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Can a Unilateral Lower Body-Training Program Increase Lower Body Power Output More than a Bilateral Lower Body Training Program?

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Abstract

(1) Introduction The purpose of this study was to analyze the effects of a unilateral or bilateral lower body training program on off ice power production. **(2) Methodology** Twenty NCAA Division 1 female hockey players were randomly assigned to either a unilateral (UNI) or bilateral (BI) group. The UNI training group performed all lower body exercises over a 6-week period using 1 leg at a time, while the BI performed all lower body exercises with both legs simultaneously. Both groups trained at the same rating of perceived exertion (RPE) two times per week throughout the training cycle. Subjects within the two groups participated in baseline and post intervention power testing in the Vertical Jump (VJ) and Standing Long Jump (SLJ). **(3) Results** Following the intervention, neither group showed statistically significant ($p \leq 0.05$) change. However, from a practical perspective the UNI group improved VJ on average 2.16 cm compared to the BI group average improvement of 0.56 cm. The UNI group improved on SLJ by an average of 7.75 cm versus the BI group improvement of 3.81 cm. **(4) Discussion** The results concluded that neither UNI nor BI training groups produced significant improvements in testing measures. **(5) Conclusion** Unilateral and bilateral training may both be effective in training for lower body power production. This study alludes to the need to continue to perform research on UNI and BI lower body training in order to most effectively trains the female hockey player.

Key words: Unilateral, bilateral, power

Introduction

Women's ice hockey is a fast paced, high-intensity intermittent sport that places a high physical, metabolic, and biomechanical demand on those competing in the sport (28). Participation in the sport has grown exponentially over the last 25 years. From 1990-2010, participation rates in women's hockey have increased by over 900% (28). Since the 2010 Winter Olympics in Vancouver, participation rates have increased an additional 36% with over 70,000 women and girls participating in hockey in just the United States alone (23). Participation rates in Canada increased 59% between the years 2002 to 2013 alone (18). With the increase in participation, the competition for success has drastically increased. More and more young women are vying for Division I Scholarships, many with aspirations to compete at the National and Olympic levels. As of 2016, there were 825 women playing NCAA Division I Hockey; 59% coming from the United States and 41% coming from Canada and Europe (18). With over 70,000 participants in the United States and only 825 possible roster spots available, the desire to find a competitive advantage is at an all time high.

As much has been researched about the on-ice success of women's hockey players, more research needs to be developed in order to continue to improve the on ice product. As success is achieved on the ice at the collegiate and international level, the excitement around the game will continue to grow leading to more participation and greater competition. Eventually that may lead to participation rates of over 100,00 girls and women participating throughout USA Hockey (23). With the increased level of competition, the need to find a competitive advantage in order to succeed will only grow.

It is here that the sport of ice women's hockey will benefit from the advances in the strength and conditioning field and the research that goes along with it.

Throughout this literature review, the demands of the sport of ice hockey including skating power and attaining it will be discussed. In addition, the concept of the bilateral deficit, developing lower body power, and the use of RPE will be examined.

Demands of the Sport

Ice hockey is an intermittent sport that is marked by periods of high speed, acceleration, change of direction, and periods of low to moderate intensity skating (20). It is the fastest moving team sport, as skating speeds of 30 mph have been attained by senior amateur players, and players as young as 12 years old regularly reach speeds of 20 mph (26). With playing speeds of this magnitude, it is necessary to have both upper body and lower body strength in order to safely absorb the forces produced between players themselves as well as between players and the boards (28).

Upper and lower body strength is not only a prerequisite to help keep hockey players safe during play, but it is also a basis for producing the force and power needed to be successful on the ice. Skating is the most basic skill required in order to compete in hockey. It demands the rapid acceleration and deceleration of one's body as well as making quick, agile turns and sharp changes in direction (10). Since skating takes place on a thin metal blade on a slick ice surface, balance and stability must be attained (3).

Ice hockey places a high demand on all three energy systems throughout the course of a competition. A majority of the game, roughly 84%, is spent in a low to moderate intensity. Despite this, the average shift reached heart rates of 92-96% of their maximum during a shift ranging 32 – 54 seconds (20). This requires a strong foundation of the aerobic energy system as well as a well-developed phosphocreatine (P-Cr) system in order to keep up with the high demands of the sport.

