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The effect of prior heavy back squat exercise and sled towing on 40 meter maximal sprint performance.

Speciale af Nicholas Krobath Olesen

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Synopsis:

Twelve Danish athletic sub-elite sprinters (six female and six male) were tested to determine the acute effect of a heavy back squat and sled towing, on 40 meter maximal sprint performance. The study consisted of a repeated measures design with three experimental conditions. During the control (CON) intervention, the participants performed a 30 minutes warm up, then a six minutes rest before performing a 40 meter maximal sprint test. For the squat intervention (SQ), the participants performed a 30 minutes warm up then one set of three repetitions 90% of one repetition maximum (1RM). The participants then had a six minutes rest before performing a 40 meter maximal sprint test. For the sled towing intervention (SL), the participants performed a 30 minutes warm up then a 15 meter maximal sled towing sprint. The participants then had a six minutes rest before performing a 40 meter maximal sprint test. The results showed no significance between the three interventions P=0.146 in the ANAOVA test

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Navn og dato

The effect of prior heavy back squat exercise and sled towing on 40 meter maximal sprint performance.

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Abstract

Twelve Danish athletic sub-elite sprinters (six female and six male) were tested to determine the acute effect of a heavy back squat and sled towing, on 40 meter maximal sprint performance. The study consisted of a repeated measures design with three experimental conditions. During the control (CON) intervention, the participants performed a 30 minutes warm up, then a six minutes rest before performing a 40 meter maximal sprint test. For the squat intervention (SQ), the participants performed a 30 minutes warm up then one set of three repetitions 90% of one repetition maximum (1RM). The participants then had a six minutes rest before performing a 40 meter maximal sprint test. For the sled towing intervention (SL), the participants performed a 30 minutes warm up then a 15 meter maximal sled towing sprint. The participants then had a six minutes rest before performing a 40 meter maximal sprint test. The results showed no significance between the three interventions P=0.146 in the ANAOVA test.

Key words: Postactivation potentiation, sprinting, heavy back squat, sled towing.

Introduction

Recent research has shown that performing muscular contractions under near maximal load conditions improves subsequent performance during movements requiring large muscular power outputs of the stimulated muscle groups. These increases in performance have been attributed to a postactivation potentiation (PAP) (1,2,3,4).

PAP is defined as an increase in the contractile ability of muscle after a bout of previous contractions. Therefore, PAP may enhance the capacity of muscle to produce more force at a faster rate following subsequent muscle contractions. This means that performance in a vertical jump or sprint may be enhanced following a set of, heavy back squats (5,6,7,8,9,10,11).

One of the underlying biochemical processes responsible for these changes in phosphorylation of regulatory light chains, which occurs as a result of the calcium (Ca^{2+}) release during the initial muscle contraction, which make the protein filaments actin and myosin more sensitive to the release of calcium (Ca2+), and this triggers a cascade of events to enhance the muscle response. This means the force of the each successive twitch contraction is increased. The most important muscle characteristic affecting the magnitude of PAP is fiber type. The greatest potential for enhanced PAP is in muscles with the highest proportion of Type II fibers.

The recruitment and expression of the high order motor units offer a secondary mechanism to explain PAP response of muscles.

Contractile activity produces both fatigue and PAP, and it is the balance between the two that determines whether the subsequent contractile response is improved, diminished, or unchanged (12).

The heavy back squat exercise has proven to be an effective exercise for improving athletic performance and also sprint performance (10).

Several studies have also examined sprint performance following a high force heavy back squat intervention (5,6,7,8,9,10,11). McBride et al. (8) assessed 40-meter sprint performance in collegiate football players and reported a decrease in completion time subsequent to 1 set of 3 back squat repetitions at 90% 1RM. In similar fashion, Yetter and Moir (5)found increased speed during the 10-20 and 30-40 meter intervals of a 40-meter sprint after a back squat intervention consisting of 5 repetitions at 30% 1RM, 4 repetitions at 50% 1RM, and 3 repetitions at 70% 1RM in football, track and field, and weightlifting athletes. Though the quantity of research investigating linear speed and acceleration after a potentiating exercise, it appears that a heavy back squat could potentially reduce sprint times (5).

