The Effect of Depth Jumping and Rope Jumping on the Vertical Jump Performance of Junior High Females

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The purpose of this investigation was to determine the effects of depth jumping and rope jumping on vertical jump performance. The investigator used a 3 X 2 factorial design consisting of two treatment groups and one control group. Two hundred forty-one subjects in grades six, seven and eight were pretested on vertical jumping ability using a jump and reach test and randomly assigned to a depth jumping group, a rope jumping group or a control group. The training period for the rope jumping and depth jumping groups consisted of two sessions each week for nine consecutive weeks. In each session, the depth jumping group (N=80) performed three sets of ten jumps from a height of 40.64 centimeters, while the rope jumping group (N=80) jumped with maximal effort for three thirty second intervals, resting one minute between each set. The control group (N=81) performed balancing tasks and was not involved in bounding or plyometric activities. At the conclusion of the nine week experimental study, all subjects were posttested on vertical jumping ability using the procedure as in the pretest. Vertical jump performance means and standard deviations were calculated for the two treatment groups and the control group. Data were primarily analyzed using a repeated measures ANOVA. The results demonstrated that vertical jump performance was significantly improved ($p<.05$) in the depth jumping and rope jumping groups when compared to the control group. Post-hoc analyses revealed that neither training program was more effective than the other in improving vertical jumping ability in junior high females.

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CHAPTER I

INTRODUCTION

In a variety of sports; such as basketball, volleyball, gymnastics and track and field, one's ability to jump higher and quicker are important to successful performance. Coaches, trainers, and athletes involved in these jumping sports are constantly in search of a better, more efficient, and less time consuming method of increasing vertical jumping ability. Until recently, weight training was thought to be the most effective method of increasing leg strength and, as a result, vertical jumping ability in athletes. Recent research and knowledge suggests that there exists a training method used to increase vertical jumping ability known as plyometrics.

Plyometrics has been a common training procedure for athletes in Eastern Bloc countries for at least twenty years, while it is a relatively new concept in the United States (Wilt, 1975; Gambetta, 1981; Brzycki, 1986; Duda, 1988). The term "plyometric" (plyo, meaning more or greater and metric, meaning measure) was first introduced in the United States in 1975 by Fred Wilt. According to Wilt, (1975) plyometric training drills seek to bridge the gap between sheer strength and the power required in producing the explosive-reactive movements necessary to excel in jumping. Wilt defined plyometrics as exercises or training drills used to produce an overload of isometric-type muscle action which produces a stretch reflex in muscles. Such training drills include depth jumps, box jumps, bounding, hopping and running in place. Any activity in which a muscle is forced to lengthen immediately before a powerful contraction can be considered a form of plyometric training (Duda, 1988, McNaughton, 1988).

Depth jumping is the most popular form of plyometrics (Kirkendall, 1987; Thomas, 1988). Depth jumping involves jumping down from a box or platform and upon landing, immediately performing a maximal vertical jump. This reactive-type explosion of the leg muscles involves two contractions. An eccentric contraction (lengthening) occurs during the landing phase and a concentric contraction (shortening) occurs during the push-off phase of the jump.

Research has indicated that a rapid lengthening of a muscle will be followed by a faster movement of the muscle in the opposite direction. Therefore, the faster a muscle is lengthened, the greater the concentric force developed (Scoles, 1978; Costello, 1984; Gambetta, 1986).

According to Gambetta (1987), a muscle on a stretch can exert more force than a muscle that is not stretching. A rubber band can be used to demonstrate this concept. When a rubber band is only slightly stretched beyond its regular shape it does not snap back with much force. When the rubber band is stretched to two or three times its original length it snaps back with great force.

According to experts (Komi & Bosco, 1978; Brzycki, 1986; Lundin, 1987) the elastic nature of muscle fibers allows a muscle to store potential energy during the eccentric phase of a movement which is then released as kinetic energy in the following concentric contraction, causing a rapid explosive movement. One can imagine a rubber playground ball being bounced on the floor. As the ball hits the floor and changes shape, potential energy is stored. When the ball rebounds back into shape, kinetic energy is being used to propel the ball into the air.

A concentric contraction immediately following an eccentric contraction will use the energy stored in that muscle during stretching (Komi and Bosco, 1978; Gambetta, 1987; Grimsley and Woolard, 1987). By using this elastic energy, greater force production in a shorter period of time will result. As the muscle is stretched, muscle spindles are stimulated which send nerve impulses to the spinal cord and back to the same muscle signaling it to contract (Wilt, 1975). This prevents overstretching of the muscle and is called the stretch or myotatic reflex (Wilt, 1975).

Plyometrics, according to Huber (1987), is a way to increase speed of movement in order to create an explosive-reactive type of movement necessary for a good vertical jump. A depth jump is simple to execute and, according to Novkov (1987), will develop an athlete's explosive strength and the reactive ability of nervous muscular activators. If these muscle activators can be trained to send messages to the Central Nervous System (CNS) at a quicker rate, a more explosive contraction of the muscle is likely to result. Therefore, a higher vertical jump will be attained.

Depth jumping, due to its forceful nature, may not be appropriate or beneficial to younger athletes who are still maturing. Depth jumping involves the force of gravity combined with the subject's body weight. According to Brzycki (1986) young athletes are more prone to trauma during depth jump training since their epiphyseal (growth) plates of their long bones have not yet fused. Without following the proper precautions and guidelines suggested by Bielik (1986), Chu (1986), Costello (1984), Gambetta (1987), Lundin (1987), Rogers (1986), Santos (1986), and Wilt (1975) injuries may result.

With the extensive involvement of novice and "parent" coaches working with younger athletes, as well as limited training time and facilities, there is a need for evaluating a safe, inexpensive training technique that will significantly improve vertical jump performance. Rope jumping may serve these purposes.

From a coach's viewpoint, rope jumping requires considerably less administrative and supervisional tasks than depth jumping. Yet, with the stretching and contracting of leg muscles, rope jumping is considered to be a form of plyometrics (Miller & Power, 1981). The repetitiveness of the explosive-reactive type action in rope jumping should enhance the reactive ability of nervous muscular activators, as explained by Novkov (1987), to send messages to the CNS at a quicker rate. This will result in a more forceful contraction of the muscle and therefore, a higher vertical jump.

Purpose

It was this experimenter's intent to examine rope jumping as a means of increasing vertical jumping ability in junior high female subjects. It was the purpose of this study to focus on the comparison of depth jumping and rope jumping as equivalent means of increasing vertical jump ability.

Definition of Terms

Concentric Contraction. During a concentric contraction the muscle shortens as it exerts force. In plyometrics, a concentric contraction immediately follows an eccentric contraction (Gambetta, 1987).

Depth Jumping. Depth jumping involves stepping down from a height and immediately performing a rebound jump vertically upwards (Miller & Power, 1981).

Eccentric Contraction. During an eccentric contraction the muscle is being stretched (lengthened) while at the same time attempts to resist the load and brake its movement (Gambetta, 1987).

Isokinetic exercises. These type of exercises allow the muscles to work at maximal force throughout the entire range of motion for each repetition (Blattner & Noble, 1979).

Isometric-static Contraction. A contraction in which no joint movement takes place. The length of the muscle remains constant while force is being exerted (Gambetta, 1987).

Isotonic-dynamic Contraction. A contraction that involves muscle activity and joint movement, either a lengthening or a shortening of the muscle when force is exerted (Gambetta, 1987).

