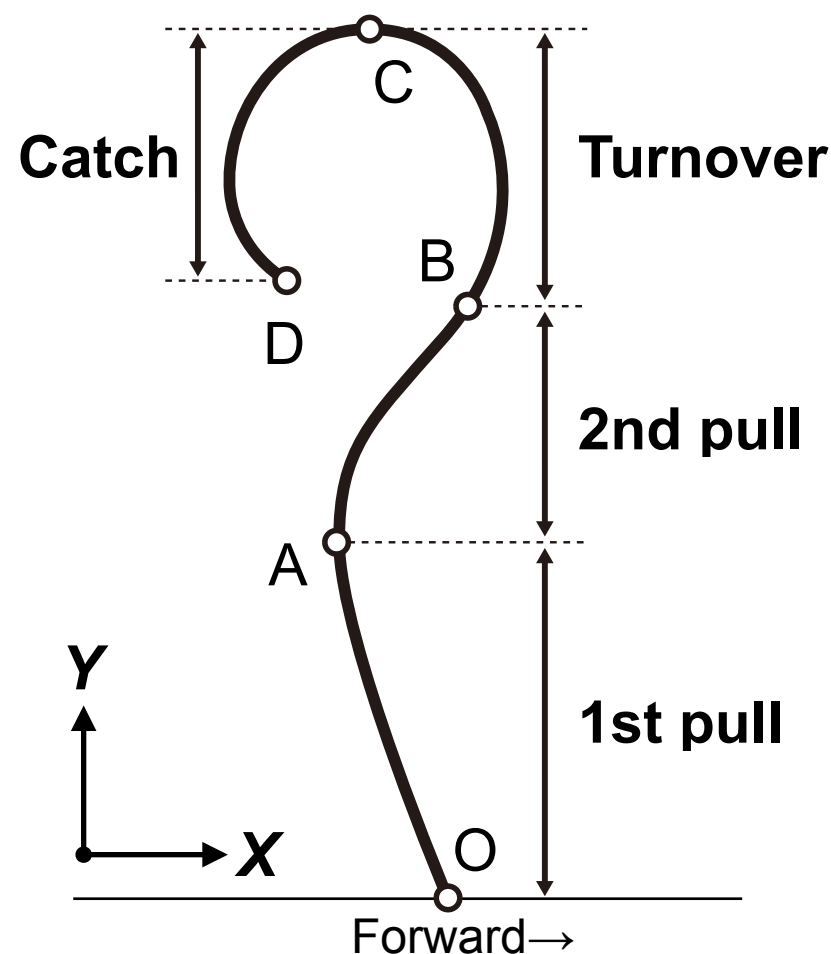
M109+ and W87+ were excluded from the analysis.
Because of large variation in body weight.

Detail of groups were shown in Table_1 Excel file.

2. Methods

2.3 Definition of the phases and events of the snatch lift

the snatch lift phases (1st pull, 2nd pull, Turnover and Catch phase) were defined according to the barbell trajectory



Event point

O: start position

A: most backward position before
Peak vertical velocity

B: peak vertical velocity

C: maximum height

D: catch position

The “start position” was defined as the time when the y-axis component of the barbell position (barbell height) was ≥ 0.225 m, and the y-axis component of the barbell velocity was ≥ 0.01 m/s.

The “catch position” was defined as the time when the y-axis component of the barbell velocity was closest to 0 m/s after the height of the barbell reached the maximum.

