# Bloody Murder!!

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## Introduction:

Blood is a specialized body fluid made up of plasma, red blood cells, white blood cells, and platelets. Blood is comprised of 55% plasma and 45% blood cells and makes up 7-8% of an individual's body weight. Blood spatter pattern analysis is a forensic technique that examines blood stains, shape, size, and distribution to gain insight into the events that led to the blood shed. Blood spatter can result in passive stains, transfer stains, and projected or impact stains. Transfer stains result from contact between a wet, bloody surface and another surface. Projected or impact stains result from pressure applied to the blood, projecting it into the surrounding area. The velocity and trajectory analysis would play a significant factor because the size and shape of the blood droplets can provide information about the velocity and trajectory of the blood source.

## Research Objectives:

This experiment studied the different types of blood splatter patterns as well as what types of cleaning products can remove blood without leaving residue behind and be detected by luminol and a UV light. This experiment examined the way that blood sets on different types of flooring and also investigated the change in the projection of blood spatter when it hit different types of flooring. Additional questions evaluated included: which cleaning products would clean the most blood, what the spatter patterns looked like after being cleaned, and how much blood residue was left behind on the flooring.

## Methods:

Began by laying a protective tarp on the floor and then placing 4 pieces of the same type of flooring onto the tarp. For the first piece of flooring, a hand was painted with synthetic blood and then gently pressed against the flooring to represent a transfer stain. For the second piece of flooring, a 5mL pipette was used to dispense a single drop of blood onto the flooring to represent passive blood spatter. For the third piece of flooring, a small amount of blood was siphoned into a plastic straw and then expelled onto the flooring to represent expiration. For the fourth and final piece of flooring, a spray bottle filled with blood was used to represent an impact stain. These steps were repeated for the remaining four types of flooring.

References

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Figure 1: Represents blood transfer on ceramic tile from a left hand

## Materials:

- Luminol Spray
- Awesome
- Bleach
- Pink stuff
- 4 types of tile
- 1 type of carpet
- Luminol reacting blood
- 5ml pipet
- Microfiber towels
- Tarp
- Measuring tape
- Tape
- Distilled water

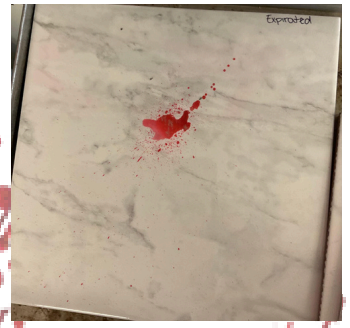



Figure 3: Represents Expiration on ceramic flooring

| Types of Blood spatter | Length | | Width | |
|---|---|---|---|---|
| Impact (Spray Bottle) | 12 cm<br>14.5cm | 10cm<br>13.2cm | 2.5cm<br>13cm | 2.5cm<br>3.8cm |
| Expiration (Plastic Straw) | 1cm<br>28cm | | .5cm<br>3cm | |
| Transfer (Left Hand) | 18cm | | 13.5cm | |
| Passive (5mL Pipet) | 1.5cm<br>2.1cm<br>1.3cm<br>6.9cm<br>1.2cm<br>1.4cm | 1.3cm<br>2cm<br>1.1cm<br>5cm | 1.5cm<br>1.3cm<br>1.2cm<br>3 cm<br>1.4cm | 2.1cm<br>6.9cm<br>.5cm<br>1.3cm |

## Results:

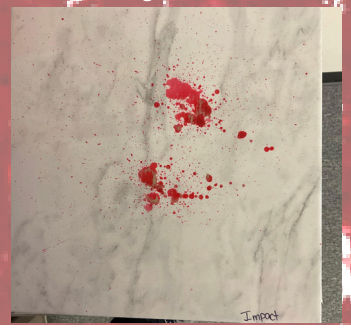
Throughout the experiment, I encountered several challenges and learned a great deal through trial and error. Originally, my project aimed to analyze blood spatter patterns and assess the effectiveness of cleaning products on various types of flooring. However, I faced a setback when the synthetic luminol-reacting blood failed to react to the luminol spray. Despite this, I refocused the project on analyzing different blood spatter patterns. When examining transfer patterns, I found that the fingerprints left by my left hand were clear, with distinct whorl, arch, and loop patterns visible on different fingers. For passive blood spatter, I noticed that the height from which the blood falls significantly influences the size of the blood droplets. In studying expulsion patterns, I used a straw filled with synthetic blood to simulate the effect of someone spitting blood, and observed that the blood splattered onto the surface in a manner similar to a paintball impact on a wall. Lastly, I examined impact spatter and observed that, under force, the blood droplets separated from each other, forming distinctive patterns. These findings provided valuable insights into the dynamics of blood spatter, which could have practical applications in forensic analysis.


Figure 2: Represents passive blood spatter on ceramic flooring

## Discussion:

The results of this experiment provided valuable insights into blood spatter patterns, focusing on transfer, passive, expulsion, and impact spatter. Although the initial attempt to analyze the effectiveness of cleaning products with synthetic luminol-reacting blood was unsuccessful, the shift in focus allowed for important findings. The transfer patterns observed from my left hand revealed clear fingerprint types, such as whorls, arches, and loops, which could be useful in forensic investigations for identifying individuals. In terms of passive blood spatter, the height from which blood fell significantly influenced the size of the droplets, aligning with the principles of gravity and blood dynamics, and offering useful information for crime scene reconstruction. The expulsion patterns, simulated by blowing synthetic blood through a straw, showed how blood splatters upon impact, similar to a paintball effect, which helps understand the force behind blood expulsion in violent actions. Finally, the impact spatter analysis demonstrated how blood droplets separate upon contact with a surface, which is critical for distinguishing the force behind injuries. While the synthetic blood didn't react as anticipated with luminol, these findings contribute to existing forensic knowledge and offer a foundation for future research exploring factors like surface texture, angle of impact, and blood viscosity to further understand blood spatter dynamics.

Figure 4: Represents Impact on ceramic flooring



# Swimming on Stimulants: Investigating the Effects of Caffeine on Zebrafish Behavior

Emma Bonnell and Dr. Mollie Sorrell

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## Background

This study investigates the effects of varying doses of caffeine on zebrafish (*Danio rerio*) behavior. Zebrafish are frequently used as a model organism due to their genetic, physiological, and anatomical similarities to humans. This research aims to determine how different concentrations of caffeine influence zebrafish responses in three key behavioral tests: a social interaction test, an aggression assay, and a feeding behavior assessment. By examining these behavioral domains, the study seeks to provide insight into the broader effects of stimulants, like caffeine, on neural and behavioral function. The findings from this research may have implications for understanding how caffeine impacts human behavior.

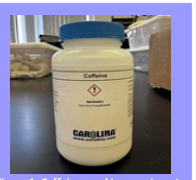

Figure 1: Caffeine used in experiment

**The purpose of this research is to examine zebrafish behavior due to different amounts of caffeine given.**

Figure 2: Food given to the fish


Figure 4: *Danio rerio* used in experiment

## Methods

Subjects were adult zebrafish. Each group consisted of 7 fish and there was a total of 3 groups. Figure 3 shows the set up and tanks used. The control group received 0 oz of caffeine, group 1 received 0.02 oz, and group 2 received 0.04 oz. Figure 1 shows the caffeine used. Caffeine was weighed and mixed with 100 ml of water on a stir plate and administered once fully dissolved. There was a 5-minute acclimation period after caffeine was introduced into each tank. 3 different behavioral tests were conducted: the feeding test, mirror biting test, and social test. All three groups were subject to each test, and results were analyzed to assess caffeine's effect on zebrafish behavior.


Figure 3: Shows the three tank set up that was used for the experiment

## Results

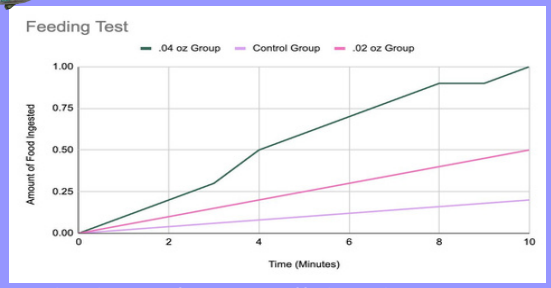

Figure 5: Shows the amount of time vs amount of food ingested

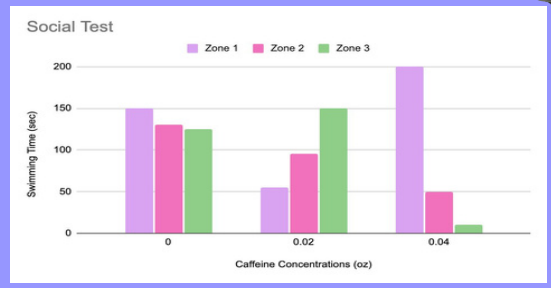

Figure 6: Shows caffeine concentrations vs amount of time swam in each zone

Figure 7:

Figure 7: How the different zones were formatted in the social test

## Results

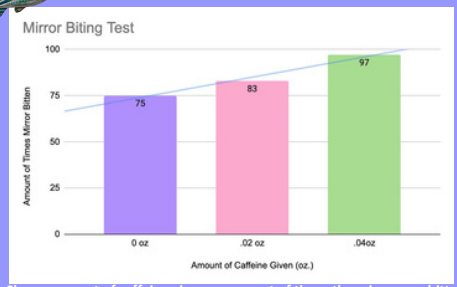

Figure 8: Shows amount of caffeine given vs amount of times the mirror was bitten

## Discussion

There was a dose-dependent increase in the time for the first feeding action and in the time for total food intake in the exposed fish. Exposure to caffeine increased aggressive behavior in zebrafish as indicated by the mirror biting test. As for the social test, as caffeine increased, fish had more sporadic movements.


Figure 9: Two zebrafish that were in the experiment

## Acknowledgments

I would like to thank Dr. Cain for allowing me to use several fish tanks and heaters, Dr. Griggs for lending me distilled water, and to the best advisor in the whole world, Dr. Sorrell, for helping me every step of the way. I am also grateful for the Defiance College Biology Department for providing the funds for this project.

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# Beyond the Yellow Tape: Investigating the Scene

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## Background

The ability to collect DNA from various fabrics is a critical component in forensic investigations, particularly in cases involving blood evidence. This study explores the effectiveness of DNA collection methods from different fabric types (e.g., cotton, silk, denim) and evaluates the potential to type the blood obtained. Samples of unknown blood types were deposited on various fabrics and allowed to dry, mimicking real-life crime scene conditions.


Figure 1: A forensic scientist collecting blood at a crime scene

Different extraction techniques were employed to maximize DNA recovery, and subsequent analysis was performed to determine the success rate of blood typing from each fabric. The study aimed to identify which fabrics retain DNA most effectively and whether fabric composition affects the accuracy of blood typing. Findings from this research could enhance forensic protocols, improving the reliability of evidence gathered from clothing or textiles at crime scenes.

**This research aims to determine which fabrics facilitate or hinder blood extraction, assess whether the extracted blood can be accurately typed, and analyze the angle of impact.**

## Methods

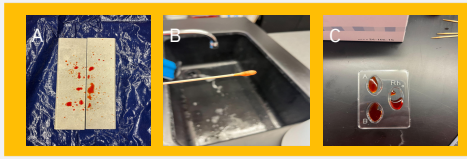


Figure 2: (A) Represents blood that was dispensed from a pipette onto tile. (B) A pink color change indicates a positive reaction for blood. (C) Represents the blood being typed.