Myotatic (stretch) Reflex. An involuntary defense mechanism which results in a powerful muscular contraction in an attempt to protect the muscle from a sudden, forceful stretch (Thomas, 1988).

Plyometric Exercises. Plyometric exercises involve production of an overload of isometric-type muscle action which invokes the stretch reflex in muscles (Wilt, 1975).

Basic Assumptions of the Study:

1. All subjects will put forth their maximal effort during the training and testing sessions.
2. All subjects will be present to participate two times per week for nine consecutive weeks.
3. All subjects will utilize the correct depth jumping, rope jumping and vertical jumping techniques for the testing and training sessions. (Appendix A).

Delimitations of the Study:

1. The results of this study can be generalized to junior high females in grades six, seven, and eight enrolled in the Batavia City School District.

Limitations of the Study:

1. There was no control over what the subjects did between trial sessions.
2. The nine week training period may not have been long enough to produce significant results.
3. The two times per week training schedule may not have been enough to produce significant results.
4. Subjects in the control group may have thought they were at a disadvantage due to non-participation in the jumping exercises.

5. Fatigue could have affected the outcome, as classes scheduled later in the day may not have been able to put forth their maximal effort.
6. Subjects could have exerted more effort during the posttesting due to knowledge of expected results.

CHAPTER II

REVIEW of LITERATURE

Research studies on plyometric training and its effect on vertical jump performance have been controversial. Experiments using plyometric training have varied considerably in regard to the ideal height of the depth jumping box and the number of repetitions per set, sets per session, sessions per week, and weeks in the training period. These methodological differences may contribute to the inconsistant results of vertical jumping performance in plyometric training studies. In the review of literature, the effectiveness of plyometrics, weight training and functional training on vertical jumping ability are discussed.

The Effectiveness of Plyometric Training

Brown, Mayhew, and Boleach (1986) conducted a study using twenty-six high school male basketball players. Each subject was pre and posttested for vertical jumping ability using a specially designed platform. Each subject performed three jumps with a double armswing and three jumps without an armswing. The best trial from each method was recorded.

The subjects were randomly assigned to a plyometric (depth jumping) group or a control group. The training group performed three sets of ten depth jumps, three days a week for twelve weeks. The control group performed only regular basketball training. The plyometric group improved in vertical jumping with armswing significantly (p>.05) more than the control group. The two groups were not significantly different in vertical jumping without arm assistance. It was concluded, in this study, that 57% of the plyometric training group's vertical jump increase was due to improvement in the skill of jumping, while 43% was due to strength gain. Therefore, depth jump training appears to enhance the coordination of the arms with strength development of the legs producing an increase in vertical jumping height.

Scoles (1978) conducted a study to determine the effects of depth jumping on the vertical jump and standing long jump of college males. The twenty-six subjects were divided randomly into a depth jump group, a flexibility group and a control group. Each subject was pre and posttested on a vertical jump and a standing broad jump. The nine subjects in the depth jump group trained two times per week for eight weeks. Each session consisted of twenty jumps from a box at a height of .75 meters. The nine subjects in the flexibility group performed stretching exercises of the hamstrings, quadriceps and lower back muscles for an eight week period of two sessions per week. The eight members of the control group participated only in the testing sessions.

Analysis of the data consisted of using a simple one-way repeated measures analysis of variance (ANOVA). While not statistically significant, the results indicated that depth jumping had a greater effect on vertical jump performance than the flexibility and control groups.

Bartholomew (1985) conducted an eight week study comparing the effect of two heights of depth jumping on vertical jump performance. College aged males were randomly divided into a 50 cm. jumping group, an 80 cm. jumping group and a control group that performed jumping skills without a box. Each group trained two times a week for two four week periods, with a one week rest between sessions.

The subjects who trained on the 50 cm. boxes improved their vertical jumping height by an average of 4.0 inches, while the group who trained on the 80 cm. boxes improved an average of only 3.27 inches. Although neither group had a significant increase, this finding suggests that a 50 cm. box produced better results than the 80 cm. box. According to the author, this could possibly be explained by the concept of overload. If the load on the muscles is too great, the explosive-reaction needed to propel the body vertically upwards is slowed resulting in less force.

The control group improved jumping height by an average of 4.57 inches. This finding suggests that plyometrics may not be the best training method used to increase vertical jumping ability.

Since all three groups showed improvement in jumping performance either method, depth jumping or traditional jumping exercises, could be effectively implemented.

Bedi, Cresswell, Engel, and Nicol, (1987) conducted a study in which depth jumps at different heights were compared. Thirty-two males between 19 and 26 years of age participated in the study. Twelve subjects were volleyball players on a university club team while the remaining subjects were physical education majors with no previous participation in a jump-related sport.

Five jumps at heights of 0, 25, 35, 45, 55, 65, 75, and 85 cm. were performed in random order. The landing surface was a Kistler force plate bolted to a mounting bracket secured in concrete. Data were analyzed by an analysis of variance with one grouping factor and repeated measures across the depth jump heights.

The vertical jump performance for physical education students was seen to first increase with dropping height and then fall off slightly with further increase in dropping height. No pattern was evident in the jump performance of the volleyball players. The differences between the performance at different dropping heights in this study were not significant. Evidently, more research needs to be conducted concerning the optimal jumping height for depth jumps from which significant results will occur.

Most research studies have utilized adult males as subjects (McKethan et al., 1974; Blattner et al., 1979; Clutch et al., 1983; Brown et al., 1986; Bedi et al., 1987; Gauffin et al., 1988;). Few research studies have been conducted on young female subjects. A study was conducted by DiBrezzo, Fort, and Diana (1988) to determine if a low-intensity plyometric program would improve explosive power in the legs of female junior high basketball players. The eight subjects who participated in this five week study were pre and posttested on vertical jump, standing long jump and knee flexor-extensor strength. The low intensity training program was progressive and consisted of stretching exercises, a quarter-mile jog/walk, rope jumping, jumping over boxes, and jumping onto boxes.

The data were analyzed by a dependent t-test and relationships among the variables were determined by the Pearson Product-Moment Correlation. It was concluded that the training improved the strength of the quadriceps for explosive jumping. There was no significant improvement in the standing long jump. There was improvement in the vertical jump of .9 inches. It was concluded that a modified plyometric training program can be effective in improving vertical jump performance of junior high girls.

<u>The Effectiveness of Weight Training</u>

McKethan and Mayhew (1974) evaluated the effect of isometrics, isotonics, and combined isometrics-isotonics on the strength of the quadriceps and vertical jump. Twenty-four male volunteers were randomly assigned to an isometric, an isotonic, a combined isometric-isotonic, or a control group. Subjects were pre and posttested on quadriceps strength and vertical jumping ability by a cable tensiometer and a jump and reach test, respectively.

The isotonic group trained using three sets of six maximum repetitions of leg extensions in a weighted boot. The isometric group performed three maximal six-second leg extensions with each leg while in a seated position. The combined isometric-isotonic group trained using a device permitting a period of isometricity followed immediately by an isotonic movement through the full range of leg extension. Three repetitions were executed with each leg. All subjects trained twice weekly for a total of 18 training sessions. The control group only participated in the testing periods.

Using an analysis of covariance, no significant differences among post-training means was apparent. The t-test for paired observations showed no significant differences between the pre and posttest means for any group. It was concluded that different neuromuscular patterns were involved in the vertical jump than were used in the strength exercises. According to Brown, et al. (1986) developing leg strength exclusively may not be sufficient for improvement in vertical jumping ability. Leg muscles must be trained to react as quickly as possible.

