

## Abstract

### Effects of Resting Periods Between Exercise Sets During Isokinetic Exercise on Muscle Performances and Physiological Variables in Middle-aged Women

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The purpose of this study was to investigate the effects of resting periods between exercise sets during isokinetic contraction on recovery from muscle fatigue, strength, heart rate, blood pressure, and lactate level. Sixteen women performed 10 repetitions of isokinetic exercise for three sets in three different conditions. During the sets, they rested 50, 100, and 150 seconds in each condition. And the results were: 1) In this population, the peak torque of extensor during the isokinetic exercise in 100 second resting condition was significantly higher than that in 50 and 150 second resting conditions ( $p < .01$ ). The total work of extensor was significant in the second and third sets in 50 and 100 second resting conditions ( $p < .01$ ). 2) During the isokinetic exercise, the heart rate was progressively increased as the sets were advanced in all resting conditions ( $p < .01$ ). And the increase was significant during the second and third sets than the first in 50 second resting condition ( $p < .01$ ), while it was significantly greater after the third set than the first in 100 and 150 second resting conditions ( $p < .01$ ). 4) No difference was found between the resting periods in blood lactate level and blood pressure during the isokinetic exercise. However, differences were found between the sets in these variables ( $p < .01$ ).

**Key Words:** Blood lactate; Blood pressure; Heat rate; Isokinetic exercise.

(estrogen)

(progesterone)

가

3 가 , , ,  
(Paffenbarger , 1978),  
(Oyster , 1983) . 가  
.  
Vitti(1984)  
(Basset, 1971; Cummings,  
1985; Pollitzer Anderson, 1989; Simkin ,  
1987; Smith Gillign, 1987). 가  
, , , , . 가  
, ( , 1987). 가  
가  
, 가  
가 가 가  
, 20 가  
56%, 64%, 72% 가 (Perrin,  
가 가 1993).  
가 (Spiriduso, 1995). 가  
, , (phosphocreatin) , pH  
( , 1991). (Boska , 1990; Lindinger , 1995;  
가 Touey , 1994).  
가 가  
( (Bilcheck , 1993;  
, 1995). Edman Lou, 1992; Touey , 1994)  
Thistle (1967)

(Pincivero, 1998)  
 (, 1993; , 1996;  
 , 1992)  
 (, 1997; , 1998;  
 , 1997)  
 (, 1996;  
 , 1997; , 1996; , 1989)가  
 가

1. (N=16)

	( )	(cm)	(kg)
±	54.1±3.68	154.1±4.30	57.6±4.30

( )

1 .

2.

가.

Cybox 6000<sup>1)</sup>

(peak torque)

, 90°/sec  
 10 3  
 50 ,  
 100 , 150 .

(Pincivero, 1998).

가  
 ,  
 가  
 ,  
 가  
 가

(dynamometer)  
 가

가  
 가  
 가  
 가

0° 90° 90° 0°

1.

(range of motion)

16

50

Torque (GET)

Gravity Effect  
 가

1) Lumax, USA

3  
 20 가 가

( ) 3.

2) SPSS

= .05

Tukey

1  
 warm-up

, 5 mmol/ syringe-

pet (calibration) 1.  
 가 가 가.

가 finger-tip 2, 3 . 50  
 needle (lancet) puncturer 1 171.75 Nm,  
 (capillary tube) (heparine) 2 165.12 Nm, 3 166.75  
 25 Ml syringe-Pet Nm 1 가 2.9%  
 mmol/ , 100 1  
 175.93 Nm, 2 178.37 Nm,

2. ( : Nm)

	1	2	3	1 · 3
50	171.75 ± 52.13	165.12 ± 49.43	166.75 ± 48.40	2.9%
100	175.93 ± 50.15	178.37 ± 54.69	178.00 ± 51.12	1.2%
150	169.81 ± 48.36	168.93 ± 51.43	170.50 ± 47.68	.4%

2) Pola system, Sweden

3.

				F-
(A)	2464.875	2	1232.437	2.873
	12871.1	30	429.038	
(B)	68.625	2	34.313	.425
A × B	387.625	4	96.906	3.022*
	1923.708	60	32.062	

\* p < .05

4.

