THICK or Thin

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Practical Applications of Advanced Mathematics

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Abstract

Does a person's thigh and calf muscle affect their performance in their range of motion? By understanding the anatomy of the knee, the comprehension of flexion and extension is possible. By measuring each Summer Ventures student's thigh and calf size, flexion, and extension of both knees, I compiled the results together. The results showed that a person's calf and thigh size may affect the extension of their knee, while their flexion ability did not seem affected by the size of their calf and thigh size. In conclusion to my project I found that a person's flexion and extension may be altered depending on the size of the thigh and the calf.

Background

The knee joint is foremost the source to human's success to any physical movement involving the leg. Yet at the same time every single person is extremely different in a lot of ways. One is their body style and more specifically, one's leg muscles. Every persons thigh and calf muscles are particularly different in many ways even though we all have the same elements.

The Anatomy of the Knee

The anatomy of the knee is very complex. Made up of ligaments, cartilage, tendons, bones, and a joint capsule, the knee works as a hinge, moving back and forward and provide support to withhold the entire mass of a human. There are four bones that are located in the knee: the femur, tibia, fibula, and patella. The femur is the large bone located right above the knee (Darrow, 2002). The femur is the largest bone in the body as well as the hardest to break. The tibia and the fibula make up the lower part of the leg. The tibia, also known as the shin bone, is located on the inner side of the leg. The tibia bears all of the weight of the human body (Tibia Unit, 2001). Running parallel to the tibia, the fibula is located on the outer part of the lower leg. The fibula does not support as much weight as the tibia, but the bone does have a vital job. The fibula is an attachment site for some muscles that connect to the knee joint (Fibula Unit, 2001). The patella, also known as the knee cap, is located in where the femur, the tibia, and the fibula join (Knee Anatomy: A Patient's Guide to Knee Anatomy, 2009).

Tendons and ligaments allow the knee to move and also keep the entire knee in place. A ligament attaches two bones together. There are four types of ligament located in the knee, the anterior circulate ligament (ACL), the medial collateral ligament (MCL), the posterior circulate (PCL), and the lateral collateral ligament (LCL). The ACL is located in the front of the inside of the knee, and the PCL is located in the back of the inside of the knee. Both of these ligaments

maintain the tibia from sliding too far forward or backward in relation to the femur's position. The LCL connects the femur to the fibula which is located on the outer side of the knee. The MCL connects the femur to the tibia on the inner side of the knee. Both the LCL and the MCL uphold the job of not allowing the femur to move to distant from the tibia and fibula at any time. A tendon connects a bone to a muscle. The patellar tendon is the largest tendon around the knee by surrounding the patella and continuing upward through the thigh. Above the knee a tendon called the quadriceps tendon is attached to the front of the femur. The hamstring tendon is the tendon that is located on the back of the femur, both of which connect themselves in different places on the knee joint (Knee Anatomy: A Patient's Guide to Knee Anatomy, 2009).

Located in between the femur and the tibia are the medial meniscus and the lateral meniscus. Both may be referred to as the cartilage of the knee. Both act as gasket, providing addition stability for the knee joint. The medial meniscus is located on the internal side of the knee. The lateral meniscus is located on the external part of the knee joint. Together they have a very critical job to fulfill. Without the medial meniscus and lateral meniscus all of a human's weight would be directed on to one point of the tibia. If the weight was not equally distributed, degeneration would slowly form over time. By having the menisci, the weight is equally distributed over the entire surface of the top of the tibia (Knee Anatomy: A Patient's Guide to Knee Anatomy, 2009).

The Range of Motion

The range of motion is used to describe the direction and distance in which a joint can move. Every joint in the body has a standard range of motion. The knee joint can be measured through flexion and extension (Lee and Moroz, 2009). Flexion is when a straight leg moves backwards in a "butt kick-like" motion. A flexion starts at zero degrees and may reach a full

flexion of one hundred forty degrees. This angle may be smaller or larger depending on the bulk of the limb. A normal woman's range of motion is minus 5 to 143, and a normal man's range of motion is minus 6 to 140 (Flexion, 2007). An extension of the knee is when the leg starts at a smaller than ninety degree angle sitting in a chair. The leg is then slowly brought up to a straight line parallel to the floor. This measure starts at one hundred twenty degrees and reaches a zero degree angle when parallel with the floor (Carol and Richard Eustice, 2008).

Goniometer

The goniometer is a measuring tool that is used to calculate angles of joints. *Gonia* means angle and *metron* means to measure. A goniometer is used by placing it over the fulcrum of the knee joint. By asking the patient to move their limb, the measurement of the angle can be recorded (Hardyal, 2010).