Blattner and Noble (1979) conducted a study with 48 college males that compared the effect of isokinetic exercises and plyometric training on vertical jumping ability. The subjects were randomly assigned to an isokinetic exercise group, a plyometric group, or a control group. Vertical jumping performance was measured by a jump and reach test given before and after the training period. The isokinetic group trained three times per week for eight weeks completing three sets of ten repetitions on "Leaper" leg press machine. The plyometric group had the same training schedule as the isokinetic group while performing three sets of ten depth jumps from a height of 34 inches. Although neither training program was more effective in improving vertical jump performance, both programs resulted in significant improvement over the control group.

In a study by Clutch, Wilton, McGown and Bryce (1983) sixteen members of a weight training class and sixteen members of the men's volleyball team at Brigham Young University, Hawaii, were randomly assigned to a weight training and depth jumping group or a weight training only group. The weight training exercises consisted of the dead lift, bench press and parallel squat.

Three sets of six repetitions were performed in each exercise. The depth jumping program was comprised of four sets of ten jumps, two sets from 0.75 meters and two sets from 1.10 meters. Weight training and depth jumps were performed twice a week for sixteen weeks.

The data were analyzed by an analysis of variance on the gain scores. All differences were tested at the .05 level. There was a significant increase in the vertical jump performance of the weight training group that performed depth jumps. No increase was identified in the weight training only group. The results indicated significant gains in vertical jump performance of the volleyball team members, even those who performed no depth jumps. From this study, depth jumps do not appear to be better than other more common training methods.

Clutch et al. (1983) conducted a second study to determine if certain depth jump routines, when combined with weight training, are better than others. Twelve male volunteers enrolled in a weight training class at Brigham Young University were randomly divided into three jumping programs. Treatment one consisted of four sets of ten repetitions of maximum jumps from a standing position. This was considered the control group, as no plyometric training took place. Treatment two consisted of depth jumps from a height of .3 meters. Four sets of ten repetitions were completed during each training session. The third group was a repeat of group two, except that depth jumps were performed from a height of 0.75 meters and 1.10 meters. All subjects participated in a recovery jog and a weight training program following the jumping routine. All subjects were pre and posttested on leg strength and vertical jump performance.

The results of this study indicated that the treatments were effective, but no significant differences between the treatments existed. Depth jumps, when combined with weight training, were no more effective than a program of regular maximum jumps. As indicated by this study, a coach can implement a jumping program to produce positive results on vertical jump performance

The Effectiveness of Functional Training

Gauffin, Ekstrand and Troup (1988) investigated the impact of functional training on improvement in jump performance for soccer players. Fifty-four male subjects from three soccer teams in a Swedish soccer league participated in the study. Thirty-six players were randomly selected for jump training while the other eighteen players acted as a control group. In the training group, the subjects jumped and headed a soccer ball suspended in the air by a rope. The training session lasted ten weeks. The subjects in the training group performed three sets of ten maximum jumps, three times per week.

All subjects were pre and posttested for vertical jump height and thigh muscle strength. Jump height was recorded by means of a contact mat utilizing flight time. The best jump out of five trials was recorded. Peak muscle torque for knee extension and knee flexion was recorded isokinetically using a Cybex II dynamometer.

A t-test was used to evaluate the differences between the training group and the control group, and before and after training within the same group. The results indicated a significant difference in vertical jumping height in the training group, while the control group showed no significant difference. There was no correlation between jump height improvement and strength increase. Gauffin, et al. (1988) suggest that after two or three training sessions the subjects had probably developed a better jumping technique and consequently could jump higher. This research has indicated that the repetition of jumping exercises themselves may have had a positive impact on vertical jump ability. Steben and Steben (1981) suggest that if an event and drill are carefully matched and practiced, there will be improvement over an array of subjects.

As indicated by the previous studies, plyometric programs can be implemented by coaches to produce positive results on vertical jump performance. Rope jumping is one form of plyometric exercise. It was the belief of this investigator that rope jumping could be conveniently implemented in a training schedule for junior high females. As a result, the rope jump training would have a positive impact on vertical jump performance.

CHAPTER III
METHODOLOGY

Subjects

Two hundred forty-one females ages 10 to 14 served as subjects for this study. All subjects were in grades six, seven, or eight and enrolled in the Batavia Middle School located in Batavia, New York 14020. The subjects returned permission slips signed by parents giving clearance to participate in the study (Appendix B). Permission by the director of health, physical education. and athletics was given to conduct the study. All subjects were pretested on vertical jump performance. The subjects were ranked from the best (highest) jump in inches to the poorest (smallest) jump in inches. Cut off points were arbitrarily assigned by the investigator to establish jumping groups of below average, average, and above average. The name of each subject was on a slip of paper and placed in the appropriate assigned pile. The investigator picked one name from each of the three piles until one group of 81 subjects and two groups of 80 subjects were formed. The groups were randomly designated as depth jumping, rope jumping and control.

Instruments

All subjects were pre and posttested on vertical jumping height by using the jump and reach test. This test had a reliability coefficient of .954 and validity coefficients of .780 when compared to the modified vertical power jump, the standing broad jump and the squat jump (Gray, Start & Glencross, 1961). This test was chosen by the investigator because it was easily administered to junior high females and the resulting information was relevant to the study.

The plyometric box used for the depth jumping group was constructed from one and one half sheets (4x8 feet) of 3/4 inch plywood (Ball, 1987). The height of the box was 40.64 cm. and a non-skid material covered the top to keep the subject from slipping while performing the jump. Figure 1 shows the construction of the box used in this study.

The jump ropes used in this study were made of beaded plastic. Each rope was 7-8 feet in length and weighed approximately twelve ounces. Small handles, no wider than the beads, were attached to each rope.