					( : Nm)
	1	2	3	1 · 3	
50	95.12 ± 28.70*	92.75 ± 30.17	91.06 ± 30.63		4.3%
100	92.87 ± 29.00	95.18 ± 33.26	93.93 ± 30.25		1.1%
150	90.62 ± 27.51	91.75 ± 24.46	90.06 ± 22.99		.6%

\* ±

3 178.00 Nm 1 4, 5 . 50  
 3 1.2% 가가 . 150 1 95.12  
 169.81 Nm, Nm, 2 92.75 Nm, 3  
 168.93 Nm, 170.50 Nm 1 91.06 Nm 1 3  
 3 0.4% 가가 . 4.3% , 100  
 1 92.87 Nm, 2 95.18  
 Nm, 3 93.93 Nm 1 · 3  
 , 1.1% 가 , 2  
 2.5% 가 2  
 . , 3 1.3% 가 .  
 150 90.62  
 (F(4, 60)=3.022, p<.05). 2 Nm, 91.75 Nm, 90.06 Nm  
 3 50 100 100 1 3 0.6%  
 150 가 .  
 (p<.01). 50  
 1 2  
 가 (p<.05). ,

가 .

5.

					F-
(A)	254.35	2	127.174		.663
	5757.20	30	191.907		
(B)	62.60	2	31.299		.774
A × B	137.19	4	34.299		1.245
	1653.25	60	27.554		

177.12 J, 3  
178.75 J, 182.50 J 1 3  
6, 7 . 50 3.0% 가가 .  
1 180.87 J,  
2 174.00 J, 3 177.43 J  
1 3 1.9% 가 .  
. 100 1 ,  
184.7 J, 2 182.75 J, 3 가 (p<.05).  
184.43 J 0.2% 150 1 100 150

6.

					( : J)
	1	2	3	1 · 3	
50	180.87 ± 57.18*	174.00 ± 60.63	177.43 ± 59.48	1.9%	
100	184.75 ± 56.59	182.75 ± 61.58	184.43 ± 57.95	.2%	
150	177.12 ± 60.39	178.75 ± 58.78	182.50 ± 59.42	3.0%	

\* ±

7.

					F-
(A)	1077.04	2	538.521		1.353
	11943.6	30	398.121		
(B)	238.17	2	119.083		.863
A × B	420.17	4	105.042		2.943*
	2141.17	60	35.686		

\*p<.05

8. ( : J)

	1	2	3	1 · 3
50	108.87 ± 37.79*	106.56 ± 38.35	102.68 ± 38.34	5.7%
100	106.81 ± 37.36	109.56 ± 41.80	106.25 ± 38.05	0.5%
150	105.62 ± 36.68	106.43 ± 32.18	103.25 ± 29.04	2.2%

\* ±

9.

	F-			
(A)	145.125	2	72.56	.323
	6746.8754	30	224.9	
(B)	342.167	2	171.08	3.431*
A × B	158.958	4	39.74	1.368
	1743.042	60	29.05	

\*p<.05

가 (p<.01). 가 , 3 2.2% 가  
 2 3 50 100 .  
 (p<.01). 50 1 가 ,  
 2 가 ,  
 (p<.05). (p<.05). 가  
 .  
 8, 9  
 . 50 1  
 108.87 J, 2 106.56 J, 3  
 102.68 J 1 3 5.7% 10, 11  
 가 . 100 . 50 1  
 1 106.81 J, 2 109.56 944.12 J, 2 907.62 J, 3  
 J, 3 106.25 J 1 2 876.25 J 1 3 7.2%  
 2.6% 가가 , 3 . 100  
 0.5% . 150 1 974.18 J, 2 950.00 J, 3  
 103.25 J 1 2 0.8% 947.06 J 1 3  
 2.8% 가 150

10. ( : J)

	1	2	3	1 · 3
50	944.12 ± 252.78*	907.62 ± 224.67	876.25 ± 218.72	7.2%
100	974.18 ± 267.07	950.00 ± 263.98	947.06 ± 242.62	2.8%
150	912.43 ± 275.31	925.75 ± 267.07	921.87 ± 247.77	1.0%

\* ±

11.

				F-
(A)	60286.6	2	30143.3	3.463*
	26116.3	30	8705.446	
(B)	19597.5	2	9798.771	2.250
A × B	25919.2	4	6479.802	7.991*
	48652.1	60	810.869	

\* p < .05

912.43 J, 925.75 J, 12, 13  
 921.87 J 1 3 1.0% . 50 1  
 가가 . 525.56 J, 2 492.43 J, 3  
 460.81 J 1 3  
 12.3% . 100  
 (F(2, 30)=3.463, p<.05), 1 519.81 J, 2  
 가 . 511.43 J, 3 505.06 J 1  
 2 1.6% , 3  
 2.8% 가 . 150  
 (F(4, 60)=7.991, p<.001). 511.00 J, 505.31  
 J, 491.43 J 1 3  
 . 3.8% 가 .

12. ( : J)

	1	2	3	1 · 3
50	525.56 ± 197.70*	492.43 ± 198.19	460.81 ± 177.40	12.3%
100	519.81 ± 199.45	511.43 ± 190.33	505.06 ± 183.35	2.8%
150	511.00 ± 180.57	505.31 ± 163.48	491.43 ± 161.95	3.8%

\* ±



13.