First I picked a piece of fabric and laid it on a tarp. Then I pipetted 10 ml of blood from the top of a meter stick. I waited 15 minutes before I collected the sample. During the 15 minutes, I measured with a ruler from the middle to the outside of the fabric and measured the farthest blood splatter spots. After the 15 minutes I pipetted 2 drops of distilled water onto a cotton swab. Then I collected the sample and added 2 drops of ethanol, 2 drops of phenolphthalein, and 2 drops of hydrogen peroxide to see if it turns pink. If it turns pink that means blood was collected. Finally, I tested the blood to find its blood type.

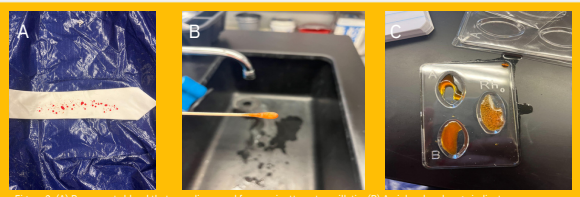


Figure 3: (A) Represents blood that was dispensed from a pipette onto a silk tie. (B) A pink color change indicates a positive reaction for blood. (C) Represents the blood being typed.

## Results

12 fabrics were tested to see if I was able to collect blood from them. Wool and denim were the only two fabrics that I could not collect a sample from. With carpet and turf I was able to collect a sample, but it was very difficult to. Since I was unable to collect a sample from wool and denim I was unable to type the blood that was found on them.

Laminate wood flooring had the largest angle of impact with 22° and turf had the smallest angle of impact with 5.7°. All the angles would be classified as small angles of impact, because none of them were over 90°. Weapons that would cause this would be blunt objects. For example a hammer, baseball bats, fists, and feet.

| Fabric | Able To Collect Sample | Blood Type |
|---|---|---|
| Counter Top | Yes | B+ |
| Carpet | Yes/Difficult | O- |
| Tile | Yes | A- |
| Turf | Yes/Difficult | B+ |
| Laminate Wood Flooring | Yes | A- |
| Cement | Yes | B+ |

| Fabric | Able To Collect Sample | Blood Type |
|---|---|---|
| Silk Ties | Yes | A- |
| Wool | No | N/A |
| Leather Belt | Yes | A- |
| Cotton Shirt | Yes | A- |
| Denim Jeans | No | N/A |
| Linen Pillow Case | Yes | O- |

| Fabric | Equation | Degree | Stain |
|---|---|---|---|
| Counter Top | sin^-1(17.5/100) | 10° | Drip Stain |
| Carpet | sin^-1(19/100) | 11° | Drip Stain |
| Tile | sin^-1(34/100) | 19.8° | Splash Pattern |
| Turf | sin^-1(10/100) | 5.7° | Drip Stain |
| Laminate Wood Flooring | sin^-1(38/100) | 22° | Drip Stain |
| Cement | sin^-1(16/100) | 9° | Pool Pattern |

| Fabric | Equation | Degrees | Stain |
|---|---|---|---|
| Silk | sin^-1(28/100) | 16° | Drip Stain |
| Wool | sin^-1(18/100) | 10.3° | Drip Stain |
| Leather | sin^-1(28/100) | 16° | Flow/Drip Stain |
| Cotton | sin^-1(12/100) | 6° | Drip Stain |
| Demin | sin^-1(15/100) | 8° | Drip Stain |
| Linen | sin^-1(30/100) | 17° | Pool Pattern |

Figure 4: The top two tables show my findings about collecting and typing the blood. The bottom two tables are angle of impacts and what type of stain or pattern the blood made.

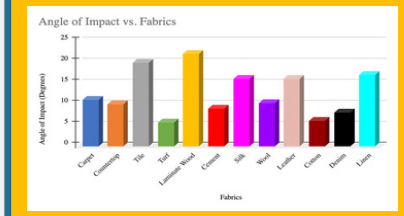


Figure 5: This bar graph shows the angle of impact vs all the fabrics that were used.

The angle of impact helps forensic scientists determine the origin and trajectory of bloodstains, bullet paths, or other impact evidence, aiding in crime scene reconstruction and validating witness statements.

| | |
|---|---|
| **Mean** | **10.65** |
| **Median** | **12.6** |
| **Mode** | **16** |

Figure 6: This table shows the mean, median, and mode of the angle of impact for each of the fabrics.

## Results

After finding all the angle of impacts I found the mean, median, and mode. From the data I collected the average angle was 10.65 and that is a small angle of impact. With the mean being less than the median that means that the data is skewed to the left.


Figure 7: (A) Represents a pool pattern on a linen pillow case. (B) Represents a drip stain on wood flooring. (C) Represents a splash pattern on tile.

## Discussion

The results of some of my findings were quite surprising. Not being able to collect a blood sample from denim was one of them. Also the carpet being difficult to collect a sample from was unexpected. I thought since a lot of crimes happen at home that the carpet would be easy to collect from. Not being able to collect from a sample from the wool was not surprising. Wool is a very thick material, so the blood would soak into the wool very easily. When analyzing the blood patterns I realized that the drip stain was the most common. This make sense because I dropped blood directly above each fabric. This will help future forensic scientist by letting them know some of the most common fabrics are hard to collect samples from. This may inspire someone to improve the way blood is collected and tested during a criminal investigation.

## Acknowledgments

- Dr. Mollie Sorrell
- Department of Biology for funding this project
- Everyone who donated a piece of fabric

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# The Impact of Exercise on Patients with Dementia

Defiance College Exercise Science Program

Student Researcher: Lexi Coward  Faculty Mentor: Jeanna Tran, Ph.D.

## BACKGROUND

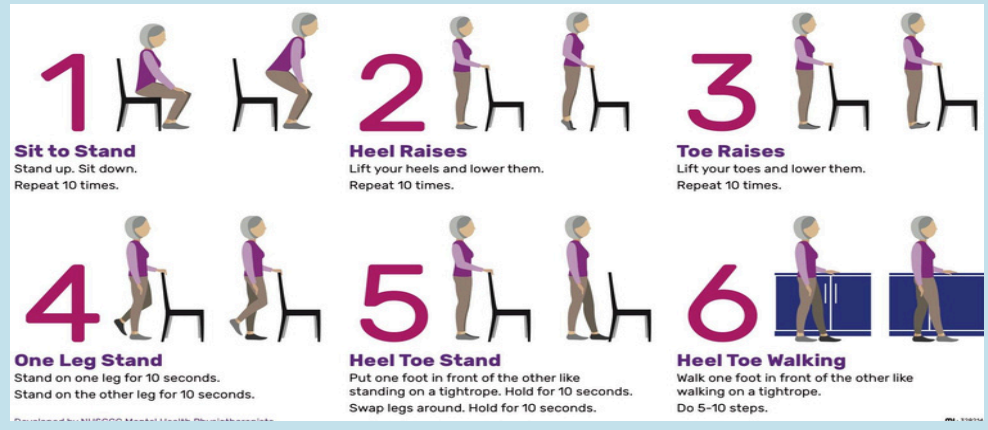
- Dementia refers to a decline in memory, language, problem-solving, and other cognitive abilities severe enough to interfere with daily life.
- It encompasses various diseases that significantly impacts individuals, families, and healthcare systems worldwide.
- While there is currently no cure for dementia, treatments exist that can help slow its progression and improve quality of life.
- One treatment is lifestyle changes, particularly exercise, which has shown potential in alleviating symptoms.

## PURPOSE

This research aims to explore the impact of exercise on dementia and its potential to slow disease progression. By understanding how exercise affects dementia, it could become a key nonpharmacological treatment option.

## METHODS

For this literature review, studies were found through an electronic database search. The key words that were used to find these studies were “dementia”, “exercise”, “effects”, and “impact of exercise on dementia”. All studies used were recent from the last fifteen years and included several dementia patients and directly looked at the impact of exercise and other treatment options compared to daily standard care.




## RESULTS

- A study in Indonesia found that combining exercise with learning therapy significantly improved cognitive function (22.49 to 24.96) and physical activity (18.56 to 19.71) in older adults with dementia, highlighting the benefits of exercise on cognitive health (Juniarti et al., 2021).
- Researchers explored the effects of physical activity on behavioral symptoms and pain in dementia patients living in nursing homes. The study indicated that exercise could help alleviate behavioral symptoms of dementia, though it does not appear to reduce pain in these patients (Maltais et al., 2019).
- The effects of adding cycling to the exercise routines of dementia patients was assessed to see if it improved balance. The results of this study showed a significant improvement in balance in the experimental group but no improvement in cognitive function was observed, as measured by the Mini-Mental State Exam (Abbas et al., 2022).
- While not measuring exercise effects directly, a study found that healthcare professionals and caregivers agree on its benefits for dementia patients but differ on appropriate types and amounts—offering insights for tailoring exercise programs (Karuncharernpanit et al., 2015).
- A study reviewing the effects of physical activity on strength, balance, mobility, and activities of daily living (ADL) in elderly individuals with dementia found a combination of endurance, strength, and balance exercises led to more significant improvements in physical functions and ADL performance compared to resistance exercises alone (Blankevoort et al., 2010).

## BARRIERS TO THE LITERATURE

Common limitations across studies include small or non-representative samples limiting the generalizability of the findings, cultural differences affecting intervention outcomes (e.g., acceptance and effectiveness), and narrow focus on specific aspects of dementia (e.g., balance only). Some studies lacked quantitative data or standardized exercise protocols, making it difficult to assess the actual impact of exercise interventions. Additionally, few studies assessed long-term effects, limiting understanding of sustained benefits for dementia patients. These barriers highlight the need for more standardized and comprehensive research to better understand the benefits of exercise for dementia patients.

## CONCLUSION

- The studies collectively suggest that exercise could play a crucial role as a nonpharmacological approach to managing dementia.
- Each study employed unique methods and interventions, They all highlight the significant benefits of incorporating exercise into the daily routines of dementia patients.
- This reinforces the idea that exercise can be an essential part of dementia care, potentially improving cognitive function, physical health, and overall quality of life.
- Additionally, one study focused on determining the appropriate types and amounts of physical activity for individuals living with dementia, offering valuable insights for healthcare providers and caregivers.

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# Summer 2025 Orientation Shirt Design

Jade Forbess: Major Graphic Design | Minor: Marketing

*Professor Michael Vanderpool*

## Problem Identification

Nicole Hoffman from Admissions came to speak with me in front of my Corporate Brand Communication Class. Admissions needed a T-shirt designed for the incoming students of Fall 2025. Students would receive these T-shirts during summer orientation. Everyone pitched ideas they did or did not like for a design.

## Focus Group Ideas

I held a focus group with my classmates to get ideas. They pitched and sent me ideas they liked and voted on other designs submitted by students. We all spoke about possible design incorporation ideas from the research findings. We all agreed a black T-shirt would look less cheap and more students would want it. This is probably the first piece of merchandise from Defiance College these future students will get. We wanted them to love it and wear it.




## Focus Group 1 Findings

This focus group presented that students like the varsity and old-timey feeling. They did not want something as modern. We all agreed we did not want something like the previous years. The previous years' shirts looked cheap and thrown together fast. We wanted a t-shirt students would want to wear out in public not just a shirt they have in their closet. We also decided to make the design not too crowded. We all came to an agreement that the idea should be simple but cool.