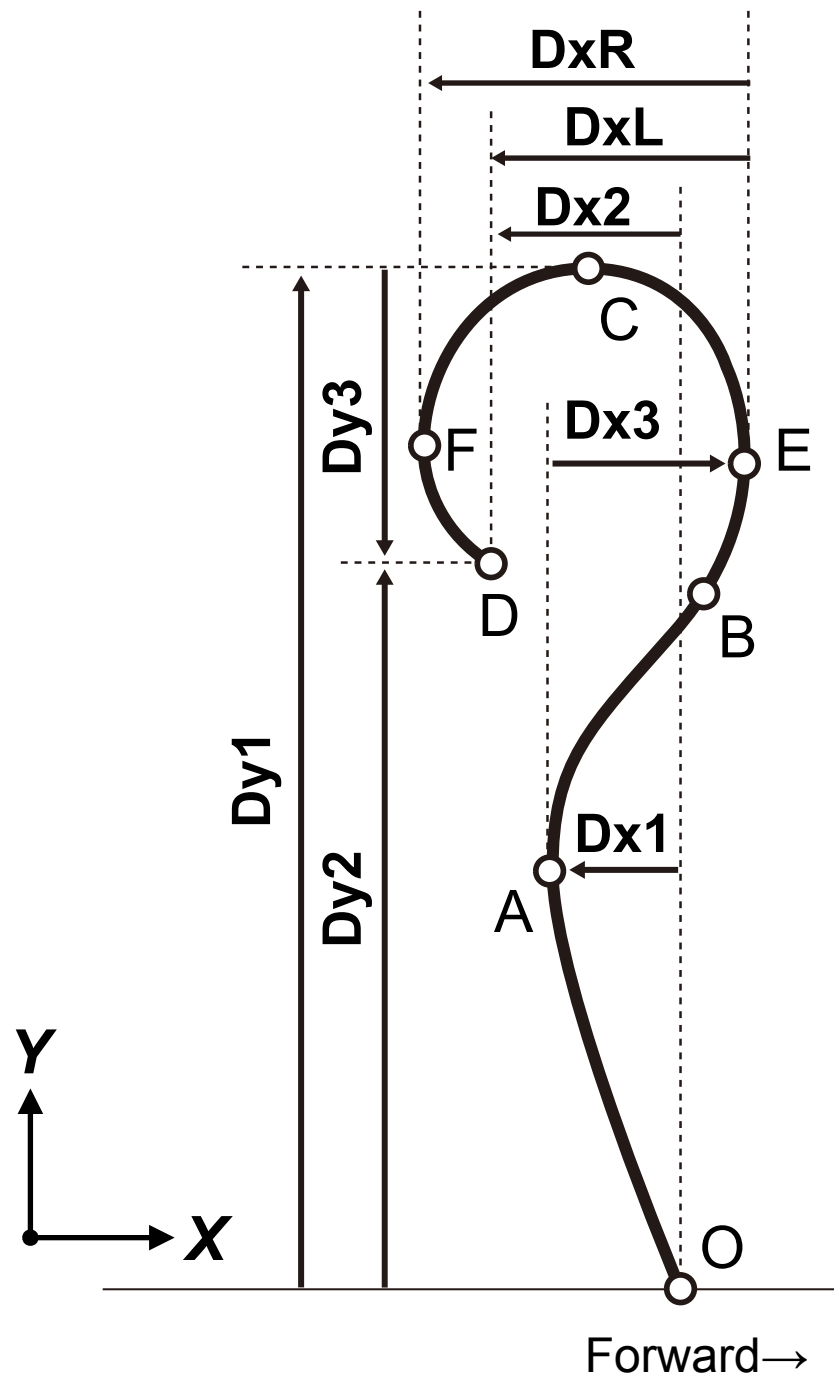
2. Methods

2.4 Barbell kinematics parameters

Symbol	Unit	Definition
Barbell vertical direction variable		
Dy1	[m]	Start position to maximum height
Dy2	[m]	Start position to the catch position
Dy3	[m]	Maximum height to the catch position (drop distance)
pVy_1st	[m/s]	Maximum vertical linear velocity in the 1st pull phase
pVy_2nd	[m/s]	Maximum vertical linear velocity in the 2nd pull phase
pFy_1st	[N]	Maximum vertical linear force in the 1st pull phase
pFy_2nd	[N]	Maximum vertical linear force in the 2nd pull phase
pFy%height	[%]	Height of peak vertical force position normalized by the maximum height
Barbell horizontal direction variable		
Dx1	[m]	Start position to the most backward position before the turnover phase
Dx2	[m]	Start position to the catch position
Dx3	[m]	Most backward position before the turnover phase to the most forward position
DxL	[m]	Most forward position in the 2nd pull phase to the catch position
DxR	[m]	Most forward position in the 2nd pull phase to the most backward position
pVx_Forward	[m/s]	Maximum horizontal linear velocity in the forward direction
pVx_Backward	[m/s]	Maximum horizontal linear velocity in the backward direction
pFx_Forward	[N]	Maximum horizontal linear force in the forward direction
pFx_Backward	[N]	Maximum horizontal linear force in the backward direction

2. Methods

2.4 Barbell kinematics parameters (image)



Event point

O: start position

A: most backward position before
Peak vertical velocity

B: peak vertical velocity

C: maximum height

D: catch position

E: most forward position in the 2nd pull phase

F: most backward position

2. Methods

2.5 Statistics

All data were presented as means \pm standard deviation. Kolmogorov-Smirnov test was used to test the normality of distributions. Paired t-tests were used to compare all barbell variables between Top30% and Bottom30% groups. The magnitude of the differences was determined via calculation of Cohen's *d* effect size. The magnitude of the effect sizes was interpreted as small (0.2~), medium (0.5~), and large (0.8~) [a]. The level of significance was set at $p < 0.05$ for all statistical tests performed.

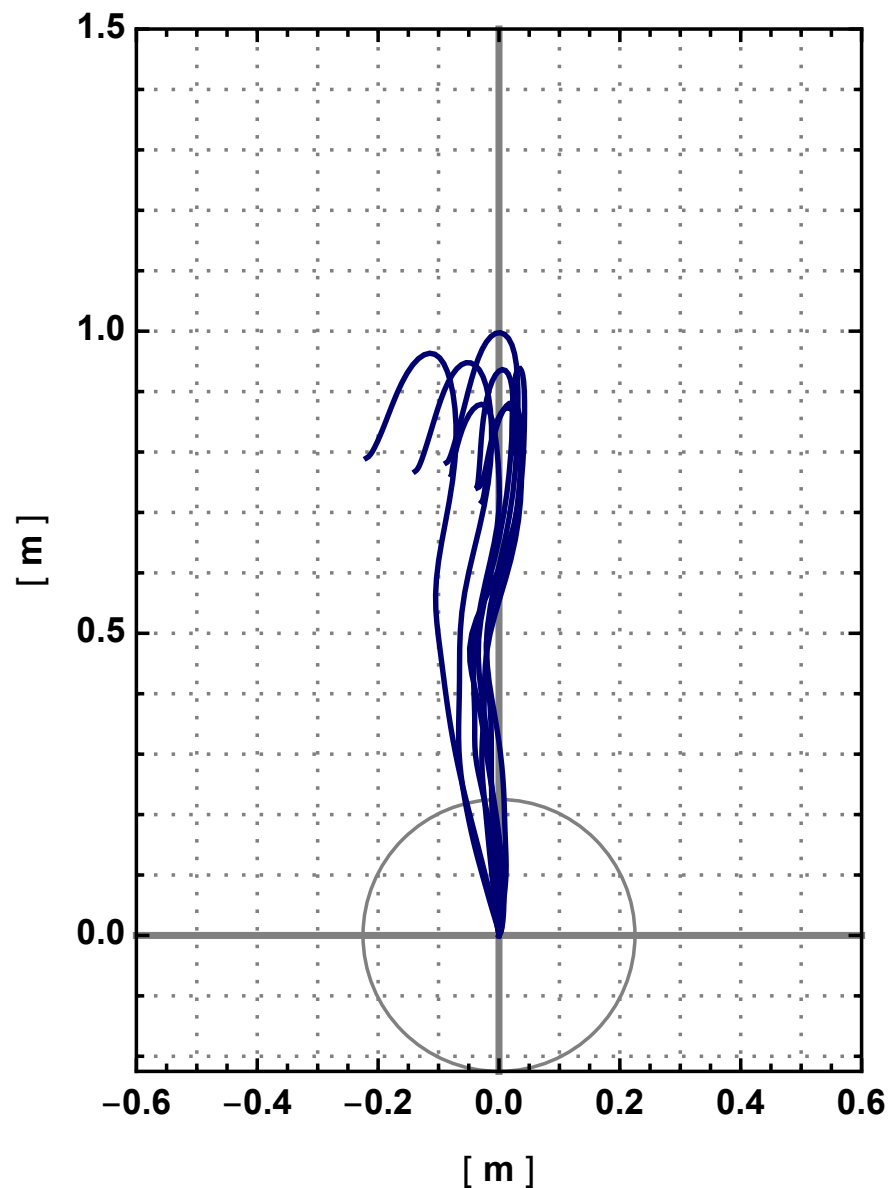
[a] Cohen, J. Statistical Power for the Behavioral Sciences; Erlbaum: Hillsdale, NJ, USA, 1988.