Research Question

Does a person's thigh and calf thickness affect their performance in their range of motion?

Methods

To investigate my question, I approached 74 students that are in the Summer Ventures of Science and Mathematics program located at UNC Charlotte inside and outside of class time. With each person I measured their thigh and calf size in centimeters. To measure the thigh size, I placed the end of the measuring tape in the middle of the top of their knee measuring five inches. From that point I wrapped the measuring tape around their thigh and recorded the measurement in centimeters. Next I measured the size of their calf. I placed the measuring tape in the middle of the patella and measured five inches downward towards the ankle. From that

point I again wrapped the measuring tape around the calf muscle/fat and recorded the measurement in centimeters.

After that I measured their range of motion through flexion and extension of the knee. To measure the flexion I first placed the goniometer right in the middle of the side of the knee and place their leg at a ninety degree angle to the floor. Then I asked them to raise their leg to the uppermost angle that their knee could go forward. Next I recorded the measure of the angle, which was the angle given minus ninety. To find extension, I placed their leg at one hundred eighty degrees, perpendicular to the floor. Again I placed the gonoimeter in the middle of the side of their knee. I asked them to kick back their leg in a "butt- kick-like" motion and to hold it.

After recording every person's thigh and calf size, flexion in both legs, and extension of both legs, I categorized the data by gender and age. Afterwards I charted the data into categories. These categories included:

- Women, Thigh Thickness vs. Left Leg Extension and Right Leg Extension
- Women, Thigh Thickness vs. Left Leg Flexion and Right Leg Flexion
- Women, Calf Thickness vs. Left Leg Extension and Right Leg Extension
- Women, Calf Thickness vs. Left Leg Flexion and Right Leg Flexion

- Men, Thigh Thickness vs. Left Leg Extension and Right Leg Extension
- Men, Thigh Thickness vs. Left Leg Flexion and Right Leg Flexion
- Men, Calf Thickness vs. Left Leg Extension and Right Leg Extension
- Men, Calf Thickness vs. Left Leg Flexion and Right Leg Flexion

Limitations

For my experiment I chose my participants to be to the Summer Ventures of Science and Mathematics students at UNC Charlotte. This created a lot of limitations for my project, some of which were time, age, gender, body style, and the number of people that are accounted for in my experiment. Only given four weeks for the project, my project was narrowed down by time. Also because I chose to use the students that are attending this class, the age division of my

experiment was only from 15 to 17. Also by choosing only to use the students in the program, I was given an uneven number of males versus females. The number of 74 students gave me 43 females and 31 males.

Results

After putting my methods into action, I retrieved a wide range of results. Appendix A shows the results of the female thigh compared to their left and right extension of the knee joint. In some students, this graph shows that the length around their thigh results in a smaller angle measurement in their right and left extension, but in some cases it does not. In Appendix B the female's thigh is compared to their left and right flexion. The results from the graph showed no correlation between them. This means that a female's thigh size does not truly affect the flexion in both legs that greatly. In Appendix C the female's calf size is compared to their left and right extension. The results showed that a female's calf size does have a slight affect on their ability of extension. In Appendix D, the graph compares the female calf to their left and right flexion. There is not a specific relationship between the three lines. The male's thigh thickness is compared to his left and right extension in Appendix E. The graph shows that the thigh thickness has nothing to do with a male's ability in extension of the left and right leg. In Appendix F, the male's thigh is compared to his left and right flexion. The relationship between the three lines is that the thicker the thigh, the smaller flexion he has in his legs. In Appendix G, the male's calf is compared to the left and right extension. The diagram seems to show no true correlation between the lines. In Appendices H, the male's calf is compared to the left and right flexion. Again the relationship between the lines shows that the thicker the calf the smaller flexion angle of his legs.

Conclusion

In conclusion to my research, I have found that a female's calf and thigh size affects extension. Also from my research I discovered that a male's calf and thigh size may sometimes affect the results of flexion and extension.

If I had not been placed within a time limit, I would have extended my search further out than the age of fifteen to eighteen. I would have extended to young children all the way through elders of seventy-five to eighty. If I could have done this my results would be more valid. I would also present them equally, given each gender the same number of participants. Also, with more expert training in using the gonoimeter, my results may have been more reliable. My results would also be more valid if I had measured each person against their skin and not around their pants/shorts. Also my measures cannot be reported accurately because I did not measure each person in exactly the same point. If possible I would have measure both thighs and calves of each person rather than just one of each of them.

A question that I asked myself throughout this project was does the amount of exercise that you do in a week has in affect on the size of your thigh and calf muscle? Taking into account the amount of exercise a person does could also extend my research.