## Mockups

I then used the focus group research, and used AI tools to help create some mockups for voting. I went with the varsity but not too sporty design. That way it can be geared towards athletes and non-athletes.




## Focus Group 2

For the second focus group, I asked and had students vote on which mockups they liked better. They mostly all went with the Philadelphia Eagles design above. We all wanted that design to be created for college students and not just athletes. So I knew it was going to be difficult to make a sporty shirt less sporty but still give off the same vibe.

## Creation

I then went to work on possible ways to recreate this type of shirt for the college. I had to get in touch with our Marketing Department at Defiance College. They would give me the branding guidelines. This includes fonts, colors, and logos I am allowed to use for Defiance College apparel. Throughout the creation of the design, I would ask my classmate's opinions. When asking for opinions, I was getting the students who would wear this t-shirt's opinions. I would ask which font they liked better, which placement is better, what color they wanted to be highlighted more throughout the whole design.

## Proof Design

I then created a designed proof of the t-shirt. Lastly, I sent a proof to Dr. Taylor and Nicole Hoffman. They said they did not want the "t175 Years" I had put on because it dated the shirt which I agreed with. Also, the "DEFI the Ordinary" was their old slogan. Therefore, that was taken off. After those were removed, I came out with the final design.

# Virtual vs. Traditional Physical Therapy: A Comparative Analysis of Benefits and Challenges

Defiance College Exercise Science Program

Student Researcher: William Gehlhausen  Faculty Mentor: Jeanna Tran, Ph.D.

## BACKGROUND

- The COVID-19 pandemic led to the surge and adoption of virtual healthcare, including physical therapy (PT) (Kim et et., 2022).
- Telehealth PT, also known as virtual PT appointments, uses video conferencing and other digital tools to connect patients with physical therapists remotely -enables individuals to receive evaluations, personalized guidance, and treatment plans from home (Kim et et., 2022).
- Studies have examined the effectiveness of virtual PT for sports and general rehabilitation, however questions remain about patient satisfaction and the effectiveness of outcomes.

## PURPOSE

The purpose of this review is to examine and compare existing research on virtual and in-person physical therapy. It aimed to evaluate patient satisfaction, clinical outcomes, and therapeutic effectiveness across both modalities.

## METHODS

For this literature review, relevant studies were identified through electronic database searches. Keywords including “Telehealth Physical Therapy”, “In-person PT versus Virtual PT”, and “Comparisons” were used to find relevant original research articles for in-person PT and virtual PT and a comparative analysis between the two therapies.

## RESULTS

One study found virtual PT had higher patient satisfaction (93.3%) compared to in-person PT (88.6%) and offered greater accessibility. However, limitations included the inability to perform hands-on assessments and direct supervision. (Kim et al., 2022).

Another study revealed a strong preference for in-person PT (rated 5.0) over virtual care (rated 2.7). Older patients, in particular, had difficulty navigating virtual platforms and felt that telehealth lacked the necessary hands-on care,and some found ensuring proper exercise form and adjustments were challenging in virtual settings (Luna et al., 2023).

A review concluded virtual PT was found to be as effective as in-person care in terms of accessibility, but in-person care may still be needed for post-surgical rehabilitation. Successful implementation requires considering patient and clinician perspectives, cost-effectiveness, and managing barriers (Lee et al., 2024).

## GAPS IN LITERATURE

There is a need for studies that explore perspectives of physical therapists and the challenges of virtual rehabilitation. Additionally, studies on long-term outcomes after virtual PT are warranted to evaluate its efficacy. Further studies are needed to address the implementation challenges in resource-limited settings or the patient populations most likely to benefit from virtual PT. Lastly, future research is needed to investigate how the hybrid model of virtual and in-person PT could address the preferences of patients while maintaining high satisfaction and effectiveness levels.

## CONCLUSION

- Telehealth has proven effective in maintaining treatment progress for physical therapy, but patient preferences strongly favor in-person care, particularly for hands-on and personalized interventions.
- Virtual PT appointments provides greater accessibility and convenience, however, older patients may have trouble navigating virtual platforms and in-person visits allowed for better understanding, guidance and adjustment of exercises.
- A hybrid model of telehealth and in-person therapy might best meet patient needs and improve outcomes especially for patients who need post-surgical rehabilitation.

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# Effects of Creatine Supplementation on Bone Health and Muscle Strength When Combined With a Whole-body Resistance Training Program

**Jacob Hild & Dr. Olivia Lozar**
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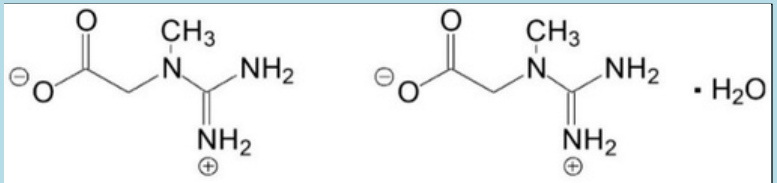
DEFIANCE COLLEGE
To Know ◆ To Lead ◆ To Serve ◆ To Understand

## Purpose

- The purpose of my research was to look at the effects of creatine when paired with resistance training on bone health and muscle strength mainly in older males, but also younger adults and females as well.

## Introduction

- Creatine is one of the most extensively studied supplements on the market today. It was discovered in 1832, but research linking creatine to improved physical performance did not begin until the early 1990's.
- Many different studies have found that creatine supplementation has a direct impact on increasing muscle strength, power, and endurance. It also helps with muscle recovery and boosts energy production.




**Creatine** **Creatine Monohydrate**

## Methods

- For this literature review, relevant studies were identified through electronic database searches. Keywords including "Creatine Supplementation", "Resistance Training", "Muscle Strength" were used to find relative articles from recent years. Studies that were used were those that directly studied the effects of creatine supplementation when paired with resistance training.

## Results

- Candow et al. determined through their study that creatine supplementation increased total bone area in the distal tibia and tibial shaft, as well as muscle density in the lower leg compared to placebo. It was also found that men above the age of 50 on creatine increased trabecular and cortical bone areas in the tibia compared with men on placebo.
- Wang et al. found that the combination of creatine supplementation and resistance training results in greater strength gains in both the upper and lower body when compared with resistance training in adults younger than 50 years of age. It was also determined that males on creatine saw more of an increase to muscle strength in the upper and lower bodies compared to males on placebo. Furthermore, creatine had no significant effect on strength in females.
- Chilibeck et al. determined that creatine supplementation had no effect on changes in bone, muscle or strength and that any of the positive changes were due to the resistance training program alone.

## Conclusion

- Results from two of the studies found benefits of creatine supplementation when paired with resistance training when it comes to bone health and muscle strength. Results related to bone health included an increase in total bone area and bone mineral density, while results related to muscle strength included more significant increases to upper- and lower-body muscle strength gain in participants using creatine compared to those not supplementing with creatine.
- These results suggest that the addition of creatine supplementation to a resistance training program will benefit upper and lower body maximal muscle strength in healthy individuals under the age of 50. Creatine supplementation when paired with resistance training is also beneficial to males above the age of 50 due to the increases found in total bone area and muscle density. Larger and stronger bones along with higher muscle density in the calf and thigh has been associated with reduced risk of falls and fractures among older adults.

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# Cupping Therapy in Sports: A Review of Dry and Wet Techniques for Athletic Recovery Research

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Exercise Science Program

## Introduction

Cupping therapy is an ancient medical practice dating back over 5,000 years, first used by Egyptians and Macedonians.

It involves placing small vessels on the skin and creating a vacuum to draw blood to or away from targeted areas. The main purpose is to relieve pain, promote healing, and improve blood flow.

There are two primary types of cupping therapy:
•Dry cupping (DCT)– uses suction only.
•Wet cupping (WCT) – includes small skin incisions before applying suction to draw out a small amount of blood.

Cupping is used in both general physical therapy and sports performance recovery.
•In physical therapy, it helps stimulate healing by increasing blood flow to injured areas.
•In sports, it reduces muscle soreness, improves mobility, and may prepare muscles for activity.

Cupping therapy has gained visibility through elite athletes—such as swimmer Michael Phelps—who use it as part of their recovery routines.

## Purpose

This research aims to compare the effects of DCT and WCT on athletic recovery and performance. It evaluates which method is more effective in reducing pain and enhancing recovery based on existing studies.

## Methods

This poster is based on peer-reviewed original research articles published within the last 10 years, identified through electronic database searches using keywords such as “wet cupping,” “dry cupping,” “athletic recovery,” “sleep,” and “cupping therapy.” The selected studies examined the effects of cupping therapies on athletic performance and physiological recovery.

Figure 1: Placement of 7 cups for dry cupping on a participant’s upper back and bilateral deltoid muscle (Chen and Tang, 2025).

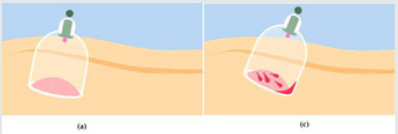


Figure 2: Images representing the two of the four technical types of cupping; (a) dry cupping, and (c) wet cupping.

## Results

**Dry Cupping**

**•Chen & Tang (2025):** Cupping had no impact on upper-extremity function or exercise performance in baseball players, however, it improved postexercise autonomic recovery during preseason and sympathetic recovery during in-season. Enhanced sleep quality was observed only during preseason, suggesting that cupping’s benefits may differ depending on the training phase.

**•Stephens et al. (2020):** DCT significantly reduced nonspecific neck pain and increased oxygenated hemoglobin levels in both superficial and deep tissue compared to sham and control groups after a single DCT treatment. Effects were not maintained 24 hours post-treatment, suggesting DCT may offer short-term benefits.

**Wet Cupping**

**•Senturk et al. (2021):** This study found that patients with musculoskeletal disorders (MSDs) who exercised regularly were significantly more likely to benefit from WCT than those who did not. Those who received wet cupping therapy (WCT) bimonthly reported greater symptom relief compared to those who used WCT only when experiencing specific health issues. Additionally, participants who experienced mild discomfort during WCT sessions were more likely to report benefits, suggesting a potential association between treatment response and therapy-induced sensations.

**Wet vs. Dry Cupping**

**•Dergaa et al. (2024):** WCT showed significant improvements in sleep latency (−82.31%) and sleep disturbances (−68.70%) compared to DCT in male runners. WCT participants reported lower exertion levels post-intervention. WCT may enhance recovery by improving sleep quality and reducing perceived exertion, however, WCT and DCT do not directly impact endurance performance.

## Barriers to the Literature

Despite growing interest in cupping therapy, current research has key limitations. Few studies directly compare dry and wet cupping, and most focus on narrow populations like male recreational or collegiate athletes. Outcomes are often subjective and inconsistent, and many studies are short-term. More long-term, controlled research across diverse athletic settings is needed.

## Conclusion

- WCT showed better results when compared to DCT in aiding recovery, especially in sleep quality as well as minimizing sleep disturbance.
- DCT, even though less beneficial in sleep related metrics, could still offer helpful support in autonomic recovery, especially when timed based on training cycles.
- Findings suggest that DCT can be more beneficial during high-stress periods like preseason and competition seasons.
- Overall, WCT may have better short-term effects on recovery and sleep, while dry cupping therapy seems to have a supportive role in physiological recovery across different points in a training calendar.
- Both forms of cupping therapy show little direct impact on endurance performance, suggesting the most important value is in recovery instead of performance enhancement.

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# Bringing Science Into Recreational Drug Regulation.


