2022 11~12 2022 12

**—**

2035

450

20 5485

5000 300

2017

2021

2022 6418 42

6 64 2 2022

“ ”

100

**( )**

2016 50 2019 71

26

25 176 66829

802

**( )**

“ ”“ ”

300

“ ”

2017 0.78% 2021

0.53%

“ ” “ ”

**( )**

IP

“ ”App “ ”App

“ + + ”“ + + ”“ + + ”

**( )**

APP

1.3 “ ” 14.5

“ ” “

” “ ”

**( )**

16 22

**( )**

2019 11

“ ”“ ”“ ”

**( )**

“ ”

500 “ ”

15 132

[illegible]

“ ”

“ ” “ ”

**( )**

2021 “5·22

” 21

2017 2022

“ ”

“ ”

“1485”

“

”“ ”

“ ”

**( )**

**1.**

“5.22”

**2.**

“ ”

2024 2028
2032

**3.**

“ ”

## 4.

**6.**

APP

+

**7.**

“ ”

“ ”

**8.**

**9.**

“ ”

**10.**

“ ”

“ ”

2035

3 5

**( )**

30m 3s 10m/s 3-4 8.73m/s

8.20m/s 5.217m/s

4cm

**( )**

2-3

**( )**

3

**( )**

**( )**

80

**( )**

90 -95

**( )**

2.40m 16

2.05m 14

110m

**(　)**

50

1936

**(　)**

2022

3　5

2004

**(　)**

**1.**

(1) 30-60m

(2) (20-40m)

(3) 10m( 3-6 ) 20m

(4) 20-30m

( )

(5) 15-20 2m

**2.**

(1)

(2)3-5 3-5

(3)3-5

(4)3-5

(5)3-5 ( )

(6)5

(7)3-5 20-30cm

**3.**

(1) ( )

(2) ( )

10cm 0.05s

(3)

**4.**

(1) 30m

10-15m

(2)

(3) 6-8

(4) ( )

6

**5. ( )**

(1)

10-15s

(2)

(3) 3-5 ( )

(4) 3-5

(5) 6-8

**6.**

(1) 5-10cm

15

(2) 15-20cm

20-30 3

5cm 3

3cm

(3)

3

3 3

(4)

(5)

5

**( )**

**1.**

8s 5 (

80 )

68 60 7.5s

**(1)**

A. ( 50 ) 5

8s

B. (40cm ) 5

C. ( )

5

D. ( 50 -70 ) 8-10

E. 6-10

F. (

80 -90). 5

**(2)**

A. 5

B. (3-5 ) 4

C. (2-4 )

D. (1 ) (3-6 ) 3-

5

**(3)**

A.4-6

B.

C. ( 30-40cm)

D. 10

E.5

( )

**2.**

**(1)**

A. ( )

( ) 8-12

4-6

B. 8-10

4-6

C.

45 5-8 4-

6

D. ( 50 )

5-8

4-6

E. (8-10 ) (30cm)

5-8 4-6

**(2)**

A. (20cm) 5-8

4

B. 10-15

4-6

C. ( ) 20-30

4-6

**(3)**

A. 5-10 4-6

0.18s ( )

B. (5-10 ) 10-15

4-6

C.3 5 4-6

D.6-8 ( ) (20-30cm) 5-6 4-5

**( )**

1.

2.

3.

4.

5.

**( )**

15-20 1-2

(

)

2-3

1. ( )

2. 10

3.