Whereas squat has been investigated in several studies, the amount of studies with focus on the acute effect of sled towing is none. All of the studies are focusing on the changes in the kinematics during sprints, with sled towing (19-20).
Other studies have been focusing on the effect of resisted sprint after a training intervention (13,14,15,16,19).
Resisted sprint running is a common training method for improving sprint-specific strength (17-18). For maximum specificity of training, the athlete's movement patterns during the training exercise should closely resemble those used when performing the sport. There are several forms of resisted sprint methods, which are used in training (14,19). In this study, resisted sprint by sled towing will be used to achieve PAP. The use of heavy back squat is a well-known exercise for improving sprint performance. Even though it does not have the same resemble as resisted sprint
The reason why these two methods are interesting is because they can be used in sports were the athlete has to make only one all out performance. The study will be interesting for single-effort power sports (sprint, high jump, weightlifting etc.), where the athlete will do one powerful trail, to see if PAP are having a positive effect on the performance. The purpose of this study is to investigate the acute effect of performing heavy back squat and sled towing prior to performing a 40 meter sprint test.

It was hypothesized that both heavy back squat and sled towing would have a reduction on 40 meter sprint times.

Method and materials

Experimental Design

This study utilized a repeated measures design, incorporating a control condition (CON) and two different interventions conditions. One intervention was heavy back squat (SQ). And the other intervention was sled towing (SL). Testing was conducted using a randomized design, wherein participants acted as their own controls.

Participants

Twelve individuals participated in this study (six female and six male). The participants were Danish sub-elite track & field sprinters, who were active competitive athletes who specialized in sprints and hurdles events. The participants were competing at both Regional competitions and national competitions and from Aalborg Athletic & Motion.

Characteristic	Mean	SD
Age (Years)	20.1	3.3
Height (cm)	174.5	7.2
Body mass (kg)	66.3	7.1
1 RM (kg)	141.2	35.7
Track & Field experience (Years)	4.4	3.9
Competitions per year (average the last two years)	7.8	2.4
Total training experience (Years)	14.2	4.4

Table 1. Descriptive characteristics of the participants

The total training experience includes the other sports that the participants had competed in during their sports carrier before track & field. The sports that most of the participants had competed in were football, handball, badminton, swimming and gymnastics. But also sports as judo, water polo, dancing and weightlifting were among them.

Procedures

The participants participated in five test sessions:
The first session was when the participants had a one repetition maximum (1RM) heavy back squat determination session. The second session was a familiarization session the week before the subsequent test sessions, were the participants had four maximal 40 meter sprints, and a 15 meter maximal sprint sled towing, to get used to the tasks. The three PAP testing sessions (CON, SQ and SL) was performed in one week, with a day of rest between every session. The order of the PAP sessions was randomized across the participants. (Appendix)

The 40 meter tests were performed in spikes and the participants were told to do a standing start for the test and run as fast as possible during the test. The participants were also told to wear the same clothes at all days.

Strength testing

The heavy back squat was performed in a power cage. The pins in the power cage were adjusted to allow the subject to descend to the point where there was 90 degrees between Femur and Tibia. The feet's placements were parallel or close to parallel. This is a subjective assessment therefore the participants coach where present at the all the sessions, to make sure that the same depth were

reached during the heavy back squat. An attempt was considered successful when the movement was completed through a full range of motion without deviating from proper technique and form. Spotters were present to provide verbal encouragement and safety for the participants.

Picture 1: Demonstrates the heavy back **squat performed I the power cage**

1RM for the heavy back squat was determined using basically the protocol out-lined by Baechle and Earle (17). but with few adjustments in the amount of kg of increase.

The participants completed two sets with light weight to allow 5-10 repetitions. Increasing weight and doing one set 3-5 repetitions. Finally one set of 2-3 repetitions heavy weight. Then increasing the weight at near maximum weight and doing one attempt. If the attempt was successful an increase of 10 kg was made. If the attempt failed then the subject had one more attempt at the same weight. Fail again then the weight was reduced by 5 kg. The subject had one attempt at that weight.

Warm up

Before the SQ, SL and CON sessions the participants completed a standardized warm up. The warm up included 10 minutes jogging, followed 10 minutes dynamic stretch. After stretching 10 minutes sprint specific technique drills was performed before running two to four submaximal and maximal short sprints. Because the participants were their own controls, they were allowed to do their own routine during the dynamic stretching and during the sprint specific technique drills. The participants did the same routine at every test session.

