Time Table:

Date:	Entry's
Dec 5 2024:	Topic. Thought about the topic we wanted to do, and brainstormed ways to apply our research.
January 18th	Background research: into hyperhidrosis Resources: Hopkins medicine Mayo clinic Cleveland clinic Background Research:into the effects of sweat on grip and friction. Resources: https://physics.aps.org/articles/v15/196
January 24th	Brainstormed experiment designs and made a hypothesis
January 31st	Met up for science fair and tried to finalize the experiment design
February 7th	Went to a mentorship meeting at school about science fair and changed our experiment design slightly
February 14th	Went to science fair meeting and discussed our project with other people
February 21st	Talked our physics teacher and grabbed experiment equipments
February 28th	Did the experiment at a badminton center
March 3rd	Graphed out our data points and analyzed our graphs
March 9th	Finished the conclusion, application and sources of error

Topic:

Dec 5 2024:

Combating Hyperhidrosis and the effect it has on badminton grips.
Palmar Hyperhidrosis, a condition in which a person will produce excessive sweat in their hands.
Design a badminton grip that remains tacky during play even in the presence of excess sweat.

Badminton grips: PU or towel grips

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Background Research

Hyperhidrosis:

- What is it?
    - Hyper meaning excessive and hidrosis meaning sweating. Hyperhidrosis is the condition in which extra sweat is produced. Sweating is usually meant to cool down one's body temperature, however people with this condition sweat excessively. People with this condition do not have extra sweat glands but instead the sympathetic nerves connected to the sweat glands are oversensitive leading to the increased production of sweat. Common areas this can happen to are armpits, palms, soles of feet, or lower back, however it's possible that other areas may be affected too.

- When does it happen?
  - Sweat glands are typically activated during emotion such as anxiety, hot conditions, or during exercise.
- Types of Hyperhidrosis
  - Two types of hyperhidrosis are primary and secondary.
    - Primary: This type is hereditary and typically passed down from family, this skin condition is from a genetic mutation.
    - Secondary: This is excessive sweating from a pre-existing medical condition or medication.

Effect of Sweat on Grip/Friction

- Whether or not water decreases the coefficient of friction depends on the two surfaces interacting. When water interacts with skin it softens the surface as well as causes the skin to wrinkle, this increases surface area and leads to greater friction. So, typically the wet surfaces compared to completely dry surfaces have a higher coefficient of friction, but, as we can see in the study done by physics aps https://physics.aps.org/articles/v15/196, as a surface becomes more wet the coefficient of friction decreases again. Therefore, a little sweat will be good for grip, so, during play people without hyperhidrosis will be able to experience an effective amount of grip. However, in cases of people with hyperhidrosis, the coefficient of friction is greatly reduced and therefore the grip becomes ineffective.

Testable Questions

How does sweat retention, simulating hyperhidrosis, impact the effectiveness (gripiness) of badminton grips over different levels of hydration?

Hypothesis/Ideas

Although initially badminton grips may become more efficient with a small amount of sweat and an increase in friction may be seen. However as excess sweat forms and builds on the grip it will begin to quickly lose effectiveness and see a sharp decline in the coefficient of friction. Grips that are more absorbent of the sweat will have better effectiveness compared to grips which simply allow the sweat to gather on the surface.

Grips with higher sweat absorption will maintain a more consistent coefficient of friction under conditions simulating hyperhidrosis, while grips that do not absorb sweat effectively will experience a sharper decline in gripiness.

Experimental Design

Objective:
To investigate how excessive sweating (simulated hyperhidrosis) affects the gripiness and sweat absorption of badminton grips over time. This experiment focuses on the relationship between sweat retention and changes in the coefficient of friction for each grip type.

Test out a badminton grip at different levels of simulated moisture. Using a spray bottle to simulate the sweat of a person with hyperhidrosis, with a different number of sprays for the different levels of moisture. Find the coefficient of friction at these different levels as a measure of the effectiveness aka the gripieness of the badminton grip. Number of sprays used are 0, 1, 2, 3, and 5. Compare the coefficients of friction between the grips and how it changes as the sweat retention changes.

Manipulated Variable: Amount of Sweat
Responding Variable:

- Coefficient of friction at different time intervals
- Weight change in the racquet/grip due to sweat retention.