3. Results

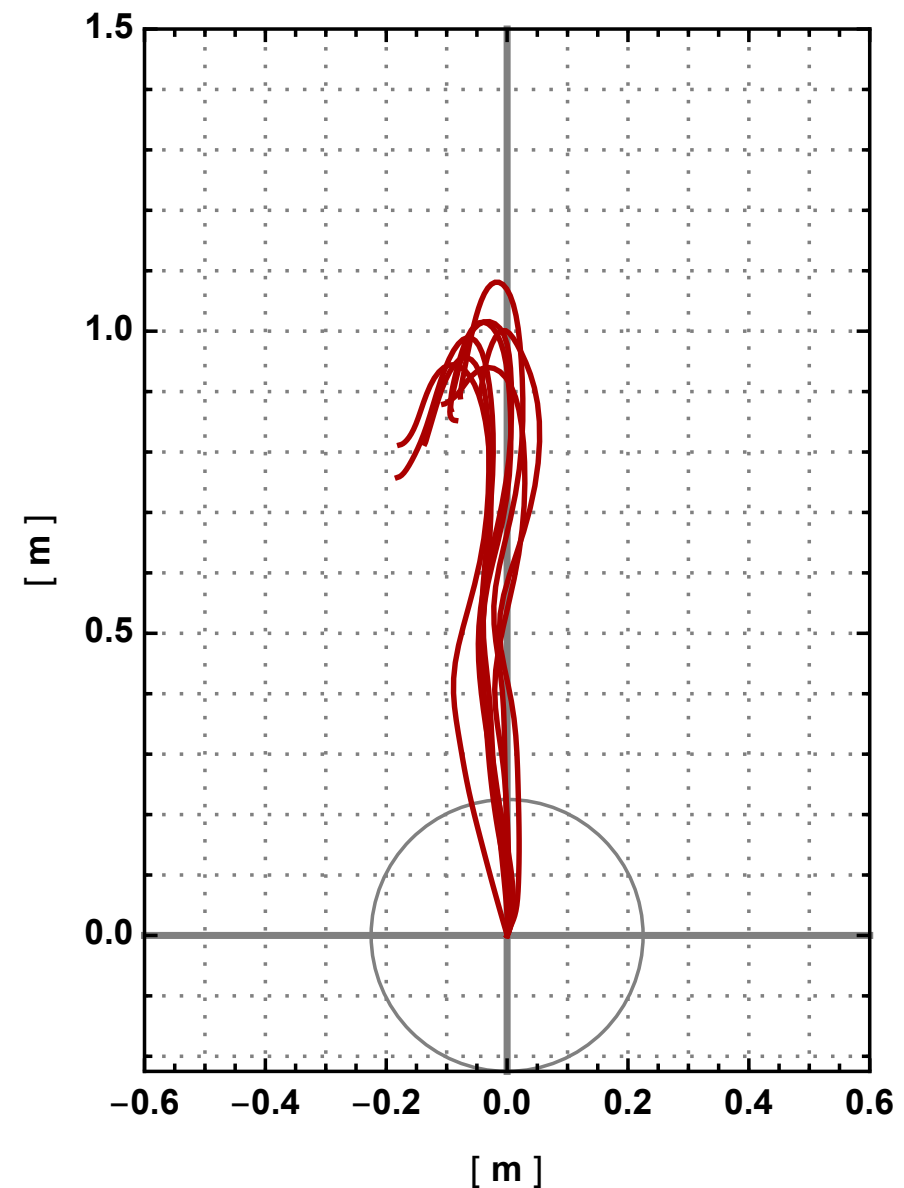
3.1 Barbell Trajectory_1

Men light weight (M55, M61, M67)