6 -8

6 8

1

1 6

2 8

( )

(          )

# 110m

110m 100m
110m

110m

110m

## 1

### 1.1

2020 110m 13.15s
2000 13.15s 10
( 1)
13.78s 2000
10
( 2)

1 110m (s)(N=10)

| | | -H1 | H2 | H3 | H4 | H5 | H6 | H7 | H8 | H9 | H10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aries MERRITT | 12.80 | 2.53 | 1.01 | 0.98 | 0.96 | 0.95 | 0.96 | 0.98 | 1.00 | 1.02 | 1.01 | 1.40 |
| Dayron Robles | 12.87 | 2.54 | 1.03 | 1.01 | 0.97 | 0.97 | 0.98 | 0.98 | 0.99 | 1.01 | 1.02 | 1.37 |
| LIU Xiang | 12.88 | 2.57 | 1.02 | 1.00 | 0.96 | 0.97 | 0.98 | 0.99 | 1.00 | 1.00 | 1.03 | 1.36 |
| Dominique Arnold | 12.90 | 2.59 | 1.02 | 0.98 | 0.96 | 0.96 | 0.96 | 0.98 | 1.00 | 1.02 | 1.01 | 1.42 |
| Terrence TRAMMELL | 13.02 | 2.54 | 1.01 | 1.00 | 0.96 | 0.97 | 0.99 | 1.02 | 1.02 | 1.02 | 1.06 | 1.43 |
| Omar MCLEOD | 13.04 | 2.36 | 1.06 | 1.00 | 1.01 | 0.99 | 1.02 | 1.01 | 1.01 | 1.02 | 1.03 | 1.53 |
| Grant Hollway | 13.10 | 2.46 | 1.00 | 0.98 | 0.97 | 1.00 | 0.99 | 1.02 | 1.02 | 1.06 | 1.10 | 1.50 |
| Brathwaite Ryan | 13.14 | 2.54 | 1.06 | 1.01 | 0.99 | 0.99 | 1.01 | 1.02 | 1.03 | 1.05 | 1.04 | 1.40 |
| Sergey SHUBENKOV | 13.14 | 2.41 | 1.04 | 1.00 | 1.01 | 0.99 | 1.01 | 1.01 | 1.01 | 1.04 | 1.05 | 1.57 |
| Payne Dzvid | 13.15 | 2.54 | 1.04 | 1.03 | 1.00 | 1.01 | 1.02 | 1.02 | 1.03 | 1.05 | 1.04 | 1.37 |

2 110m (s)(N=10)

| | | -H1 | H2 | H3 | H4 | H5 | H6 | H7 | H8 | H9 | H10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14.15 | 2.71 | 1.09 | 1.09 | 1.08 | 1.11 | 1.08 | 1.11 | 1.10 | 1.13 | 1.12 | 1.53 |
| | 14.12 | 2.70 | 1.11 | 1.09 | 1.06 | 1.07 | 1.07 | 1.08 | 1.10 | 1.12 | 1.18 | 1.54 |
| Omar Mcleod | 14.10 | 2.53 | 1.00 | 1.01 | 1.03 | 0.99 | 0.97 | 1.01 | 1.00 | 1.16 | 1.30 | 2.10 |
| | 14.03 | 2.75 | 1.11 | 1.10 | 1.07 | 1.07 | 1.08 | 1.08 | 1.09 | 1.10 | 1.10 | 1.48 |
| | 13.98 | 2.69 | 1.08 | 1.05 | 1.10 | 1.07 | 1.07 | 1.09 | 1.10 | 1.09 | 1.10 | 1.54 |
| | 13.93 | 2.68 | 1.09 | 1.06 | 1.06 | 1.07 | 1.07 | 1.09 | 1.08 | 1.11 | 1.13 | 1.49 |
| | 13.92 | 2.71 | 1.07 | 1.07 | 1.06 | 1.08 | 1.06 | 1.09 | 1.07 | 1.11 | 1.09 | 1.51 |
| Milan Trajkovic | 13.87 | 2.57 | 1.05 | 1.00 | 1.02 | 0.99 | 1.02 | 1.16 | 1.26 | 1.18 | 1.14 | 1.48 |
| Genta MASUNO | 13.79 | 2.46 | 1.05 | 1.06 | 1.06 | 1.08 | 1.07 | 1.09 | 1.07 | 1.11 | 1.12 | 1.62 |
| Matthias BÜHLER | 13.79 | 2.48 | 1.09 | 1.07 | 1.07 | 1.06 | 1.05 | 1.05 | 1.08 | 1.07 | 1.11 | 1.66 |