Skating Power

Skating power is so vital to the sport of hockey that some National Hockey League scouts believe that it is the single greatest predictor of an individual's hockey potential (5). Skating, unlike sprinting, requires force to be placed into the ice for a longer period of time and in a diagonal pattern versus the dynamic linear pattern of sprinting. Sprinting success is due in part to an efficient stretch shortening cycle whereas skating success is more dependent on the production of impulsive forces. This could mean that, for hockey players, maximum strength may be a more important quality to develop than reactive strength (3). When developing power for the ice hockey player, the direction of the forces produced on the ice need to be taken into consideration for the skaters off-ice training program. While on the ice, hockey players create power in both a lateral and diagonal manner, as opposed to the typical double leg frontal power that is developed in most strength and conditioning training programs (29).

Developing Power

According to Ransdell, Murray, & Gao (28), athletes from the dominating countries in women's hockey, USA and Canada, had higher levels of lower body power than athletes from countries that have not attained international success. These athletes demonstrated 6-12% higher values in lower body power tests including the vertical jump and standing long jump. This has developed from strength and conditioning programs focusing on the development of lower body strength and power. Off-ice training is essential for the development of the skills needed to enhance athletic performance and success in the sport of ice hockey (2). Strength and conditioning programs that place an emphasis on resistance training and plyometric jump training through bilateral and unilateral pushing and pulling means aid in the development of power production when skating, which translates to better performance on the ice (28).

Plyometric jump training exercises have long been used to enhance lower body power production during strength training. In order to perform plyometric training, optimum levels of both muscular strength and coordination must be obtained, as plyometric movements are technical in nature (8). Once a foundation of strength has been established, training that focuses on maximal power can play a major role in improving athletic performance. Balsalobre-Fernández et al. (2), found that a 10-week training period focused on maximum power significantly improved maximum strength, jump height, and 30 meter sprint performance all while improving maximum power output.

Bilateral Deficit

The bilateral deficit is a training concept in which the total forces that are produced by the limbs simultaneously are less than the sum of the total forces produced individually (31). EMG readings of the primary movers during maximum voluntary contractions were found to be lower during bilateral training when compared to the findings of the unilateral training group, suggesting motor unit recruitment to be greater in unilateral exercises (36). Since there is a reduction in activation during bilateral contractions, unilateral training may lead to a greater increase in strength development and hypertrophy of working skeletal muscles (31). Unilateral training allows for an individual to exercise with a greater load per limb versus its bilateral counterpart, which allows for a greater development of muscular adaptations. In one study with 43 young women, it was found that the unilateral training group had a 10% increase in maximal knee extensor contraction versus a 3% increase from the bilateral training group over a 12-week training period (4).

Strength development is not the only scenario in which the bilateral deficit has been made apparent. With regards to power development, it has been shown that the combined power and height produced on a vertical jump bilaterally was less than that of the sum of vertical jumps performed unilaterally (1). When it comes to change of direction speed and sprinting, unilateral jumps in a horizontal motion had a significant positive relationship, whereas bilateral horizontal jumping did not (7,17). Unilateral power training provides an increase in movement specificity during team sport activity and therefore may be preferable when looking to improve performance (33).

Bilateral Deficit in Skating

In the sport of ice hockey, a majority of the game takes place while skating in a forward glide with both skates in contact with the ice (20). Despite both skates often being in contact with the ice, nearly 80% of that time is spent with the athlete’s body weight shifted onto a single leg (16). When turning, both skates are often in contact with the ice, however the outside leg will typically undergo greater forces than the inside leg as it is the primary supporting leg (9).

Since the forces absorbed and produced while skating typically occur on a single leg, the skills needed to succeed while skating also require unilateral strength and power (28). Balance, which plays a significant role in the sport of hockey, was significantly associated with skating speeds of players (3). With the amount of time the hockey player spends predominantly on one leg, they develop significant levels of unilateral power in the diagonal and lateral planes (28). With the constant stress that is placed upon them in this manner, the hockey player must have a strong foundation of unilateral strength in order to withstand the multidirectional forces placed upon their legs during play. This underlying strength a player has will be the limiting factor to how well a player can potentially perform in a high paced technical setting (16).

RPE

Rating of Perceived Exertion (RPE) is a scale from 1-10 used to measure how difficult the performance of a given task is (35). RPE allows the individual to auto regulate their training loads based upon how difficult the weight felt at that time (35).