Top30%



Bottom30%

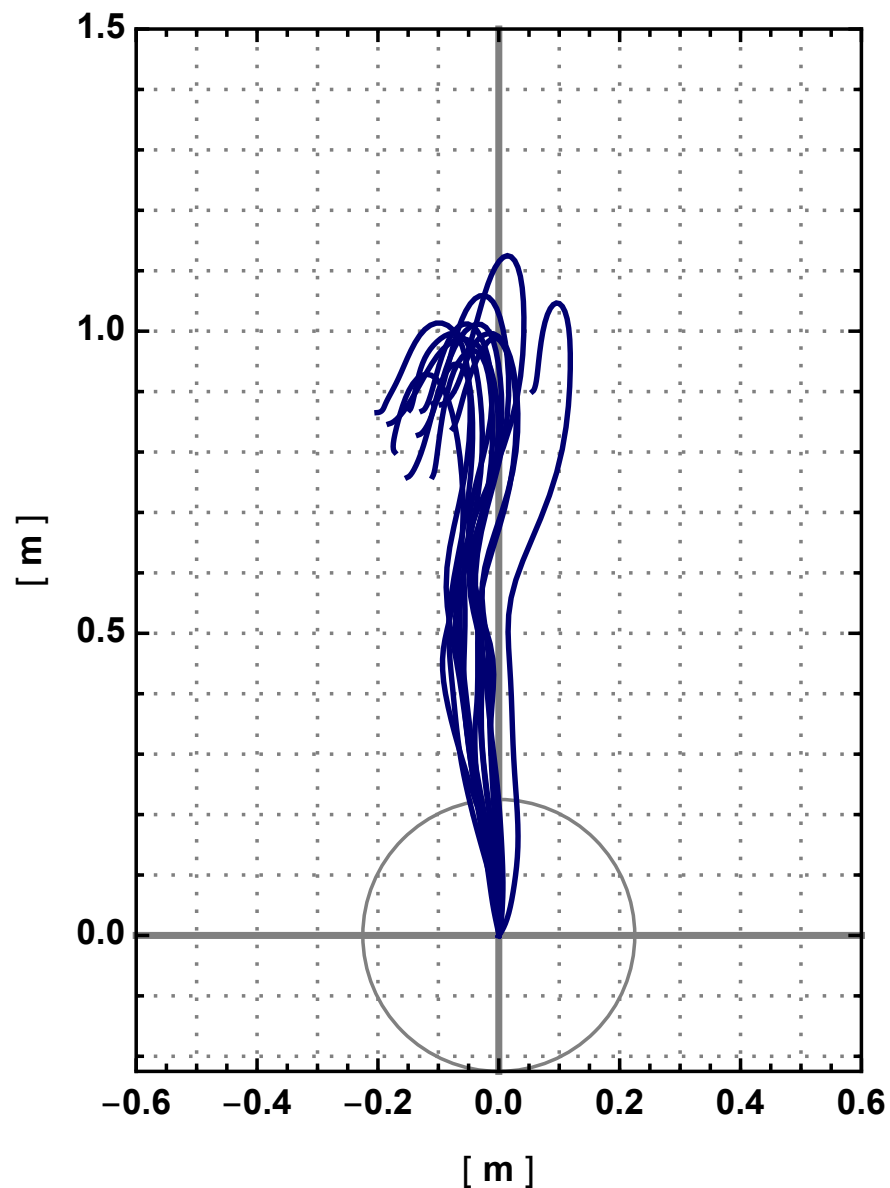


3. Results

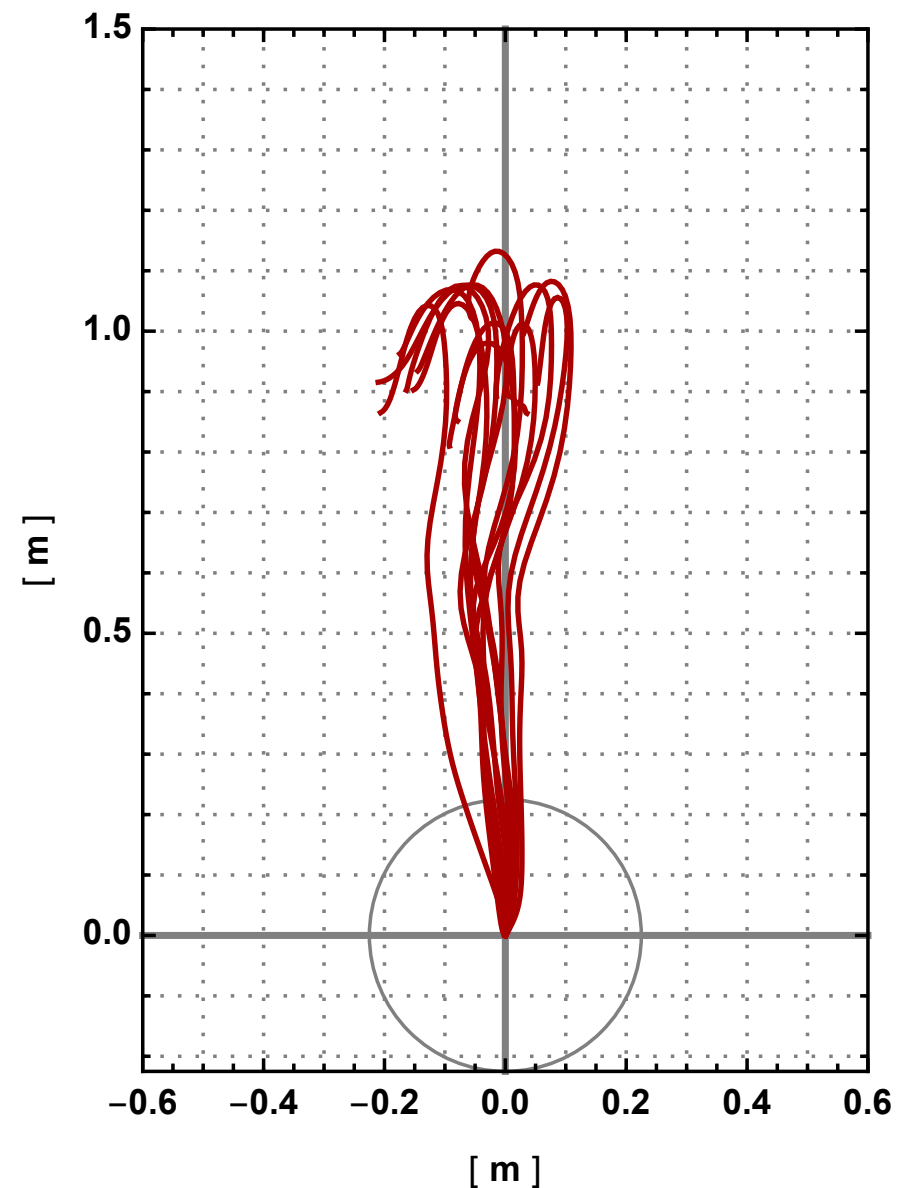
3.1 Barbell Trajectory_2

Men medium weight (M73, M81, M89)