				F -
(A)	8816.8	2	4408.40	.959
	137851	30	4595.03	
(B)	26188.5	2	13094.3	7.645**
A × B	12349.4	4	3087.35	12.974*
	14277.7	60	237.96	

\* p<.01 \*\* p<.001

(p<.05). 3 50 100  
가 . , 50 150  
가  
(p<.01), (p<.01).  
가  
(p<.001). 50 1 · 2 · 3 2.  
(p<.01). 150 1 가.  
3  
가 (p<.05). 2 50 100 가 14, 15

14.

( : beats/min)				
		1	2	3
50	68.18 ± 6.24*	115.75 ± 18.64	127.18 ± 17.69	129.06 ± 17.69
100	69.06 ± 6.55	126.75 ± 18.08	129.06 ± 17.63	133.68 ± 17.42
150	70.75 ± 6.38	119.81 ± 21.11	126.62 ± 21.24	130.37 ± 20.79

\* ±

15.

				F -
(A)	684.042	2	342.02	2.354
	4359.625	30	145.32	
(B)	120190	3	40063.2	159.620*
A × B	594.208	6	99.04	2.995*
	2976.125	90	33.07	

\* p<.05

16. ( : mmol/ )

		1	2	3
50	0.73 ± 0.21*	0.93 ± 0.42	1.59 ± 0.52	2.18 ± 0.76
100	0.79 ± 0.28	0.95 ± 0.36	1.87 ± 0.68	2.21 ± 0.83
150	0.78 ± 0.28	0.95 ± 0.42	1.85 ± 0.62	2.19 ± 0.89

\* ±

17.

				F-
(A)	.373	2	.186	1.384
	4.04	30	.135	
(B)	65.77	3	21.923	45.519*
A × B	.49	6	.082	1.606
	4.60	90	.051	

\* p < .001

. 50  
 68.18 beats/min, 1 115.75 가 (F(6,90)=2.995, p<.01). 50 , 100  
 beats/min, 2 127.18 beats/min, 3 , 150  
 129.06 beats/min 1,2,3 가  
 가 (p<.01). 50  
 가가 . 100 1 2,3  
 69.06 beats/min, 1 가 (p<.01). 100 150  
 126.75 beats/min, 2 129.06 beats/min, 1 3 가  
 3 133.68 beats/min 가가 (p<.01), 1  
 가 50 100 가 (p<.01). 100  
 가 . 150 가 (p<.01). 100  
 70.75 beats/min, 119.81 150  
 beats/min, 126.62 beats/min, 130.37 beats/min (p<.01).  
 가  
 가 .  
 가 .  
 가 . , 16, 17 . 50  
 (F(3, 0.73 mmol/ , 1  
 90)= 159.620, p<.001), 0.93 mmol/ , 2 1.59 mmol/ , 3

18. ( : mmHg)

		가	
50	122.31 ± 13.6*	152.25 ± 25.76	24.5%
100	117.25 ± 14.03	144.12 ± 21.60	22.9%
150	116.93 ± 15.40	141.12 ± 26.80	20.7%

\* ±

2.18 mmol/ 가 18, 19 . 50  
 가가 . 100 122.31  
 0.79 mmol/ , 1 mmHg, 152.25 mmHg 24.5%  
 0.95 mmol/ , 2 1.87 mmol/ , 3 가 , 100  
 2.21 mmol/ 117.25 mmHg,  
 가 144.12 mmHg 22.9% 가 가 . 150  
 가가 . 150 116.93  
 0.78 mmol/ , 0.95 mmHg, 141.12 mmHg  
 mmol/ , 1.85 mmol/ , 2.19 mmol/ 20.7% 가 가 .  
 가  
 가가 .

가

(F (1, 30)=124.242, p<.001).

가

(F (3, 90)=45.519, p<.001).

20, 21 .

19.

		F-		
(A)	1219.021	2	609.510	2.137
	8558.312	30	285.277	
(B)	17496.0	1	17496.0	124.242*
A × B	132.437	2	66.219	.672
	2954.229	30	98.474	

\*p<.001

20. ( : mmHg)

50	76.25 ± 8.58	85.18 ± 16.24
100	72.93 ± 10.64	85.75 ± 9.25
150	77.68 ± 7.47	85.75 ± 16.23

\* ±

21.

