



Science fair project:  
**FLAMING PJ MADNESS**

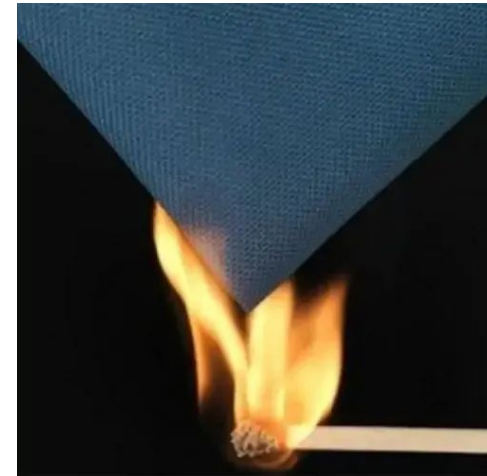
By Amare Lakhani



**Research question:** Will the amount of times a fire resistant fabric is washed affect how safe it is?

**Hypothesis:** I think that the more we wash the piece of fabric, the more flammable it will be. This is because if we wash the fabric multiple times, the fire resistant chemicals will be washing off from the washer and dryer causing it to be less flame resistant.

I think the chemicals wash off in the water because they are dissolving and they come off the fabric. So if we wash a fabric more, it will have more scorch area.



<https://www.heaterk.com/products/fireproof-fiberglass-fabric>

**Why is it important to research about this topic?**



<https://blog.megannielsen.com/2022/07/testing-your-textiles-how-to-use-burn-tests-fabric-characteristics-to-identify-composition/>

# Variables

**Controlled:** The washing procedure

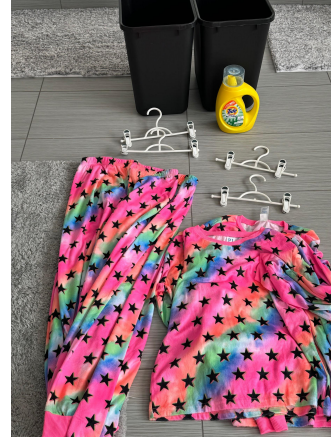
- same temperature of 55 degrees Celsius
- same time for washing and drying
- same detergent for all washes),
- all samples were burned at the right bottom corner until they caught flame

**Manipulated:** The amount of times a sample is washed

**Responding:** What percentage of sample is scorched after burning, time taken to burn the sample

# Procedure

- Label with number of washes
- Hand wash different number of times (0, 1, 5, 10, 20)
- Dry and wring out water
- Cut the fabrics using a stencil



# Procedure

- Put them on a hanger above a bowl of water (for safety) and light each on fire until it burns. Record the start and stop time for each.
- Calculate how long each piece burned



# Procedure

- Calculate the mean of each group (may have to remove outliers)
- To calculate the scorch area, trace each burned piece and turn the scorch into a triangle
- Record the dimensions of the scorch
- Calculate the area of scorch (estimated dimensions)

# Research

## Child sleepwear regulations

Until 1996, natural fibres were only considered flame resistant if they were treated with flame retardants. Rules changed to allow tight fitting pajamas since they are less likely to catch fire than baggy clothing.

Canada and the US require pjs for children between 9 months old to 14 years old to meet flammability requirements or be tight fitting.



# Research

There is a common misconception that polyester is flame resistant because its plastic. Unlike other fabric material polyester doesn't burn, it melts without fire retardants.

In United States, the flame retardant must be added after 50 washes, however, in Canada after 20. This means that washing fire resistant fabric is not an effective solution to reducing exposure to fire resistants.

# Research

## Loose-fitting sleepwear — other tests

Any fire resistant chemicals used in PJs must not cause any of the following consequences:

- Dangerous or toxic to humans when absorbed or consumed
- Go into the dna and change your genes.
- Tumors

## Guidelines for washing, drying and dry cleaning

- The temperature of the wash water must be maintained between 58°C and 62°C; or 52 to 62 (different websites)
- The hardness of the wash water must be less than 50 ppm of calcium carbonate
- The washing cycle must be set for normal washing cycle

# Observations

- We had to test different sizes of fabric before finding the right one for burning.
- There were a few outliers that we accidentally burned more than others.
- It seemed if the fabric was washed more, it burns more
- A few signs that show chemical change are difference in colour, difference in smell and difference in temperature.