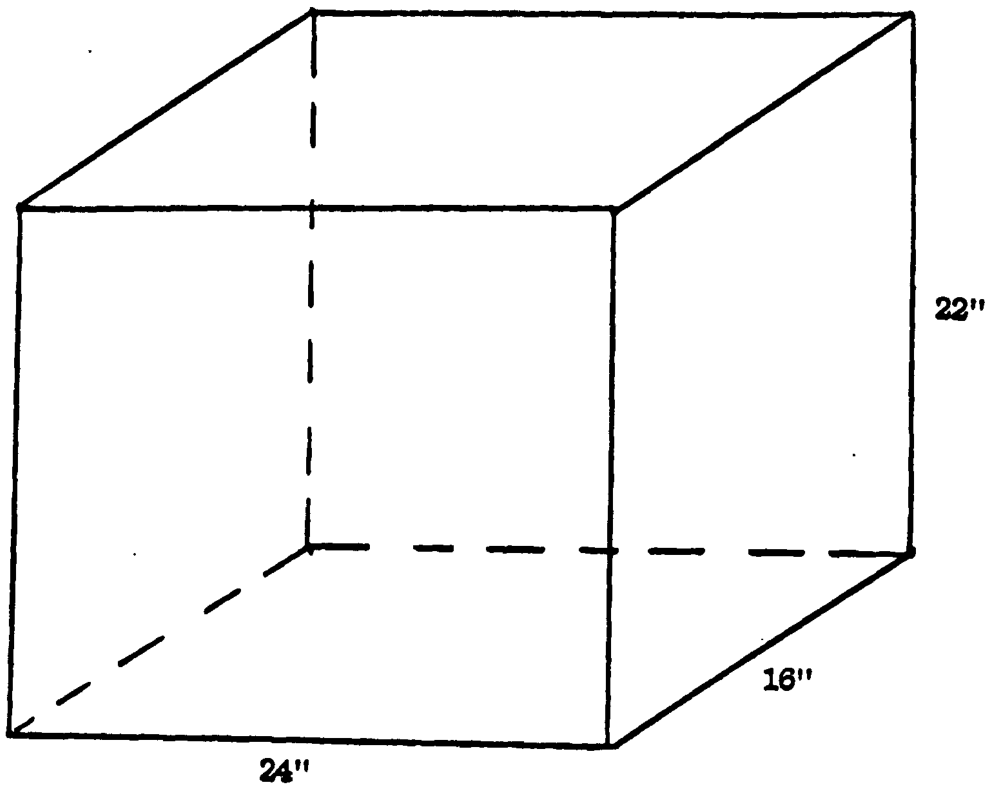

Figure 1. The plyometric box

Procedures

The correct rope jumping, depth jumping and vertical jumping techniques and criteria were taught and explained to all subjects before the start of the experiment. As a safety precaution, general jumping exercises were performed by all subjects as a means of conditioning before the start of the investigation (Appendix C).

A vertical jump and reach test was administered to all subjects by the investigator of this study. Each subject stood on a flat, wooden surface with the heels of both feet touching the floor and parallel to a wall. Subjects were instructed to chalk the hand closest to the wall and reach as high as possible with this hand. A scale on the wall marked off in inches was used to record the maximum height reached by the tips of the fingers of the reaching hand. Subjects were permitted to flex the knees and jump as high as possible, again touching the scale. This height was recorded and the procedure was repeated two more times. The height achieved while standing and reaching was subtracted from the greatest of three trials achieved by jumping and reaching and was used as the subject's score. This procedure was used during pretesting and posttesting sessions.

The training period for the three groups (depth jumping, rope jumping and control) included two sessions per week for nine consecutive weeks and took place during regular physical education classes. A ten minute warm-up of basic stretching and jogging exercises was performed by all subjects in each class before the start of each training session.

The depth jumping group performed three sets of ten jumps with a two minute rest interval between sets. The depth jumping height for this group was 40.64 cm. and, as suggested by Wilt (1975), Costello (1984) and Duda (1988), a two inch wrestling mat was used to cushion the landing before the maximal vertical jump was performed.

Controversy exists in the research as to the basic strength requirements necessary prior to the implementation of a plyometric training program. It is believed that in order to perform high intensity jumps, such as depth jumps, the athlete must be able to full squat one and one-half to two times his or her body weight (Gambetta, 1987). It seems that this prerequisite may pertain more to the mature high school or college level athlete, than to the junior high level athlete. According to Lundin (1987), a squat of 1.5 to 2 times a child's body weight is highly questionable and probably never intended for the pre-pubescent or pubescent athlete. It is suggested that children at play often engage in jumping activities that resemble plyometrics and if common sense serves as a guide to the application and intensity of such activities, injuries will rarely occur (Bielick, Chu, Costello, Gambetta, Lundin, Rogers, Santos, & Wilt, 1986).

Although training loads are not completely understood for youths and beginners, the following guidelines have been established for this population. A gradual progression of exercise from a general to a more specific nature is suggested (Bielik, et al., 1986; DiBrezzo, et al., 1988; Lundin, 1987; Miller & Power, 1981). In depth jump training, the suggested number of contacts should increase gradually to 30 per session (Bielik, et al., 1986; Gambetta, 1987; Lundin, 1987). The number of sessions should gradually increase to two or three per week (Gambetta, 1987; Lundin, 1987). The recommended height of the depth jumping box for this age group is 40 cm. (Bielik, et al., 1986; Lundin, 1987). In the present study, all possible efforts were exhausted in accomodating to these suggested depth jump training guidelines.

In the literature, two interpretations of the definition of depth jumping were revealed. Some experts support the definition: "Depth jumping involves jumping down from a height and immediately performing a rebound jump vertically upwards" (Duda, 1988; Gambetta, 1987; Miller & Power, 1981; Myers, 1984; Wilt 1975). Others have suggested that, depth jumping is, "a technique by which an athlete drops from an elevated surface and immediately upon landing performs a maximal vertical jump" (Clutch, Wilton, McGown & Bryce, 1983; Grimsley & Woolard, 1987; Huber, 1987; Kirkendall, 1987; Thomas, 1988). Brzycki (1986) and Rogers (in Bielik, et al., 1986) have used the terms "stepping off a box" when describing depth jumping.

In the present study, appropriate terminology used by the investigator seemed imperative. During the experiment, it was intended by the investigator to control the intensity of the plyometric drills. For depth jumps to be executed safely by the subjects, the investigator chose to avoid the words, "jump down." It was feared that if a subject was asked to "jump off the box," she would jump vertically upwards before descending to the landing mat. This could have produced an unnecessary amount of force on the subject's ankle, knee, and hip joints. In an effort to reduce the possibility of injuries to the prepubescent and pubescent subjects in this study, the investigator used the terms "stepping off the box."

At the start of the study the depth jumping group consisted of 80 subjects. Four subjects transferred to a different school while one subject was removed due to an unrelated medical condition. Twenty subjects did not meet the criteria for depth jumps (see Appendix A) and, although they continued the depth jumping program they were eliminated from the analysis. Therefore, 55 subjects were included in the analysis of the depth jumping group. During the study, no injuries were reported as a result of depth jump training.

The subjects in the rope jumping group jumped with maximal effort and as quickly as possible for three 30 second intervals, resting one minute between each set. Each subject performed a two-feet single bounce jump with no preparatory bounce between turns of the rope. To ensure that each subject was jumping with maximal effort a record of the number of jumps per 30 seconds was tallied during each session. This was only to raise the subjects' level of concern and was not included in the final analyses.

The rope jumping group consisted of 80 subjects at the start of the experiment. Four subjects were medically excused while four subjects moved from the district. Twenty-one subjects did not meet the criteria for the rope jumping group (see Appendix A). These subjects continued the training program, but were excluded from the analysis. The scores for the remaining 51 subjects were used in the analysis of the rope jumping group. No injuries occurred as a result of jump rope training.

The control group did not participate in either jumping activity. Each subject in the control group completed a balancing task assigned to them for that week. These balancing activities were performed forwards, backwards, sideways, while blindfolded and within various time limits. The specific activities are included in Appendix D. It was the experimenter's belief that keeping the control group interested would be a difficult task and therefore, a variety of activities were presented.

At the beginning of the study the control group consisted of 81 subjects. Two subjects moved from the district and one subject was medically excused. The remaining 78 subjects were included in the analysis of the control group. No injuries were reported as a result of the control group activities.

Design and Analyses

This particular study utilized a 3x2 factorial design. Factor A consisted of two experimental groups (rope jumping and depth jumping) and one control group (balancing activities). Factor B consisted of pre and posttests on vertical jumping ability. Rope jumping, depth jumping and balance activities were the independent variables and the measure of vertical jumping height was the dependent variable. This study compared the effects of depth jumping from a height of 40.64 cm. to rope jumping at 30 second intervals. It was hypothesized that pre and posttest differences of the two training groups should be significantly greater than the differences in the control group. Data were analyzed using a repeated measures Analysis of Variance.