**Noah Kimble**

Advisor: Dr. Lisa Beringer


## Introduction

The use of cigarettes has decreased year after year in the U.S. for the last 25 to 50 years. In its place however, we have seen a dramatic rise in the use of products such as Cannabis and Vaping.

There is a rising social problem concerning the safety and efficacy of vaping and cannabis use. In this project, I aim to compare vaping pens with marijuana, and other products to emphasize the social impact of unchecked concentrations in THC products.

## What is an LD-50?

- LD-50 is a toxicology term which refers for lethal dose a particular substance. Everything has a LD-50 too, not just dangerous substances.
- Take Water for example, which has an LD-50 of 90,000mg/kg. This takes into account the person's weight for the chemical to diffuse through. The average person's weight is about 60kg, which would be close too 30 gallons of water to be lethal most of the time, so we can conclude water is very safe.
- Since it is difficult to compare the effects of each substance against each other, this is a great metric to determine the safety of chemicals.

## Emerging Social Problems

While not a danger innately, high concentrations of THC can cause problems for young or otherwise susceptible individuals. As a psychotropic, THC can cause damage to nerve receptors at high concentrations, leading to worsening depression, or more sever conditions like Cannabinoid Hyperemesis Syndrome (CHS). A condition characterized by heavy use of cannabis products. This is disproportionally affects individuals who are Depressed, LGBT+, Native Americans, and other groups who are more prone to use these as a way of dealing with anxiety from discrimination.Coupled with that, is the conditions heightened rate of misdiagnosis. CHS, due to its symptoms appearing similar to gastrointestinal disorders, can take years to diagnose properly.


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## Concentration Cautions

THC is used in both Vape pens and Marijuana, but there is a big difference between them. Vape pens are highly refined and can contain upwards of 90% THC in them. With some brands reaching close too 100% THC.

THC has an LD-50 of 30 mg/kg, which for an average adult, works out to a lethall dose of 2 Grams for the average adult. This is INCREDIBLY dangerous to have these sorts of concentrations in everyday products.

Compare this to other products: Nicotine (the active substance in cigarettes) has an even HIGHER LD-50 of 0.06 mg/kg. But since its less than 3% of a cigarette, it would take over 150 of them to be lethal. Alcohol is almost as bad as Nicotine, but even in extremely high proof beverages, it would take 30 or more bottles for the same result.

The concentrations in Vape pens, and certain other THC products means that 3 pens could be fatal. These levels of concentration pose a serious problem in society.

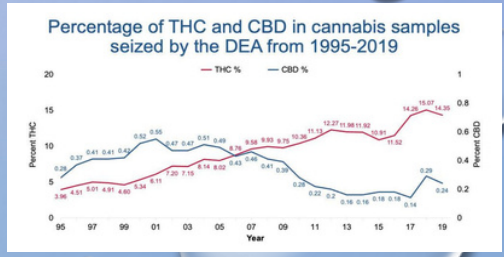
## Solutions

The best solution for this problem, like many others, is *knowledge*.

- It's important to know just what your taking when using vapes, edibles, or other THC products. Its also important to know the concentrations present and your own limits.
- Like with alcohol, it is also important to create outreach to youth with information about these substances.
- Clearer labeling on THC products can also help people make clear decisions on this.
- With legalization of THC products, knowledge of these conditions can help healthcare professionals to make correct diagnoses.

## What is THC?

Figure 1 –THC (Tetrahydrocannabinol) is a psychotropic depressant found in cannabis which produces a stronger 'high' than CBD. Cannabis has been selectively bred for higher and higher levels of THC over the years. With modern strains being almost 20x Stronger than the original.



# The Effect of Humidity on Chicken Egg Hatching Rate

By: Anabella Marble and Patrick Cain, PhD

Division of Natural Science, Applied Science, & Mathematics, Defiance College, Defiance, OH

## Background

Many backyard farmers face a common challenge: they are overwhelmed with the vast amount of information available on humidity levels. Many beginning farmers are uncertain of humidity's impact on hatching success. As selling chicks is a profitable business venture for farmers, any hindrance to successful hatching can negatively impact their business. Therefore, understanding the role of humidity in hatching rate success may significantly enhance their business prospects. **This research investigates how difference in humidity affects hatching success in chickens.**

Figure 1: Picture of eggs

## Methods

This study was conducted in one of the science laboratories at Defiance College. Two groups were tested: Group 1was exposed to low humidity, while Group 2 maintained normal humidity levels. Two Sailnovo egg incubators and 24 Black Copper Marans hatching eggs were purchased for the experiment.


Figure 2: Eggs in a low-humidity incubator.

The incubators were set up and labeled. One was designated as the low-humidity group, which had its water supply restricted, while the other was labeled the normal-humidity group, where the water supply was not limited. The incubation period was 21 days, during which the chickens started hatching. Data was recorded on which chickens hatched from which group and the temperature and humidity levels.

Figure 3: Normal humidity incubator.

## Results

Out of the 12 eggs in Group 1, four of them failed to develop. One egg died while hatching due to dehydration caused by low humidity. Only one egg from group one successfully hatched; eight eggs failed to hatch within the 21-day period. In contrast, eight eggs from Group 2 successfully hatched. Three eggs failed to hatch within the 21-day period. Additionally, three eggs from group two and eight from group one did not hatch.

Figure 4: Hatched chicks in incubator.

In Figure 5, we can see that group one, the group exposed to low humidity, had a success rate of 8% with a mortality rate of 91%. When we compare that to group two, which was the regular humidity group they had a success rate of 66% and a mortality rate of 33%. That is a 58% difference in the success rate and mortality rate.

The study showed a connection between the hatching rate and humidity levels. Group two showed how the eggs exposed to normal humidity levels had a better outcome than those in Group one.

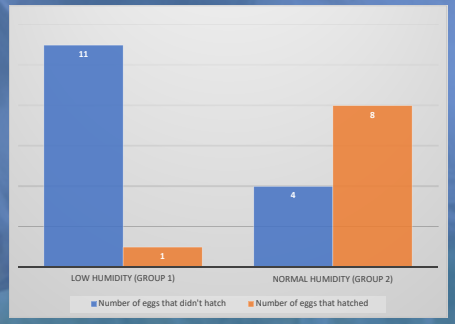



Figure 5: A bar graph illustrating the comparison of various groups.

## Discussion

The experiment mostly followed the expected pathway. The low humidity group was expected to have more than just a single egg hatch, which was different from the actual result. A study by Van der Pol et al. (2013) focused on the effect of humidity during incubation on embryonic mortality and chick quality. The research found that low humidity during incubation led to increased egg weight loss, third-week embryonic mortality, and decreased hatching of fertile eggs. This research supported our study's outcomes because low humidity increases the mortality rate. Vick et. Al writes in "Relationship of Incubation Humidity and Flock Age to Hatchability of Broiler Hatching Eggs" Low humidity causes eggs to lose too much moisture, leading to an enlarged air cell. This can result in smaller, weaker chicks that may struggle to hatch or fail to survive. This is shown in our research when one egg died 24 hours later because the hatching process was too challenging and energy-intensive.

## Conclusions

In conclusion, humidity significantly influences the hatching rate of chicken eggs. The hatching rate in the normal humidity group was 66%, with a mortality rate of only 33%.

## Acknowledgments

We want to thank Defiance College for its use of its facilities. The Defiance College Natural Science, Applied Science, and Mathematics Division provided funding for this project.

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# Knee Health and Balance: A Comparative study of Surgery, Injury, and Healthy Individuals Aged 18-22

Student Researcher : Maile Misleh
Faculty Mentor : Jeanna Tran Ph.D.

Defiance College
Exercise Science Program

## Background

- Knee health includes the knees overall strength, stability, proprioception, and range of motion at baseline. It is important for both high-level athletic function and for normal day-to-day activities. Impaired knee health can limit mobility, increased risk to injury, and overall lead to an influence on long-term joint function (Ibeachuet al., 2019).
- Balance serves as an important indicator of functional knee health, especially in the athletic/youth populations. It reflects neuromuscular control and proprioception, both of which are disrupted after knee injuries (Whittaker et al., 2019). Balance deficits are associated with increased re-injury risk and a delay in return to sport protocols (Blasimannet al., 2021).
- Knee health whether muscular or bone density have an increased impact on an individual's overall balance and vice versa.

## Purpose

The purpose of this literature review was to compare overall knee health and balance among young, athletic individuals with a history of ACL surgery, those with knee injuries, and those with no known knee conditions. The review aimed to identify common trends, rehabilitation outcomes, and functional balance differences to inform injury prevention and recovery strategies in this population.

## Methods

To explore the relationship between knee health and balance across individuals with a history of knee surgery, knee injury, and those with no history of knee pathology, a comprehensive literature review was conducted. Relevant studies published between 2015 and 2024 were identified using electronic databases including **PubMed**, **CINAHL**, and **Google Scholar**. Keywords used in the search included: *knee injury*, *knee surgery*, *anterior cruciate ligament (ACL)*, *postural control*, *balance*, *proprioception*, *youth athletes*, and *college-aged individuals*.

## Results

- **Post-Surgical Individuals** Balance Deficits on patients after ACL reconstruction exhibit diminished postural stability and increased sway, especially on dynamic tasks (Fernandes et al., 2016; Buhl et al., 2023). This is due to delayed muscle activation and neuromuscular control most often notable in the quadriceps and hamstring muscle groups (Blasimannet al., 2021). Over time these deficits can lead to increased risk of re-injury if not rehabilitated correctly or return to sports protocols not taken seriously.
- **Injured Non-Surgical individuals** Impact on Proprioception and Balance: Individuals with chronic ACL injury without surgical treatment had impaired static and dynamic balance in comparison with healthy controls (Fernandes et al., 2016). Non-surgical interventions such as proprioceptive and neuromuscular training have been found to effectively restore functional stability and balance in individuals with knee injuries. However, it can be a variable between subjects and limbs, indicating the need for a subject-specific rehabilitation approach (Buhl et al., 2023).
- **Healthy young adults** typically demonstrate excellent postural stability and dynamic neuromuscular control, which serves as an important point of reference to determine functional deficiencies (Culvenoret al., 2016). Comparative insight is typically presented in minimal mediolateral sway and good function on functional assessments such as the Y-Balance Test, illustrating the functional deficiency between healthy versus injured populations.

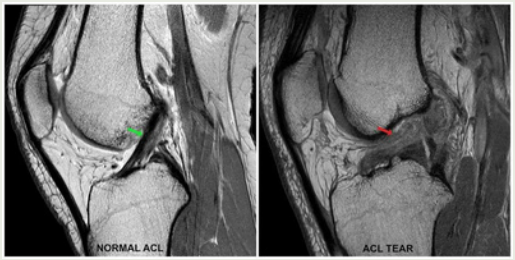


**Figure 1:** The MRI on the left shows a normal ACL, whereas on the right there is an ACL tear, as you can no longer clearly see the ligament.
*Image retrieved from: https://complete-physio.co.uk/anterior-cruciate-ligament-acl-injury/*

**Figure 2: Single-Leg Squat** -Participants stood barefoot to on 1 l leg in the middle of a Wii Balance Board (WBB) (Nintendo Co, Ltd, Kyoto, Japan), with their eyes open and arms folded across their chest (Culvenor et al., 2016).