References

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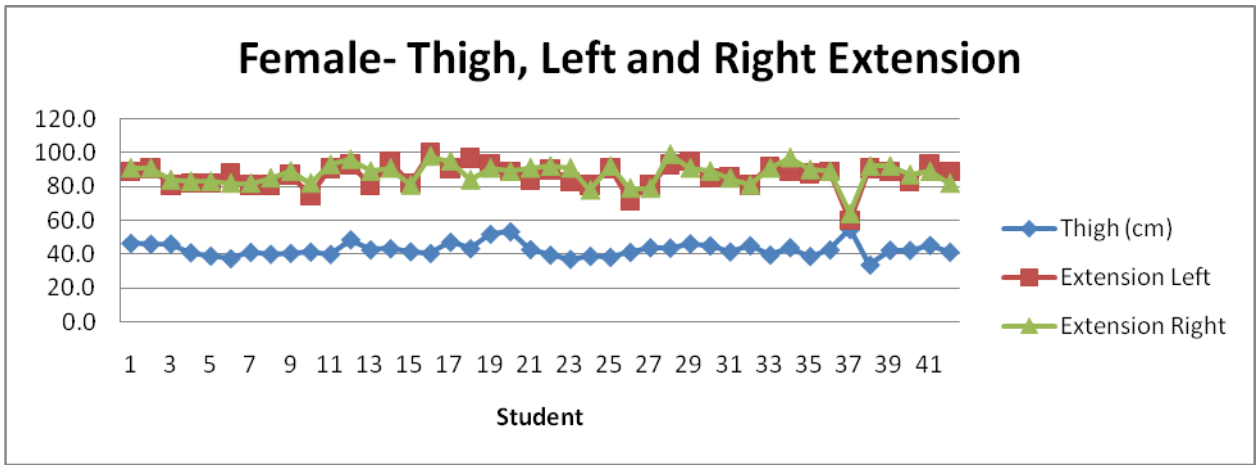
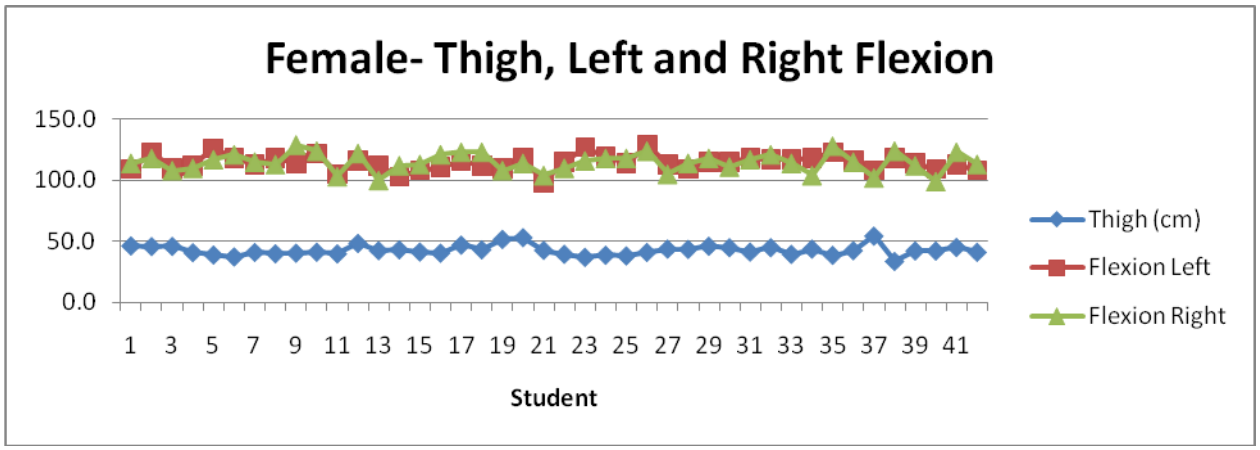
Appendices