CON, SQ and SL protocol

For the CON session the participants did the warm up. After the warm up there was a six minutes rest before the 40 meter maximal sprint test was performed.

For the SQ session the participants did the standardized warm up. The participants then changed shoes and walked to a free -weights room, rest period were about 2 minutes. In the free -weights room the participants performed one set of three reps. on 90 % of 1RM (1x3 90% of 1 RM) in the 90˚ back squat. After the heavy back squat exercise, the participants had six minutes rest, where they changed back to their spikes. After the rest period the participants performed a 40 meter maximal sprint test.

Picture 2: Demonstrates the 90 degrees between Femur and Tibia during the heavy back squat.

For the SL session the participants did the standardized warm up. After warm the participants performed a 15 meter maximal sprint sled towing. The weight of the sled was 12,6 % of body mass and was decided from the results from Alcaraz et al. (21) shown in table two. Alcaraz et al. (21) used results from Lockie et al. (20).

The equation used to calculate the load for the sled. % Body mass = (-1.96 x % velocity) + 188,99 where % velocity = the required training velocity as a percentage of maximum velocity (e.g., 90% of maximum). This study uses the load for 90% of maximum velocity.

Example of calculation with a participant weighing 65 kg.

12,6=(-1.96 x 90) + 188,99. Load for a participant 12,6% off body mass on the sled. 65kg*100/12,6=8,18 kg.

Table 2 illustrates the optimal load for sled towing during acceleration sprints. The athletes were performing a standing start, with the line to the sled

stretch out.
When the 15 meter sprint was performed, there was a six minutes rest period, before the participants performed a 40 meter maximal sprint test.

Individual body mass (kg)	Maximum velocity percentage		
	90%	92.5%	95%
120	15.11	9.23	3.35
115	14.48	8.84	3.21
110	13.85	8.46	3.07
105	13.22	8.07	2.93
100	12.59	7.69	2.79
95	11.96	7.31	2.65
90	11.33	6.92	2.51
85	10.70	6.54	2.37
80	10.07	6.15	2.23
75	9.44	5.77	2.09
70	8.81	5.38	1.95
65	8.18	5.00	1.81
60	7.55	4.61	1.67
55	6.92	4.23	1.53
50	6.30	3.85	1.40
45	5.67	3.46	1.26

Table 2: Tabel made by Alcaraz et al. illustrates the amount of kg. The participants need as resistance during sled
Towing.

Picture 3: Demonstrates the standing start performed with sled.

40 meter sprint measurement.

All three test sessions were completed between 5 pm. and 7 pm. The sprint tests were performed on a synthetic running track (Conipur SP. Spray Coating System, Schaffhausen, Switzerland).
Sprint times of the 40 meter test were measured using an infrared timing system (Eleiko Sport Tine-It, Halmstad, Sweden). Photocells were placed one meter wide from each other and a set at the starting line and one set at the finish line.
The cells were placed in the height of 70 cm at the start and in the height of 100 cm at the finish line. Participants were performing a standing starting 30 cm behind the first cell. The participants were at the starting line, they decided them self when they were ready and wanted to start the test.
Temperatures were measured by using a digital thermometer (TFA 30.1025 Vision, Denmark). Wind was measured for every test. It was measured by using a (Compact Wind Gauge, Torrance, USA). All tests were made at the same section of the track, and always in a direction that gave the participants tailwind at the three test sessions.

Statistical analysis

All statistical analyses were performed using the statistical software SPSS for Windows (version 19.0; SPSS Inc., Chicago, Ill.)
The Kolmogorov-Smirnov test was applied to evaluate whether data resembled a normal distribution. A one-way ANOVA with repeated measures was made. The α-value was set at $P < 0.05$ for all analyses.

Results

The Kolmogorov-Smirnov results indicated that all data were normal distributed.
I table 3 are the means and SD of the weight in the heavy back squat and also the weight of the sled in sled towing. Table 4 shows means and SD for the temperature measured during the test sessions. In table 5 are the means and SD for the tailwind measured during the test sessions.
A one way ANOVA with repeated measures was made on the results of temperature and tailwind. Temperature was not different p=0.23 neither was the tailwind different p=0.109.