## 1.2

### 1.2.1

Web of Science 2000

110m 13.15s 13.18s

14.10s 10

110m 110m

### 1.2.2

Excel2016 20

SPSS23

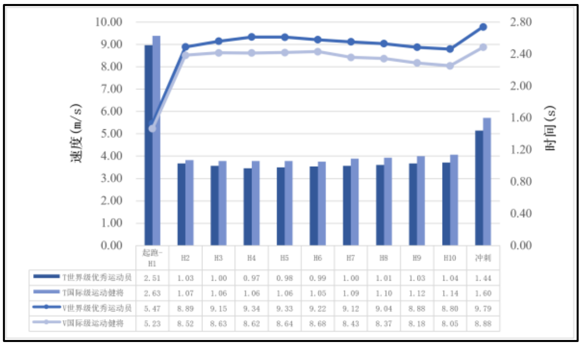
### 1.2.3

110m

### 1.2.4

# 2

## 2.1 110m



1

1 110m

110m

3

4 7

8

3

| (%) | -H1~H2 | H2~H3 | H3~H4 | H4~H5 | H5~H6 | H6~H7 | H7~H8 | H8~H9 | H9~H10 | H10~ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 62.52% | 2.92% | 2.08% | -0.11% | -1.18% | -1.08% | -0.88% | -1.77% | -0.90% | 11.25% |
| | 62.91% | 1.29% | -0.12% | 0.23% | 0.46% | -2.88% | -0.71% | -2.27% | -1.59% | 10.31% |

3

## 2.2 110m

### 2.2.1

4

| | (s) | | | (m/s) | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Mean±SD | 4.76±0.15<br>(34.09%) | 4.26±0.10<br>(30.49%) | 4.95±0.23<br>(35.42%) | 8.65±0.28 | 8.59±0.22 | 6.54±0.28 |

5

| | (s) | | | (m/s) | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Mean±SD | 4.54±0.07(34.89%) | 3.95±0.07(30.40%) | 4.51±0.11<br>(34.71%) | 9.07±0.15 | 9.25±0.17 | 7.16±0.17 |
| r | -0.22 | 0.93** | 0.75* | 0.22 | -0.93** | -0.75* |
| p | 0.55 | 0.00 | 0.01 | 0.54 | 0.00 | 0.01 |

*p 0.05 **p 0.01

4 5

5 110m

( )

|r|=0.93 p 0.01 110m

|r|=0.75 p 0.05 110m

110m

### 2.2.2

6

| | -H1 | | |
|---|---|---|---|
| Mean±SD | (s)<br>(m/s) | 2.51±0.07<br>5.47±0.16 | 2.63±0.11<br>5.23±0.22 |
| r | | -0.44<br>0.44 | |
| p | | 0.20<br>0.20 | |

6

|r|=0.44 p 0.05

110m

**2.2.3**

7 ≤1s

≥1.1s

110m

≤1s |r|=0.84 p

0.01 1s

110m

1s

7

| | ≤1s | ≥1.1s | | ≤1s | ≥1.1s |
|---|---|---|---|---|---|
| Aries MERRITT | H3 H4 H5 H6 H7 H8 | 0 | | 0 | H5 H7 H8 H9 H10 |
| Dayron Robles | H4 H5 H6 H7 H8 | 0 | | 0 | H2 H8 H9 H10 |
| LIU Xiang | H3 H4 H5 H6 H7 H8 H9 | 0 | Omar Mcleod | H2 H5 H6 H8 | H9 H10 |
| Dominique Arnold | H3 H4 H5 H6 H7 H8 | 0 | | 0 | H2 H3 H9 H10 |
| Terrence TRAMMELL | H3 H4 H5 H6 | 0 | | 0 | H4 H8 H10 |
| Omar MCLEOD | H3 H5 | 0 | | 0 | H9 H10 |
| Grant Hollway | H2 H3 H4 H5 H6 | H10 | | 0 | H9 |
| Brathwaite Ryan | H4 H5 | 0 | Milan Trajkovic | H3 H5 | H7 H8 H9 H10 |
| Sergey SHUBENKOV | H3 H5 | 0 | Genta MASUNO | 0 | H9 H10 |
| Payne Dzvid | H4 | 0 | Matthias BÜHLER | 0 | H10 |
| Mean | 4 | 0.1 | Mean | 0.6 | 2.8 |
| r( ≤1s) | -0.84** | | r( ≥1.1s) | 0.62 | |
| p( ≤1s) | | | | | |