CHAPTER IV
RESULTS AND DISCUSSION

The data were statistically analyzed to compare the effects of the two training methods with a control group on vertical jump performance. A repeated measures analysis of variance and post-hoc analyses were utilized to determine which groups significantly improved over time.

Jump and reach raw scores for all subjects in the study, including those subjects who did not meet the required criteria, are listed by group in Appendix E. The analysis of data includes only those subjects who met the criteria for inclusion in the study presented in Chapter III.

Means and standard deviations for pre and posttest vertical jump performance scores for the treatment groups and control group are presented in Table 1.

TABLE 1. MEAN AND STANDARD DEVIATIONS FOR CONTROL GROUP, DEPTH JUMPING GROUP AND ROPE JUMPING GROUP ON PRE AND POSTTEST TRIALS.

	Control (n=78)		Depth Jump (n=55)		Rope Jump (n=51)	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Pretest (in.)	11.47	2.60	11.25	2.61	11.16	2.69
Posttest (in.)	11.66	2.62	12.65	2.31	12.34	2.18

A cursory glance at Table 1 suggests that the pretest mean scores for the three groups were similar (ranging from 11.16 to 11.47 inches). The comparison between pre and posttest scores indicates that the depth jumping and rope jumping groups increased by 1.40 and 1.18 inches, respectively. The control group increased by only .19 inches.

Pre and posttest mean scores for the three groups are displayed graphically in Figure 2.

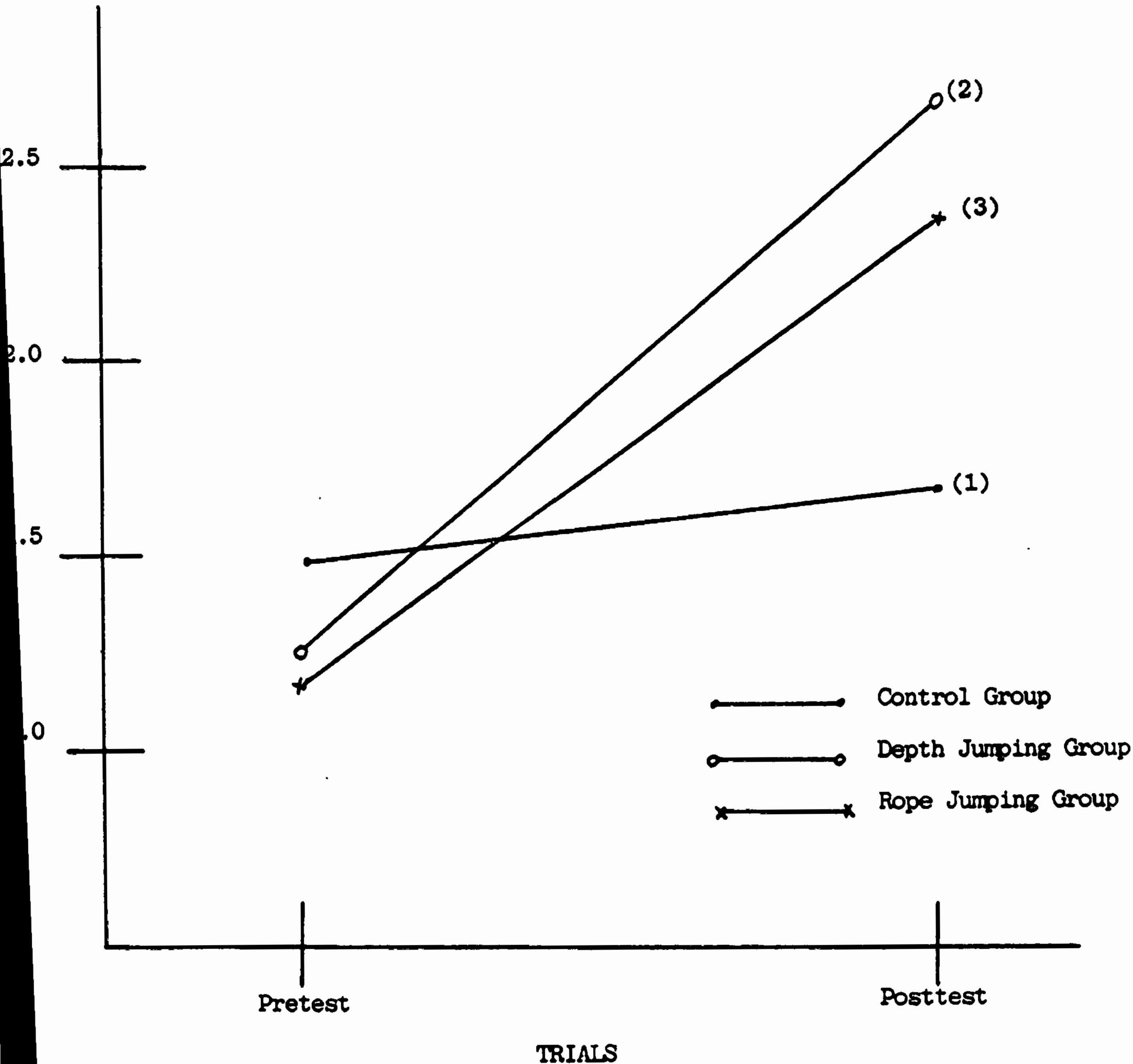

Figure 2. Means for pretest and posttest scores for control group (1), depth jumping group (2), and rope jumping group (3).

An inspection of Figure 2 suggests an increase in vertical jumping ability for all three groups. This increase is more pronounced in the two treatment groups than in the control condition. Therefore, the increase may be directly related to the jumping programs implemented.

To determine if increases in performance of the depth jumping and rope jumping groups were statistically significant a repeated measures analysis of variance was applied to the data. The results of this analysis appears in Table 2.

TABLE 2. ANOVA OF DIFFERENCES BETWEEN GROUP MEMBERSHIP AND TRIALS.

Source of Variation	S.S.	df	M.S.	F
Between Subjects				
Group Membership	9.19	2	4.60	.38
Error	2171.34	181	12.00	
Within Subjects				
Trials	76.10	1	76.10	104.37*
Group X Trials	28.19	2	14.10	19.33*
Error	131.98	181	0.73	

*p< .05

The results of the analysis of variance indicate that the difference between the pre and posttest trials was significant. The group by trials interaction effect was also significant, suggesting that all groups did not benefit equally from the treatments that occurred between the trials. Therefore, to determine the nature of the interaction a post-hoc analysis looked at the simple effects of trials on the performance of each group. The results of this analysis are presented in Table 3.

TABLE 3. SIMPLE EFFECTS OF THE GROUP BY TRIALS INTERACTION.

	S.S.	df	M.S.	F
Control by Trials	1.39	1	1.39	1.91
Depth Jump by Trials	53.90	1	53.90	73.92*
Rope Jump by Trials	35.88	1	35.88	49.21*
Error	131.98	181	.73	

*p< .05

The results presented in Table 3 indicate that pre and posttest scores of the depth jumping and the rope jumping groups improved significantly while the improvement in the control group was not significant. This supports the contention that the increases in vertical jumping ability of subjects in the depth jumping group and the rope jumping group was a direct result of the treatments provided.

To determine if one of these treatments was superior to the other in the improvement of vertical jumping ability, a third analysis was performed. In this analysis, the control group was eliminated and a repeated measures analysis was applied to the depth jumping and rope jumping groups. The results of this analysis are presented in Table 4.