# Results

0



1



5



10



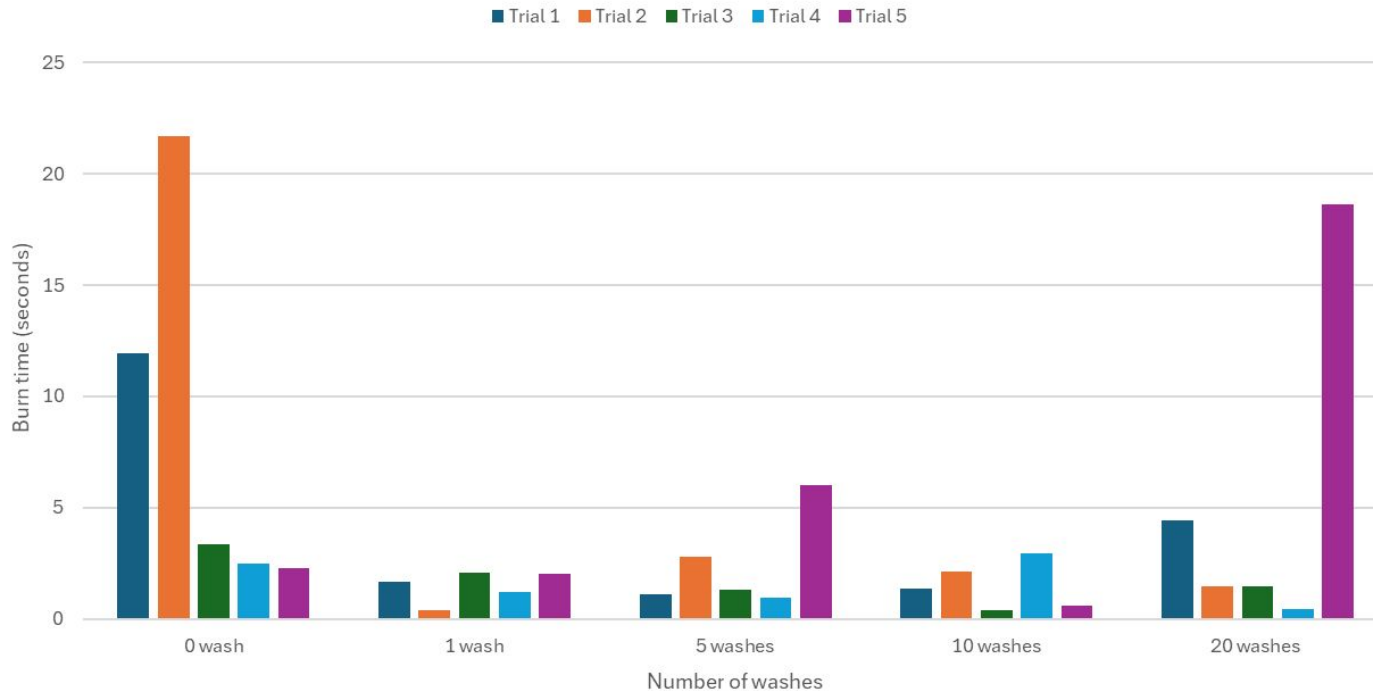
20



# Analysis

*Pattern does not match the expected result - see sources of error*

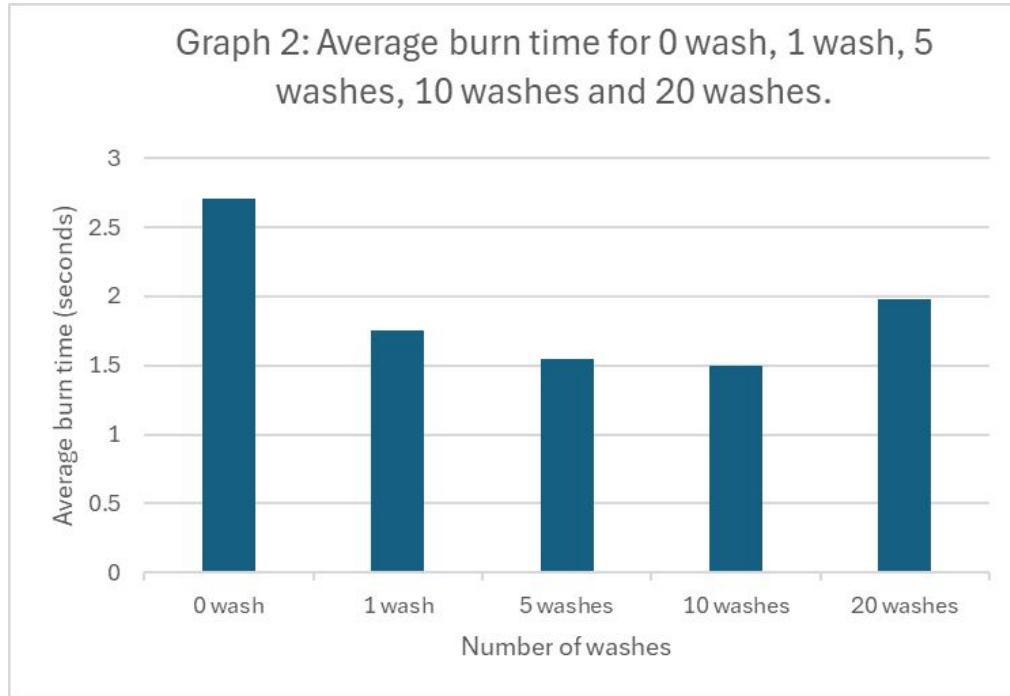
Graph 1. Burn time for 0 wash, 1 wash, 5 washes, 10 washes and 20 washes.



- The trend increases and decreases
- Highest burn time: 5 wash (trial 5)(without outliers)
- Lowest burn time: 10 wash (trial 3)
- **Outliers:** 0 wash (trials 1 and 2) and 20 wash (trial 5) are outliers because the burn time is too high compared to the other values