Controlled Variables:

- Same amount of sweat for each test (to represent hyperhidrosis)
- Testing Environment (humidity, temperature etc.)
- Playing against the same level opponent?
- Same duration of testing for each grip

List of Items

- Varying Weights (200g,500g, 700g, 1000g)
- Spring Scale
- Badminton racquet
- Badminton Grip
- Spray bottle

Procedure.

1. attach the spring scale to the weight so that it can be dragged and place it one top of the flat layed out grip, Record the weight.

2. Pull on the spring scale until the weight starts to barely move, record the force required.

3.Regrip the raquet then spray your hand with the desired amount of sprays.

4. Perform 10 clears with the grip and raquet

5. Repeat steps 1-3 for each level of spray. Recording the weight and force required

Trials

Dry grip

Weight (g)	Force (N)
200g	4N
500g	5N
700g	7N
1000g	13N

1 Spray

Weight (g)	Force (N)
200g	1.5N
500g	2.5N
700g	5N
1000g	8N

2 Spray

Weight (g)	Force (N)
200g	1.25N
500g	3N
700g	4.5
1000g	7N

3 Spray

Weight(g)	Force(N)
200g	1N

500g	3N
700g	4N
1000g	6.5N

4 Spray

Weight(g)	Force(N)
200	0.75
500	2.25
700	3
1000	6.5

5 Spray

Weight(g)	Force (N)
200g	0.75N
500g	2.5N
700g	3N
1000g	6N

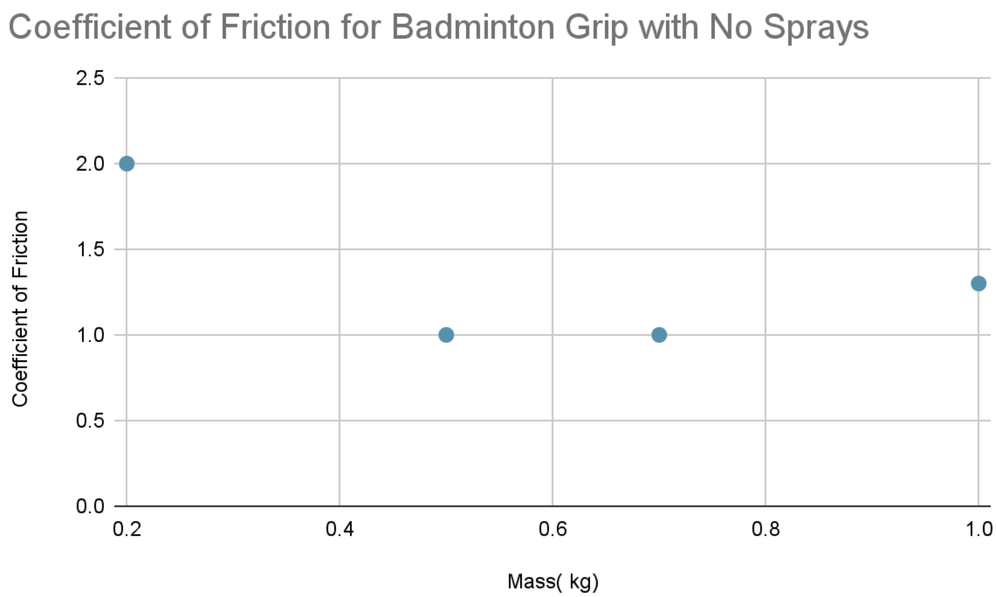
Data

Dry grip

Mass (kg)	Force (N)	Coefficient of friction
0.200	4.0	2.0
0.500	5.0	1.0
0.700	7.0	1.0
1.000	13	1.3