## Barriers

- Age specific gaps are there are minimalstudies exclusively examining individuals aging between 18-22; many include broader ranges and older populations which reduces specificity.
- Smaller sample sizes which are hard to incorporate to support or not support beliefs/findings.
- Lack of literature that conducts studies with different balance assessments' to see a variance in test between the healthy, injured, and post-surgical subjects.

## Conclusion

- Research shows distinct differences in balance and knee health based on injury status. Individuals with surgical treatment, particularly ACL reconstruction, often experience long-term balance impairments even after completing rehab. Those with conservatively treated injuries tend to recover better, while healthy individuals consistently show superior neuromuscular control.
- Future research should focus on the 18–22 age group, using standardized balance assessments like the Y-Balance Test, BESS, and STAR, along with tools such as force plates, 2-D cameras, and EMG to analyze biomechanics and muscle activation.
- These findings support the value of balance testing in return-to-play decisions, highlight the need for continued neuromuscular training post-rehab, and promote balance as a key indicator of recovery to help reduce re-injury risk in young adults.

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Student Researcher: Jalynn Parrett
Faculty Mentor: Olivia Lozar, Ph.D.

# The Effects of Resistance Training on Individuals with Parkinson's Disease

Defiance College
Exercise Science Program

## Background

Parkinson's Disease is a debilitating chronic progressive neurodegenerative disorder. It has many downfalls and affects the nervous system. Patients with PD display reductions in maximal muscle strength and rate of force development.

Classic symptoms of Parkinson's disease are tremors/uncontrolled movements. The weakening of muscles may contribute to postural instability and gait difficulties.

Resistance training may be an effective strategy to delay or reverse functional decline, in addition to medication.

## Purpose

This literature review aims to describe howresistance training can be helpful in making a difference in individuals with Parkinson's Disease, preventing worsening of symptoms and maintaining movement.


## Methods

For this literature review, relevant studies were identified through electronic database searches. Keywords including "Parkinson's Disease", "strength training", "muscle strength", and "heavy resistance training" were used to find relative articles from recent years. Studies that were used were those that directly studied the impact of resistance training on individuals with Parkinson's disease and the effects that this exercise program had on PD symptoms.

## Results

- Brienesse et al. assessed the muscle isometric contraction, one of which also measured the maximal voluntary contraction and the rate of force development. Their results were positive and strength training appeared to be a suitable physical activity to improve physical parameters of PD subjects.1
- Colon-Semenza et al. determined that remote peer coaching using mHealth is feasible, safe, and acceptable for individuals with PD. mHealth is defined as a mobile health program used as a remote peer-mentored program for walking. This method is viable in helping increase the physical activity in persons with PD.2
- Helgerud et al. demonstrated that 4 weeks of maximal strength training can effectively improve skeletal muscle force-generating capacity (FGC), efferent neural drive, and functional performance in elderly PD patients.3
- Ramazzina et al. demonstrated that resistance training increased fat free mass, muscle strength, and endurance as well as improved mobility and performance in functional tasks in individuals with PD.4
- Roeder et al. explains that data showed that knee extension, knee flexion and leg press strength were greater in PD patients that participated in resistance training compared to the control groups that did not partake in RT.5

## Barriers

Parkinson's disease is frequently treated using medication and exercise. After researching in further studies, it was examined that more testing with larger control trials to be able to determine just how effective resistance training, specifically, is on PD individuals versus including it with other exercise programs. Small sample sizes were used in many of these studies, which makes it difficult in determining its overall effectiveness.

## Conclusion

The results from each article allowed for PD individuals, caretakers, and medical professions to get a deeper understanding on Parkinson's disease and its effect on the body and muscles of those affected. Each article demonstrated that resistance training is beneficial in showing increases in muscular strength that improves gait training as well as postural fixations that occur in these individuals. Medication alone is helpful in improving neurological symptoms, however pairing medication with resistance exercise allows for overall improvements in both physical symptoms and cognitive.

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Student Researcher: Christa Phillips
Faculty Mentor: Jeanna Tran, Ph.D.

# How Sensory Processing Challenges Affect Oral Health in Individuals With Autism Spectrum Disorder

Defiance College
Exercise Science Program

## Background

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by developmental delays and sensory processing. differences, which manifest in a broad range of behaviors.

• Sensory differences often become pronounced in healthcare settings.

•There are 60 distinct barriers identified by autistic individuals within healthcare environments, with sensory discomfort being a primary concern (Raymaker et al., 2017).

•Participants reported that noise sensitivity was especially challenging, with sounds often perceived as physically overwhelming (Landon et al., 2016).

•It is known there are barriers in healthcare but there is a lack of knowledge of specific healthcare barriers faced by individuals with autism (Raymaker et al., 2017).

## Purpose

The purpose of this research is to explore the impact of sensory processing challenges in individuals with Autism Spectrum Disorder (ASD) on their oral health behaviors and outcomes. By investigating the relationship between sensory sensitivities and dental care routines, this study aims to identify specific barriers that individuals with ASD face in maintaining oral health. Additionally, it seeks to understand how these challenges contribute to oral health outcomes, such as the prevalence of dental issues and overall oral hygiene practices.

## Methods

For this literature review, relevant studies were identified through electronic database searches. Keywords including "Autism Spectrum Disorder", "sensory processing", "oral health", and "dentistry" were used to find relative articles from recent years. Studies that were used were original research that directly studied the impact of oral health for individuals who were diagnosed with ASD and the effects of sensory processing had during dental visits.

## Results

A study by Fallea and colleagues investigates the relationship between oral health, quality of life, and behavioral characteristics in individuals with Autism Spectrum Disorder (ASD).
•Measured with Oral Health Assessment Tool (OHAT) and EuroQol 5-Dimensions Youth version (EQ-5D-Y).
•Those who reported higher quality of life scores also reported better oral health.

The research article by Cheen Y. Loo, Richard M. Graham, and Christopher V. Hughes explores the dental health challenges and behaviors observed in individuals with ASD and their experience with dental caries (tooth decay).
•55.2% of individuals with ASD were uncooperative during dental treatment.
•37.2% required general anesthesia for dental procedures, compared to the non-ASD group.

A study by Stein and colleagues investigated the oral care experiences and challenges faced by children with ASD compared to their typically developing peers by surveying parents.
•Sensory discomfort and uncooperative behaviors increased while at the dentist for individuals with ASD compared to typically developing peers.
•50% of parents in the ASD group claimed that their child's behaviors at the dentist impacted the dental environment.

A study by Cermak and colleagues investigated the effectiveness of a sensory-adapted dental environment (SADE) in reducing distress, sensory discomfort, and pain perception during dental cleanings for children with ASD.
•Both ASD and typical children showed decreased physiological anxiety, lower pain intensity, and less sensory discomfort during the SADE condition compared to the RDE.
•64% of individuals in the ASD group had positive behaviors in the SADE compared to the RDE.
•59% of individuals in the ASD group were more cooperative and relaxed in the SADE compared to the RDE.

This "butterfly wrap" was used for the ASD patients in the treatment group in the sensory-adapted dental environment. Deep pressure was provided when the wings were wrapped around the patient, giving a hugging

Cermak, S. A., Stein Duker, L. I., Dawson, M. E., Lane, C. J., Williams, M. E., & Polido, J. C. (2015).

## Barriers

There is a need for more research that systematically links specific sensory processing challenges (e.g., tactile sensitivity, oral defensiveness) to oral health behaviors, like brushing frequency, the ability to tolerate dental visits, or the types of foods individuals can eat comfortably. Also, more research is needed to investigate effective, individualized strategies for improving oral health care in people with ASD, such as adaptations in toothbrush design, toothpaste options, sensory-friendly dental office settings, or training caregivers and professionals in sensory-sensitive techniques.

## Conclusion

All four studies acknowledge the increased challenges that individuals with ASD face during dental treatments.

- Stein and colleagues, specifically highlight increased sensory discomfort and uncooperative behavior in dental settings.
- Loo and colleagues note that a higher percentage of ASD patients require general anesthesia due to behavioral difficulties.
- Cermak and colleagues find that a sensory-adapted environment improves cooperation and reduces distress.
- Fallea and colleagues found that better oral health was correlated with higher quality of life.

The research intends to inform healthcare providers, caregivers, and educators on tailored approaches to improve oral healthcare strategies for individuals with ASD, fostering better health outcomes and quality of life.

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# Body Dysmorphic Disorder

## DEFIANCE COLLEGE EXERCISE SCIENCE PROGRAM

Student Researcher: Nevaeh Schiffhauer Faculty Mentor: Jeanna Tran, Ph.D.

## BACKGROUND

- Body Dysmorphia, also known as Body Dysmorphic Disorder (BDD), is a mental health condition primarily focused on obsessive-compulsions directed towards physical appearance or perceived flaws.
- BDD is commonly known to have significant impacts on various aspects concerned with mental health, emotional distress and impaired functioning.
- Body Dysmorphic Disorder currently affects 1.7%-2.9% of the general population, meaning nearly 5-10 million people in the United States suffer from BDD.

## PURPOSE

The Purpose of this literature review is to examine existing research on body dysmorphia (BDD) in students, comparing the impacts of BDD between college students, comparing the impacts of BDD between college athletes and non-athletes. This review aims to highlight the unique factors influencing body image concerns in these two groups and identify common outcomes.

## METHODS

A comprehensive literature search was conducted to identify peer-reviewed articles related to BDD. The search included articles published between **2010 and 2024** to ensure contemporary relevance. Keywords used included: *"body dysmorphic disorder," "body dysmorphia," "body image disturbance," "BDD," "appearance-related anxiety,"* and *"psychological impact of body image."*.

## RESULTS

- Findings from three studies highlight notable gender and activity-based differences in body image and eating behaviors among college students.
- One study found 26% of undergraduate students and muscle dysmorphia was present in approximately 7%, while, another study found the prevalence of disordered eating was higher in non-athletes versus athletes (16.5%, vs. 6.6%).
- Muscle dysmorphia was more present in males with this group showing a stronger preference for a more muscular physique and reporting higher self-perceived ideal body weights than females.
- Females were found to be more than twice as likely to experience disordered eating and 5 times greater risk for body shape dissatisfaction, with college freshmen and non-athletes particularly at greater risk.

eat26 EATING ATTITUDES TEST

## GAPS

Although current research suggests that female athletes may experience some protection against disordered eating compared to non-athletes, the underlying mechanisms remain unclear. Additionally, there is a lack of comprehensive studies exploring contributing factors such as self-esteem and body satisfaction across a diverse range of sports. The persistent elevated risk among females highlights the continued need for expanded, inclusive research to better inform college health services and intervention efforts.

## CONCLUSION

Regular exercisers showed a higher risk for both disordered eating and muscle dysmorphia, indicating a potential vulnerability among this group. Among female college students, body dissatisfaction remained a persistent concern, particularly for those not engaged in collegiate athletics. Female athletes demonstrated lower rates of disordered eating and better emotion regulation compared to non-athletes, suggesting that participation in sports may offer protective benefits against disordered eating and emotional dysregulation. These findings suggest a need for targeted prevention and intervention strategies addressing disordered eating and muscle dysmorphia, particularly among female non-athletes and regular exercisers, while also highlighting the potential protective role of athletic participation in promoting healthier body image and emotional regulation.

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# Blood Flow Restriction Training for Athletes: Benefits, Risks, and Applications

Cooper Sloan

Faculty Mentor:
Jeanna Tran, Ph.D.