TABLE 4. ANOVA OF DIFFERENCES BETWEEN GROUP MEMBERSHIP AND TRIALS WITH THE CONTROL GROUP ELIMINATED

Source of Variation	S.S	df	M.S	F
Between Subjects				
Group Membership	2.02	1	2.02	0.18
Error	1158.36	104	11.14	
Within Subjects				
Trials	88.50	1	88.50	96.98*
Group X Trials	0.60	1	0.60	0.66
Error	94.90	104	0.91	

*p<.05

According to the data in Table 4, the main effect for trials for the the two treatment groups was significant. This was true of the previous analysis that also included the control group (Table 2). However, unlike the results in the Table 2 analysis, when the control group was eliminated (Table 4) the group by trials interaction was not significant. This suggests that the significant group by trials interaction term in Table 2 was due to the relative differences in gain made by the control group when contrasted to the treatment groups. The lack of a significant interaction in Table 4 further suggests no difference in regard to the effects of rope jumping and depth jumping in enhancing vertical jumping ability.

Discussion

The Effectiveness of Plyometrics

Studies have demonstrated that plyometric training increases vertical jumping ability in subjects at the college level, (Bartholomew, 1985; Blattner & Noble, 1979; Scoles, 1978;) high school level, (Brown, et al., 1986) and junior high level (DiBrezzo, et al., 1988). Although most of these studies used males as subjects, DiBrezzo, et al. (1988) found plyometric training to have a positive effect on vertical jumping ability of junior high females. While depth jumping was the predominant type of plyometric exercise used in most of the studies, the subjects in the study by

DiBrezzo, et al. (1988) performed general jumping routines and the subjects in the Gaufin et al. (1988) study performed specific jumping exercises. All three types of plyometric training methods resulted in an increase in vertical jumping performance of the subjects. Therefore, it can be concluded that regardless of age, gender, or type of plyometric exercise, vertical jumping ability can be improved through the use of plyometric training.

Components of Plyometric Training

There is evidence to show that components of a plyometric training program vary among researchers. Studies conducted with a plyometric exercise, such as depth jumping, have differed in the number of training sessions per week, the number of weeks in the training schedule, and the height of the depth jumping box.

Some researchers support the notion that two plyometric training sessions per week will adequately produce an increase in vertical jumping ability (Bartholomew, 1985; Clutch, et al., 1983; Scoles, 1978). Other researchers suggest that three training sessions per week are needed to produce positive results on vertical jump performance (Blattner & Noble, 1979; Brown et al., 1986; DiBrezzo, et al., 1988; Gaufin, et. al., 1988). Since either schedule is effective it becomes a matter of convenience. Therefore, coaches may choose, which training schedule is most appropriate for their particular sport.

The number of weeks in a plyometric training schedule also varies among researchers. DiBrezzo, et al. (1988) conducted a five week program, while a 16 week program was conducted by Clutch, et al. (1983). Although not significant, the five week program was found to produce positive results, while the results of the 16 week program indicated that depth jump training had no effect on vertical jumping ability. It seems that a five week training program may not be a sufficient amount of time to produce significant results on vertical jumping ability, while a 16 week training program may be too long of a time period. Studies conducted by Bartholomew (1985), Blattner & Noble (1979) and Scoles (1978) consisted of eight week training schedules and produced positive results on vertical jumping ability. The study conducted by Brown, et al. (1986) consisted of a twelve week training program and resulted in a significant increase in vertical jumping ability of the subjects. Therefore, according to the research, eight to twelve weeks seems to be the appropriate number of weeks in a training schedule needed to produce legitimate results in a plyometric training program.

Experts have identified depth jumping as a popular form of plyometric training (Bielik, et al., 1986; Clutch, et al., 1983; Duda, 1988; Gambetta, 1987; Grimsley & Woolard, 1987; Huber, 1987; Kirkendall, 1987; Lundin, 1987; McDermott, 1986; Scoles, 1978; Thomas, 1988; Wilt, 1975). However, the ideal height of the depth jumping box has not yet been determined among researchers. Increases in vertical jumping ability have resulted after depth jumping from heights of 18 inches (Brown, et al., 1986), 20 in. (Bartholomew, 1985), 29 in. (Scoles, 1978) and 31 in. (Bartholomew, 1985). Significant increases in vertical jumping ability have resulted with programs using combined heights of 29 in. and 43 in. (Clutch, et al., 1983) and jumping heights of 34 in. (Blattner & Noble, 1979). Vertical jump performance has also been found to first increase with dropping height and then fall off slightly with further increases in dropping height when performing depth jumps at 10, 14, 18, 22, 26, 30 and 34 inches (Bedi, et al., 1987).

Experts have agreed that the height of the depth jumping box is dependent upon the strength, maturity and experience of the athlete (Gambetta, 1987; Lundin, 1987; Wilt, 1975). A depth jumping box at a height of 40.64 cm. (16 in.) was used in the present study. According to Bielik, et al. (1986), this is the recommended height of the depth jumping box for junior high female subjects. However, it is apparent that more research needs to be conducted in determining the ideal height of the depth jumping box.

<u>The Practicality of Plyometrics</u>

In the present study, the mean improvement in vertical jump was 1.40 inches for the depth jumping group and 1.18 inches for the rope jumping group. From a coaching perspective, the resulting difference in the training programs may be undetectable at the junior high level. Therefore, although the statistical significance is evident in the results of this study, a coach needs to examine the practical element involved.

When deciding on a vertical jump training program, one important practical consideration is storage availability. In a time of increasing enrollment, school districts have creatively converted large storage areas into teaching stations. Therefore, team equipment may be stored in a small, confined area. Since depth jumping boxes are considerably more difficult to store than a bag of jump ropes, coaches may choose a rope jumping program instead of a depth jumping program as a method of increasing vertical jump performance in athletes.

Another practical element a coach should consider when deciding on a vertical jump training program is the time involved in implementing the training. Depth jumping involves more time than rope jumping. In depth jumping, the boxes have to be set up and safely spaced, with mats arranged for landing. Unless each athlete has his or her own depth jumping box, which is highly unlikely at the junior high level, only two or three athletes can perform simultaneously, thus causing the remainder of the team to wait. When all athletes have completed the required number of repetitions, the boxes need to be removed from the area. In the present study, this process took approximately fifteen minutes to complete.

Rope jump training, described in this study, involved distributing jump ropes to all group members, all simultaneously jumping for three 30-second intervals, with a one minute rest between sets, then collecting the jump ropes. In the present study, this process took approximately five minutes to complete.

Due to the scheduling of facilities, practice sessions at the junior high level are approximately ninety minutes in length. During this practice session, a coach who plans adequate warm-up activities, skill acquisition drills, and game-like situations may not have time to allot for depth jump training, but may have time for rope jump training.

The results of this study support the contention that depth jumping and rope jumping are effective in improving vertical jump performance. However, neither treatment was more effective than the other in increasing vertical jump. Therefore, rope jump training is just as effective as depth jump training and, from a coach's viewpoint, seems to be a practically more efficient and perhaps safer method of achieving an increase in vertical jump performance of junior high females.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this investigation was to determine the effects of depth jumping and rope jumping on the vertical jump performance of junior high females. The two hundred forty-one subjects in this study were in grades six, seven or eight and enrolled in the Batavia City School District located in Batavia, New York 14020. The subjects were pretested on vertical jumping ability using a jump and reach test and randomly assigned to a depth jumping group, a rope jumping group or a control group. The subjects were separated according to jumping ability in order to reduce differences in the groups at the start of the study.

