

Student Version

Title: Comparison of Standing Vertical Jump Performance Using a Counter-Movement Jump (CMJ) versus an Isometric Preload Jump (IPJ)

Abstract: This project is designed to quickly introduce beginning kinesiology students to measurement and data analysis by comparing two interesting methods of increasing vertical jump height. Unit 1 of this project will involve students measuring the vertical jumping performance of their classmates when using a (1) *Counter-Movement Jump (CMJ)*, compared to an (2) *Isometric Preload Jump (IPJ)*. See below for descriptions of these. Performance measurements will be recorded on a spreadsheet and compared using fundamental descriptive and inferential statistical software. The primary purposes of the project for Unit 1 are to (1) use correct measurement principles to collect data and, (2) describe differences in jumping height from the two movements using measures of central tendency and variability. The testing methodology, types of jumps, and biomechanical principle involved in increasing force production during the vertical jump, the *stretch-shortening cycle (SSC)*, may be easily grasped by students without extensive study on the subject (see below for a description of these). The hypothesis for this study would not necessarily be directional, but would instead reflect the question: How does IPJ compare to CMJ in increasing vertical jump height?

Instructions to Students:

Background Information: The *vertical jump* is the most common measure of power in athletics. This is because it is easy to administer, safe to perform, reasonably reliable and valid with respect to measuring lower body power, is inexpensive, and allows comparisons to many different sources of norms and classification indexes. The height an athlete jumps depends upon the speed they achieve while moving their body weight before the last segment of the body becomes airborne (the “toe-off”). In Biomechanics, students learn that $power = force \times velocity$, so the vertical jump is an indication of how fast an athlete is applying force and has both *strength* and *speed* of movement components. Most vertical jumps occur in about .2 seconds! One of the most helpful charts with vertical test scores by gender is available at the Topend Sports® site (topendsports.com) and is included on the data collection spreadsheet for this project for easy reference. The simplest method of measuring vertical jumping height without special equipment is for the athlete to stand flat-footed and reach as high as possible, marking a wall with the chalked fingertips of one hand. The athlete then jumps as high as possible, marking the wall with the chalked fingertips of one hand. The athlete can jump as many times as desired with the best effort recorded on a data sheet. The difference between the jumping height and the standing height is the athletes recorded vertical jump in centimeters and/or inches. A common improvement to the test used with high-performance testing is a vertical jump measuring device containing columns of .5 inch bars the athlete displaces with their hand at the highest point in the jump (Vertec Testing Device®). This common equipment is found at almost all universities and can also be purchased if desired.

The *Counter-Movement Jump (CMJ)*, *Isometric Preload Jump (IPJ)*, and *Stretch-Shortening Cycle (SSC)*: In short, the *stretch-shortening cycle (SSC)* is a biomechanical property of muscle

force production and may be utilized to dramatically increase muscle force production, particularly during performances requiring power generation such as the vertical jump. When a person wishes to increase vertical jumping height, as in dunking a basketball, blocking a shot in volleyball, or intercepting a pass in football, the body naturally descends into a crouched position requiring eccentric knee and hip flexion followed immediately by forceful extension at the hip and knee, propelling the body upward with great force. The entire motion is called a *counter-movement* and requires the muscle to stretch followed quickly by a contraction or shortening of the muscle called the *stretch-shortening cycle SSC*. Because a *CMJ* does not include a pause at the bottom of the crouch, it activates the *SSC*, increasing force, and therefore, power production about 12% over pausing isometrically at the bottom of the crouch. Recently, some athletes have used an *IPJ* for purposes of increasing their vertical jump height. The *IPJ* includes an *isometric preload (IP)* to the thigh and gluteal muscles by pausing for several seconds in the crouch while assuming a specific position conducive to preloading the muscles before forcefully jumping upwards. Because this motion activates the *SSC* similar to pressing on a coiled spring before releasing, greater power can be produced than with an isometric pause at the bottom of the crouch. Even though most athletes prefer the more traditional *CMJ*, some researchers have found the difference in influencing jump heights between the two methods negligible.