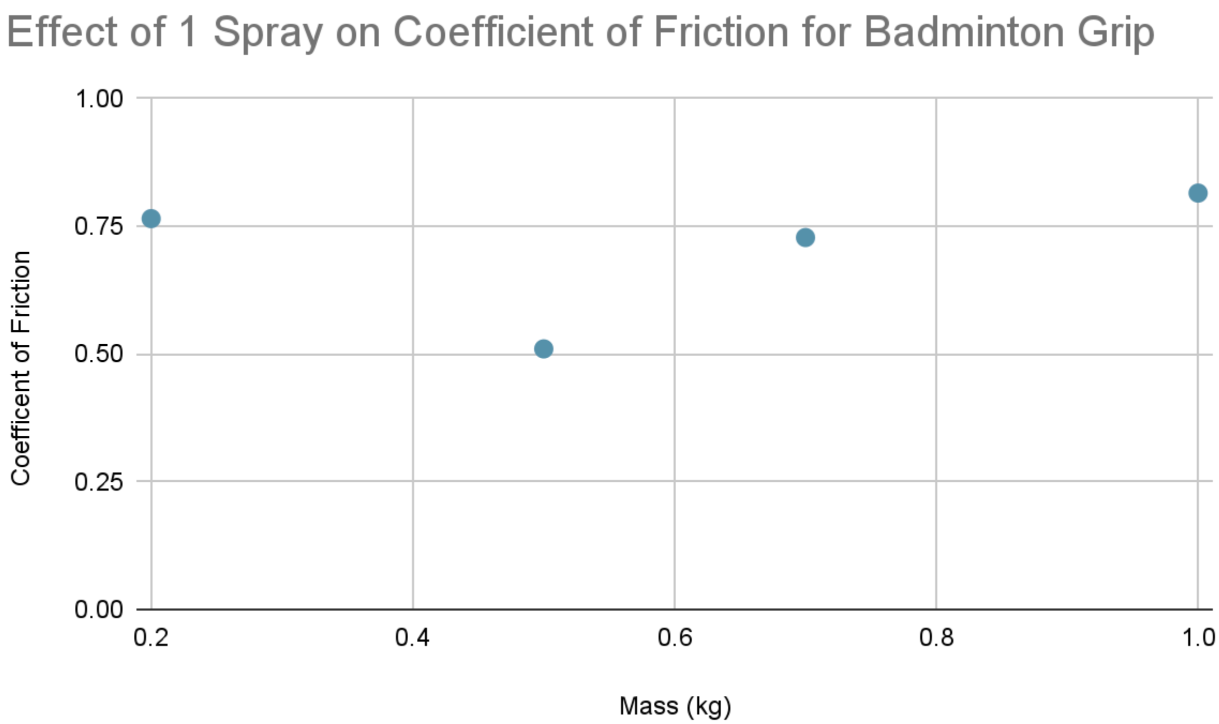
Sample calculation for coefficient of friction: Fn = (0.2kg*9.81m/s^2), Ff = μFn, Force applied = Ff,

$\mu = Ff/Fn$, $\mu = 4.0/1.962 = 2.0$



1 Spray Data Table

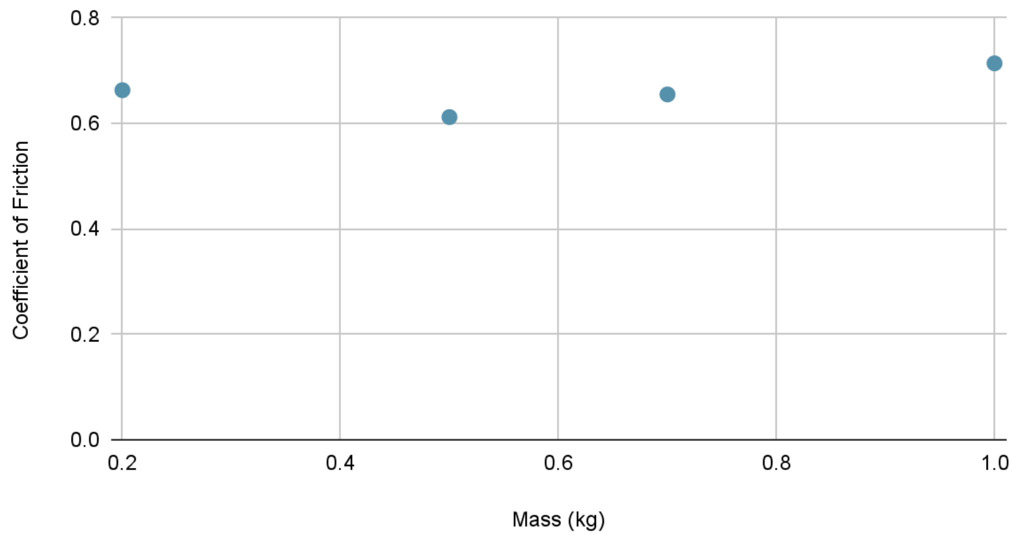
Mass (kg)	Force (N)	Coefficient of Friction
0.200	1.5	0.77
0.500	2.5	0.51
0.700	5.0	0.73
1.000	8.0	0.82