Defiance College
Exercise Science Program

## Introduction

Blood Flow Restriction (BFR) Training is a growing technique in physical therapy and rehabilitation used to enhance muscle strength and growth, especially during recovery (Pignanelliet al., 2021)..

It involves applying a cuff to partially restrict blood flow to a limb, creating a low-oxygen (hypoxic) environment that amplifies the body's response to low-intensity exercise (Pignanelliet al., 2021).

Research has shown that BFR can lead to significant gains in muscle size, strength, and endurance, even at reduced training loads (Pignanelli et al., 2021).

This makes BFR especially useful for individuals recovering from injury, surgery, or those with chronic conditions who cannot tolerate high-intensity training.

By enabling earlier and safer participation in strength training, BFR can speed up recovery, reduce muscle atrophy, and improve rehabilitation outcomes. Additionally, it may encourage active involvement in the recovery process, which may enhance motivation and overall well-being.

## Purpose

The purpose of this research is to evaluate the effectiveness of Blood Flow Restriction (BFR) training as a tool in the rehabilitation of injured athletes and explore whether BFR offers a safe and efficient alternative to traditional high-intensity training during periods when athletes are unable to fully load injured limbs.

## Methods

A literature search was conducted using online databases, focusing on studies published within the last 10 years. Keywords such as "BFR," "Athletes," "Recovery," and "Risks" were used to identify relevant articles. Studies were selected based on criteria that included direct relevance to Blood Flow Restriction and its effects on athletes during the recovery process.

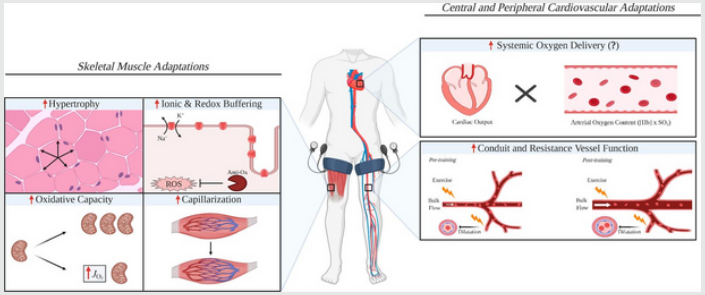


Figure 1: BFR skeletal muscle and central/peripheral cardiovascular adaptations.

## Results

**BFR Compared to High Load Resistance Training**

**Early et al. 2020:** BFR training produced similar improvements in muscle strength and vascular function as high-load resistance training, despite using lower exercise intensity. Additionally, participants in the BFR group reported reduced muscle soreness by the end of the eight-week program, indicating BFR may be a well-tolerated and effective training alternative.

**Luebberset al. 2015:** Found football players who followed high-intensity training with low-intensity BFR experienced significantly greater gains in 1RM squat performance compared to other groups, suggesting a synergistic benefit for lower-body strength. However, no additional improvements were observed in upper-body strength (bench press) or muscle size (arm, thigh, or chest girth) beyond those achieved through high-intensity training alone.

**Bowman et al., 2019:** Low-load BFR training resulted in approximately twice the strength and muscle size improvements compared to controls, including an 11% increase in knee extension torque (vs. 3%), 15% in total work (vs. 6%), and 12% in average power (vs. 4%). Thigh and leg circumferences increased significantly more in the BFR group (3.5% and 2.8%, respectively) than in controls (0.8% and 0.4%), with additional strength gains observed in the non-restricted limb (8% vs. 3%), suggesting a crossover effect. No adverse events were reported.

**BFR and Safety**

**Jacobs et al., 2023:** Compared autoregulated (AUTO) and non-autoregulated (NAUTO) BFR and found the AUTO BFR approach resulted in significantly lower delayed onset muscle soreness (DOMS), perceived effort, and discomfort, while also reducing adverse events—particularly in fixed-repetition protocols where NAUTO had a sevenfold higher incidence. Importantly, both AUTO and NAUTO protocols showed no significant differences in cardiovascular responses, indicating that AUTO BFR enhances safety and comfort without compromising performance.

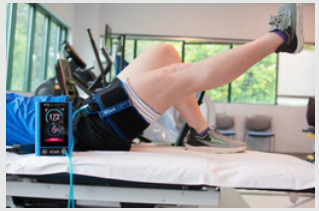

Figure 2: BFR exercise targeting the upper quadriceps.

## Barriers to the Literature

While current studies demonstrate the effectiveness of BFR in enhancing athletic performance and recovery, several barriers still need to be addressed:

- Need for more research focused on sport-specific, injury-specific, and body-type-specific applications of BFR to tailor protocols for different populations.
- More studies are needed to explore the long-term safety and potential risks associated with BFR, including adverse events and the optimal intensity of use.
- The variability in BFR protocols across studies also complicates standardization, making it difficult to apply findings universally.

## Conclusion

Blood Flow Restriction (BFR) training has emerged as a safe and effective alternative or complement to high-load resistance training for athletes. Evidence shows that BFR can significantly enhance lower-body strength, muscle size, and power—achieving results comparable to traditional methods while reducing training loads and muscle soreness. When properly monitored, especially using autoregulated protocols, BFR minimizes discomfort and adverse events, making it a well-tolerated strategy to optimize performance and recovery in athletic populations.

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# Northwest Ohio Agriculture: Using the microBIOMETER as an Indicator of Soil Health

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## Background

Soil health is important for sustainable farming and good crop growth. Healthy soil holds nutrients, retains water, and strengthens roots, leading to better harvests (Srivastava et al.). Biological testing helps farmers provide insights into the soil's ability to cycle nutrients and supply them to growing crops. Soil health is especially important in Northwest Ohio because it is a part of the Maumee Basin, a watershed that feeds into Lake Erie and other drinking sources for those living in Northwest Ohio.

Research by Ohio State University (OSU) has focused on several soil health test metrics, namely CO2 respiration, POXC, and soil protein. Other methods of interest include ones developed by the USDA-ARS; the Soil Test Biological Activity (SBTA) and the Haney test. However, these methods must often be outsourced to private laboratories, vary in expense, and can be time-consuming waiting for test results.

The Conservation Action Project (CAP) through Alan Sundermeier's research examined the MicroBIOMETER as an alternative to help producers better understand soil health conditions on their fields. The MicroBiometer is a portable test kit with a mobile app that analyzes fungal and bacterial populations in soil. Results are delivered in approximately twenty minutes. The 2024 CAP data from MicroBIOMETER tests showed results changed through the seasons. This project investigates whether spring soil samples can be manipulated into giving summer Microbial Biomass Carbon readings using the MicroBIOMETER. This project investigates three aspects of using the MicroBIOMETER as an indicator of soil health: 1) in-field variability of readings; 2) the effect of seasonality on microbial activity; and 3) potential changes in results that may occur under controlled lab conditions.

## Methods

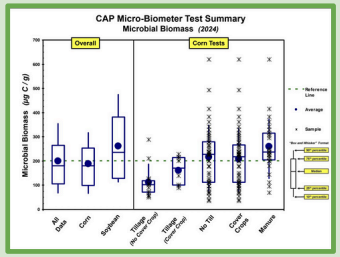
Methods development for this project consisted of two aspects. First, to examine 2024 CAP data and identify key patterns related to agriculture in Northwest Ohio (Figures 1-2). While management practices and crop season are related to MicroBIOMETER readings, this evaluation also revealed a high degree of variability between fields. The second part of this project developed a methodology to further investigate this variability using two City-owned agricultural fields. Six soil samples were analyzed for microbial activity using the MicroBIOMETER test kit. We recognize the microbial activity increases with temperature. Franzluebber's 3-day flush was developed around aiming to "wake-up" the microbial activity through heat (Franzluebbers & Pershing). Samples were heated in an incubator at 48-50°C for at least 3 days and re-tested using the microBIOMETER test kit.

## Sample Sites

**WPC: Silty Clay**

**Reservoir: Paulding Clay**

## Results



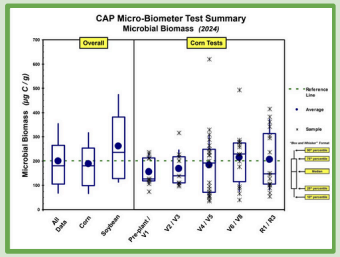




**Figure 1.** (Left) Uses pattern analysis to highlight the relationship between management practices and microbial biomass. 2024 CAP data showed microbial activity changing through seasons. The microbial activity increased through the growing season.

**Figure 2.** (Right) Illustrates the effect of crop growing season.

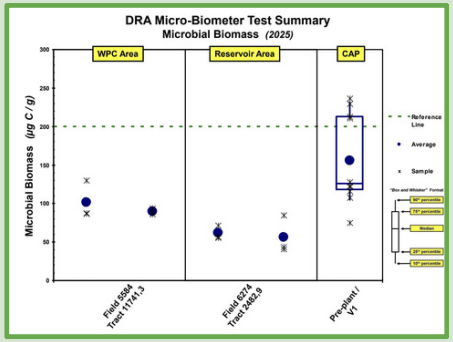



**Figure 3.** WPC site shows in-field variability and a higher average in microbial biomass pre- and post-incubation than the Reservoir. The Reservoir sites also show in-field variability and a slightly lower average microbial biomass reading post-incubation. CAP data represents seasonality.

## Discussion

This project started with nothing more than a large spreadsheet of raw data from CAP. Part of this research included distilling this data down into a form for pattern analysis. This pattern analysis was behind the critical thinking that went into the field aspect of this research.

We were interested in determining if incubating the soil could increase the Biomass readings to mimic late-season soil samples. After one round of sampling and tests, the results show similar or decreased readings in microbial biomass, with the exception of one sample from the Reservoir field.

More microbes mean more natural nutrients, reducing the need for fertilizers. Fungi improve soil structure and prevent erosion. A drop in microbes after fertilizing means you used too much. A higher F:B ratio shows AMF presence, boosting drought and pest resistance. Increased F:B ratio signals effective green manure. Soil carbon comes from dead microbes—no microbes, no soil health. Fast microbial growth shows cover crops and amendments are working. (***Understanding Your Results***, n.d.) Higher levels of microbial activity are seen in fields which are managed with no till and cover crops over those which are tilled with no cover crops.

Additional testing will take place and help to complete the data set in order to draw more concrete conclusions and paint a better picture of the results. The goal of this project is to continue regular testing throughout the growing season. The dataset resulting from a full growing season of tests should paint a more complete picture of seasonality in microbial activity. Long-term testing could also demonstrate year-to-year variability in microbial activity.

**Acknowledgments**

City of Defiance, Conservation Action Project, Defiance College, Defiance Research Alliance, Alan Sundermeier, K. Smith, S. Singer and K. Theisen

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# Establishing A Long-Term Assessment Study on Water Quality Across Watersheds in the Lake Erie Basin

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## INTRODUCTION

The Maumee River begins in Fort Wayne, Indiana and flows through a number of large cities, including Defiance, Ohio, before draining into Lake Erie (Ohio EPA, 2014). The Maumee River watershed covers more than 6,500 mi2 and two of its largest tributaries, the Tiffin and Auglaize Rivers enter the Maumee River in Defiance, Ohio (Ohio EPA, 2014). As such, the Maumee River serves as the main source of drinking water for the city of Defiance and is heavily impacted by human activities (Ohio Lake Erie Commission, 2015). Since water quality can impact human health as well as aquatic ecosystems, it is crucial to track changes in water quality over an extended period of time (Bridgeman et al., 2012). The purpose of this study is to establish a long-term assessment program of the water quality in the rivers around Defiance, Ohio using chemical analysis, streamflow, and bioassessment of golden-brown algae and macroinvertebrates.