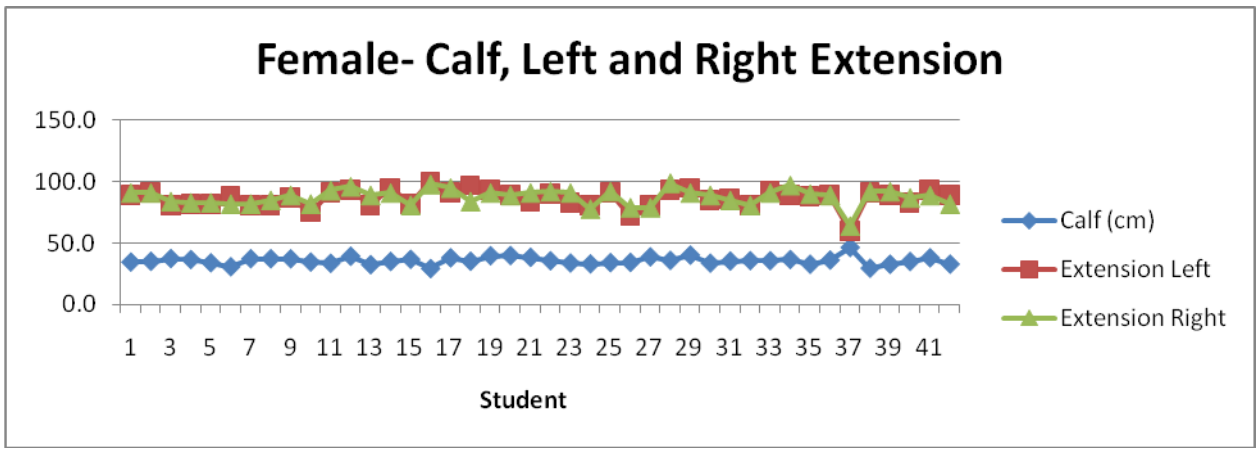
Appendix A



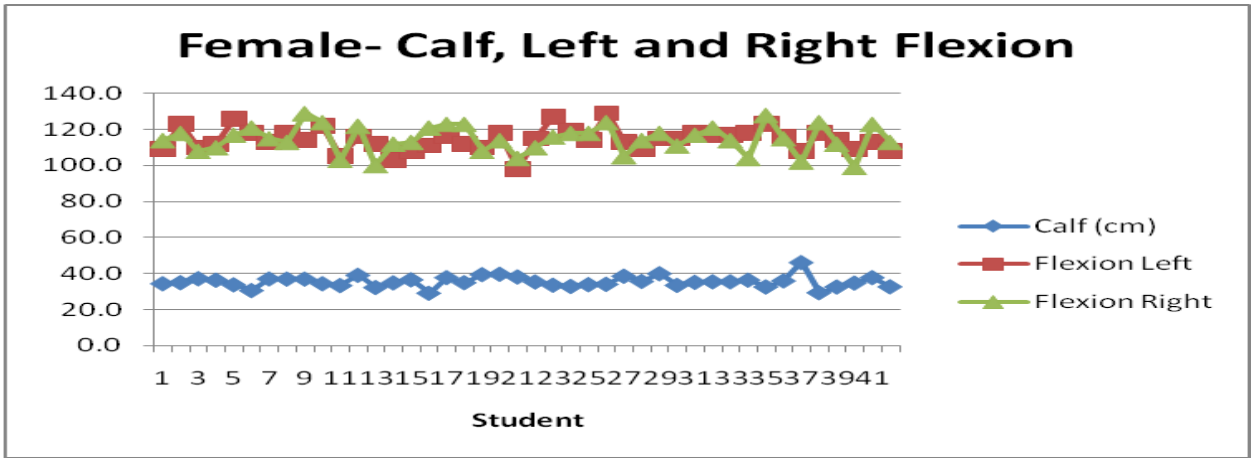
Appendix B



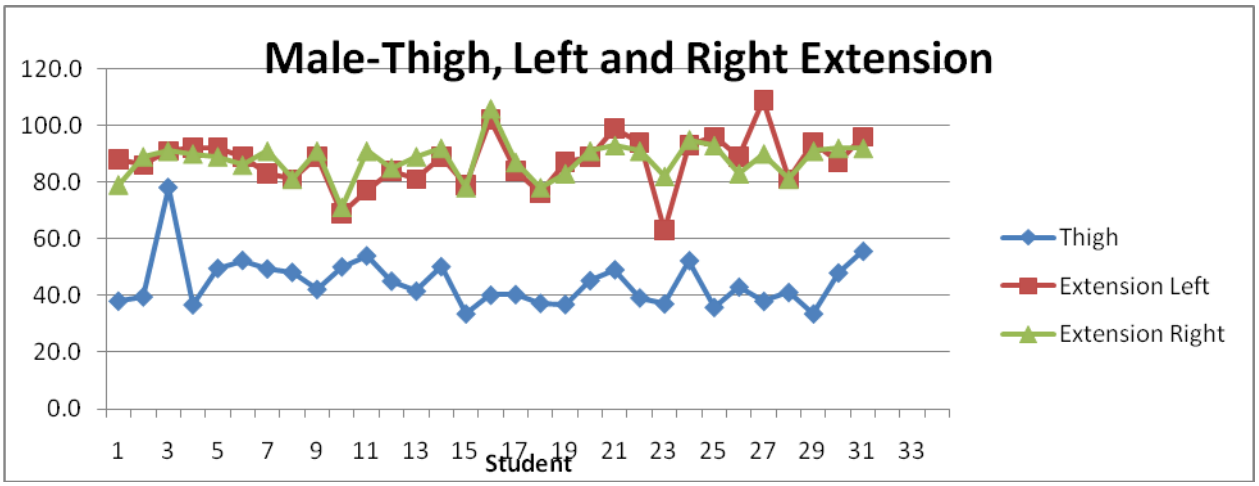