	1	2	3	4	5	6	7	8	9	10
10	100%	96%	92%	89%	86%	84%	81%	79%	76%	74%
9.5	98%	94%	91%	88%	85%	82%	80%	77%	75%	72%
9	96%	92%	89%	86%	84%	81%	79%	76%	74%	71%
8.5	94%	91%	88%	85%	82%	80%	77%	75%	72%	69%
8	92%	89%	86%	84%	81%	79%	76%	74%	71%	68%
7.5	91%	88%	85%	82%	80%	77%	75%	72%	69%	67%
7	89%	86%	84%	81%	79%	76%	74%	71%	68%	65%
6.5	88%	85%	82%	80%	77%	75%	72%	69%	67%	64%

Figure 1. RPE: Intensity relationship chart used in Reactive Training Systems (35)

In traditional strength training, training loads are often prescribed based on a percent of an individual athlete's 1 repetition max (1RM) (11). Often times, following the completion of an exercise, athletes provide an RPE in order to quantify how much effort was required to complete said lift (30). According to Tuchscherer (35), percentage based training programs are limited in how accurate they can be. Percentage based training is reliant on the accuracy of the 1RM that an individual is programming off of. If a training cycle goes weeks to months without retesting a 1RM, then the percentage the athlete may be working off of may no longer be the desired percentage (35).

Often times, 1RM testing may not be practical given the training population or time constraints. In this situation, prescribing loads based off of an individual's RPE may be the most accurate way to reach desired outcomes (30). Since an athlete provides an RPE based upon their own perception of training, both physical and psychological stress can be accounted for, thus providing an even more accurate depiction of the training load placed upon them (19).

Throughout a training period, tracking external training loads has become the way to monitor appropriateness of a training program (19). In recent years, researchers and sports performance coaches have begun tracking internal training loads, the amount of stress perceived by the body, in order to find out what type of effect their training is having on the individual (25). However, the devices used to do so are costly and require experts to properly analyze the data. A 2004 study found that quantifying internal training loads could be easily calculated by multiplying the RPE of a training session by its duration. This not only produced a valid quantifiable number, but was also simple and cost efficient (19). This information can be used to determine if the stress that is being placed upon the body matches what the program is intending. For example if the goal of a training phase is to improve power output, the information gathered using RPE should match the external load being placed on the athlete.

Conclusion

Ice hockey is the fastest played team sport in terms of the velocities players reach during competition (26). As advances in training continue to develop, the speed of the sport is only going to continue to grow. The requirements for increased speed, explosive leg power, skating efficiency, change of direction speed, and turning capability will also be greater. Therefore, the expectations placed upon the strength and conditioning coach for player development will continue to increase (10,28).

As recent research has shown, off-ice training variables strongly correlate to on-ice sprint speed, specifically vertical jump heights, standing long jump distances, and 30-meter sprint times (10). Even more apparent is the evidence of on-ice acceleration and horizontal and lateral power output (10). Said acceleration occurs in more of an impulse manner as opposed to traditional sprinting, which utilizes the stretch shortening cycle (5). This only increases the need to develop a foundation of lower body maximal strength, particularly in a unilateral fashion (28).

As strength and conditioning professionals continue to push the training envelope with athletes, more innovative techniques will continue to be developed. It may seem as though training bilaterally is a staple for the future, as it is the way training has traditionally been performed. However, the use of unilateral training, specifically within the hockey playing community, has increased in recent years. The purpose of this study is to determine if unilateral training can produces lower body power at a higher rate than traditional bilateral training. It is hypothesized that unilateral training will indeed be more effective than bilateral training, thus changing the landscape for the future training of elite level hockey players.

Methods

Study Design

A randomized controlled 6-week study was used in order to determine if a unilateral lower body-training program will produce a higher lower body power output than a bilateral lower body training program. A total body strength and conditioning program will be utilized during this intervention. During the intervention, the lower body portion of the training program was either completely bilateral or completely unilateral. Power can be expressed in a multitude of ways. For the sake of this study, it will be expressed as height of a vertical jump and distance of a standing long jump, both measured in centimeters. It is suggested that unilateral training may recruit more muscles than its' bilateral training counterpart, and therefore, will increase strength, which in turn will increase power at a greater rate than bilateral training.