# Analysis

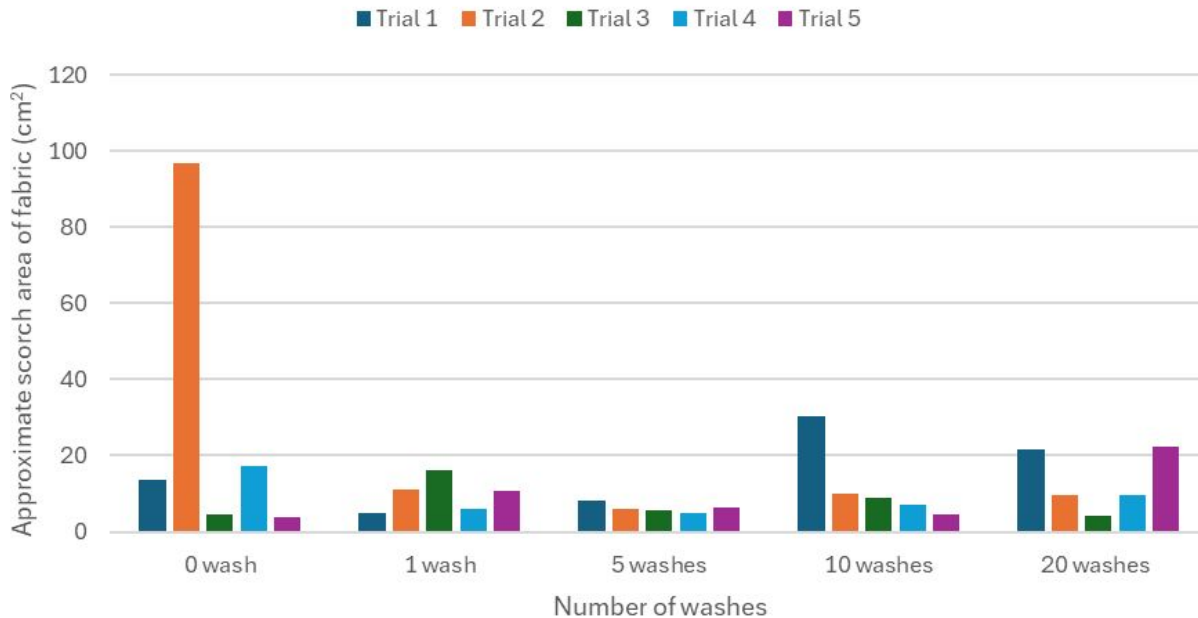
*Pattern does not match the expected result - see sources of error*



- Graph shape: stretched out U shape.
- The trend for average burn time seems to be decreasing until it gets to the 20 wash
- Highest burn time: 0 wash
- Lowest burn time: 10 wash

# Analysis

Graph 3: Approximate scorch area of fabric for 0 wash, 1 wash, 5 washes, 10 washes and 20 washes.