2 Spray Data Table

Mass (kg)	Force (N)	Coefficient of Friction
0.200	1.3	0.66
0.500	3.0	0.61
0.700	4.5	0.66
1.000	7.0	0.71

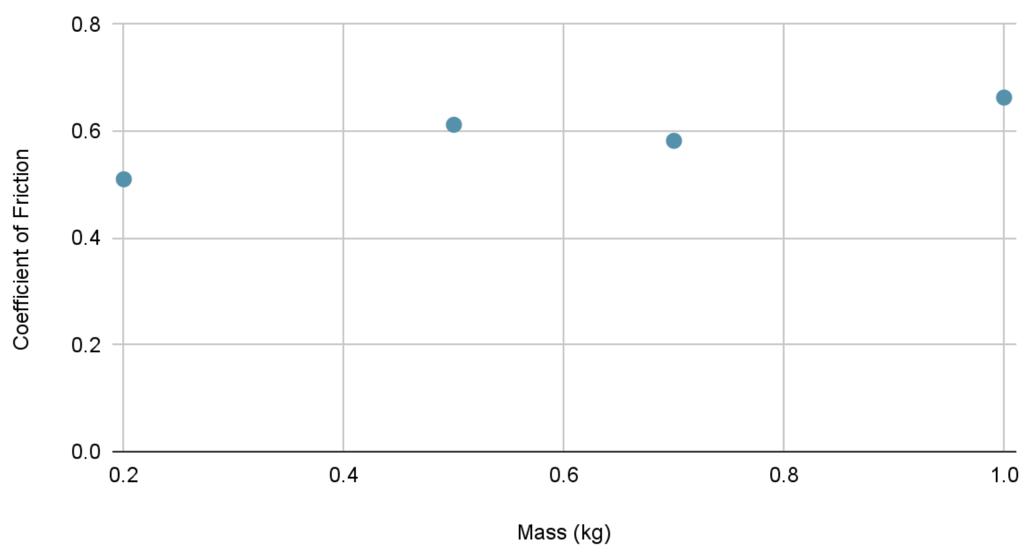
Effect of 2 Sprays on Coefficient of Friction for Badminton Grip



3 Spray

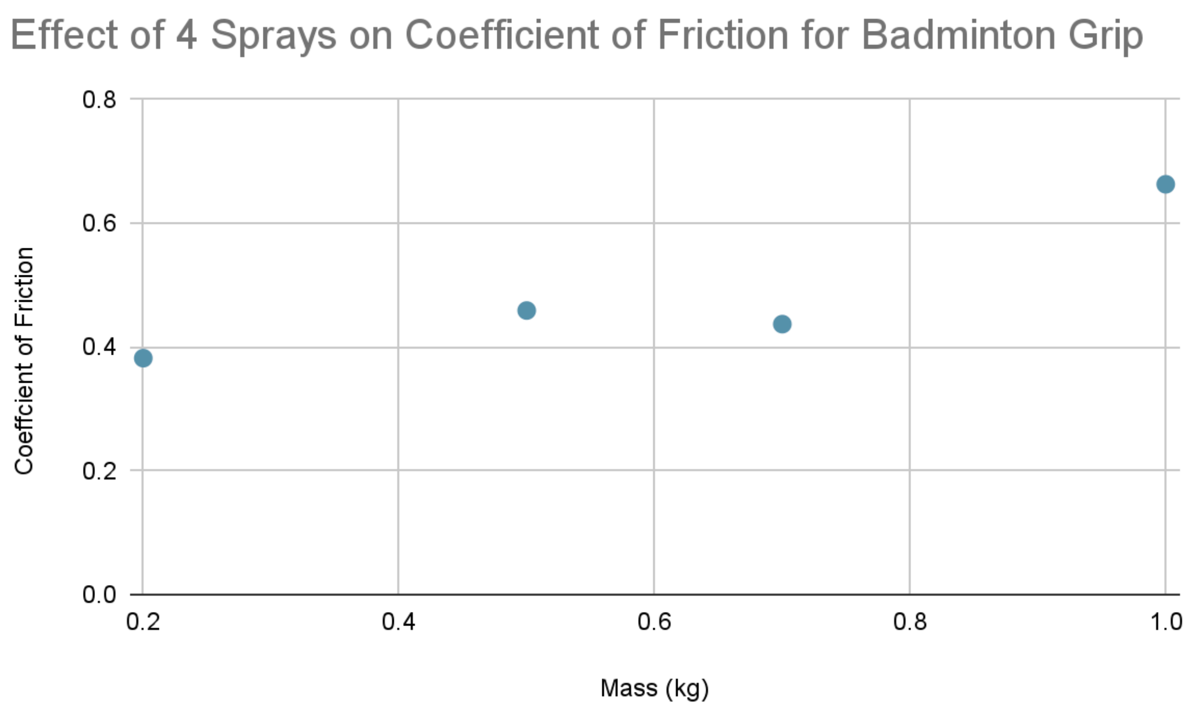
Mass (kg)	Force(N)	Coefficient of Friction
0.200	1.0	0.51
0.500	3.0	0.61
0.700	4.0	0.59
1.000	6.5	0.66