Participants

After receiving approval from the Merrimack College IRB, the members of the Merrimack College Division 1 Women's Hockey Team were recruited and provided written consent to be participants in the study. Twenty female athletes between the ages of eighteen and twenty-one were recruited to participate. The 6-week intervention took place in the Merrimack College Strength and Conditioning Center during a portion of the team's in-season training. The players were recruited through permission of the women's hockey coaching staff. The subjects participated in strength training at least two times per week and were all physically cleared to participate within this study. The participants were considered advanced lifters, as they had all been strength training for a minimum of two years prior to the beginning of this study. All subjects were in the in-season period of their strength and conditioning program and participated in three to four hockey practices and two games each week.

Nineteen of the twenty members of the Merrimack College Women's Hockey team that were recruited for this study completed the entire intervention. One player came down with an illness, which didn't allow her to complete the protocol.

Measures

The purpose of this study was to see if unilateral lower body training would increase power output at a greater rate than bilateral lower body training. Prior to the study, subjects were measured on their vertical jump heights and standing long jump distances. Subjects had three attempts at each exercise and the highest height and furthest distance were recorded in centimeters. These numbers served as their baseline scores.

Power Output

Vertical jump tests as well as standing long jump tests are often used in the strength and conditioning field in order to determine anaerobic power for hockey players (5). The greater the amount of maximal anaerobic power produced by the legs, the higher the vertical jump height and the further the standing long jump distance.

A Vertec was used to measure the vertical power produced by the athlete. Each athlete performed three countermovement vertical jumps, the best height of the three were recorded. Following the 6-week intervention, the athletes performed another three countermovement vertical jumps, with the highest height being recorded.

A tape measure taped to the floor was used to measure the horizontal power produced by the athlete. Each athlete performed three countermovement standing long jumps. The furthest distance of the three was recorded. Following the 6-week intervention the athletes performed another three countermovement standing long jumps, with the furthest distance being recorded.

To complete the vertical jump, the athlete stood on a flat rubber surface with their feet in a comfortable athletic position. They performed a countermovement by reaching their hands as high as they can, followed by rapidly bring them back behind their hips, sinking their legs into a quarter squat. They then performed a maximal effort vertical jump using their arms to propel them upward towards the highest tic mark they could reach on the Vertec.

To complete the standing long jump, the athlete stood on a flat rubber surface with their feet in a comfortable athletic position. They performed a countermovement by reaching their hands as far forward as they could, followed by rapidly bringing them back behind their hips, sinking their legs into a quarter squat. They then performed a maximal effort standing long jump using their arms to propel them outward as far as they could, landing in a quarter squat.

Procedure

The subjects had been familiarized with all of the exercises that were incorporated within the intervention. Rating of Perceived Exertion (RPE) was used to determine training load for the six weeks leading up to the intervention. During the six-week intervention, all subjects completed the same warm-up, mobility, upper body, core, and cool down exercises. The differences in the training program between the unilateral and bilateral groups occurred within the lower body plyometrics, loaded power exercises, and strength based exercises.

First 3 Weeks

The first three weeks of the training program looked to improve maximal strength while still addressing power qualities. Plyometric exercises took place following a standard dynamic warm-up. Plyometric exercises were not determined by an RPE scale, as there is no external load. The subjects were instructed to perform each repetition with maximal effort. Subjects performed the plyometric exercises for 3 sets of 5 repetitions during all three weeks. (Table 1)

Table 1. Weeks 1-3 Sets and Repetition Scheme for Plyometric Exercises

Plyometric Exercises		
Week #	Sets	Reps
1	3	5
2	3	5
3	3	5

During this period, loads for power exercises were determined based off an RPE of 7 out of 10. The subjects performed 3 sets of 3 reps in weeks one and three, and performed 4 sets of 3 reps during week two. (Table 2)

Table 2. Weeks 1-3 Sets Repetition and RPE Scheme for Power Exercises

Power Exercises			
Week #	Sets	Reps	RPE (10 Scale)
1	3	3	7
2	4	3	7
3	3	3	7

The loads for strength exercises were determined based off an RPE of 7 for week one and 8 for weeks two and three. The subjects performed 4 sets of 5 in week one, 5 sets of 4 in week two, and 4 sets of 4 in week three. (Table 3)

Table 3. Weeks 1-3 Sets Repetition and RPE Scheme for Strength Exercises

Strength Exercises			
Week #	Sets	Reps	RPE (10 Scale)
1	4	5	7
2	5	4	8
3	4	4	8

Final 3 Weeks

The final three weeks of the training program aimed to address maximal power output. The plyometric exercises took place following the standard dynamic warm-up and were not determined by an RPE scale. Subjects were instructed to perform each repetition with maximal effort. Sets and repetitions for all three weeks were 3 sets of 3 repetitions. (Table 4)