	Kg. of heavy back squat (90% 1RM)	Kg. of sled
Mean	127.04	8.4
SD	32.09	0.9

Table 3: Mean and SD for the kg lifted in the heavy back squat and on the sled in sprint with sled towing.

Temperature. (˚C)	Con	SQ	SL
Mean	14.3	14.7	15
SD	2.1	2.0	1.8

Table 4: Mean and SD for the temperature for each intervention. Measured in Celsius.

Tailwind. m/s	Con	SQ	SL
Mean	1.02	0.93	1.03
SD	0.68	0.55	0.58

Table 5: M**ean and SD for the wind for each intervention. Measured in m/s.**

Sprint time was not different p=0.146. The results from the ANOVA indicated there were no significant differences between CON, SQ and SL intervention. Times for each subject, means and SD for all participants are shown in table 6.

	Time		
Subject	Con	SQ	SL
1	5.8	5.75	5.83
2	5.19	5.04	5.07
3	5.2	5.11	5.23
4	5.86	5.87	5.87
5	5.87	5.43	5.45
6	5.04	5.06	5.05
7	5.94	5.22	5.87
8	5.21	5.73	5.25
9	6	6.07	6.02
10	5.95	5.88	5.82
11	6.16	6.19	6.12
12	5.37	5.39	5.48
Mean	5.63	5.56	5.59
SD	0.40	0.41	0.38

Table 6: Times for each subject and mean and SD for all participants. Measured in seconds.

Discussion

The purpose of the present study was to investigate the acute effects of two different resistance exercises, heavy back squat and sled towing. The primary findings of this study indicate that there is no acute positive effect on sprint performance. By the measurement performed the wind and temperature could not have influence on the results performed by the participants. All the participants completed the repetitions in the SQ intervention and sprinted 15 meter sled towing following Alcaraz et al. guidelines (20,21). Previously, McBride et al. (8) reported that heavy back squats (3 x 90% 1RM) performed by strength-trained participants significantly reduced subsequent 40 meter sprint time during a single trial, whereas 10 meter and 30 meter sprint times were not significantly changed. Other studies have also shown a reduction in sprint times after performing the squat exercise(6,22).

A study suggest that to maintain load specificity in sprints, the horizontal velocity should not fall below 90% of the athlete's maximum velocity these guidelines were used in this study (21). It is important to keep in mind that the load applied to the athlete by a weighted sled depends on the coefficient of friction between the sled and the running surface and also on the weight of the sled. Therefore, the proposed equation is specific to the combination of sled and surface used in exactly that study (20,21). The present study does not consider the differences in the coefficient of friction between the sled and the running surface. Instead of following the guidelines from Alcaraz et al. (20,21). during the SL intervention, changes of kg. on the sled could perhaps have had a positive effect on the 40 meter sprint. If the weight of the sled had been heavier, perhaps the results would have been different. If the weight would have been heavier, kinematic during the sprint would be different. Stride length and frequents would change, and the hip angle could also be different (19). There are no studies there have investigated the acute effect of sled towing. All studies are training interventions. This area need further investigation, to clarify the acute effect of sled towing right before had maximal sprint.

Some points in the test protocol could have influence on the results. The six minutes rest that the participants had between the intervention and the 40 meter test could perhaps have been too long. The rest period in those studies that have found an effect doing back squat before sprinting have used four and five minutes (22). More than six minutes rest period have been used in other PAP studies.

In the present study, the factors that could have an effect on the results have been standardized in the protocol. The factors that are out of control such as wind and temperature have no significant difference between the three conditions.

Factors such as the participants' clothes and shoes, resting periods, weight in heavy back squat and on the sled, measurement equipment and the track was standardized in the protocol. The participants had resting days in between the test session, so there was no fatigue in the last test sessions. standardized the tests even more, the participants should have had guidelines for factors such as nutrition and work load during the days in the week were the tests were performed.