Effect of 3 Sprays on Coefficient of Friction for Badminton Grip



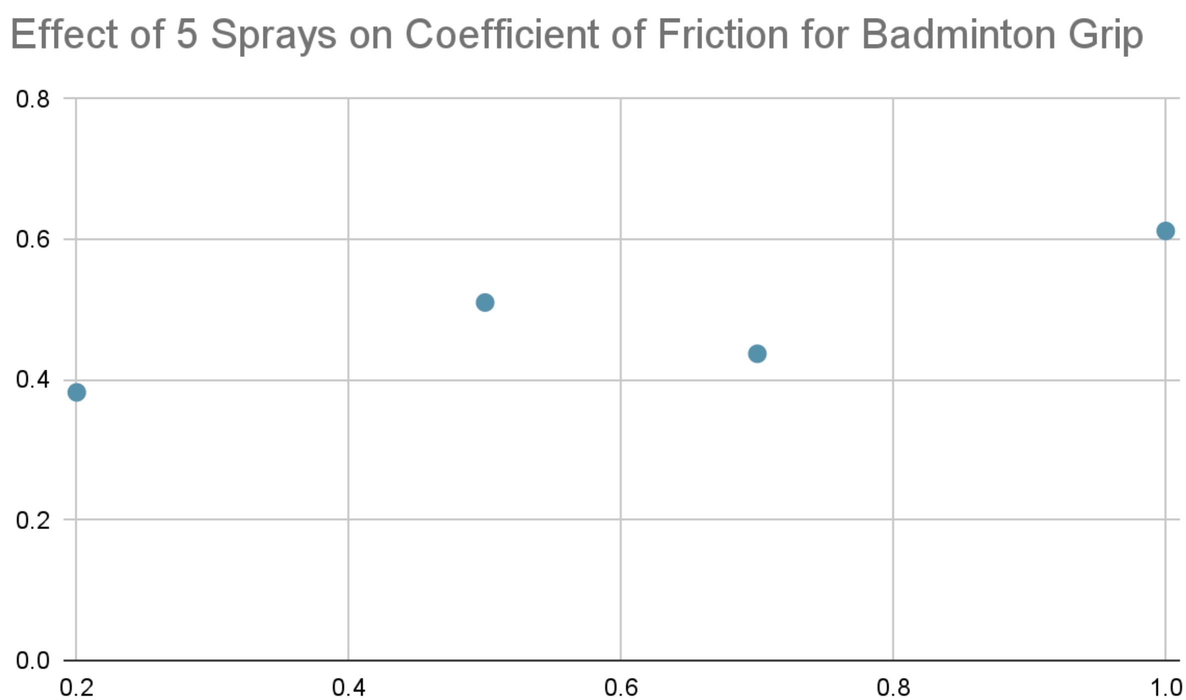
4 Spray

Mass (kg)	Force(N)	Coefficient of Friction
0.200	0.75	0.38
0.500	2.25	0.46
0.700	3.0	0.44
1.000	6.5	0.66