Table 4. Weeks 4-6 Sets and Repetition Scheme for Plyometric Exercises

Plyometric Exercises		
Week #	Sets	Reps
4	3	3
5	3	3
6	3	3

The external loads for the power exercises during this period were 6 out of 10 on the RPE scale. Subjects performed 3 sets of 3 repetitions in week four, 4 sets of 3 repetitions in week five, and 4 sets of 2 repetitions in week six. (Table 5)

Table 5. Weeks 4-6 Sets Repetition and RPE Scheme for Power Exercises

Power Exercises			
Week #	Sets	Reps	RPE (10 Scale)
4	3	3	6
5	4	3	6
6	4	2	6

The loads for the strength-based exercises were performed at an RPE of 6 for the final three weeks of the training program. Subjects performed 4 sets of 4 repetitions in week four, 5 sets of 3 repetitions in week five, and 6 sets of 2 repetitions in week six. (Table 6)

Table 6. Weeks 4-6 Sets Repetition and RPE Scheme for Strength Exercises

Strength Exercises			
Week #	Sets	Reps	RPE (10 Scale)
4	4	4	6
5	5	3	6
6	6	2	6

Exercise Selection

During the course of the six-week intervention, the athletes in the bilateral group performed 4 lower body exercises per day, 2 plyometric exercises, 1 loaded power exercise and 1 loaded strength exercise. The loaded power exercise and loaded strength exercise differed between training days 1 and 2, but the plyometric exercise remained constant. (Table 7)

Table 7. Daily Bilateral Lower Body Exercise Selection

Bilateral Exercise Selection		
Category	Day 1	Day 2
Plyometric	Hurdle Jump	Hurdle Jump
Plyometric	Standing Long Jump	Standing Long Jump
Loaded Power	Hang Power Clean	Loaded Squat Jump
Loaded Strength	Barbell RDL	Goblet Squat

In terms of patterning, the training protocol for the unilateral training group directly matched the exercise selection of the bilateral training group, with exercises performed one leg at a time. Ex: On Day 1, the unilateral training group performed single leg hang power cleans as their loaded power exercise, whereas the bilateral group performed bilateral hang power cleans. (Table 8)

Table 8. Daily Unilateral Lower Body Exercise Selection

Unilateral Exercise Selection		
Category	Day 1	Day 2
Plyometric	1 Leg Hurdle Hop	1 Leg Hurdle Hop
Plyometric	1 Leg Standing Long Jump	1 Leg Standing Long Jump
Loaded Power	1 Leg Hang Power Clean	1 Leg Loaded Squat Jump
Loaded Strength	1 Leg Barbell RDL	1 Leg Squat

Data Analysis

A T-Test analysis was utilized to compare the results of the two groups over the course of the six-week intervention. This form of analysis was used to determine if there was a significant difference in pre and posttest results for the vertical jump and the standing long jump between the unilateral and bilateral training groups. Data was reported by analyzing the mean and the standard deviation of the results, pre and posttest, between the groups.

Results

The results of our protocol indicate that the six-week intervention did not have a statistically significant difference in performance measures (vertical jump and standing long jump) between the UNI or BI groups across testing time points. The results for all dependent variables are presented in Table 9.

Table 9. Comparison of mean (SD) pretest and posttest results between the 2 groups.

	Unilateral (n=10)		Bilateral (n=9)	
Test	Pre	Post	Pre	Post
Vertical Jump (cm)	48.77 (5.75)	50.93 (4.88)	47.27 (4.19)	47.83 (4.01)
Standing Long Jump (cm)	207.52 (8.56)	215.27 (12.65)	210.54 (15.21)	214.35 (15.29)

Vertical Jump

The results from the vertical jump test presented no significant difference from pretest to posttest for either the UNI ($p = .38$) or BI group ($p = .77$). The UNI group had a net improvement of 21.59cm and an average of 2.16cm. The BI group had a net improvement of 5.08cm following the six-week intervention and an average of 0.56 cm. Figure 2 charts the change in VJ heights between both groups during the protocol.