## SITE SELECTION

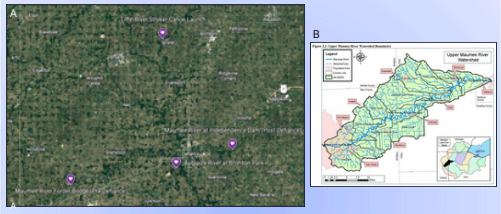



**Figure 1. (A)** Satellite image of study site with sampling locations indicated by purple hearts. **(B)** Map showing the boundaries of the Upper Maumee River watershed. **(C)** Image of sampling site #1, the Tiffin River, a tributary of the Maumee, located in Stryker. **(D)** Image of sampling site #2, located on the Maumee River near Antwerp, before the confluence of the Tiffin and pre-Defiance. **(E)** Image of sampling site #3, tributary on the Auglaize River near Defiance. **(F)** Image of sampling site #4, along the Maumee River past the confluence of the Maumee and Auglaize Rivers, and downstream of the Independence Dam.

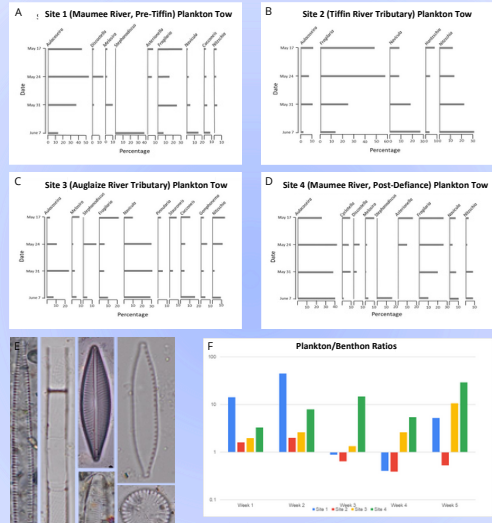
## METHODS

Four locations were sampled over five consecutive weeks from May-June, of 2021, 2022, and 2023 (Figure 1). Field tests were used to assess dissolved oxygen, electrical conductivity, salinity, turbidity, and the temperature of the at each sampling site. Samples were collected and returned to the lab where chemical tests were used to assess nitrates and nitrites, phosphates, pH, ammonia, and alkalinity levels in the water from each site (Figure 2). Diatom samples were collected from the water column using plankton tows and benthic grab samples. These were returned to the lab and processed in 35% hydrogen peroxide to remove organic matter, rinsed thrice, and permanently mounted to slides. Diatom frustules were identified to genus level and enumerated under the microscope (Figure 3). Macroinvertebrates were collected using a kick-net and then returned to the lab for processing. Macroinvertebrate samples were enumerated under the microscope (Figure 3).

Figure 2. Chemical Analysis Field and Laboratory Work

## DIATOM BIOASSESSMENT

**Methodology:** Diatom samples were collected from the water column using plankton tows and benthic grab samples. These were returned to the lab and processed in 35% hydrogen peroxide to remove organic matter, rinsed thrice, and permanently mounted to slides. Diatom frustules were identified to the genus level and enumerated under a light microscope.



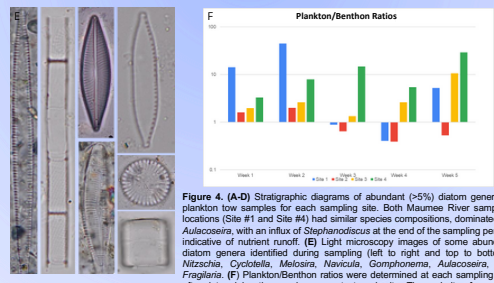
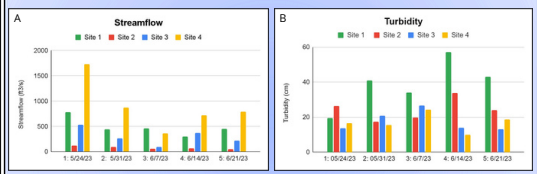




**Figure 4. (A-D)** Stratigraphic diagrams of abundant (>5%) diatom genera in plankton tow samples for each sampling site. Both Maumee River sampling locations (Site #1 and Site #4) had similar species compositions, dominated by *Aulacoseira*, with an influx of *Stephanodiscus* at the end of the sampling period, indicative of nutrient runoff. **(E)** Light microscopy images of some abundant diatom genera identified during sampling (left to right and top to bottom): *Nitzschia*, *Cyclotella*, *Melosira*, *Navicula*, *Gomphonema*, *Aulacoseira*, and *Fragilaria*. **(F)** Plankton/Benthon ratios were determined at each sampling site after determining the species present at each site. The majority of samples have plankton: benthon ratios greater than one, indicating that they are dominated by plankton.

## STREAMFLOW, TURBIDITY, AND DISSOLVED OXYGEN

**Methodology**: The streamflow of water was measured using the USGS website. Using the USGS website, we were able to correlate the streamflow of each site to the time we were there. A transparency tube was used to measure the turbidity of the water at each sampling site over the course of the five-week sampling period. Turbidity was impacted heavily by the amount of rainfall we received the night before sampling. Water samples were also collected at each sampling site for a dissolved oxygen analysis. Water samples were fixed in the field, and then returned to the laboratory for chemical analysis.



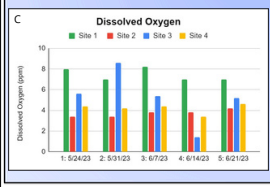




Figure 5. (A) Streamflow was assessed at each sampling site over the course of five weeks from May-June 2023. The streamflow at each site was consistent throughout the five week collection period. Site #4 had the highest average streamflow while Site #2 had the lowest average streamflow. (B) The turbidity was measured at each sampling site over the course of five weeks. The turbidity of water remained relatively consistent over the five- week period. Site #1 (Maumee River prior to the confluence of the Tiffin and pre-Defiance) consistently had the least turbid water. (C) Dissolved oxygen was assessed for each collection site over the course of the five-week sampling period. Site #1 had the highest average dissolved oxygen levels throughout the collection period. Site #3 showed a bit of fluctuation over the five weeks, while all other collection sites remained fairly consistent.

## ACKNOWLEDGMENTS

- Defiance College Summer Undergraduate Research Program and the faculty and staff that run the program
- Title III Strengthening Institutions Program Grant for providing project funding for the past four summers
- Photo credit: Dr. Sabrina Brown and Dr. Mollie Sorrell
- Special thanks to all members of the 2021, 2022, 2023, and 2024 MATI STEM Research Teams for their hard work during the six weeks of the summer undergraduate research program

## CHEMICAL ANALYSES

**Methodology:** Water samples were collected at each sampling site and labeled by site number and date. Samples were returned to the laboratory and stored in a refrigerator until chemical analyses for ammonia, nitrates, nitrites, pH, alkalinity, and phosphate were performed the following day.

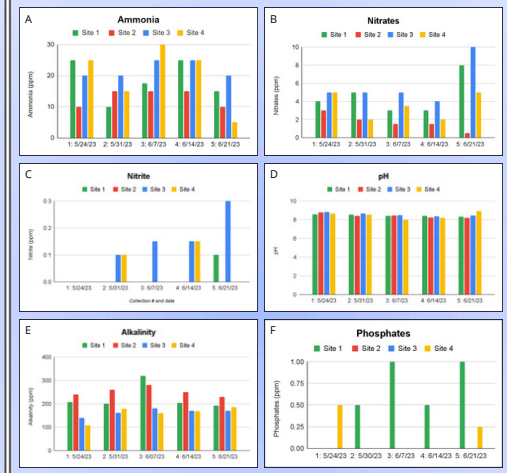



**Figure 6.** Water samples were collected at each sampling site over the course of five weeks from May-June 2023. Samples were returned to the laboratory for chemical analysis. **(A)** A histogram representing the recorded ammonia levels at each collection site over the course of five weeks. Site #3 showed the highest average ammonia levels over the course of the five weeks and Site #2 showed the lowest average ammonia levels. **(B)** A histogram representing the recorded nitrate levels at each collection site over the course of five weeks. The data suggests that Site #3 consistently had the highest nitrate levels, and Site #2 consistently had the lowest levels. These levels fluctuated throughout the study at several sites. **(C)** A histogram representing the recorded nitrite levels at each collection site over the five-week sampling period. Levels were undetectable at Site #2 for the entire sampling period and were only detectable at Site #1 during one of the collections. While nitrites were detected at Site #3 and #4 , levels were consistently low. **(D)** A histogram representing the recorded pH of water samples collected at each site over the course of five weeks. pH was consistent across all sites over the entire sampling period with minimal fluctuation. **(E)** A histogram representing the recorded alkalinity of samples collected at each sampling site throughout the five-week study. Site #1 and #2 had the highest average levels over the five week sampling period. Alkalinity levels remained fairly consistent at each collection site throughout the five-week study. **(F)** A histogram representing the recorded phosphates at each collection site over the course of five weeks. Phosphate levels were undetectable at Site #2 and #3 throughout the entire study. Site #1 had the highest average levels of phosphate over the five-week sampling period.

## SUMMARY AND FUTURE DIRECTIONS

- On average, the Maumee River prior to the confluence of the Tiffin and pre-Defiance (Site #1), had the least turbid water with the highest levels of dissolved oxygen over the course of the sampling period.
- The Auglaize River (Site #3) had relatively turbid water with the lowest average levels of dissolved oxygen. Plankton tows taken at the Auglaize River over the same sampling period had a high percentage of benthic species present, also indicating relatively turbid conditions.
- The Auglaize River (Site #3) also had the highest average levels of nitrates, nitrites, and ammonia, and exhibited a lower average streamflow than both Maumee River sampling sites.
- Both Maumee River sampling locations had similar species compositions, dominated by *Aulacoseira*, with an influx of *Stephanodiscus* indicative of nutrient runoff at the end of the sampling period.
- The Tiffin River (Site #2) exhibited the highest diversity in diatoms over the course of all three sampling periods.
- Diatom species indicative of high nutrient availability. Diatom assemblages were dominated by *Fragilaria*, *Aulacoseira*, and *Navicula*.
- Our ongoing study focused on establishing a long-term assessment program of the water quality in the rivers around Defiance, Ohio using four major assessment tools: chemical analysis, streamflow, and the bioassessment of macroinvertebrates and diatoms. Our undergraduate research program's fifth summer sampling period will begin in May 2025.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# Blood Serotonin Levels in Mice Exposed to Disruption of Social Hierarchy

DEFIANCE COLLEGE
To Know ◆ To Lead ◆ To Serve ◆ To Understand

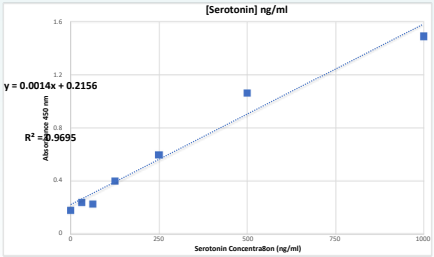
Rachel Varga
Advisor: Dr. Nathan Griggs

## Abstract

Serotonin, a key neurotransmitter in the central nervous system (CNS), plays a vital role in regulating mood, behavior, and stress responses. Chronic psychosocial stress has been shown to reduce serotonin levels, which can have significant implications for mental health; a chronic psychosocial stress model in mice was used to investigate these effects. The results revealed a significant decrease in serotonin levels in those mice exhibiting psychic social stress, highlighting the physiological consequences of chronic psychosocial stress, while providing a valuable tool for studying the neurochemical regulation of stress responses.