Even though the results are not significant, there are tendencies that show faster times in the SQ and SL intervention. The mean times for SQ are 5.56 seconds and for SL the mean is 5.59 seconds whereas the mean for CON is 5.63 seconds. This indicates that there perhaps can be a positive effect from PAP. However five of the twelve participants had the fastest time in the SQ intervention but five also had fastest time during the CON intervention, and two had the fastest time during the SL intervention.

In the present study, PAP did not have a positive effect on sprint performance. In conclusion a single set of 3 reps of 90% of 1RM, heavy back squats was not found effective in acutely enhancing a 40 meter maximal sprint. Neither was a 15 meter sled towing with the amount of weight recommended by Alcaraz et al. guidelines.

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References

1. Lorenz D. Postactivation potentiation: An introduction. Int. J. of sport. Psy. Therapy (6): 234-240, 2011

2. Robbins DW. Postactivation potentiation and its practical applicability: A brief review. J. Strength Cond. Res. (19): 453-458, 2005

3. Esformes JI., Cameron N. and Bampouras TM. Postactivation potential following different modes of exercise. J. Strength Cond. Res. (24): 1911-1916, 2010

4. Hodgson M., Docherty D. and Robbins D. Postactivation potentiation. Underlying Physiology and Implications for Motor Performance. Sports Med. (35): 585-595, 2005

5. Yetter M. and Moir GL. The acute effects of heavy back and front squat on speed during forty-meter sprint trails. J. Strength Cond. Res. (22): 159-165,2008

6.13-17 Rahimi R. The acute effect of heavy versus light-load squats on sprint performance. Phy Educ Sport (5): 163-169, 2007;

7. McBride, J.M., T. Triplett-McBride, A. Davie and R.U. Newton. The effect of heavy versus light load jump squats on the development of strength, power, and speed. J. Strength Cond. Res. (16):75–82. 2002.

8. McBride, J M, Nimphius, S, and Erickson, TM. The acute effects of heavy-load squats and loaded countermovement jumps on sprint performance. J Strength Cond. Res (19): 893–897, 2005.

9. Matthews MJ., Matthews HP, and Snook B. The acute effects of a resistance training
warmup on sprint performance. Research in Sports Medicine (12): 151-159, 2010

10. Crewther BT., Kilduff LP., Cook CJ., Middleton MK., Bunce PJ and Yang GZ. The acute potentiating effect of back squat on athlete performance. J. Strength Cond. Res. (25): 3319-3325, 2011

11. Guggenheimer JD., Dickin DC., Reyes GF. and Dolny DG. The effects of specific preconditioning activities on acute sprint performance. J. Strength Cond. Res. (23): 1135-1139, 2009

12. Rassier DE. and Macintosh BR. Coexistence of potentiation and fatigue in skeletal muscle. Braz. J. Med. Biol. Res. (33): 499-508, 2000

13. Spinks. CD, Murphy, AJ, Spinks, WL, and Lockie, RG. The effects of resisted sprint training on acceleration performance and kinematics in soccer, rugby union, and Australian football players. J Strength Cond Res (21): 77–85, 2007

14. Clark KP., Stearne DJ., Walts CT. and Miller AD. The longitudinal effects of resisted sprint training using weighted sleds vs. weighted vests. J. Strength Cond. Res. (24): 3287-3295, 2010

15. Upton DE. The effects of assisted and resisted sprint training on acceleration and velocity in division IA female soccer athletes. J. Strength Cond. Res. (25): 2645-2652, 2011

16. Paulson S. and Braun WA. The influence of parachute-resisted sprinting on running mechanics in collegiate track athletes. J. Strength Cond. Res. (25): 1680-1685), 2011

17. Baechle, TR, Earle, RW , and Wathen, D. Essentials of Strength Training and Conditioning . T.R. Baechle and R.W. Earle (eds.): Human Kinetics Publishers, 2000.

18. Gamble P. Training for speed and agility. An evidence approach: Routledge, 2011

19. Alcaraz, PE, Palao, JM, Elvira, JLL, and Linthorne, NP. Effects of three types of resisted sprint training devices on the kinematics of sprinting at maximal velocity. J Strength Cond Res (22): 890–897, 2008

20. Lockie, RG., AJ. Murphy and CD. Spinks. Effects of resisted sled towing on sprint kinematics in field-sport athletes. J. Strength Cond. Res. (17):760–767. 2003.