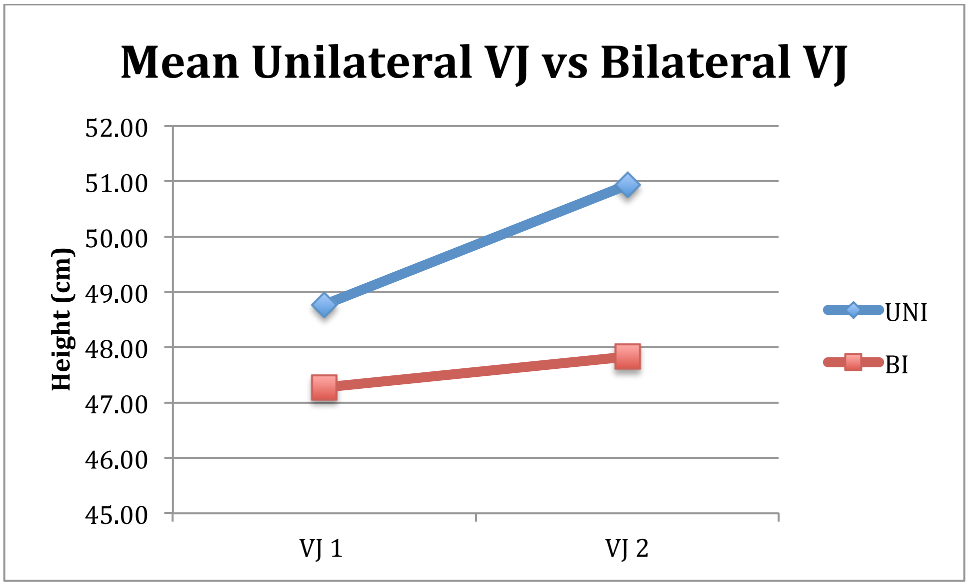

Figure 2. Mean change in vertical jump heights from the unilateral and bilateral groups.

Standing Long Jump

The results from the standing long jump test presented no significant difference from pretest to posttest for either the UNI ($p = .13$) or BI group ($p = .60$). The UNI group had a net improvement of 77.47cm with an average of 7.75cm. The BI group had a net improvement of 34.29cm and an average of 3.81cm. Figure 3 depicts the change in SLJ distances between both groups during the protocol.

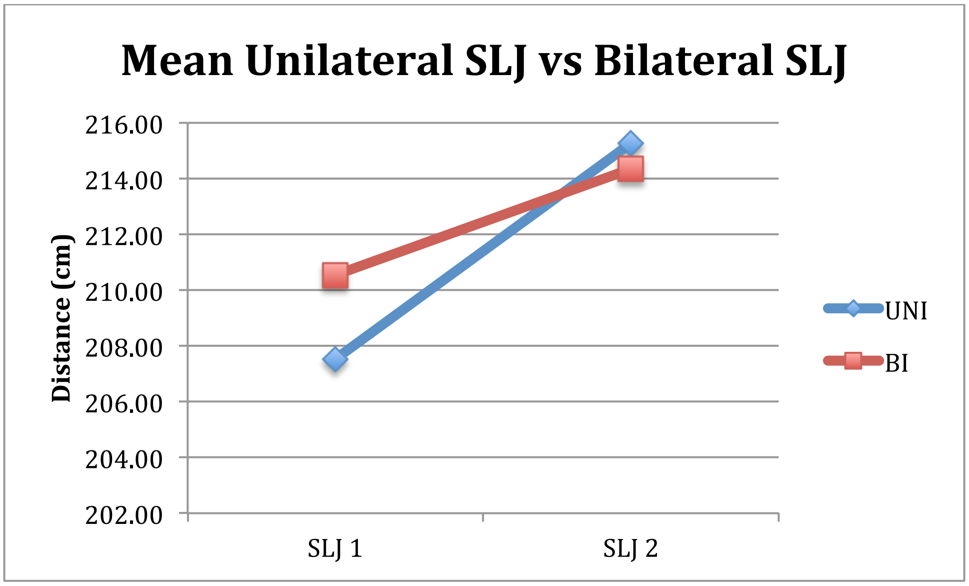

Figure 3. Mean change in standing long jump distances from the unilateral and bilateral groups.

Discussion

The purpose of this study was to determine if unilateral lower body training was able to produce lower body power outputs at a greater rate than bilateral lower body training in a six-week intervention with collegiate female hockey players. The results of this study indicated that there was not a statistically significant difference between UNI and BI training as it relates to lower body power production. Despite the lack of statistical significance, there were increases in vertical jump height, seen in 12 of the 19 participants, and increases in standing long jump distances, seen in 16 of the 19 participants.