## Introduction

Serotonin is a crucial neurotransmitter in the central nervous system (CNS), playing a central role in mood regulation, behavior, and the body's response to stress. Chronic psychosocial stress has been shown to significantly reduce serotonin levels, potentially contributing to mental health disorders such as depression and anxiety. To investigate this relationship, a chronic psychosocial stress model was developed using male mice. Initially, mice were housed in groups of three for one week to allow the formation of stable social hierarchies. Following this period, mice in the experimental group were subjected to randomized cage switching every two days over a four-week period, continuously disrupting their social structures and inducing stress. In contrast, the control group remained in stable housing without cage changes. Serotonin levels were measured using a blood-based ELISA assay, with absorbance values at 450 nm converted into serotonin concentrations through a standard curve generated from known serotonin standards. This experimental design provided a reliable framework for studying how prolonged social instability influences serotonin regulation and stress physiology.

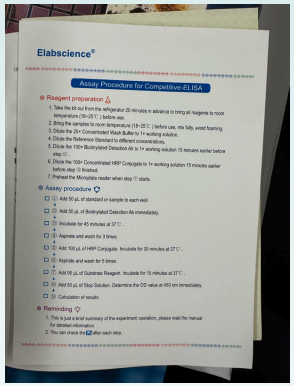


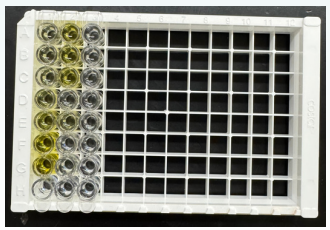

## Methodology

- **Animal Model:** Male mice were housed in groups of three for one week to allow a stable social hierarchy to form.
- **Experimental Design:**
  - **Control Group:** Mice maintained in stable housing with no cage changes.
  - **Experimental Group:** Mice underwent psychosocial stress induced by randomized cage switching every two days for four weeks, disrupting established social hierarchies.
- **Serotonin Measurement:**
  - Blood samples were collected and analyzed using a serotonin ELISA assay.
  - A standard curve was created using known serotonin concentrations.

Sample absorbance values were measured at 450 nm and converted to serotonin concentrations using the equation:
Concentration (ng/mL)= Absorbance−0.2156/0.0014

Procedure for ELISA



## Results

**Control Group (Stable Social Hierarchy)**

| Well | Absorbance | Serotonin (ng/mL) |
|---|---|---|
| CON 1 | 0.042 | 0 |
| CON 2 | 0.606 | 278.86 |
| CON 3 | 0.614 | 285.29 |
| CON 4 | 0.673 | 326.71 |

→ **Average: 222.71 ng/mL**

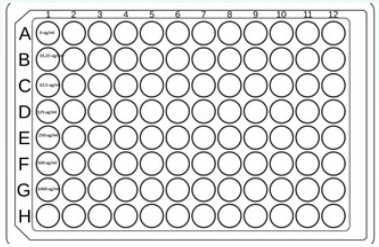
**Experimental Group (Disrupted Social Hierarchy)**

| Well | Absorbance | Serotonin (ng/mL) |
|---|---|---|
| EXP 1 | 0.113 | 0 |
| EXP 2 | 0.270 | 38.86 |
| EXP 3 | 0.065 | 0 |
| EXP 4 | 0.103 | 0 |
| EXP 5 | 0.046 | 0 |
| EXP 6 | 0.115 | 0 |
| EXP 7 | 0.078 | 0 |
| EXP 8 | 0.109 | 0 |

→ **Average 4.85 ng/mL**
→ **Majority of values were below detectable range ,** indicating a severe drop in serotonin levels.

**Absorbance Values**

| | 1 | 2 | 3 |
|---|---|---|---|
| A | 0.180 | 0.606 | 0.115 |
| B | 0.239 | 0.614 | 0.078 |
| C | 0.224 | 0.673 | 0.109 |
| D | 0.401 | 0.113 | 0.106 |
| E | 0.599 | 0.270 | 0.098 |
| F | 1.066 | 0.056 | 0.067 |
| G | 1.492 | 0.103 | 0.056 |
| H | 0.042 | 0.046 | 0.056 |




## Interpretation of results

Based on the data tables, mice in the control group, which experienced stable social conditions, maintained normal serotonin levels, indicating a healthy and balanced neurochemical state. In contrast, mice in the experimental group, exposed to repeated social disruptions through cage switching, showed a marked decline in serotonin concentrations. This substantial decrease suggests that chronic psychosocial stress significantly impairs serotonin regulation. These results highlight how ongoing social instability can produce measurable physiological effects, reinforcing the value of this model for studying the neurochemical basis of stress-related disorders such as depression and anxiety.

## Conclusion

The results of this study demonstrate a clear and significant impact of chronic psychosocial stress on serotonin levels in mice. As illustrated in the bar graph, mice in the control group maintained high serotonin concentrations, averaging approximately 298 ng/mL, while those in the experimental group, exposed to repeated disruption of social hierarchy, showed drastically reduced levels—averaging around –74 ng/mL, falling below detectable limits. This noticeable difference highlights the physical impact of long-term social stress, especially in how it interferes with serotonin regulation.

These findings strongly support the hypothesis that ongoing social instability is an effective model for inducing chronic stress and replicating its neurochemical effects. The data offer valuable insight into serotonin's role in stress response and provide a solid foundation for future research exploring the mechanisms and treatment of stress-related mood disorders such as anxiety and depression.

## Acknowledgments

I would like to thank Defiance College for giving me the opportunity to dive into this research as I wrap up my undergrad. I would also like to thank Dr. Griggs for his continuous support, guidance and invaluable expertise throughout this project

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# The Impact of MSEs on Children with ASD

Student Researcher: McKenna Walker

Faculty Mentor: Jeanna Tran, Ph.D.

Defiance College
Exercise Science Program

## Introduction

- Autism Spectrum Disorder (ASD) is a neurodevelopmental condition marked by (De Domencio et al., 2024):
  - Social communication challenges
  - Repetitive behaviors or routines
  - Developmental differences
- ASD is typically diagnosed in early childhood and is more common in males. Children with ASD often rely on family or trained professionals to support their sensory and social needs.
- Many experience sensory processing difficulties and may engage in sensory-seeking behaviors—prolonged observation or repetitive touching of objects (Savarese et al., 2025). Recent research has begun to explore the impact of Multi-Sensory Environment (MSE), or sensory room, use in therapy and intervention programs for children with ASD to help improve focus and concentration (Unwin, 2022).
- **MSEs** are designed to support (Savarese et al., 2025):
  - Sensory regulation
  - Development of motor skills

## Purpose

- **Purpose of the review:** Examine the effectiveness of Multi-Sensory Environments (MSEs) for individuals with Autism Spectrum Disorder (ASD).
- **Self-controlled vs. uncontrollable environments:** Focus on how self-controlled sensory environments are more beneficial than uncontrollable ones.
- **Motor skill improvement:** Explore why MSEs contribute to improved motor skills in individuals with ASD.

## Methods

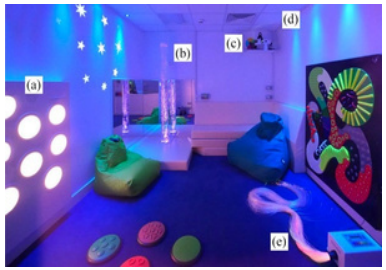
For this literature review, relevant studies were identified through electronic database searches. Keywords including "Autism Spectrum Disorder", "Multi-sensory Environments", and "sensory motor intervention" were used to find relevant articles from recent years. Studies that were used were original research that directly studied the impact of multi-sensory environments within children who were diagnosed with ASD, and the effects that the sensory motor interventions had on cognitive and developmental aspects.

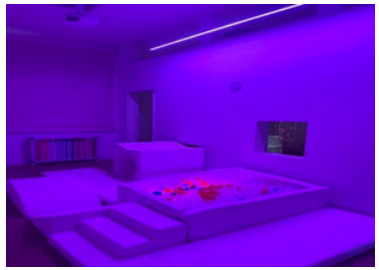
## Results

De Domencio et al. (2024) studied the impact of self-controlled MSEs on developmental skills in children with ASD. Researchers found significant improvements in sensory behaviors, such as taste, smell, tactile responses, verbal and nonverbal communication, and gross motor skills. The results indicated that allowing children to control the MSE likely contributed to these improvements, but no significant changes were observed in the severity of autism symptoms.

Savarese et al. (2025) investigated the impact of sensory rooms on motor development in children with ASD. In the post-tests, 30% of mild diagnosis participants showed increased sensitivity to hypo-sensory stimuli, and 35% to hyper-sensory stimuli. Greater severity diagnosis participant group showed 20% sensitivity to hypo-sensory and 25% to hyper-sensory stimuli, while intermediate diagnosis group reported 50% sensitivity to hypo-sensory and 40% to hyper-sensory stimuli. The 3-month training experimental group showed improvements in motor skills compared to the control group, which had higher sensitivity levels.

Unwin et al. (2022) conducted a study to examine how controlled versus uncontrolled MSEs influence social behavior, anxiety, arousal, and positive affect in children with ASD. The results showed a significant reduction in sensory behaviors in an active-change condition, with the children experiencing fewer and shorter sensory episodes. Children also showed increased attention in the active-change condition compared to the passive-change condition. However, the study found limited changes in anxiety, positive affect, and arousal.



**Multi-Sensory Environment Setup:** designed to engage multiple senses simultaneously. Key elements of the environment:

- **Touch, Sound, and Light Board:** An interactive surface that combines tactile, auditory, and visual stimuli.
- **Bubble Tube: :** A calming feature that provides visual stimulation through flowing bubbles.
- **Pin Spot for Mirror Ball:** Highlights the reflective patterns from an adjacent mirror ball (not pictured).
- **Colored LED Room Lights:** Adjustable lights that create a dynamic and relaxing atmosphere.
- **Fibre Optics:** Lights that provide a soft and soothing visual effect. (Unwin et al., 2022)

## Barriers to the Literature

- **Short-term focus in current research:** Most studies on MSEs for this population focus on short-term outcomes, which may not capture long-term effects.
- **Need for longitudinal studies:** Future research should collect data over extended periods to better understand long-term trends and impacts of MSEs.
- **Influence on atypical behaviors:** Studies should examine how sensory activities affect atypical behaviors in children with ASD to enhance inclusive environments and support.
- **Gap in sensory intervention knowledge:** There is limited understanding of sensory interventions and challenges with researching MSEs.

## Conclusion

- MSEs offer meaningful support for children with ASD. Research highlights benefits such as:
  - Improved attention span and focus
  - Enhanced social interaction and engagement
  - Better sensory regulation
  - Reduction in atypical behaviors
- Self-directed MSEs, or allowing children to adjust the sensory equipment, lead to more effective outcomes.
- Encouraging hands-on sensory exploration is essential for developmental growth.
- These findings are particularly relevant for healthcare providers, therapists, educators, and caregivers. They can help develop therapeutic interventions, enhance motor skill management, and improve ASD support knowledge.
- As ASD diagnoses continue to rise and vary, MSEs present a promising tool for personalized support and care.

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