The training period for the depth jumping and rope jumping groups consisted of two sessions per week for nine consecutive weeks. In each session, the depth jumping group performed three sets of ten jumps from a height of 40.64 centimeters with a two-minute rest interval between sets. Of the 80 subjects that began the experiment in the depth jumping group 55 met the performance requirements and completed the study.

The rope jumping group jumped with maximal effort and as quickly as possible for three 30-second intervals, resting one minute between each set. Although 80 subjects were assigned to the rope jumping group at the start of the investigation 51 met the performance requirements and completed the study.

The control group participated in balancing activities for the nine-week training session. No rebounding or jumping skills were included in their assigned tasks. At the beginning of the study, 81 subjects were included in the control group and 78 subjects completed the study.

At the end of the nine-week training session, all subjects were posttested with the identical jump and reach test used at the start of the investigation. The data were statistically analyzed and the results presented. Analysis of variance was utilized to determine which groups significantly improved over time. The results indicated that the difference between the pre and posttest trials were significant in the depth jumping and rope jumping groups. The group by trials interaction effect was also significant indicating that all groups did not benefit equally from the treatments provided. Post-hoc analysis indicated that the depth jumping and rope jumping groups significantly improved vertical jumping ability. The results of this analysis also indicated no difference between rope jump training and depth jump training in increasing vertical jumping ability in junior high females.

Conclusions

Based upon the results of this investigation the following conclusions are made:

1. Depth jumping and rope jumping are significantly effective training methods used to increase the vertical jumping ability of junior high females.

2. Rope jumping and depth jumping are not significantly different in regard to increasing the vertical jump performance of junior high females.

Recommendations

The following recommendations for further research are suggested:

1. Extend the present study to high school and college athletes to determine if rope jump training could be used as a substitute for depth jump training at those age levels.

2. Replicate the present study over a period of time longer than nine weeks.

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APPENDICES

APPENDIX A

TECHNIQUES AND CRITERIA FOR ROPE JUMPING, DEPTH JUMPING, AND VERTICAL JUMPING

Techniques for Rope Jumping Subjects

1. Subject must jump with two feet simultaneously exploding from the floor.

2. Subject must jump one time for each turn of the rope.

3. Subject must complete three sets of jumping per training session.

4. Subject must complete two training sessions per week for nine weeks.

5. Subject must average 45 jumps in the 30 second interval.

Techniques for Depth Jumping Subjects.

1. Subject must drop off the box with one foot leading. During the descent, the other foot catches up to the first foot in an effort that both feet land together.

2. Subject must land with both feet on floor simultaneously and with a slight bend in knees.

3. Subject must immediately explode in the air upon landing.

4. Subject must use arms to help propel the body upward.

5. Subject must perform the required number of repetitions per session.

6. Subject must perform two training sessions per week for nine consecutive weeks.

Techniques for Vertical Jump and Reach Testing Sessions

1. Subject must stand close to wall with one arm extended upward as high as possible with fingertips touching the measuring device.

2. Subject bends knees and uses both arms to propel her body upward.

3. Subject performs three maximal vertical jumps touching the measuring device with chalked fingertips each time.

APPENDIX B

To: Parents and/or Guardians
From: Miss Kelly L. Bissell
Date: January 2, 1990

Dear Parents and/or Guardians:
During the next nine weeks, girls in grades six through eight will be participating in a unique study on vertical jumping ability. The experiment will take place in the beginning of each physical education class period. Each student will be assigned to a rope jumping group, a depth jumping group, or a control group. The rope jumping will consist of three one-minute intervals of jump roping as quickly as possible. The depth jumping group will consist of stepping off a 16 inch box and immediately performing a maximal vertical jump. The students in this group will progress to three sets of ten jumps. The control group will perform various balancing tasks. The safety of the participants is of extreme importance and all precautions will be carefully considered.
This experiment is being conducted as part of my thesis requirement in an effort to complete my Master's degree in physical education at the State University of New York College at Brockport.

Your cooperation in signing the form below granting permission for your daughter to participate is greatly appreciated.
If you have any questions or concerns feel free to call the Batavia Middle School at 343-2480.

Sincerely,

Kelly L. Bissell

My daughter ________________________________ has permission to participate in the jumping ability experiment being conducted at the Batavia Middle School.

____

Signature of Parent/Guardian Date

APPENDIX C

GENERAL JUMPING EXERCISES

1. Hop on right foot
2. Hop on left foot
3. Alternate hopping on right and left feet
4. Jump from side to side with feet together
5. Skip with high knee lift
6. Do the grapevine
7. Gallop
8. Leap
9. Hop onto and then over folded mats
10. Hop over objects (beanbags, ropes and hoops)
11. Jump forward
12. Jump backwards

APPENDIX D

Balance Activities for the Control Group

Week 1
1. Stand on right foot (45 sec.)
2. Stand on left foot (45 sec.)
3. Stand on right foot with eyes closed (45 sec.)
4. Stand on left foot with eyes closed (45 sec.)

Week 2
5. Stand on toes right foot (45 sec.)
6. Stand on toes left foot (45 sec.)
7. Stand on toes right foot with eyes closed (45 sec.)
8. Stand on toes left foot with eyes closed (45 sec.)

Week 3
9. Walk forward on line - 25 feet
10. Walk backwards on line - 25 feet
11. Walk sideways on line - 25 feet

Week 4
12. Balance object on head - repeat number 9
13. Balance object on head - repeat number 10
14. Balance object on head - repeat number 11

Week 5
15. Walk forward across low beam - three times
16. Walk backwards across low beam - three times
17. Walk sideways across low beam - three times

Week 6
18. Stork stand (45 sec.)
19. Stand on right foot - pick up object
20. Stand on left foot - pick up object

Week 7
21. Frog stand (30 sec.)
22. Head stand (30 sec.)

Week 8
23. Handstand (10 sec.)
24. Frog stand without head touching mat (10 sec.)

Week 9
25. V-sit balance (30 sec.)
26. Bridge balance (30 sec.)

Week 10
27. Twister game

APPENDIX E

VERTICAL JUMP RAW SCORES IN INCHES OF SUBJECTS IN THE CONTROL GROUP

* denotes subject did not meet the critèria necessary for inclusion in the analysis of the study.