A Quick Guide to Describing Data with Statistics for this Project: A quick way to describe and compare a group of numbers such as the performance of the class using a particular vertical jumping technique, is to use one number in the middle of the data which best represents the group. These statistics are called measures of “*central tendency*,” and include the *mean, median, and mode*. For this project the “*mean*” should be used because we are assuming the data is “normal” and the mean best represents all of the scores in the group. Using the *descriptive statistics* tool in the *data analysis add-in* for MS Excel® as described below under the *data collection* heading you can have the computer do the heavy calculating and provide you with the means for the performances of both groups you tested. An additional piece of information, the *variability* or “spread” of the performances in each group, is necessary to describe the data more completely. For this project, the “*standard deviation*” should be used to describe the variability in each group of performances. Once again, the *descriptive statistics* tool in the *data analysis add-in* for MS Excel® as described below under the *data collection* heading provides you with the needed statistic. So, you should use both statistics to help answer the question of which technique of vertical jumping was better for the class in this project. It is important to also note that the *mean* and *standard deviation* will be used in the calculation of the inferential statistics used in module2.

Individual or Group Project: Students will perform the statistical analyses and produce a concise final report individually. Students will be paired for the data collection involving the vertical jump for ease in measurement. If students are off campus it is possible for students to measure the jump individually by marking the jumps on an adjacent wall with powdered chalk on the fingertips. Students who are not able to jump will still have access to the data set, see below).

Data Collection: Data for both methods of performing the vertical jump will be collected and reported so that all students will have the complete class data set to analyze. Measurements for the class will be recorded for analysis on the supplied Excel spreadsheet. Students will be divided into pairs for the measurement and will alternate as performers and collectors of the data. If students are off campus it is possible for students to measure the jump individually by marking the jumps on an adjacent wall with powdered chalk on the fingertips and then measuring the distance. Further details about how to collect the data follow.

Instructions for Conducting the Standing Vertical Jump Test: The simplest method of measuring vertical jumping height without special equipment is for the athlete to stand flat-footed and reach as high as possible, marking a wall with the chalked fingertips of one hand. The athlete then jumps as high as possible, marking the wall with the chalked fingertips of one hand. For this project, the performer should be limited to three jumps, with the best effort recorded on the Excel data sheet provided by the instructor. It is best if the two methods of jumping are alternated order-wise so that one partner performs the *CMJ* first and the other partner performs the *IPJ* first. The difference between the jumping height and the standing height is the athletes recorded vertical jump in centimeters and inches.

When performing the vertical jump using *CMJ*, students should descend to the crouch position with hands behind their buttocks naturally and knees bent no further than 90° and, in a ballistic fashion without pausing, immediately explode upward while reaching with the marking hand as high as possible. When performing the *IPJ*, students should descend to the crouch position with hands behind their buttocks naturally and pause for a 3-second count with knees bent no further than 90° before exploding upward while reaching with the marking hand as high as possible. When holding the crouch position in the *IPJ*, students should not lean too far forward so that more weight is directly transferred to the hips and legs. Additional examples for how to accomplish this will be provided in class.

The following safety guidelines should be followed: (1) Students should not participate in the jumping part of this project if they do not feel they are physically ready to exert themselves and/or have injuries and/or other factors limiting their ability to jump and land, (2) Students should be allowed to thoroughly warm up before jumping for measurement, and (3) Students should be told not to swipe at the wall or marker, and (4) Students accept responsibility for their own health and safety and can decline to jump for any reason.

Procedures/Instructions for Analyzing the Data: Once data is collected on the entire class for both jumping techniques and is appropriately organized in the Excel spreadsheet, the following steps should be followed for analyzing the data:

Descriptive Statistical Analysis software: The statistical analysis tool “**Descriptive Statistics**” included in the *Data Analysis* add-in for *MS Excel*® will be used for this project. This is important as the mathematical formulas necessary for computing the specific statistics are found there. Students should find the data analysis tools in *MS Excel* easy to access on and off campus on PC’s and most Apple computer versions of *MS Office*®. *MS Excel* does not require institutional technical help or specialized classrooms for student use and students are encouraged

to notify the instructor if they anticipate any problems with computing while taking this course. The '*Data Analysis*' add-in may already be activated and found in the far-right hand side of the top ribbon and category buttons as '*Data Analysis*' after opening *Excel* and clicking the '*Data*' button. Because computers do not automatically activate the add-ins, the following steps may be required:

Open Excel | File | Options | Add-Ins (from left list) | Analysis Toolpak | Go | OK

Find the Data Analysis add-in by:

Open Excel | Data | Data Analysis (on right hand side of tools)

Computers that do not allow permanent changes require activation of the *Data Analysis* Add-In every time the computer is turned on (most university computers).