110m

8 9

| 9 | (s) | (s) |
|---|---|---|
| **Mean±SD** | 9.06±0.13 | 9.75±0.13 |
| **r** | 0.96** | |
| **p** | 0.00 | |

## 2.2.5

9 9.37m/s

4 98% 4

98%

[12]

|r|=0.82 p 0.01

10 9

98%

9

| | (m/s) | 98% | |
|---|---|---|---|
| Aries MERRITT | 9.62 | H5 | 3 |
| Dayron Robles | 9.42 | H4 | 5 |
| LIU Xiang | 9.52 | H4 | 3 |
| Dominique Arnold | 9.52 | H4 | 5 |
| Terrence TRAMMELL | 9.52 | H4 | 2 |
| Omar MCLEOD | 9.23 | H5 | 5 |
| Grant Hollway | 9.42 | H4 | 3 |
| Brathwaite Ryan | 9.23 | H4 | 4 |
| Sergey SHUBENKOV | 9.05 | H4 | 6 |
| Payne Dzvid | 9.14 | H4 | 4 |
| **Mean** | 9.37 | | 4 |
| **r** | -0.82** | | |
| **p** | 0.00 | | |

110m

9.30m/s

10

| | (m/s) | 98% | |
|---|---|---|---|
| Omar Mcleod | 8.46 | H4 | 5 |
| | 8.62 | H4 | 4 |
| | 9.42 | H6 | 2 |
| | 8.54 | H4 | 5 |
| | 8.70 | H3 | 3 |
| | 8.62 | H3 | 5 |
| | 8.62 | H4 | 6 |
| Milan Trajkovic | 9.23 | H5 | 2 |
| Genta MASUNO | 8.70 | H2 | 5 |
| Matthias BÜHLER | 8.70 | H6 | 6 |
| **Mean** | 8.76 | | 4.3 |

### 2.2.6

11 |r|=0.96 p 0.01

9.00m/s

8.40m/s

110m

9.0m/s

11

| | (m/s) | (m/s) |
|---|---|---|
| Mean±SD | 9.09±0.14 | 8.46±0.13 |
| r | -0.96** | |
| p | 0.00 | |

### 2.2.7

12

|r|=0.46 p 0.05

1.50s 9.3m/s

110m

12

| | | | |
|---|---|---|---|
| Mean±SD | (s) | 1.44±0.07 | 1.60±0.19 |
| | (m/s) | 9.79±0.48 | 8.88±0.84 |
| r | | 0.47 | |
| | | -0.47 | |
| p | | 0.17 | |
| | | 0.17 | |

**3**

3.1 110m

3

4 7

8

3.2 110m

3.3

3.4 110m 1s

3.5 1s

:Jiménez-Reyes, Pedro, Pareja-Blanco F , Cuadrado-Peñafiel, Víctor, et al. Jump height loss as an indicator of fatigue during sprint training[J]. Journal of Sports ences, 2018, 37:1-9.