SUBJECTS	PRETEST	POSTTEST	GRADE LEVEL
001	10.50	12.50	7
002	09.50	09.75	7
003	10.75	11.00	7
004	15.50	17.50	7
005	08.75	11.75	7
006	16.00	17.00	7
007	10.75	12.00	7
008	14.25	14.00	7
009	09.75	09.75	6
010	06.00	06.00	6
011	11.25	11.50	6
012	07.00	08.50	6
013	12.50	13.75	6
014	10.75	11.25	6
015	10.75	10.00	6
016	09.00	07.50	6
017	11.00	11.75	6
018	10.50	11.00	8
019	10.50	10.25	8
020	08.50	08.50	8
021	16.25	16.00	8
022	15.00	16.00	8
023	09.50	11.00	8
024	10.00	09.75	8
025*	11.50	DROPPED	7
026	13.00	13.25	8
027	11.25	12.25	8
028	12.50	11.25	8
029	15.25	16.25	8
030	10.75	10.75	8
031	21.50	20.00	8
032	09.50	10.75	8
033	14.50	15.25	8
034	10.25	09.75	8
035	11.50	13.25	8
036	11.00	12.50	7

SUBJECTS	PRETEST	POSTTEST	GRADE LEVEL
037	09.50	09.25	7
038*	12.00	DROPPED	7
039	10.75	10.50	7
040	11.25	12.25	7
041	09.00	10.00	7
042	10.50	10.25	7
043	09.50	10.50	7
044	11.50	11.50	6
045	14.00	12.50	6
046	08.00	09.00	6
047	10.75	10.00	6
048	07.75	08.50	6
049	08.25	08.50	6
050	07.25	06.50	6
051	14.00	12.00	6
052	10.25	11.00	6
053	09.00	08.50	6
054	12.75	13.25	8
055	13.00	13.25	8
056	14.00	12.25	8
057	13.75	14.00	8
058	10.75	10.75	8
059	15.25	15.00	8
060	12.75	12.75	8
061	17.25	18.00	8
062	12.00	11.00	8
063	11.25	11.00	8
064	10.00	11.00	8
065	12.50	12.00	8
066	12.50	13.50	8
067*	07.50	DROPPED	8
068	12.00	11.50	8
069	09.75	10.50	7
070	12.00	12.00	7
071	15.00	15.00	7
072	13.75	14.50	7
073	13.50	13.25	7
074	09.00	10.00	7
075	12.25	12.75	7
076	12.50	10.00	7
077	08.00	08.25	7
078	11.50	10.50	7

SUBJECTS	PRETEST	POSTTEST	GRADE LEVEL
079	12.75	11.75	7
080	10.00	08.25	7
081	08.75	08.75	7

VERTICAL JUMP RAW SCORES IN INCHES OF SUBJECTS IN THE DEPTH JUMPING GROUP

* denotes subject did not meet the criteria necessary for inclusion in the analysis of the study.

SUBJECTS	PRETEST	POSTTEST	GRADE LEVEL
082	13.75	16.00	7
083*	14.75	14.00	7
084	09.00	10.25	7
085	14.25	13.75	7
086	08.50	10.75	7
087*	07.25	09.00	7
088*	09.75	10.25	7
089	09.75	15.75	7
090	08.75	12.00	6
091	09.75	10.75	6
092	10.00	11.50	6
093	09.00	10.00	6
094	10.75	11.50	6
095	08.25	09.75	6
096	11.00	14.00	6
097	04.75	10.75	6
098*	11.25	10.75	8
099	16.75	16.50	8
100	11.50	12.25	8
101*	10.00	08.00	8
102	15.00	16.75	8
103	11.75	13.50	8
104*	13.75	13.25	8
105*	14.00	13.50	8
106	10.00	11.25	8
107*	18.75	17.25	8
108	06.50	08.00	8
109	11.00	11.50	8
110*	16.75	15.75	8
111	13.00	13.25	8
112*	15.75	14.75	8
113	14.75	15.00	8
114	12.25	14.50	8
115	11.25	14.25	8
116*	08.00	DROPPED	7
117*	11.50	11.00	7

SUBJECTS	PRETEST	POSTTEST	GRADE LEVEL
118	09.00	10.25	7
119	08.50	08.50	7
120*	12.25	DROPPED	7
121*	12.00	12.00	7
122	11.25	13.00	7
123	16.25	16.25	7
124	09.00	10.75	7
125*	12.00	11.25	7
126*	09.75	09.75	7
127	15.25	15.75	7
128*	12.00	10.75	7
129	09.00	10.00	7
130	16.25	18.00	7
131*	10.50	09.00	7
132	13.00	14.25	6
133	10.75	11.00	6
134	10.00	11.50	6
135	12.50	13.00	6
136	11.00	13.25	6
137	08.75	11.75	6
138	09.00	09.25	6
139	08.50	10.50	6
140	13.25	13.50	8
141	10.50	10.00	8
142*	14.00	11.75	8
143	16.25	15.25	8
144	12.50	14.00	8
145	10.75	13.75	8
146	08.75	09.50	8
147	09.25	11.75	8
148*	10.50	10.50	8
149*	09.00	07.50	8
150	10.50	13.50	8
151*	13.25	DROPPED	8
152*	12.50	11.00	8
153	12.25	13.50	7
154	14.00	16.50	7
155	12.75	13.00	7
156	14.25	13.25	7
157*	08.75	10.00	7
158	12.00	13.75	7
159	09.00	10.75	7

SUBJECTS	PRETEST	POSTTEST	GRADE LEVEL
160	13.25	13.00	7
161*	11.25	DROPPED	6

VERTICAL JUMP RAW SCORES IN INCHES OF SUBJECTS IN THE ROPE JUMPING GROUP

* denotes subject did not meet the criteria necessary for inclusion in the analysis of the study.

SUBJECTS	PRETEST	POSTTEST	GRADE LEVEL
162	15.50	15.50	7
163*	11.25	11.50	7
164	09.50	13.50	7
165	09.75	10.50	7
166	08.25	11.25	7
167*	10.25	11.75	6
168	07.00	12.25	6
169*	09.00	08.50	6
170*	12.25	13.00	6
171	07.00	09.00	6
172	10.75	12.00	6
173	06.75	08.50	6
174	08.00	08.25	6
175*	13.25	13.25	6
176	11.00	15.00	8
177	09.50	10.75	8
178	12.50	12.75	8
179	11.25	11.50	8
180	13.50	14.00	8
181	09.75	11.50	8
182	11.00	12.50	8
183	16.00	16.75	8
184	11.25	10.50	8
185	13.25	15.75	8
186*	09.25	08.25	8
187	13.50	13.50	8
188*	13.00	DROPPED	8
189	11.00	11.75	8
190	14.00	13.25	8
191	11.75	11.50	7
192	09.50	11.00	7
193	10.50	12.50	7
194*	08.50	08.75	7
196	07.50	09.50	7
197*	10.75	DROPPED	7

SUBJECTS	PRETEST	POSTTEST	GRADE LEVEL
198	10.25	12.75	7
199*	11.75	11.50	7
200	08.50	10.00	7
201	14.50	15.00	7
202*	11.00	12.00	7
203	09.00	09.00	7
204*	05.00	07.00	7
205	10.75	11.75	7
206*	15.50	13.50	7
207	12.50	13.75	6
208	06.50	09.00	6
209*	12.25	12.00	6
210*	06.50	07.75	6
211	12.25	14.00	6
212	09.25	10.75	6
213*	08.00	09.50	6
214*	10.50	11.50	8
215*	11.25	13.00	8
216	15.50	15.50	8
217	14.50	14.25	8
218	11.75	11.75	8
219*	10.00	DROPPED	8
220*	08.00	10.25	8
221	13.25	13.75	8
222*	15.75	15.75	8
223	09.50	12.50	8
224*	15.00	DROPPED	8
225	14.25	14.50	8
226*	11.75	DROPPED	8
227*	08.25	11.50	8
228	10.75	13.00	8
229	16.00	14.75	8
230	13.00	14.00	7
231*	14.00	13.50	7
232	16.00	16.00	7
233*	10.75	11.25	7
234	09.50	11.50	7
235*	12.00	11.75	7
236	10.75	12.50	7
237	09.25	08.00	7
238	12.75	12.50	7
239	12.50	13.50	7

SUBJECTS	PRETEST	POSTTEST	GRADE LEVEL
240*	11.25	12.25	7
241*	06.25	06.75	7