Top30%



Bottom30%

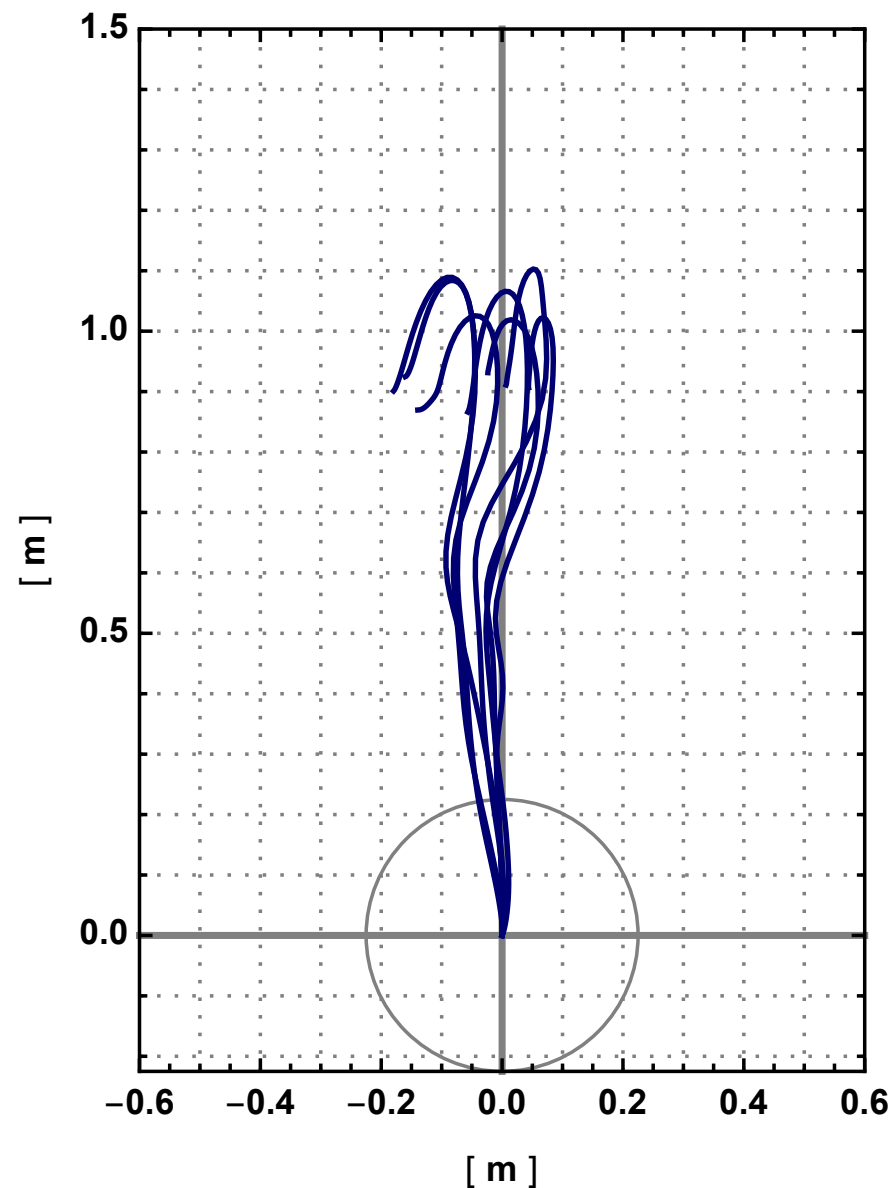


3. Results

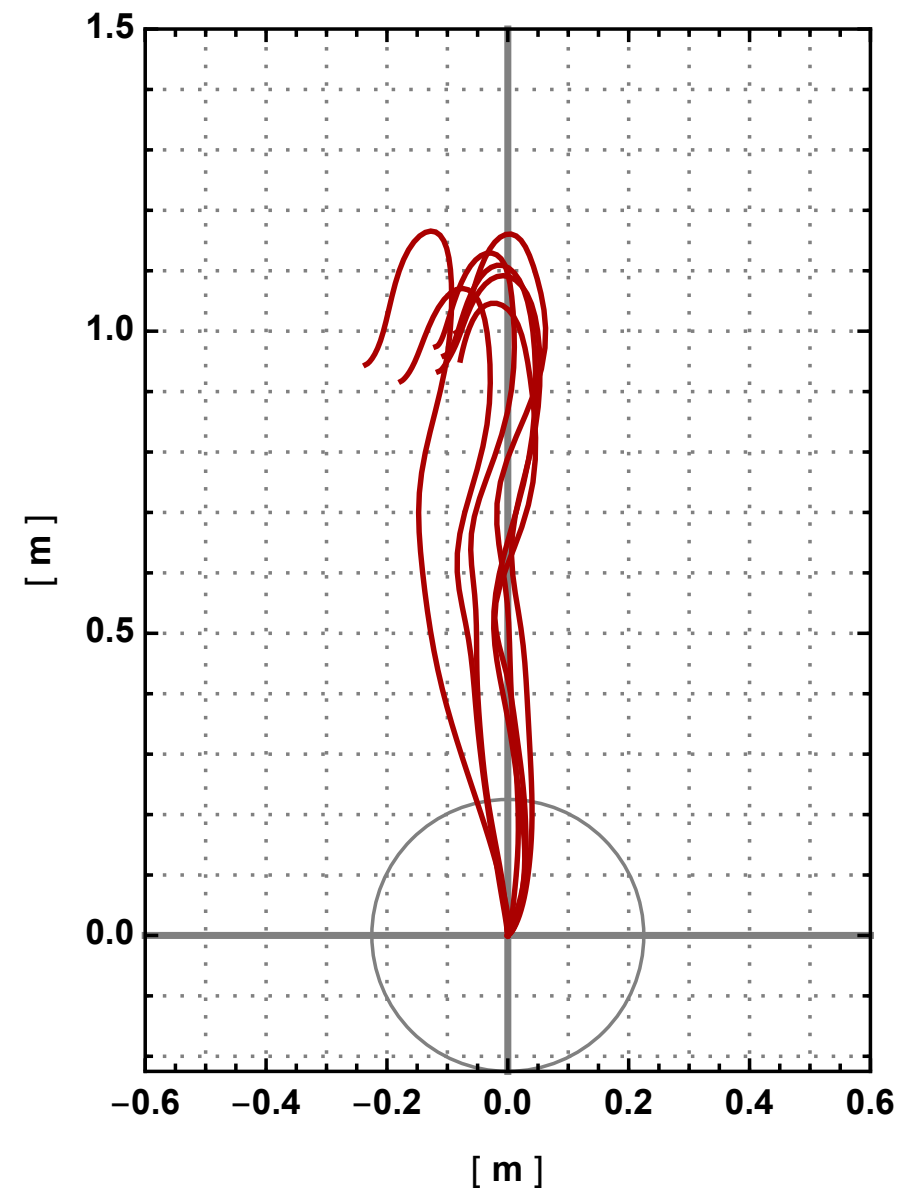
3.1 Barbell Trajectory_3

Men heavy weight (M96, M102, M109)