## 1.

40

60m

(PCr)

PCr 5-7s

100m

(ATP ), ( 55-75%)

PCr ATP

ATP

(H+) (Pi)

AMP IMP (PNC)

ATP/ADP ATP

400m (30s)

(4 ) (

) (r = 0.85–0.96)

(0.92-0.97)

(~ 60 m)

(45.3±9.7%)

(FI)

( )

(CMJ)

1) ( ) ( )

(3%)

2)

## 2.

### 2.1

9 ( 23.1±4.4 73.7±4.6 177.6±5.9cm 9.6±2.9%) 100m 10.29-11.17s ( 7 100m 11.00s ) 5

200m(20.47s)

### 2.2

60m 6

3%

FI

3% FI

( 200m) FI

40m

3% FI 10s CMJ

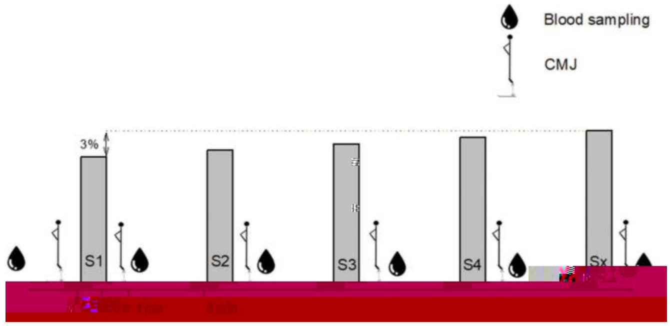
1 ( 1)

(18:00-20:00 h) (20-22°C

55-65% ) 1)

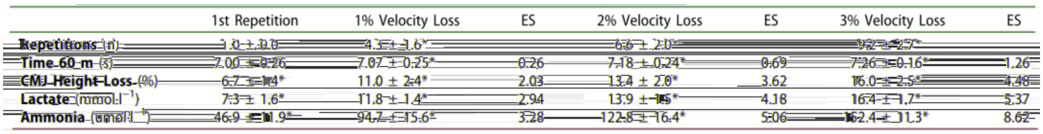
5 2)5 3) 30m 4)

50m 5) CMJ



1

1 3%



| | 1st Repetition | 1% Velocity Loss | ES | 2% Velocity Loss | ES | 3% Velocity Loss | ES |
|---|---|---|---|---|---|---|---|
| Repetitions (n) | 1.0 ± 0.0 | 4.3 ± 1.6* | | 6.6 ± 2.0* | | 9.2 ± 2.7* | |
| Time 60 m (s) | 7.00 ± 0.26 | 7.07 ± 0.25* | 0.26 | 7.18 ± 0.24* | 0.69 | 7.26 ± 0.16* | 1.26 |
| CMJ Height Loss (%) | 6.7 ± 1.4* | 11.0 ± 2.4* | 2.03 | 13.4 ± 2.0* | 3.62 | 16.0 ± 2.5* | 4.48 |
| Lactate (mmol·l$^{-1}$) | 7.3 ± 1.6* | 11.8 ± 1.4* | 2.94 | 13.9 ± 1.5* | 4.18 | 16.4 ± 1.7* | 5.37 |
| Ammonia (μmol·l$^{-1}$) | 46.9 ± 11.9* | 94.7 ± 15.6* | 3.28 | 122.8 ± 16.4* | 5.06 | 162.4 ± 11.3* | 8.62 |