				F
(A)	91.00	2	45.500	.442
	3088.33	30	102.94	
(B)	2370.09	1	2370.09	28.723*
A × B	102.25	2	51.125	.796
	1926.41	30	64.214	

\*p<.001

50 mmHg, 76.25 mmHg, 85.18 mmHg, 11.7%  
가 , 100  
72.93 mmHg, 85.75 mmHg,  
mmHg 17.6%가 가 . 150  
77.68 mmHg,  
85.75 mmHg 10.4%가 가  
가  
Jones (1990) Kowalchuk (1988)  
, , 가  
, K<sup>+</sup>, Ca<sup>++</sup>, Mg<sup>++</sup>, Cl<sup>-</sup>  
pH  
가 (p<.001).  
Green (1995) Sahlin (1992)  
H<sup>+</sup> 가  
Ca<sup>++</sup>  
K<sup>+</sup> 가,  
K<sup>+</sup> , K<sup>+</sup>

가  
 가 (Cairns Dulhunty, , ,  
 1995; Lindinger , 1995). Allen (1995)  
 Williams Klug(1995)  
 , Bilcheck (1993)  
 170 120°/sec 30  
 3  
 . Touey  
 (1994) 60 180°/sec  
 (Boska , 1990; Douris,  
 1993; Spriet, 1995; Takahashi , 1995;  
 Tesch, 1980). 120  
 Davies (1985) 30 , 60 Aiki 90  
 10  
 Keizer, 1988). , , 90 30 60  
 가  
 90  
 . Pincivero  
 (Baker , (1998) 60°/sec 40  
 1993; Edman Lou, 1992; Miller , 1987). 160 2가 40  
 ,  
 , 가 , 160  
 가  
 ,  
 40  
 12.8 19.0%, 160  
 2.2 5.7%  
 (Jones, 1992; Kraemer , 1996). 50  
 H<sup>+</sup> 4 2.9%, 4.3%,  
 10 150  
 (Hermansen Osnes, 1972; Saltin, 1990). 0.6% 가  
 60  
 가  
 , - pH , , 150  
 가 0.4% 100  
 (Gordon , 1994; Kraemer , 1990). 1.2% 1.1% 가가  
 . 100 150

가 89%, 94% 84%

가가 3

Sewall Lander(1991) 16 Greer (1984) 5

60 · 180 · 300 100%

600 bench press 10

10

가 50 가 가 100%

100 · 150 75%

(Stull Clarke, 1971)

Hannel (1967)

(p<.05).

Scharf (1994) 25 가 가 가

21 30°/sec 가 60°/sec Scharf (1994) 가

가 92%

, Douris(1991) 21 (1996) 114 mmHg

40 10 60°/sec

1 130 mmHg, 0°/sec 128.2 mmHg, 180°

가 73% 92% /sec 20 136 mmHg

(1996) 22 31 60° 14%, 12% 19% 가

/sec 180°/sec 4 가 74 mmHg

4.3% (77 mmHg), 2.7% (76 mmHg)

2.9% (76 mmHg) 가

가 75 50

24% 12%, 100 23%

60°/sec 120 , 180°/sec 18% 150 21% 10%

107 가 가가

59% 44%

가 180°/sec

20 142 91%

가

(1996) 20 (Duchateau , 1987; Horita Ishiko, 1987;

60°/sec 10 Nakamaru Schwartz, 1972; Tesch, 1980).

Sahlin(1986) ATP

75

124 66% 가

가

가 .  
 ,  
 가 , ,  
 ,  
 (Kraemer , 1990;  
 McMillan , 1993; Rozenek , 1993; 가  
 Warren , 1992). (1994) , 50 ,  
 10, 30 10 100 , 150  
 10  
 10 가 50  
 30  
 . (1999)  
 , 1RM (repeat maximum) 90%  
 180 가  
 5  
 가 가 5  
 4 mmol/  
 Keul (1976) , 가  
 5 , 2 ,  
 4.5 mmol/  
 Guezennec (1986) 50 16  
 4  
 bench press  
 5.3 mmol/  
 . Tesch Larsson(1982) 1.  
 4 10  
 / , 1 , 6 ,  
 13.3 mmol/ 가  
 .  
 Kraemer (1990) 180 가 (p<.05),  
 5 7 mmol/ 가 (p<.05) (p<.01)  
 60 120 가  
 9 14 mmol/ 가  
 50 2.18 mmol/ , (p<.05) (p<.001)  
 100 2.21 mmol/ 150 2.19 가  
 mmol/ 2.

가 . 가 . (p<.001). , 1992;17:205- 217.

가 (p<.01). . 1998; 22:934- 943.

. 1996;20:721-727.

. 1994;33:444-452.

1991.

, 1997;8:1:121- 128.

. 1

, 1997;1-28.

가

. 1999; 12 504-512.

, 1997. 1

( ). . 1995.

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