- The trend mostly is a mix between increasing and decreasing
- Biggest scorch area was 10 wash (trial 1) (without outlier)
- Lowest scorch area was 20 wash (trial 3)
- Outlier: The 0 wash (trial 2) sticks out because it is so huge

# Analysis



- The general pattern was lowest to highest but 5 washes does not fit the pattern.
- General pattern: As the number of washes increases, the mean scorch area increases
- 20 washes had the highest mean scorch area
- 5 washes had the lowest mean scorch area



# Sources of Error

- During the washes some pajamas may have had excess soap than others. This might affect the results because there could be more chemicals reacting in one pair than in another and make it an unfair experiment
- It was difficult to use our stencil to cut the pajamas into equal pieces.
- It was difficult to burn them evenly because the fabric was crinkling up at the corner and it was hard to see if there was a flame already started or not
- It was also difficult to watch the time and watch the flame at the same time and be accurate with the timer
- We cannot time it exactly because it might be 5-10 milliseconds late

# Conclusion

- Highest scorch area - 10 wash fabric
- Highest average scorch area - 20 washes fabric
- The common flame retardant chemicals are called Organophosphate flame retardants (OPFR) and perfluoroalkyl substances (PFAS). Both chemicals have hydrophobic and hydrophilic structures.
- OFPRs and PFAs are chemicals can mix easily with water. This explains the results of my experiment because the water dissolves the flame resistant chemicals in the PJs
- PJs would burn more because the chemicals stop the fire and that is what is getting dissolved

# Conclusion (Neutralization reaction)

- Sodium hydroxide is the main ingredient in the laundry detergent and is also a base
- The organophosphates (the flame resistant chemicals) are acids because they have phosphate groups which are acidic
- Neutralization reaction: When acids and bases mix they form a new neutral substance through a neutralization reaction
- Organophosphates + laundry soap reaction neutralizes the organophosphates and the structure of the chemicals change
- When the structure changes, the fire resistant chemicals are not that effective anymore
- This explains why the 20 wash had the most burn area on average.

# Applications

- 20 wash fabric burned more because I washed it more (Graph 3). This affects people wearing flame resistant clothes because they might wash it more and it will become less fire resistant

## Health Hazards:

- Flame retardants like OFPRS and PFAs are not chemically bound to the PJs. They can flush into the external environment and people could consume these chemicals through dust or through hand to mouth contact
- Flame retardants have chemicals that can lead to cancer, neurotoxicity and hormone disruption

# Applications

## Health hazards:

- In 1972, rules were in place that required children's pajamas to be flame resistant. They used Brominated tris but then it was replaced with chlorinated tris, because children were exposed to carcinogens in their sleep through exposure in the skin
- Chlorinated tris was also bad because it was found to affect DNA. People may be exposed directly to the flame retardants by the chemicals directly on their clothes.

Environmental hazard: laundry water washes off flame retardants and it can go into the lakes and rivers and affect animals and fish in the water. In a study from South Korea, scientists found out that tap water had a high concentration of flame retardant chemicals

# Experimental changes

- Have a third person to help - 1 for the timer, 1 to light the flame, and 1 to record when it started and when it stopped burning.
- Have multiple trials: So if 1 fails we have more and we could use the more accurate ones.
- Avoid crinkling: Holding and keeping the fabric straight by using an object such as a clothespin
- Change our washing procedure: Using a washing machine. In the machine each fabric gets an equal amount of soap.
- Measuring accurately: Using a ruler to measure and a marker to mark how we are going to cut the fabric. We label the dimensions then cut along the guidelines.

# Acknowledgement

I want to thank Raheel Lakhani (dad) for helping bring up hot water and wringing out excess water from pyjamas before they went into the dryer.

I want to thank Reneeta Lakhani (mom) for lighting all my pajama samples on fire because it was too dangerous for me.

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I want to thank Mr. Neilson for teaching me about how to calculate mean because I used it in my project.

# References

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