VL ( - )/ -100] ES Repetiton 60m 60m CMJ Lactate 60m 1 Ammonia 60m 1 * P < 0.05

## 3.

1 60m

7.00±0.26s( 1) CMJ 46.4±5.4cm

1.5±0.5mmol-l-1 31.7±3.2μmol-l-1 2

CMJ

6 1 2 3%

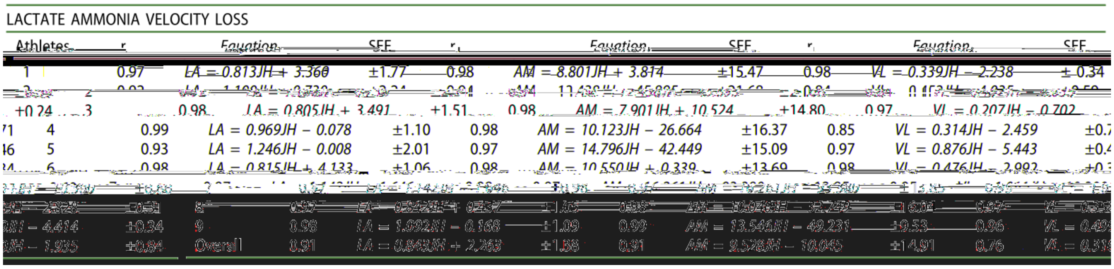
(CMJ 1% 21.8% 2% 14.9%, 3%: 15.6% 6 23.4%

1%: 11.9%, 2%: 10.8%, 3%: 10.4% 6 21.8%

1% 16.5% 2% 13.4%, 3%: 7.4% 6 24.2%).

9 CMJ (r = 0.91) (r = 0.91) 60m (r = 0.76) / ( 2) CMJ (r=0.93-0.99) (r=0.94-0.99) (r=0.84-0.98) ( 2)

2



LACTATE AMMONIA VELOCITY LOSS

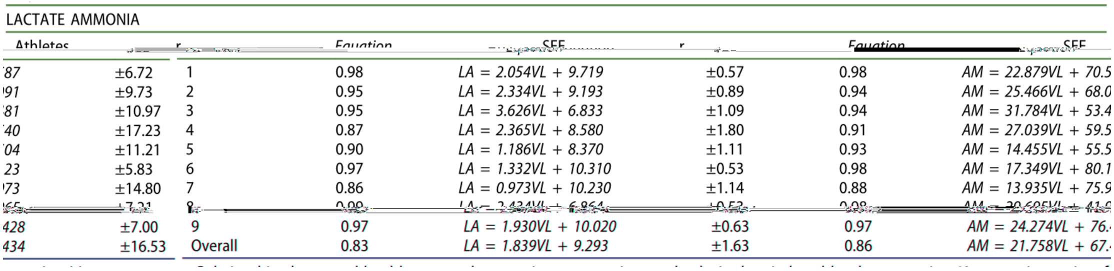
| | Athletes | r | Equation | SEE | r | Equation | SEE | r | Equation | SEE |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0.97 | LA = 0.813JH + 3.360 | ±1.77 | 0.98 | AM = 8.801JH + 3.814 | ±15.47 | 0.98 | VL = 0.339JH − 2.238 | ± 0.34 |
| [illegible] | 2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| ±0.24 | 3 | 0.98 | LA = 0.805JH + 3.491 | ±1.51 | 0.98 | AM = 7.901JH + 10.524 | ±14.80 | 0.97 | VL = 0.207JH − 0.702 | |
| 71 | 4 | 0.99 | LA = 0.969JH − 0.078 | ±1.10 | 0.98 | AM = 10.123JH − 26.664 | ±16.37 | 0.85 | VL = 0.314JH − 2.459 | ±0.7 |
| 46 | 5 | 0.93 | LA = 1.246JH − 0.008 | ±2.01 | 0.97 | AM = 14.796JH − 42.449 | ±15.09 | 0.97 | VL = 0.876JH − 5.443 | ±0.4 |
| 34 | 6 | 0.98 | LA = 0.815JH + 4.133 | ±1.06 | 0.98 | AM = 10.550JH + 0.339 | ±13.69 | 0.98 | VL = 0.476JH − 2.992 | ±0.3 |
| [illegible] | 7 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| JH − 2.828 ±0.31 | 8 | 0.97 | LA = 0.842JH + 0.437 | ±1.65 | 0.98 | AM = 10.040JH − 32.749 | ±16.04 | 0.97 | VL = 0.35 | |
| JH − 4.414 ±0.34 | 9 | 0.98 | LA = 1.092JH − 0.168 | ±1.09 | 0.99 | AM = 13.546JH − 49.231 | ±9.53 | 0.96 | VL = 0.49 | |
| JH − 1.935 ±0.84 | Overall | 0.91 | LA = 0.843JH + 2.263 | ±1.38 | 0.91 | AM = 9.528JH − 10.045 | ±14.91 | 0.76 | VL = 0.31 | |

r: 60m Equation 60m SEE: JH LA 60m 1 AM: AM 60m 1 VL ( - )/ - 100]