Top30%



Bottom30%

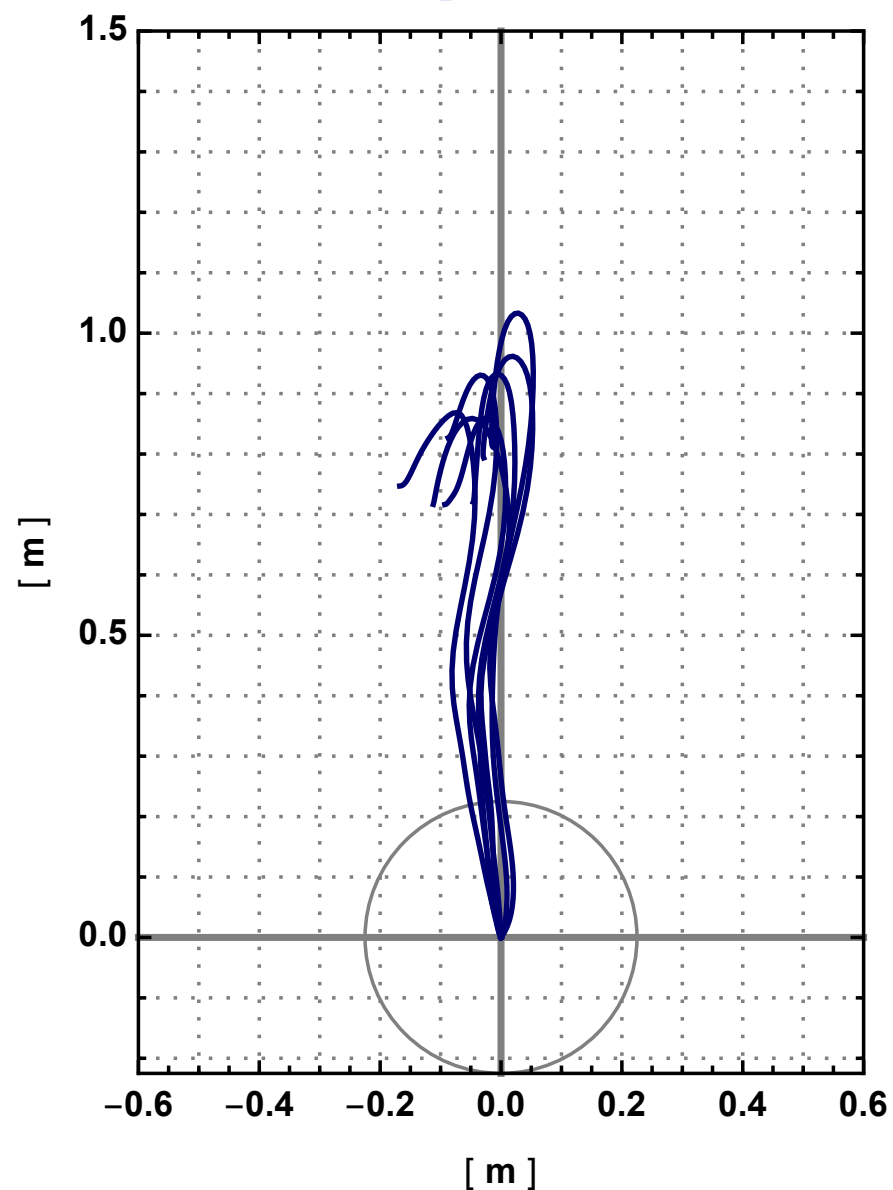


3. Results

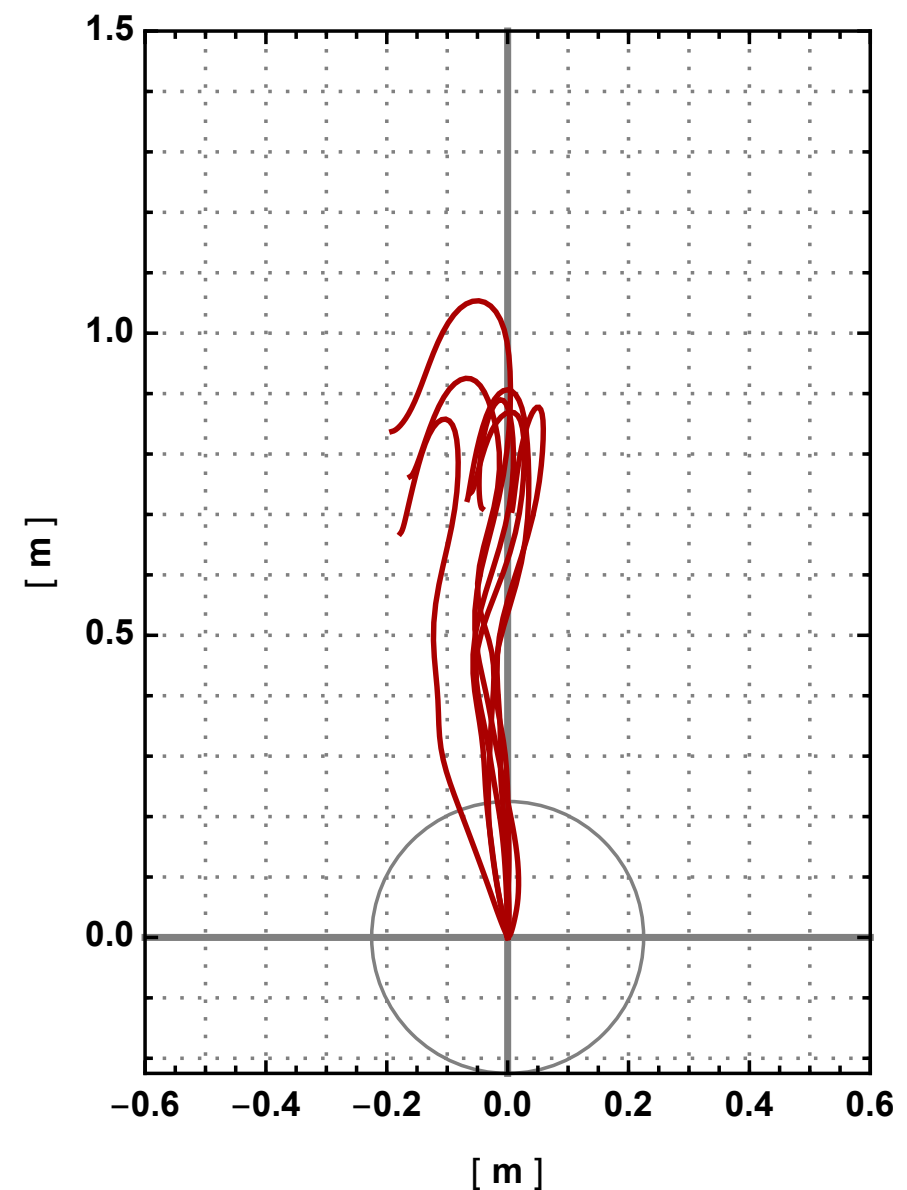
3.1 Barbell Trajectory_4

Woman light weight (W45, W49, W55)