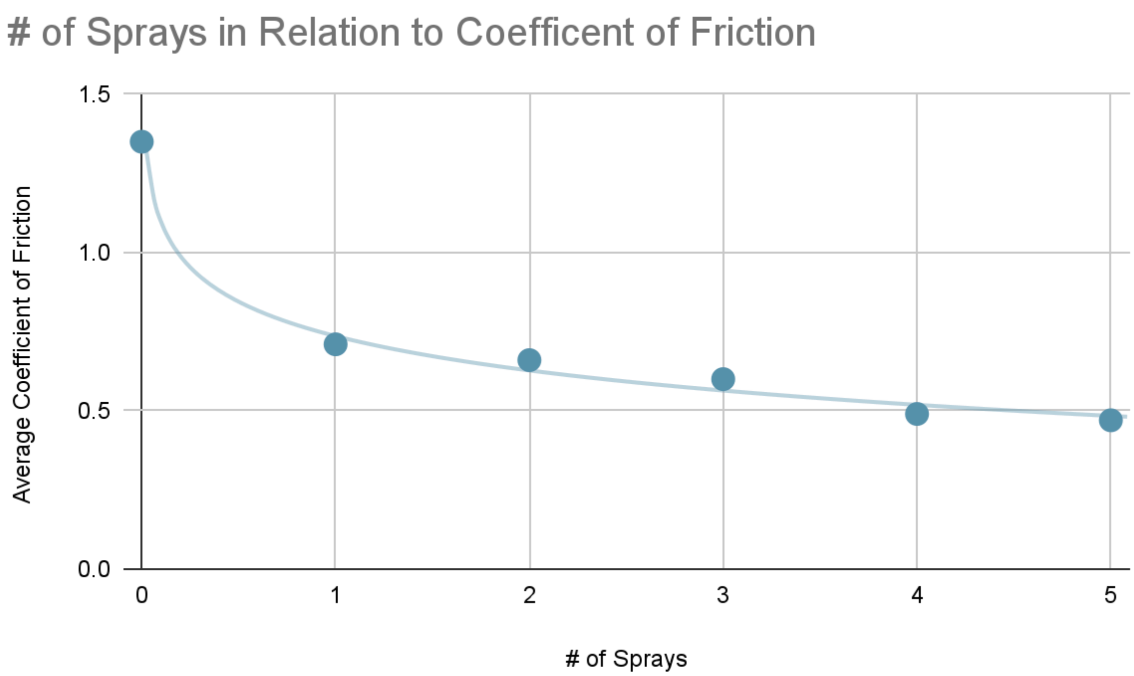
5 Spray

Mass (kg)	Force (N)	Coefficient of Friction
0.200	0.75	0.33
0.500	2.5	0.51
0.700	3.0	0.44
1.000	6.0	0.61



Change in the Coefficient of Friction based on Sprays

Number of Sprays	Average Coefficient of Friction
0	1.35
1	0.71
2	0.66
3	0.60
4	0.49
5	0.47



Sample calculation:
Average coefficient of friction for a dry grip:
(2.04+1.02+1.02+1.33)/4 = 1.35

Effect of Moisture on Badminton Grip Friction Analysis

Dry Grip: The graph shows that the last three data points remain relatively constant, which aligns with expectations since the coefficient of friction should stay constant with a dry grip. The first data point is an outlier, most likely because the weight was light meaning even a small margin in error in the measurement will lead to a large difference. The coefficient of friction remains the same because, according to the equation **$f = \mu N$**, frictional force and normal force have a direct relationship. Since the normal force is determined by mass multiplied by gravity, an increase in mass leads to a proportional increase in frictional force. As a result, the coefficient of friction should remain constant regardless of mass.

1 spray: After I spray there is a significant decrease seen in the coefficient of friction although the coefficient measure throughout the trials are inconsistent this is most likely because the water was saturated in certain areas of the grip while dry in others as the volume of water is not yet high enough to fully saturate the grip. However, despite minor fluctuations in the coefficient most of the trials are within a close range with trial 2 being the only outlier, this could be because the weight went over a more saturated area.

2 Sprays. At this point there is more water and the distribution of water and the absorption in the grip is more even and so the coefficient of friction across the grip is more consistent. This is seen in our graph

and data where the calculated coefficient is within a 0.1 margin, with this difference most likely from not starting the weight from the same spot every time or differences in the way the racquet is gripped leading to small differences in water distribution.