Appendix C



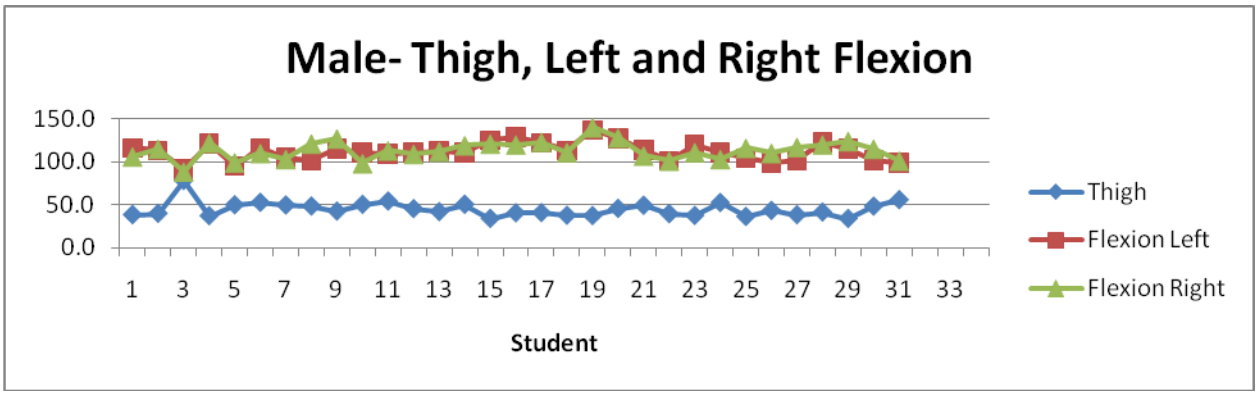
Appendix D



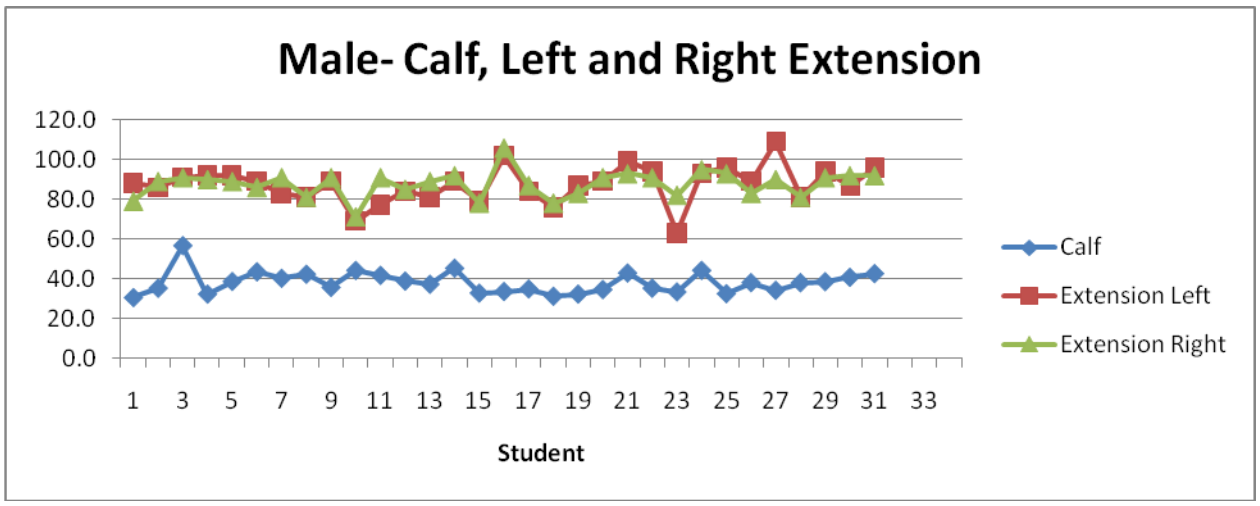
Appendix E



Appendix F



Appendix G



Appendix H