The results came in contrast to the hypothesis that UNI lower body training would in fact increase lower body power output at a greater rate than BI lower body training. These results compared similarly to research done by Speirs et al. (33) which showed that neither bilateral nor unilateral training were more effective in enhancing 10 meter and 40 meter sprint times.

Despite the lack of statistical significance in the present study, the researchers found that there is practical significance to the results attained. Over the course of the six-week intervention, the UNI group increased their vertical jump heights by an average of 2.16 cm. The BI group, on the other hand, only increased vertical jump heights by an average of 0.56 cm. This difference represents an improvement in UNI group jump heights at a rate of nearly 4 times that of the BI group.

Practical significance also showed true when looking at the standing long jump results between the UNI and BI groups. The average increase of 7.75cm for the UNI group is more than double the average increase of the BI group's 3.81cm.

Despite the lack of statistical significance, the results showed that there were greater improvements made in the UNI group when compared to the BI group. This showed that the bilateral deficit, the sum of forces produced by each limb, is greater than those produced by both limbs simultaneously (4), was present in this study. The presence of the bilateral deficit is similar to the findings from Sale (31) in which unilateral training led to greater increases in muscle strength and hypertrophy compared to the bilateral group. The results of this intervention also showed that unilateral training did not hinder bilateral adaptations, as was also found by Botton et al. (4)

Applications and Implications

Strength and conditioning coaches and practitioners are constantly on the lookout for the most effective and efficient way to increase power production in athletes. Lower body power production is vital to the production of on-ice skating speed. (5). Strength and conditioning professionals' jobs and livelihoods can potentially be determined by their ability to help their athletes run and skate faster. Coaches who are able to do so in the most effective and efficient way possible may likely have the greatest amount of success and longevity within the field.

This speaks to the importance of research and finding the best applications of training to sport. If unilateral training helps produce greater EMG readings of primary movers and increases muscle recruitment when compared to bilateral training (36), then muscular strength and power results from training should be greater.

The findings of the present study may help to provide the strength and conditioning professional with additional means to produce improvements in lower body strength and power. In addition, it may also offer benefits to areas of training that were not assessed during this study. It may assist in the reduction of non-contact injuries due to the high prevalence of unilateral movement in sport, as well as the recruitment of smaller stabilizing muscles that may be limited during bilateral movement due to the instability factor of training on one leg (36). Furthermore, increased research needs to be done when comparing UNI and BI training as the prevalence of unilateral training in the field is becoming more and more common.

Limitations

The outcome of this study, specifically the statistical significance of the results, may in fact be due to the small sample size. This study had 19 participants in total, 10 in the UNI group and 9 in the BI group. When looking at other similar research studies, the sample size was often more than double that of the present study. (4,5,27)

Another area in which this study could have been improved is the addition of a combination group of both unilateral and bilateral training. As is often times the case with current strength and conditioning programs, both unilateral and bilateral exercises are utilized to elicit improvements in strength and power. This would once again involve increasing the sample size of the group involved in future research.

The study may also have been limited during the time of year in which it took place. Subjects participated in this study during their competitive hockey season in which outside stressors, such as games, practices, and schoolwork, may have affected their ability to recover from training, thus hindering their ability to maximize their results. In the future, it may be wise to perform this intervention during the off-season, in which the primary focus of the athlete is their training as opposed to their on-ice performance during the season.

Conclusion

In summary, statistical significance was not found when comparing the effects of UNI and BI lower body training on jump performance. Despite this, the findings showed that UNI training did in fact produce improvements in lower body power production. In contrary, bilateral improvements were not greatly made during the six-week intervention, even though the BI group had the greatest exposure to the tests during their intervention. Though unintentional, this study speaks to the importance of training for power during the competitive season. Traditionally, in-season training is reserved for the maintenance of strength and power, not the increase of those training goals. This study was able to reveal that although on-ice performance may be the primary goal of in-season training, it is still possible to make improvements in performance metrics such as vertical jump height and standing long jump distance.

Although results were not statistically proven by this study, the information provided does contribute to the discussion as to whether bilateral or unilateral training is of greater benefit to the competitive athlete. This can lead to greater research performed in this area, which will provide information as to how strength and conditioning professionals can best train the student-athlete.

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