3 Sprays: With three sprays, the increased moisture on the racket grip reduces friction, leading to a noticeable drop in the coefficient of friction. This occurs because water creates a thin layer between the hand and the grip, reducing surface contact and traction. The four data points remain relatively consistent, aligning with the predicted outcome.

4 sprays: With four sprays, the coefficient of friction decreases even further due to increased moisture on the grip, further reducing traction. While the last data point appears to be an outlier, the other three data points remain fairly consistent, showing a consistently low coefficient of friction as expected.

5 sprays: at 5 sprays the coefficient begins to reach a plateau where it no longer decreases by a significant margin, this tells us that the grip has most likely reached maximum saturation and any more water added will have a minimal effect on the coefficient of friction

# of sprays to the coefficient: The graph shows an initial exponential decrease in the coefficient of friction, but after the second or third spray, it plateaus with little further reduction. The most significant drop occurs between zero and one spray, where the coefficient is nearly halved. This indicates that even a small amount of water or sweat significantly reduces friction and weakens the grip's effectiveness. The continued decrease beyond one spray is likely due to the grip not being fully saturated initially, with dry spots still present. Additional sprays allow full saturation, further lowering the coefficient until it stabilizes.

Conclusions

This experiment shows just how much of a challenge hyperhidrosis can be for badminton players and athletes as when sweat soaks into the grip of a racquet, it drastically reduces the static friction, cutting it almost in half. This makes it so that the racquet can slip out of your hand much easier since less frictional force is needed to move it. Initially we hypothesized that the coefficient will increase initially with a small amount of sweat however, one spray may have been too much and already have passed that mark. Which is why we only saw a decrease in the coefficient of friction.

Since badminton is such a fast sport players need quick swings to generate power, in the process they make adjustments to their grip constantly. A slippery grip due to sweat will make it harder to control the racquet, increasing the chances of it slipping during matches. It also makes it tougher to generate power in shots, since a loose to firm grip is important in transferring and generating energy.

For players with hyperhidrosis, the issue is even worse. As excess sweat builds up for them, the grip will get more and more slippery, making it harder to perform strong shots. This puts them at a disadvantage, influencing their performance and potentially leading to more fatigue as they struggle to compensate for the lack of control. This shows the importance of designing new grips that can help to combat hyperhidrosis inadvertently also helping players without it, allowing them to perform their best and reduce the risk of accidents or injuries during play.

Sources of Error

For this experiment sources of error could be found in the testing phase as well as the preparation. During testing and gathering data for the calculation of the coefficient of friction one error could have been that we did not begin the weight at the same place every time we pulled the spring. We did not have a mechanism to ensure that the weight started at the exact same place every time.So, it could have been dragged along the grip where there were different levels of saturation leading to different Frictional forces and therefore different coefficients of friction. Additionally, the spring scale was only accurate to 2 significant digits and so we could not get a perfectly accurate reading, this led to some of the calculations having a lower than desired accuracy as a result, swaying some of the data to either be higher or lower than it actually is. Finally, during the preparation it was required to do 10 clears to simulate playing with a sweaty hand and saturating the sweat into the grip, however, as we did the clears ourselves there was no guarantee that each time we did 10 clears they were the same quality as the previous trials. This may have led to some trials having a more saturated grip and some a less saturated grip, causing the data to be higher or lower than expected.

Application

This experiment has significant applications for all racquet sports in the world. Players both recreational and professional who are experiencing hyperhidrosis/excessive sweating can be benefitted from the insights provided since this study highlights the importance of a secure grip for best performances. Development of better equipment that focuses on reducing the likelihood of racquet slipping will be crucial for athletes. Equipment such as moisture-absorbing grips or specialized gloves can be considered. Additionally, athletes with hyperhidrosis can use this knowledge to make informed decisions to change grips more often during gameplay or possibling using some anti-sweat products. Ultimately, this experiment highlights that hyperhidrosis is a widespread issue affecting all racquet sports. Moisture on the grip reduces friction which impacts control and performance. It’s crucial that people pay attention to this challenge, as it affects athletes across badminton, tennis, and squash, underscoring the need for effective solutions.