### 3.4 60m

(r = 0.83) (r = 0.86) ( 3) (r=0.86-0.99) (r=0.88-0.98) / ( 3)

3



LACTATE AMMONIA

| | | Athletes | r | Equation | SEE | r | Equation |
|---|---|---|---|---|---|---|---|
| 87 | ±6.72 | 1 | 0.98 | LA = 2.054VL + 9.719 | ±0.57 | 0.98 | AM = 22.879VL + 70.5 |
| 91 | ±9.73 | 2 | 0.95 | LA = 2.334VL + 9.193 | ±0.89 | 0.94 | AM = 25.466VL + 68.0 |
| 81 | ±10.97 | 3 | 0.95 | LA = 3.626VL + 6.833 | ±1.09 | 0.94 | AM = 31.784VL + 53.4 |
| 40 | ±17.23 | 4 | 0.87 | LA = 2.365VL + 8.580 | ±1.80 | 0.91 | AM = 27.039VL + 59.5 |
| 04 | ±11.21 | 5 | 0.90 | LA = 1.186VL + 8.370 | ±1.11 | 0.93 | AM = 14.455VL + 55.5 |
| 23 | ±5.83 | 6 | 0.97 | LA = 1.332VL + 10.310 | ±0.53 | 0.98 | AM = 17.349VL + 80.1 |
| 73 | ±14.80 | 7 | 0.86 | LA = 0.973VL + 10.230 | ±1.14 | 0.88 | AM = 13.935VL + 75.9 |
| [illegible] | ±7.21 | 8 | 0.99 | LA = 2.434VL + 6.864 | ±0.53 | 0.98 | AM = 20.605VL + 41.9 |
| 428 | ±7.00 | 9 | 0.97 | LA = 1.930VL + 10.020 | ±0.63 | 0.97 | AM = 24.274VL + 76. |
| 434 | ±16.53 | Overall | 0.83 | LA = 1.839VL + 9.293 | ±1.63 | 0.86 | AM = 21.758VL + 67. |

r: 60m Equation 60m SEE LA: 60m 1 AM 60m 1 VL ( - )/ -100]

### 4.

40m 4 3%

60m 6
3% " " 10m
1

CMJ CMJ

(9.2±2.7 )
(3% )
6

40m 60m

60m (
)

3% CMJ
(CMJ 1 2 3%
CMJ 6.7±1.4 11.0±2.4 13.4±2.0 16.0±2.5% 1)

1)

3% 2) CMJ
CMJ

( r = 0.76)
CMJ ( r = 0.91 r = 0. 2)
3%
( 16.5 ± 1.7 mmol-l-1 153.1 ± 11.6
µmol-l-1 1) " "
Johnston 6 50m
5 9.3±1.7mmol-l-1 Jiménez-Reyes 40m 4 3%
( 14.3 ± 3.4 mmol-l-1 122±33µmol-l-1) ( 3%) "
"
Jiménez-Reyes
" "
10-12% 10-12mmol-l-1 90-100µmol-l-1 CMJ
(r=0.93-0.99) (r=0.94-0.99) (r=0.84-0.98)
( 2)
60m

( r=0.83 r=0.86) ( r=0.86-0.99
r=0.88-0. 3)
CMJ

(H+ ADP Pi)

H+

H+ Pi

ATP

pH

PCr PCr ATP AMP

AMP IMP

48-72

CMJ

CMJ

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. 010-87182520 13233033817 :hpp9797 E-mail
tkshpp@163.com yuantinggang@ciss.cn

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