21. Alcaraz, PE, Palao, JM, Elvira, JLL. Determining the optimal load for resisted sprint training with sled towing. J Strength Cond Res (23): 480-485, 2009

22. Chatzopoulos DE, Michailidis CJ, Giannakos AK. Postactivation potentiation effects after heavy resistance exercise on running speed. J Strength Cond Res 2007 Nov; 21 (4): 1278-81

Appendix: Randomizering and Participant info

Randomisering

			Dag 1			Dag 2			Dag 3		
Navn	squat	slæde	SQ	SL	CON	SQ	SL	CON	SQ	SL	CON
1	135	3,17		5,83				5,8	5,75		
2	153	4,68	5,04				5,07				5,19
3	171	5,57	5,11				5,23				5,2
4	72	3,42		5,87				5,86	5,87		
5	139,5	3,55			5,87	5,43				5,45	
6	153	4,62			5,04	5,06				5,05	
7	130,5	3,36			5,94		5,87		5,73		
8	144	3,21	5,22					5,21		5,25	
9	90	3,05		6,02		6,07					6
10	99	2,67		5,82		5,88					5,95
11	81	3,68			6,16		6,12		6,19		
12	162	5,25	5,39				5,48				5,37

Participant	Age	Height	Weight	Squat Max	Competitions	Track & Field experience	Total training experience	kg on sled	kg in squat
1	27,1	165	60	100	6	14,6	18,6	7,55 (3,05)	90
2	17,7	178	72,5	170	11	2	4,3	9,12 (4,62)	153
3	18,6	168	65	90	4	1	10,2	8,18 (3,68)	81
4	23,8	184	77,5	180	12	5,4	19	9,75 (5,25)	162
5	25,6	186	80	190	6	0,5	20,5	10,07 (5,57)	171
6	18,1	178	61,3	160	9	4,3	13,1	7,71 (3,21)	144
7	18,9	174	62,5	145	6	1,6	15,2	7,86 (3,36)	130,5
8	15,5	165,5	57	110	10	4,7	10,5	7,17 (2,67)	99
9	22,6	173	65	135	7	0,5	13,2	8,18 (3,68)	121,5
10	21,6	170	64	155	8	4,6	16,9	8,05 (3,55)	139,5
11	19,3	174	63	80	6	5	13	7,92 (3,42)	72
12	20,6	168,5	61	150	10	7,2	17,4	7,67 (3,17)	135
14	19,1	185	73	170	6	6,2	12,2	9,18 (4,68)	153
mean	20,65385	174,5385	66,29231	141,1538462	7,769230769	4,430769231	14,16153846	8,374167	127,0384615
std	3,341062	7,24414	7,128167	35,65773912	2,420531834	3,788004007	4,43424899	0,92861	32,09196521
								kg/7,95	90% of 1RM

Appendix:

Time, Temperature and tailwind

Time			
Subject	Con	SQ	SL
1	5,8	5,75	5,83
2	5,19	5,04	5,07
3	5,2	5,11	5,23
4	5,86	5,87	5,87
5	5,87	5,43	5,45
6	5,04	5,06	5,05
7	5,94	5,73	5,87
8	5,21	5,22	5,25
9	6	6,07	6,02
10	5,95	5,88	5,82
11	6,16	6,19	6,12
12	5,37	5,39	5,48
Mean	5,6325	5,561667	5,588333
STD	0,396143	0,405055	0,378029

Wind	Con	SQ	SL
1	0,5	0,8	0,7
2	1,1	1,3	1,7
3	1,3	1,2	1
4	0,7	0,5	0,7
5	0	2	1,9
6	1,4	1	0,4
7	0	0,4	0,4
8	1,9	1,2	1
9	0,5	0	0,7
10	2	1,4	1,1
11	1,7	0,4	0,6
12	1,1	1	2,1
Mean	1,016666667	0,933333333	1,025
STD	0,684680859	0,546614927	0,577022136

Temp	Con	SQ	SL
	16	16	16
	16	16	16
	16	16	16
	16	16	16
	16	16	16
	16	16	16
	16	16	16
	12	16	16
	12	12	16
	12	12	12
	12	12	12
	12	12	12
Mean	14,33333333	14,66667	15
STD	2,059714602	1,969464	1,809068