The following instructions should be followed when using the **descriptive statistics** tool in the data analysis add-in to produce the print-out used under the "examples" heading in this document:

Using the **Descriptive Statistics** data analysis tool:

1. Select **Data | Data Analysis** (to open the Data Analysis dialog box)
2. Choose *Descriptive Statistics* (to open the Descriptive Statistics dialog box)
3. **In the *Descriptive Statistics* dialog box, enter the appropriate values by highlighting the cells** containing the data plus the first line above the data if you want to automatically use the first line above the data as a label (recommended, and the reason each of these lines is a unique set of letters and numbers on the spreadsheet). Be careful not to include empty cells and cells with symbols other than numbers.
4. **Click the *Columns Radio Button*** to indicate that the data are organized into columns (the standard way to enter data on a spreadsheet)
5. **Check the *Labels in First Row checkbox*** so that Excel does not recognize the cell as a number if you used the first line above the data as a label in step 3 above.
6. **Click the *New Worksheet Ply radio button*** to create a new tabbed sheet at the bottom within the current worksheet, and to send the results to the newly created worksheet (recommended).
7. **Click the *Summary Statistics checkbox*** (and leave the others unchecked)
8. **Click *OK* to close the dialog box.**

Students should use a measure of (1) central tendency and (2) variability to describe differences in performance and spread of jumping height measures between groups. The highlighted numbers in the example are using the best measures and the ones students should use for this project, the *Mean* and *Standard Deviation*. These statistics should be all the student needs to answer the research question (without using the inferential statistics in Module 2). A short description of these two statistics is included in the background information above. Further

examples/guidance may be provided by the instructor as needed. A good habit is to also run the “Histogram” tool found in the data analysis package (same list) as it helps display the shape of the data and understanding of central tendency. This is accomplished by providing the data in the appropriate box.

Examples of the data spreadsheet and descriptive statistics printout:

<u>SUBJ</u>	<u>AGE</u> (years)	<u>GENDER</u>	<u>HT</u> height (inches)	<u>WT</u> weight (lbs)	<u>CMJ</u> Counter- Movement Jump (inches)	<u>IPJ</u> Isometric Preload Jump (inches)
1	18	F	66	136	18	16
2	18	M	70	188	26	22
3	20	F	68	120	24	21
4	19	F	66	110	20	20
5	18	M	72	192	24	20
6	19	M	68	168	28	26
7	20	M	69	178	19	20
8	21	F	64	138	17	16
9	19	M	71	210	23	20
10	18	F	71	160	21	19
11	18	M	74	218	22	20
12	18	M	70	191	32	28

CMJ

Mean	21.00
Standard Error	0.78
Median	21.00
Mode	24.00
Standard Deviation	4.44
Sample Variance	19.68
Kurtosis	0.78
Skewness	0.04
Range	22.00
Minimum	10.00
Maximum	32.00
Sum	672.00
Count	32.00

Duration: This project can be completed in two class sessions—one session for introducing the research question and recording the data, and one session on running and interpreting the *descriptive statistics* procedure in Excel. A third session involving further discussion about the topic and/or results of the analysis may be used if desired.

Deliverables and Evaluation: Each student will deliver a short report answering the basic research question (hypothesis) posed above. The answer should be no more than ½ - 1 page in length and accompanied by a data print-out using the results of the descriptive analysis tool in Excel. The evaluation will be based upon (1) correct measurement values, (2) correct analysis using the results of the descriptive statistics tool in Excel (print-out), and (3) answers to the research question using logical conclusions drawn from the data.