Top30%



Bottom30%

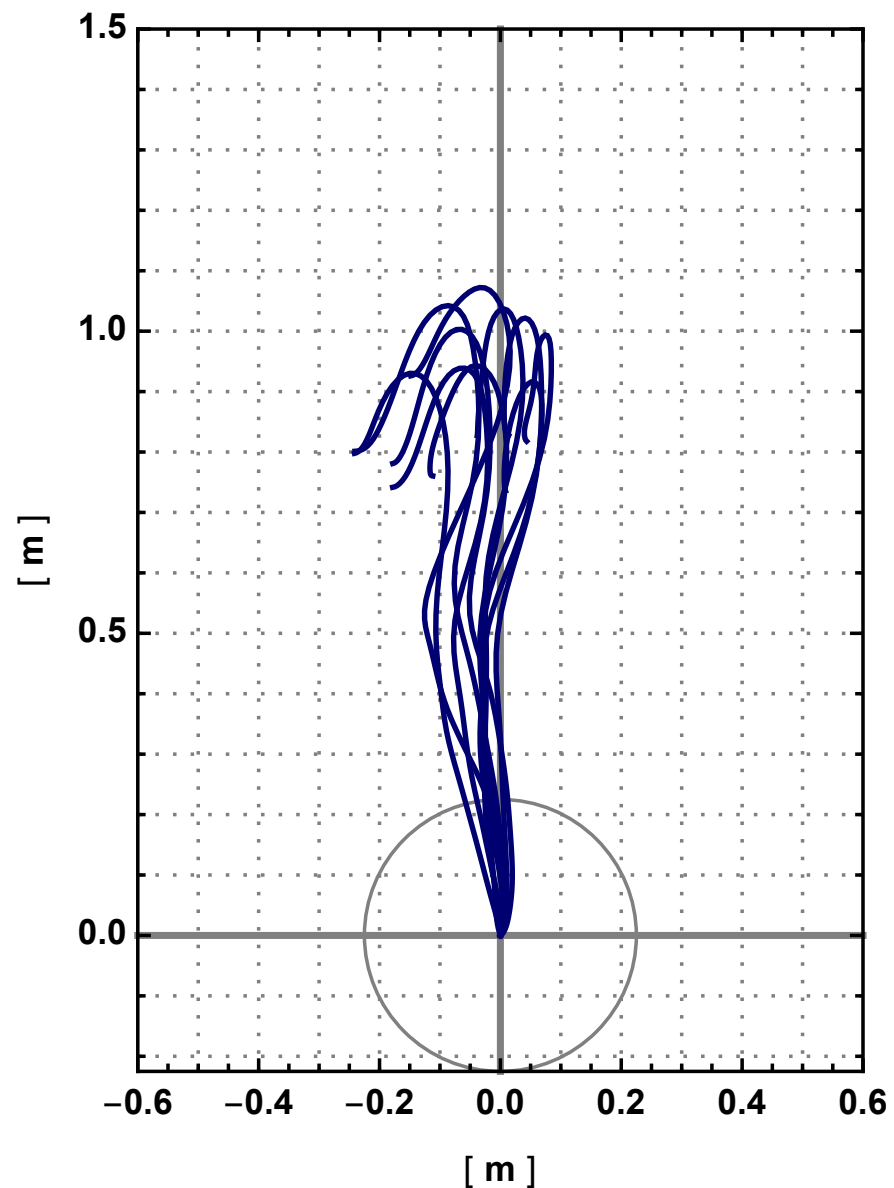


3. Results

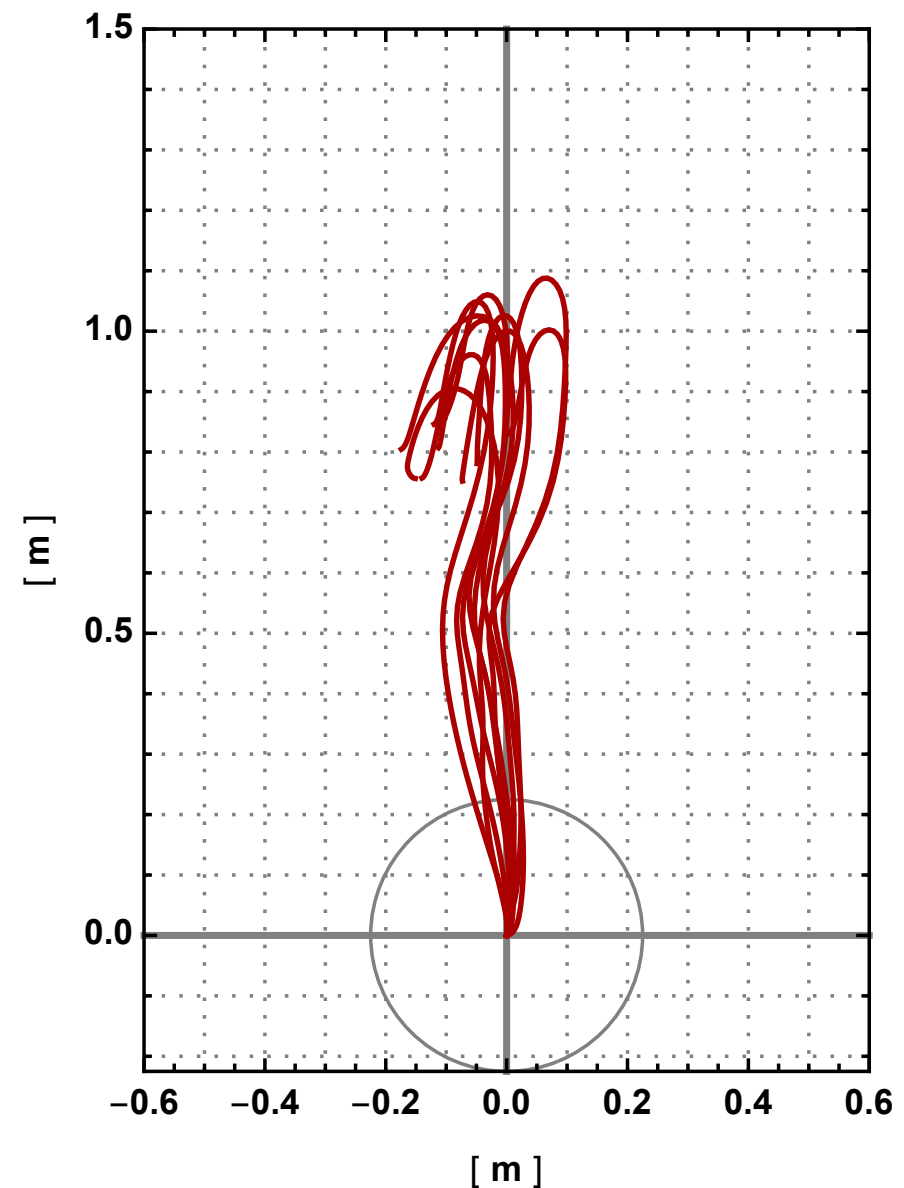
3.1 Barbell Trajectory_5

Woman medium weight (W59, W64, W71)

Top30%



Bottom30%

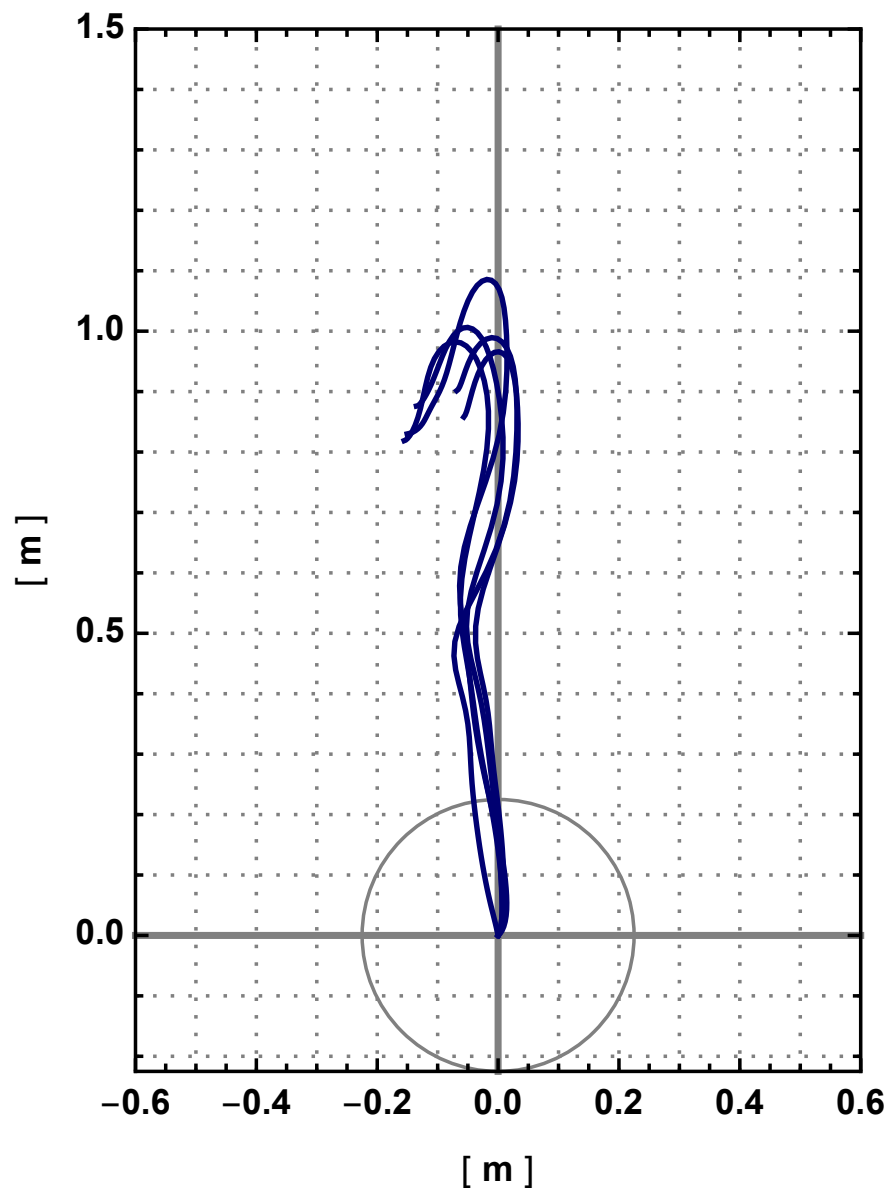


3. Results

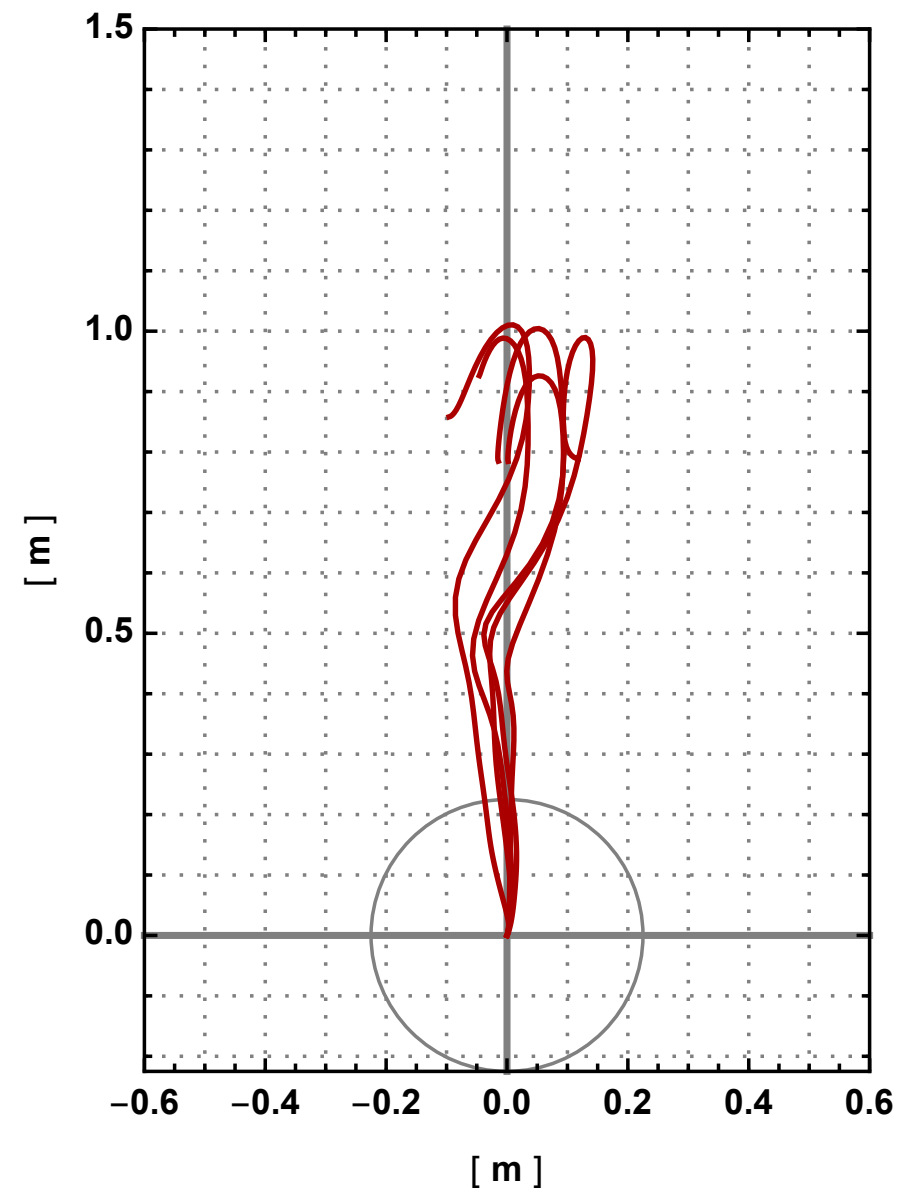
3.1 Barbell Trajectory_6

Woman heavy weight (W76, W81, W87)

Top30%



Bottom30%



3. Results

3.2 Results of statistical analysis of barbell parameter

Summary

Variable	Unit	Men			Women		
		Light	Medium	Heavy	Light	Medium	Heavy
Dy1	[m]	T < B	T < B	T < B	n.s.	n.s.	n.s.
Dy2	[m]	T < B	T < B	T < B	n.s.	n.s.	n.s.
Dy3	[m]	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
pVy_1st	[m/s]	T < B	n.s.	n.s.	n.s.	n.s.	n.s.
pVy_2nd	[m/s]	T < B	T < B	T < B	T > B	n.s.	n.s.
pFy_1st	[N]	T > B	T > B	T > B	T > B	T > B	T > B
pFy_2nd	[N]	T > B	T > B	T > B	T > B	T > B	n.s.
pFy_%height	[%]	n.s.	n.s.	n.s.	T < B	n.s.	n.s.
Dx1	[m]	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Dx2	[m]	n.s.	n.s.	n.s.	n.s.	n.s.	T > B
Dx3	[m]	n.s.	n.s.	n.s.	n.s.	n.s.	T < B
DxL	[m]	T < B	n.s.	T < B	n.s.	n.s.	n.s.
DxR	[m]	T < B	n.s.	T < B	n.s.	n.s.	n.s.
pVx_Forward	[m/s]	n.s.	n.s.	n.s.	n.s.	n.s.	T < B
pVx_Backward	[m/s]	T < B	n.s.	T < B	n.s.	n.s.	n.s.
pFx_Forward	[N]	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
pFx_Backward	[N]	n.s.	T > B	n.s.	n.s.	T > B	n.s.
pFz_1st/barbell mass	[N/kg]	n.s.	n.s.	n.s.	n.s.	n.s.	T > B
pFz_2nd/barbell mass	[N/kg]	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
pFx_Forward/barbell mass	[N/kg]	n.s.	n.s.	n.s.	T < B	T < B	T < B
pFx_Backward/barbell mass	[N/kg]	n.s.	n.s.	n.s.	n.s.	n.s.	T < B

n.s.: NOT significant difference between Top30% and Bottom30%.

T < B: variable of Top30% was significantly smaller than Bottom30% with sufficient effect size.

T > B: variable of Top30% was significantly bigger than Bottom30% with sufficient effect size.

***Detail of results were shown in Table_2 Excel file.**

4. Discussion

4.1 Men

- ✓ All of Top30% group's Dy_1 , Dy_2 and pVy_{2nd} were significantly smaller than Bottom30%.

Superior lifter has a technique that allows them to catch the barbell at a low position, even if the peak velocity of the barbell is small and its maximum height is low. Or superior group may be short in height.

- ✓ All of Top30% group's pFy_{1st} and pFy_{2nd} were significantly larger than Bottom30%. However, There was no significant difference in those values that normalized by barbell mass.

It is considered that the peak vertical force that applied on the barbell does not affect the result in men's snatch.

- ✓ Top30% of Light and Heavy group's DxL , DyR and $pFx_{Backward}$ were significantly smaller than Bottom30%. However, There was no significant difference in those values in Medium group.

It is considered that the amount of backward displacement of barbell affect the result in men's snatch.

4. Discussion

4.2 Women

- ✓ There was no significant difference between Top30% and Bottom30% of all category in Dy1 and Dy2.

It is considered that the maximum barbell height does not affect the result in women's snatch.

- ✓ Light and Medium of Top30% group's pFy_2nd were significantly larger than Bottom30%. However, There was no significant difference in those values that normalized by barbell mass.

It is considered that the peak vertical force that applied on the barbell in the 2nd pull phase does not affect the result in women's snatch.

- ✓ All of Top30% group's pFx_Forward/barbell mass was significantly smaller than Bottom30%. Furthermore, Heavy category's pFx_Backward/barbell mass was significantly smaller than Bottom30%.

It is considered that the peak horizontal force that applied on the barbell affect the result in women's snatch.

- ✓ In the Light category, pVy_2nd of Top30% was larger than Bottom30%. Furthermore, pFy_%height of Top30% was smaller than Bottom30%.

These results suggest that the timing of exerting force and vertical barbell velocity in the 2nd pull phase affect the result in the Light category of women's snatch.